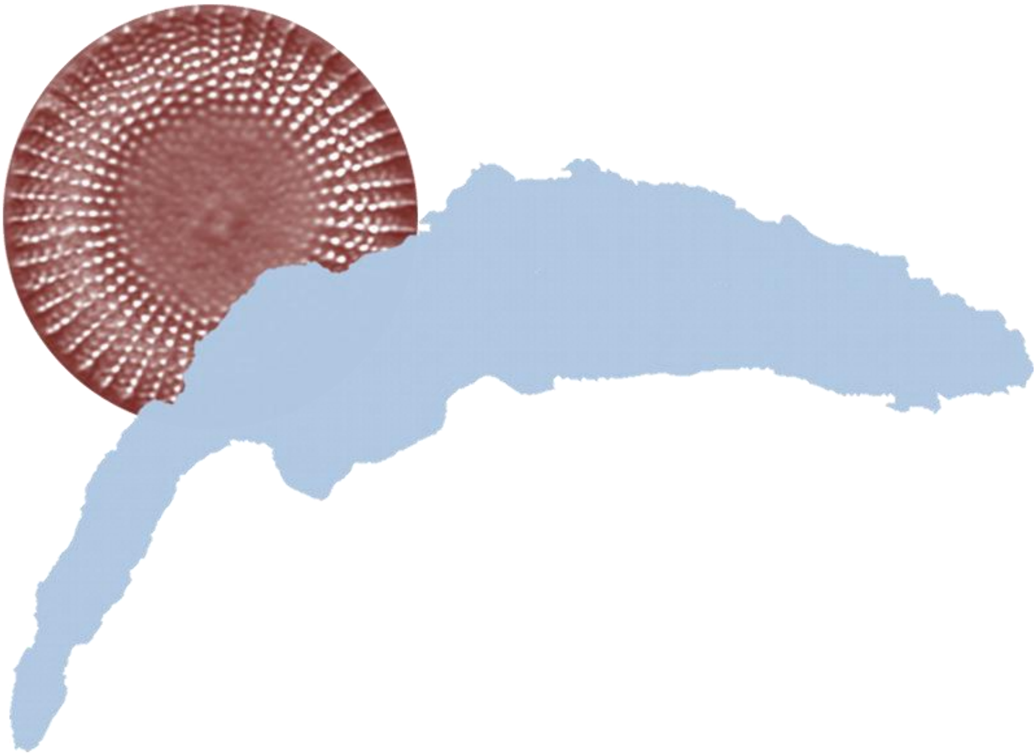

Livre des résumés et programme

Abstract book and program

32ème Colloque de l'Association des Diatomistes de Langue Française

&

7th Central European Diatom Meeting

16-20 sept. 2013

Thonon-les-Bains France

32ème Colloque de l'Association des Diatomistes de Langue Française
&
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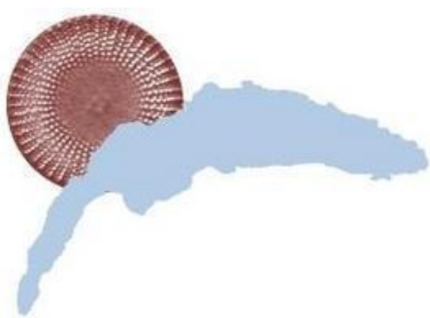

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Book of abstracts and program

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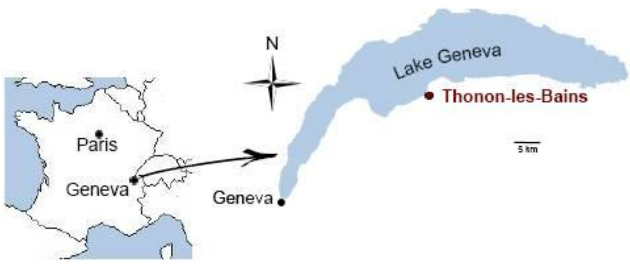

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32ème Colloque de l'Association des Diatomistes de Langue Française
&
7th Central European Diatom Meeting

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Informations générales

General information

<u>Français</u>

L'équipe d'organisation est heureuse de vous recevoir à Thonon-les-Bains pour le 32ème Colloque de l'ADLaF et le 7th CE-Diatom meeting. Plus de 110 participants venant de toute l'Europe, d'Amérique du Nord et du Sud, d'Afrique et d'Asie sont présents. Tous les domaines touchant à la recherche sur les diatomées sont abordés : la taxonomie, l'écologie, la paléoécologie, la phylogénie, la physiologie et la bioindication. Nous vous souhaitons un agréable séjour et une semaine fructueuse.

Les conférences, lunchs, pause café auront lieu à l'Espace des Ursules.

Communication orale :
15 minutes de présentation orale + 5 minutes de questions
Poster :
Adlaf : 5 minutes de présentation orale (PowerPoint ou pdf) et 5 minutes de discussion + présence devant vos affiches pendant les sessions poster
CE-Diatom : 5 minutes de présentation orale devant vos affiches pendant les sessions poster

Visite et dîner de gala :
Une visite et un apéritif sont organisés le mercredi 18/09 en fin d'après-midi au Château de Ripaille. Le dîner de gala aura lieu ensuite à l'Espace Tully. Des bus seront mis à votre disposition pour aller au Château de Ripaille, puis pour aller à l'espace Tully.
Si vous souhaitez vous rendre par vos propres moyens au Château de Ripaille et à l'Espace Tully, avertissez l'accueil.

<u>English</u>

The organizing team is pleased to welcome you in Thonon-les-Bains for the 7th CE-Diatom and the 32nd ADLaF join meetings. More than 110 participants coming from the whole Europe, North and South America, Africa and Asia are present. All themes about diatom research are addressed: taxonomy, ecology, paleoecology, phylogeny, physiology and biomonitoring. We wish you a pleasant stay and a fruitfull week.

Conferences, lunch, coffe breaks will take place in the Espace des Ursules.

Oral presentation:
15 minutes of oral presentation (in English) and 5 minutes discussion.
Poster presentation:
Adlaf: 5 minutes of oral presentation (PowerPoint or pdf) and 5 minutes discussion (in french). Then the authors must be present near their poster during the poster session.
CE-Diatom: 5 minutes presentation in turn to the audience in front of your poster during the poster session

Visit and gala diner:
A visit and a drink will be organised in the Ripaille Castle on Wednesday 18 sept in the end of the afternoon. Then, the gala diner will be in the Espace Tully.
If you prefer going by your own to the Ripaille Castle and to the Espace Tully, please notify it to the registration desk.

Programme

Program

PROGRAMME DU 32ème COLLOQUE DE L'ADLaF

Lundi 16 sept. 2013

13h30 - 14h00	Accueil
14h00 - 14h40	Ouverture du 32ème Colloque de l'ADLaF

Session écotoxicologie, physiologie et écophysiologie
Présidents de scéance : BOUCHEZ Agnès et STRAUB François

14h40 - 15h00 Page 73	Métabolisme carboné et intensité lumineuse chez les diatomées - Une approche transcriptomique HEYDARIZADEH Parisa, MARCHAND Justine, MOREAU Brigitte, MARTIN-JEZEQUEL Véronique, SCHOEFS Benoît
15h00 - 15h20 Page 87	Effets de la température sur la croissance et les teneurs en acides gras polyinsaturés à longue chaîne (oméga-3) chez *Odontella aurita,* une diatomée marine PASQUET Virginie, ULMANN Lionel, MIMOUNI Virginie, GUIHENEUF Freddy, JACQUETTE Boris, MORANT-MANCEAU Annick, TREMBLIN Gérard
15h20 - 15h40 Page 56	Impact de stress multiples sur les communautés de diatomées MORIN Soizic, BOTTIN Marius, BONET Berta, CORCOLL Natàlia, GUASCH Helena, COSTE Michel
15h40 - 16h00 Page 59	Modélisation de la Distribution de Sensibilité des Espèces (SSD) pour évaluer le risque environnemental lié aux pesticides en milieu aquatique BOUCHEZ Agnès, LARRAS Floriane, RIMET Frédéric
16h00 - 16h20	Pause café

Session écologie
Présidentes de scéance : BEAUGER Aude et ALMEIDA Salomé F.P.

16h20 - 16h40 Page 24	Impact d'un assec sur un biofilm de mésocosme : conséquences pour les communautés algales et bactériennes et sur les indices utilisés (IBD/IPS) en routine BARTHÈS Amélie, LEFLAIVE Joséphine, PERES Florence, ROLS Jean-Luc, TEN-HAGE Loïc
16h40 - 17h00 Page 30	Ecologie des mares II - mesure de la qualité des eaux : essai BERTRAND Jean, RENON Jean-Pierre
17h00 - 17h10 Page 21 Poster 1	Utilisation des groupes morpho-fonctionnels du phytoplancton pour le diagnostic écologique des plans d'eau du bassin Loire-Bretagne : focus sur les diatomées BAILLOT Sonia, RIMET Frédéric

17h10 - 17h20 Les diatomées bryophytiques de la région antarctique maritime
Page 42 KOPALOVÁ Kateřina, NEDBALOVA Linda, VAN DE VIJVER Bart
Poster 2

17h20 - 17h40 Présentation d’un outil de valorisation des données hydrobiologiques
Page 39 KARABAGHLI Chafika, BARTHON Stéphane, MANGOT Sylvain, BRUNSON Fabrice

Mardi 17 sept. 2013

8h40 - 9h00 Acceuil

Session paléoécologie
Présidentes de scéance : SERIEYSSOL Karen K. et CHALIÉ Françoise

9h00 - 9h20
Page 70
Etude approfondie de l’espèce *Thalassiosira faurii* (Gasse) Hasle dans le système lacustre Ziway-Shalla (Ethiopie) : implications pour les reconstitutions paléoclimatiques
ROUBEIX Vincent, CHALIÉ Françoise, GASSE Françoise

9h20 - 9h40
Page 45
Les diatomées holocènes des dépôts lacustres de l’Erg Er Raoui (nord-ouest du Sahara algérien) et leur signification paléoécologique
MANSOUR Bouhameur, YAHIAOUI Nassima, MAHBOUBI Mhamed, BELKEBIR Lahcène

9h40 - 10h00
Page 77
Preuve fondée sur les algues siliceuses de l’augmentation du niveau d’eau et du refroidissement à court terme autour de 9.2-ka dans les Carpates du Sud, Roumanie
SOROCZKI-PINTER Éva, MAGYARI Enikő Katalin, BUCZKÓ Krisztina

10h00 - 10h10
Page 84
Poster 3
Etude de l’influence des changements climatiques et environnementaux sur les diatomées du lac de Cadagno (Tessin, Suisse)
TIFFAY Marie-Caroline, STOLL Serge, PEDUZZI Sandro

10h10 - 10h30
Page 33
Apports des diatomées fossiles à l’histoire paléoenvironnementale des lacs d’altitude du massif du Mercantour (France) sur les 10 derniers millénaires : premiers résultats
CARTIER Rosine, SYLVESTRE Florence, GUITER Frédéric, BRISSET Elodie, PAILLÈS Christine, MIRAMONT Cécile

10h30 - 10h40 Pause café

10h40 - 11h10 **Session poster**

Session taxonomie (1)
Présidents de scéance : ROLLAND Anne et ECTOR Luc

11h10 - 11h30 Le genre *Planothidium* dans la région antarctique
Page 93 VAN DE VIJVER Bart, KOPALOVÁ Kateřina, ZIDAROVA Ralitsa, WETZEL Carlos E., ECTOR Luc

11h30 - 11h50 Quelques nouvelles espèces de *Planothidium* et comparaison avec plusieurs matériels types
Page 96 WETZEL Carlos E., VAN DE VIJVER Bart, HOFFMANN Lucien, ECTOR Luc

11h50 - 12h00 Une nouvelle espèce de diatomée fossile du genre *Entomoneis* dans les sédiments de la mer de Marmara
Page 64 PAILLÈS Christine, BLANC-VALLERON Marie-Madeleine, POULIN Michel, CRÉMIÈRE Antoine, BOUDOUMA Omar, PIERRE Catherine
Poster 4

12h00 - 13h30 Lunch

Session taxonomie (2)
Présidente de scéance : PAILLÈS Christine et GUILLARD Didier

13h30 - 13h40 Flore diatomique des bassins versants de l'Agnéby et de la Mé (Côte d'Ivoire)
Page 61 N'GUESSAN Koffi Richard, COSTE Michel, ROSEBERY Juliette, COCQUYT Christine, VAN DE VIJVER Bart, ECTOR Luc, WETZEL Carlos E., ESSETCHI KOUAMELAN Paul
Poster 5

13h40 - 13h50 Atlas des diatomées des cours d'eau de la région Rhône-Alpes (France)
Page 36 BEY Maurice-Yves, CHAVAUX Rémy, ECTOR Luc
Poster 6

13h50 - 14h00 Nouvelles espèces fragilarioides de la Région antarctique maritime
Page 90 VAN DE VIJVER Bart, MORALES Eduardo A., KOPALOVÁ Kateřina, ZIDAROVA Ralitsa
Poster 7

Session bioindication (1)
Présidents de scéance : PAILLÈS Christine et GUILLARD Didier

14h00 - 14h20 AQUAWEB – un outil en ligne pour des études écologiques de rivières portugaises à partir des diatomées et des macroinvertébrés
Page 18 ALMEIDA Salomé F.P., MENDES Tânia, SERRA Sónia, CALAPEZ Ana Raquel, FEIO Maria João

14h20 - 14h40 Utilisation des diatomées pour l'évaluation des lâchers d'eau d'un système d'installations hydroélectriques d'une vallée alpine: le cas de la rivière Varaita (Région du Piémont, Italie du nord-ouest)
Page 27 BATTEGAZZORE Maurizio, GASTALDI Enrico, GIORDANO Lorenzo, MATTONE Ilario, MOLINERI Paola

14h40 - 15h00 L'indice EPI-L pour l'évaluation de la trophie des lacs profonds par les diatomées benthiques
Page 53 MARCHETTO Aldo

15h00 - 15h20	Pause café
15h20 - 16h00	**Assemblée générale de l'ADLaF** ECTOR Luc
16h00 - 18h00	**Session poster**

Mercredi 18 sept. 2013

8h40 - 9h00	Accueil

Session bioindication (2)
Présidents de scéance : CORDONIER Arielle et WETZEL Carlos E.

9h00 - 9h20 Page 67	Mise en place d'un outil en ligne communautaire pour une détermination et un comptage des diatomées efficaces ainsi qu'une communication améliorée sur les microalgues ROLLAND Anne, ROLLAND Antoine
9h20 - 9h40 Page 49	Aperçu sur la structure systématique des diatomées épilithiques et qualité biologique de l'Oued Derdouse (affluent de l'Oued Chélif, Algérie) SIDI YAKOUB-BEZZEGHOUD Bouchra, MANSOUR Bouhameur
9h40 - 10h00 Page 81	Premier programme national suisse d'observations coordonnées des eaux de surface (NAWA) : résultats préliminaires des indications fournies par les diatomées HÜRLIMANN Joachim, STRAUB François, GOEGGEL Werner
10h00 - 10h10	Clôture du colloque de l'ADLaF
10h10 - 10h20	Pause café et visite de l'écomusée

PROGRAMME OF THE 7th CE DIATOM MEETING

Wednesday 18 sept. 2013

10:20 - 11:30	Registration
11:30 - 12:00	Welcome words
12:00 - 13:40	Lunch
13:40 - 14:10 Page 143	**Keynote speaker** Barcoding as a data analysis problem FRANC Alain

Session: Phylogeny and evolution
Chairpersons: ENKE Neela & SABBE Koen

14:10 - 14:30 Page 232	*Nitzschia:* a complex variation pattern has a complex explanation TROBAJO Rosa, MANN David G., ROVIRA Laia, RIMET Frédéric, KERMARREC Lenaïg
14:30 - 14:50 Page 156	Linking diatoms polluo-sensibility to phylogeny: New perspectives for aquatic ecosystems bioassessment KECK François, RIMET Frédéric, BOUCHEZ Agnès
14:50 - 15:10 Page 199	Cryptic diversity in diatom species: case study of a good water quality indicator, *Nitzschia palea* (Kützing) W. Smith RIMET Frédéric, TROBAJO Rosa, MANN David G., KERMARREC Lenaïg, FRANC Alain, DOMAIZON Isabelle, BOUCHEZ Agnès
15:10 - 15:30	Coffee

Session: Taxonomy (1)
Chairpersons: JÜTTNER Ingrid & CANTONATI Marco

15:30 - 15:50 Page 174	Unconventional diatom collections MANN David G.
15:50 - 16:10 Page 149	The marine planktonic, potentially toxic species, *Pseudonitzschia multistriata* (Bacillariophyta) in the Mexican Pacific: first record, abundance, culture and morphology HERNÁNDEZ-BECERRIL David U., AHUJA-JIMÉNEZ Yacciry, BARÓN-CAMPIS Sofía A., VEGA-JUÁREZ Germán
16:10 - 16:30 Page 102	Morphological diversity of *Fragilaria* s. str. in central Portugal ALMEIDA Salomé F.P., DELGADO Cristina, NOVAIS Helena, BLANCO Saul
16:30 - 16:50 Page 189	Assessing the identity of freshwater araphid diatoms (Bacillariophyceae) by studying their type materials: an ongoing task with mixed results MORALES Eduardo A., WETZEL Carlos E., VAN DE VIJVER Bart, HOFFMANN Lucien, ECTOR Luc

17:00 Visit of the Ripaille castle

20:00 Gala dinner in Tully

Thursday 19 sept. 2013

8:20 - 8:40 Registration

Keynote speaker
8:40 - 9:10
Page 173
Impact of environmental factors on diatom silicification capability and morphogenesis
BUSSARD Adrien, HERVE Vincent, LOPEZ Pascal Jean

Session: Physiology and ecophysiology
Chairpersons: LOPEZ Pascal-Jean & MORIN Soizic

9:10 - 9:30
Page 210
High light stress in diatoms - Induction of nonphotochemical quenching (qN), its relaxation kinetics and three components
BERTRAND Martine, ROHÁCEK Karel, MOREAU Brigitte, JACQUETTE Boris, MORANT-MANCEAU Annick, SCHOEFS Benoît

9:30 - 9:50
Page 247
Effects of nutrients on the lipid production of the diatom *Pseudostaurosira brevistriata* D.M. Williams and Round (1988) (syn. Fragilaria *brevistriata*)
VITUG Lawrence Victor, BALDIA Susana

9:50 - 10:10
Page 205
Functional ecology of marine intertidal diatoms: linking photophysiology to community ecology
SABBE Koen, BLOMMAERT Lander, BARNETT Alexandre, LEPETIT Bernard, MELEDER Vona, DUPUY Christine, GAUDIN Pierre, VYVERMAN Wim, LAVAUD Johann

10:10 - 10:30 Coffee break

Session: Ecology (1)
Chairpersons: VAN DAM Herman & VYVERMAN Wim

10:30 - 10:50
Page 118
Marine biofilm communities colonizing antifouling paints
BOUCHEZ Agnès, RIMET Frédéric, LE BERRE Brigitte, GERGORI Gerald, BRESSY Christine, BRIAND Jean-François

10:50 - 11:10
Page 145
Diatom community response to simulated variations of water pollution
GOMÀ Joan

11:10 - 11:30
Page 221
A few important factors effecting on the ecological status of a Hungarian large river (River Danube) based on phytobenthos
SZILÁGYI Zsuzsa, SZEKERES József, CSÁNYI Béla, KISS Keve T., TÓTH Bence, ÁCS Éva

11:30 - 11:50
Page 154
Environmental thresholds for changes in diatom communities in Swedish streams
KAHLERT Maria, TRIGAL Cristina

11:50 - 12:10 Page 111	First results of a study done on a cut-off meander deepened at its confluence using diatom community: a sedimentology approach (Allier River, France) BEAUGER Aude, PETIT Quentin, SERIEYSSOL Karen K., PEIRY Jean-Luc, VOLDOIRE Olivier
12:10 - 13:40	Lunch

Session: Ecology (2)
Chairpersons: ALMEIDA Salomé F.P. & KULIKOVSKIY Maxim

13:40 - 14:00 Page 121	Unexpectedly-high diatom biodiversity in spring-habitats of the Emilia-Romagna Region (Italy, EBERs Project), and its hydrogeological and hydrochemical prerequisites CANTONATI Marco, LANGE-BERTALOT Horst, SEGADELLI Stefano, ANGELI Nicola, GABRIELI Jacopo
14:00 - 14:20 Page 207	Diatoms from different freshwater habitats of El-Farafra Oasis (Egypt), with special attention to wells and hot springs SHAABAN Abd El-Salam, CANTONATI Marco, MANSOUR Hoda, SABER Abdullah
14:20 - 14:40 Page 127	Diversity and ecology of soil diatoms in urban habitats CHATTOVA Barbora, UHER Bohuslav
14:40 - 15:00 Page 161	James Ross Island: diatom gate to two biogeographical zones KOPALOVÁ Kateřina, NEDBALOVA Linda, VERLEYEN Elie, VAN DE VIJVER Bart
15:00 - 15:20	Coffee break

Session: Biomonitoring
Chairpersons: ULANOVA Anna & TAYLOR Jonathan

15:20 - 15:40 Page 159	Comparing aspirations: intercalibration of ecological status concepts across European lakes using littoral diatoms KELLY Martyn, URBANIC Gorazd, ÁCS Éva, BERTRIN Vincent, MORIN Soizic, DENYS Luc, KAHLERT Maria, KARJALAINEN Satu Maaria, KENNEDY Bryan, MARCHETTO Aldo, PICINSKA-FAŁTYNOWICZ Joanna, POIKANE Sandra, SCHOENFELDER Joerg, SCHOENFELDER Ilka, VARBIRO Gabor
15:40 - 16:00 Page 108	Diatoms used for the evaluation of the effects of experimental water releases from hydroelectric power plants in alpine river systems: the case of the Cairasca-Devero basins (NW Italy) BATTEGAZZORE Maurizio, POMPILIO Lucia, BOTTA Paola, D'ARNESE Lucrezia, BENIGNI Elisabetta, BERTOLA Andrea, SPANO' Mauro
16:00 - 16:20 Page 130	Determining water quality with diatom DNA barcodes CREMER Holger, ATSMA Adrie, DE GRAAF Bendert, JASPERS Marco, SCHUREN Frank, VAN DER OOST Ron, VAN DER WIJNGAART Tessa, VAN EE Gert

Poster sessions

16:20 **Poster session: Taxonomy**
Chairpersons: VAN DE VIJVER Bart & ECTOR Luc

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Poster 8
Morphological and ecological investigations of *Achnanthidium caledonicum* and related species
JÜTTNER Ingrid, ECTOR Luc, VAN DE VIJVER Bart, WETZEL Carlos E., KROKOWSKI Jan, LANGE-BERTALOT Horst

Page 186
Poster 9
A re-analysis of Scottish material studied by Haworth (1975) containing abundant araphid diatom taxa (Bacillariophyceae)
MORALES Eduardo A., WETZEL Carlos E., HAWORTH Elizabeth Y., ECTOR Luc

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Poster 10
A new fossil species of *Entomoneis* from the Turkish Marmara Sea sediments
PAILLÈS Christine, BLANC-VALLERON Marie-Madeleine, POULIN Michel, CRÉMIÈRE Antoine, BOUDOUMA Omar, PIERRE Catherine

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Poster 11
Cocconeis pinnata Gregory ex Greville from type material (Arran Island, Scotland) and from Tahiti Island (South Pacific, Society Archipelago)
RIAUX-GOBIN Catherine, COMPÈRE Pierre, ROMERO Oscar E.

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Poster 12
Square openings in the outer cell wall of an aerophilic *Diploneis* Ehrenberg ex Cleve from Zambia
TAYLOR Jonathan C., KARTHICK Balasubramanian, COCQUYT Christine

Page 227
Poster 13
Two species of *Achnanthidium* Kützing from Kolli Hills, Eastern Ghats, India
KARTHICK Balasubramanian, TAYLOR Jonathan C., HAMILTON Paul B.

Page 235
Poster 14
Morphological observation of a poorly described and rare diatom *Licmophora hastata*
ULANOVA Anna, STEPANOVA Vera

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Poster 15
The genus *Halamphora* in the Antarctic Region
VAN DE VIJVER Bart, ZIDAROVA Ralitsa, KOPALOVÁ Kateřina, LEVKOV Zlatko

16:20 **Poster session: Biomonitoring**
Chairpersons: KAHLERT Maria & KELLY Martyn

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Poster 16
DiaDem EU - Implementing DNA Barcoding into the Water Framework Directive: standardisation of sampling, taxonomic validation and data storage
ENKE Neela, ÁCS Éva, BOUCHEZ Agnès, DVORAK Petr, JAHN Regine, KELLY Martyn, KUSBER Wolf-Henning, MANN David, POULICKOVA Aloisie, RIMET Frédéric, SABBE Koen, TROBAJO Rosa, VYVERMAN Wim, ZIMMERMANN Jonas

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Poster 17
Precision and accuracy of benthic diatom metrics for detecting human-induced impairment of boreal lakes
GOTTSCHALK Steffi, KAHLERT Maria

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Poster 18
Benthic diatoms and implementation of Water Framework Directive in Croatia
KRALJ BOROJEVIĆ Koraljka, GLIGORA UDOVIČ Marija, ŽUTINIĆ Petar, CORING Eckhard, PLENKOVIĆ-MORAJ Anđelka

Page 229 Poster 19	Ring-test exercise on identification and counting protocols of benthic rheophilous diatoms of Trento Province (Italy) TORRISI Mariacristina, DELLA BELLA Valentina, MONAUNI Catia, SILIGARDI Maurizio, ZORZA Raffaella, WETZEL Carlos E., ECTOR Luc

16:40	**Poster session: Ecology** Chairpersons: KAHLERT Maria & KELLY Martyn
Page 105 Poster 20	Impact of drying-out on diatom communities and the consequences for their use in bioindication in river Maureillas (Pyrénées-Orientales, France) BARTHÈS Amélie, LEFLAIVE Joséphine, COULON Sylvain, PERES Florence, ROLS Jean-Luc, TEN-HAGE Loïc
Page 176 Poster 21	Periphytic diatom communities of four subtropical environments with different trophic status MATIAS DE FARIA Denise, BERTOLLI Lucielle Merlym, DA SILVA Angela Maria, TREMARIN Priscila Izabel, LUDWIG Thelma Alvim Veiga
Page 179 Poster 22	Precipitation and wind model succession and dynamic of periphytic diatoms in a large subtropical shallow lake MATIAS DE FARIA Denise, CARDOSO Luciana de Souza, DA MOTTA MARQUES David
Page 182 Poster 23	On the symbiotic relationship between *Microcystis aeruginosa* Kützing - *Nitzschia palea* (Kützing) W. Smith in Alalay Pond, Cochabamba, Bolivia MORALES Eduardo A., RIVERA Sinziana F., WETZEL Carlos E., HAMILTON Paul B., ECTOR Luc
Page 124 Poster 24	Epilithic diatom assemblages of an extremely-low-alkalinity high mountain lake (Adamello-Brenta Nature Park, south-eastern Alps) with special reference to the depth-distribution SEGNANA Michela, CANTONATI Marco, ANGELI Nicola

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Page 140 Poster 25	Metal tolerance in *Nitzschia palea*: intraspecific differences SANTOS José, ESTEVES Sara, MARTINS Marta, ALMEIDA Salomé. F.P., FIGUEIRA Etelvina
Page 170 Poster 26	Ecophysiological and morphological differentiation between *Navicula perminuta* Grunow strains isolated from different biogeographic regions LEMKE Paulina, PNIEWSKI Filip Franciszek, LATAŁA Adam
Page 214 Poster 27	Carbon metabolism and light intensity in diatoms - A transcriptional approach HEYDARIZADEH Parisa, MARCHAND Justine, MOREAU Brigitte, MARTIN-JEZEQUEL Véronique, SCHOEFS Benoît

16:40	**Poster session: Paleoecology** Chairpersons: MORIN Soizic & MONTUELLE Bernard
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Page 218 Poster 29	Changing diatom associations and preservation as Holocene palaeoclimate indicator in Lake Nam Co (Tibetan Plateau) SCHWARZ Anja, KASPER Thomas, FRENZEL Peter, HABERZETTL Torsten, SCHWALB Antje

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8:40 - 9:10 Page 133	**Keynote speaker** Coupling paleolimnology and molecular tools to reveal the long-term dynamics and diversity of planktonic assemblages: focus on diatoms and cyanobacteria DOMAIZON Isabelle, DEBROAS Didier, PERGA Marie Elodie, ARNAUD Fabien, SAVICHTEVA Olga, KIRKHAM Amy, VILLAR Clément, BERTHON Vincent, BRONNER Gisèle, GREGORY EAVES Irene

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Chairpersons: PIENITZ Reinhard & DOMAIZON Isabelle

9:10 - 9:30 Page 253	Diatom responses to climate variability in temperate Chilean lakes: a combined neolimnological and paleolimnological approach VAN DE VYVER Evelien, VYVERMAN Wim, VANORMELINGEN Pieter, VAN WICHELEN Jeroen, VERLEYEN Elie
9:30 - 9:50 Page 250	Holocene palaeoclimate reconstruction in the Eastern Mediterranean: a quantitative diatom study of an approximately 18 m long sediment core from Lake Kinneret (Israel) VOSSEL Hannah
9:50 - 10:10 Page 115	Magnitude and specific responses of diatoms to climate warming versus local stressors in anthropogenized lakes BERTHON Vincent, ALRIC Benjamin, RIMET Frédéric, JENNY Jean-Philippe, PIGNOL Cécile, PERGA Marie-Elodie
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Session: Taxonomy (2)
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10:30 - 10:50 Page 238	Centric diatoms from the Miocene deposits of the Baikal region, Russia USOLTSEVA Marina, KHURSEVICH Galina
10:50 - 11:10 Page 244	Freshwater diatoms from the Maritime Antarctic Region: biodiversity hotspot or taxonomical artifact VAN DE VIJVER Bart, ZIDAROVA Ralitsa, KOPALOVÁ Kateřina, VERLEYEN Elie
11:10 - 11:30 Page 135	Phylogenetic and ecological study on *Skeletonema potamos* (Weber) Hasle DULEBA Mónika, BÍRÓ Péter, KISS Keve Tihamér, POHNER Zsuzsanna, ÁCS Éva
11:30 - 12:00	Closing words
12:00 - 14:00	Lunch

2nd European Workshop on Diatom Taxonomy
&
Diatom barcoding and biomonitoring workshop (closed workshop)

14:00-18:00 Program of the 2nd European Workshop on Diatom Taxonomy:
Araphid freshwater diatoms
Chairperson: ECTOR Luc

Are we nowadays able to identify freshwater araphid diatoms in Europe for biomonitoring?
ECTOR Luc & WETZEL Carlos E.

New freshwater araphid diatom species from different freshwater habitats
CANTONATI Marco & LANGE-BERTALOT Horst
(with contributions of Martyn Kelly and David Armanini)

Small-celled araphid diatoms in Sweden
VAN DE VIJVER Bart, MORALES Eduardo A., JARLMAN Amelie, SUNDBERG Iréne, WETZEL Carlos E. & ECTOR Luc

Morphological and molecular data of some Fragilaria and Staurosira strains
JAHN Regine & BURFEID CASTELLANOS Andrea

NORBAF diatom intercalibrations – quantitative results for Araphids and impact on species list comparisons
KAHLERT Maria

Taxonomic revision of needle shaped Fragilaria species
LANGE-BERTALOT Horst & ULRICH Sabine

Collecting together the many author illustrations of the Fragilaria – related taxa
HAWORTH Elizabeth Y.

Selected Fragilariales in Poland estimating morphological ranges and early ecology
WOJTAL Agata Z.

Species composition and morphology of recent and fossil small fragilarioid diatoms from Lake Baikal (Russia)
KULIKOVSKIY Maxim, LANGE-BERTALOT Horst, KHURSEVICH Galina & KUZNETSOVA Irina V.

Revision of type material of araphid diatoms reveals more problems than solutions
MORALES Eduardo A., WETZEL Carlos E., VAN DE VIJVER Bart & ECTOR Luc

An overview of some araphid diatoms from central and southern Africa – are these the same species that occur in Europe?
TAYLOR Jonathan

Investigations on Diatoma – Odontidium
JÜTTNER Ingrid

14:00-18:00	Diatom barcoding and biomonitoring workshop Chairpersons: ENKE Neela & BOUCHEZ Agnès

Résumés

du Colloque

de l'ADLaF

Présentation orale

AQUAWEB – un outil en ligne pour des études écologiques de rivières portugaises à partir des diatomées et des macroinvertébrés

Orateur : ALMEIDA Salomé F.P.

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Principaux points de l'étude

AQUAWEB - outil en ligne pour des études écologiques et d'évaluation de la qualité des eaux douces

Macroinvertébrés - clé taxonomique

Diatomées - Information écologique et morphométrique

Modèles prédictifs basées sur le concept de Condition de Référence

Introduction

Les études écologiques et d'évaluation de la qualité de l'eau basées sur les diatomées ou sur les macroinvertebrés nécessitent de bonnes données taxonomiques et d'écologie, de préférence appartenant aux régions où les études vont être réalisées (Potapova et al., 2004). Le service en ligne – AQUAWEB, financé par la Fondation Portugaise pour la Science et la Technologie (FCT), a pour objectif de faciliter les études d'évaluation de la qualité des eaux douces courantes basées sur les communautés biologiques, notamment les macroinvertébrés et les diatomées, ainsi que des modèles récents basés sur les communautés piscicoles. Quelques modèles prédictifs basés sur le concept de Condition de Référence – Reynoldson et al., 1997 - (de type RIVPACS/BEAST et la nouvelle technique développée en Machine Learning Techniques -HYDRA- (Feio et al., 2012) sont disponibles dans AQUAWEB pour une utilisation par des personnes autorisées. Ces modèles prédictifs ont été développés et testés pour quelques régions du Portugal et pour le pays entier, ou même pour d'autres pays (Feio et al., 2009; Almeida & Feio, 2012). Ce service peut également être utile pour des surveillances dans le cadre de la Directive Cadre de l'Eau (DCE – The European Parliament and the

Council of the European Union, 2000), notamment parce que la philosophie de la DCE pour les méthodes biologiques se base également sur une comparaison avec des conditions de référence.

Résultats et discussion

Le service en ligne AQUAWEB est accessible à l'adresse électronique http://aquaweb.uc.pt/. Pour obtenir la permission d'utilisation des contenus, il suffit de s'inscrire à cette adresse. Ensuite, la coordinatrice du projet et de ce service (Maria João Feio) vous donnera les autorisations d'accès.

Il est possible de visualiser les macroinvertébrés des rivières portugaises, au moyen d'une clé d'identification digitale qui comporte des photos et des petits films montrant les caractéristiques morphologiques et les animaux en mouvement dans l'eau. Les utilisateurs doivent choisir les caractéristiques de l'invertébré à identifier, une par une, et des exemples illustrent chaque étape. A partir d'une liste initiale de toutes les familles d'invertébrés d'eau douce, on peut arriver finalement à une identification correcte, avec une petite vidéo qui représente cette famille.

Les diatomées dominantes et les plus fréquentes dans les rivières portugaises ont été photographiées en microscopie optique et placées dans une liste à laquelle nous avons ajouté des données morphométriques, mesurées sur nos spécimens, et des informations sur leurs préférences écologiques dans nos eaux. Nous avons aussi ajouté des données morphométriques et bien sûr quelques données écologiques et des références bibliographiques.

Il y a des modèles comportant exclusivement des macroinvertébrés, ou des diatomées, ou encore des modèles mixtes qui intègrent les deux communautés simultanément. Ces modèles peuvent être utilisés pour l'évaluation de la qualité écologique des rivières portugaises. D'autres modèles ont aussi été développés pour des études spécifiques ou à caractère plus expérimental, comme par exemple le modèle sur poissons en Multiple Machine Learning techniques, qui a comme objectif principal la prédiction de l'existence des espèces dans le bassin du fleuve Ebro, en Espagne, dans des scénarios d'altération climatique (Filipe et al., 2012).

Donc, AQUAWEB prétend être un outil diversifié, en cours de rénovation et amélioration permanentes, interactif et utilisable pour faciliter l'évaluation écologique des rivières avec des techniques plus actuelles, ou pour d'autres objectifs liés aux études écologiques des eaux courantes, voire même d'autres systèmes.

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Mots clés

plateforme digitale, taxonomie, qualité écologique, modèles prédictifs

Présentation poster

Utilisation des groupes morpho-fonctionnels du phytoplancton pour le diagnostic écologique des plans d'eau du bassin Loire-Bretagne : focus sur les diatomées

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Principaux points de l'étude

L'objectif de cette étude est d'évaluer l'intérêt de l'utilisation des groupes morpho-fonctionnels du phytoplancton, plus particulièrement des groupes constitués de diatomées pour le diagnostic écologique des plans d'eau.

Introduction

Le phytoplancton possède un temps de génération très court, son étude permet une perception rapide de l'évolution des conditions du milieu. La limitation des nutriments est considérée comme le stress limitant à son taux de croissance et à sa division cellulaire. Le transport non volontaire des individus phytoplanctoniques lors du brassage est une perturbation entraînant les successions de communautés planctoniques. L'intensité des stress et des perturbations varient considérablement en fonction du type d'habitat, du cycle thermique, et de la typologie du plan d'eau (naturel, retenue,…) (Sandgren, 1988).

La grande diversité des espèces constituant le phytoplancton et notamment les diatomées planctoniques, a entrainé un besoin grandissant de se substituer à la taxonomie traditionnelle pour faciliter la compréhension du phytoplancton. L'observation des assemblages d'espèces du phytoplancton a abouti récemment à l'émergence de trois approches de classification morpho-fonctionnelle (Salmaso et al., 2012).

Les « functional groups » -FG- (Reynolds et al., 2002) sont inspirés de la phytosociologie. Ils regroupent en plus de 40 assemblages (Padisák et al., 2009), les espèces retrouvées fréquemment ensemble dans un même milieu et partageant les mêmes exigences écologiques.

Les « morpho functional groups » -MFG- (Salmaso & Padisák, 2007) constituent une approche basée sur la stratégie de vie des individus. 31 groupes sont définis selon plusieurs critères : la mobilité, la capacité potentielle d'acquisition de carbone et de nutriments par mixotrophie, les nutriments spécifiques requis, la taille et la forme, et la présence d'une enveloppe.

Les « morphologically based functional groups» -MBFG- (Kruk et al., 2010) reposent sur l'assemblage d'espèces regroupées en sept groupes en fonction de leur similitude morphologique. Neuf traits sont utilisés pour les définir : la dimension linéaire maximum, le volume, la surface, le ratio surface/volume, la présence d'aérotope, de flagelle, de mucilage, d'hétérocyste, ou d'exosquelette siliceux.

L'objectif de cette étude est d'évaluer l'intérêt de l'utilisation des groupes morpho-fonctionnels du phytoplancton, plus particulièrement des groupes constitués de diatomées par rapport à une approche taxonomique classique pour le diagnostic écologique des plans d'eau.

Résultats et discussion

L'étude porte sur des données phytoplancton échantillonnées sur 45 plans d'eau situés dans sept hydroécorégions différentes (Chandesris et al., 2006) sur le quart nord-ouest et le centre de la France. Quatre prélèvements ont été réalisés entre mars et octobre, soit un total de 180 échantillons. Une fois les espèces identifiées, les assemblages d'espèces sont attribués aux différents groupes morpho-fonctionnels décrits.

Afin de tester la signification des approches morpho-fonctionnelles (FG, MFG, MBFG) et de comparer cette signification à la classification taxonomique (espèce, classe), des MRPPs ont été calculés (Multi-Response Permutation Procedures; Biondini et al., 1985). Une MRPP est une analyse non paramétrique qui permet de tester l'homogénéité inter-groupes, comparée à ce qui est attendu aléatoirement. Une statistique A est calculée, elle varie entre -1 et 1, plus elle est forte, plus le paramètre testé influe sur la structuration des groupes.

Huit paramètres exprimés en classes ont été testés, trois reflétant les nutriments présents dans le milieu (nitrates, orthophosphates, conductivité), cinq expliquant les caractéristiques du milieu (typologie, hydroécorégion, résistance thermique relative, turbidité, indice de creux moyen).

Nous avons observé que l'approche taxonomique au rang de la classe est la plus différenciée par les paramètres testés. L'approche taxonomique espèce est au contraire la moins bien définie. Les approches morpho-fonctionnelles approximent les résultats obtenus à la classe, mais restent moins informatives excepté pour les hydroécorégions et la typologie.

L'analyse de Dufrêne & Legendre (1997), effectuée sur les paramètres présentant une statistique A maximum, permet de détecter les groupes morpho-fonctionnels indicateurs des paramètres environnementaux testés. Cette méthode combine l'abondance d'un groupe morpho-fonctionnel dans un paramètre exprimé en classe, et sa fidélité dans la classe. Si un groupe possède un indice élevé, il est bon indicateur de cette classe. Ces groupes indicateurs sont testés (test de Monte-Carlo valeur p).

Ainsi, nous observons que le MBFG regroupant les organismes non-flagellés présentant un exosquelette siliceux, soit les Bacillariophycées, est caractéristique de l'Hydroécorégion de niveau 1 «dépôt argilo-sableux », et des plans d'eau présentant une conductivité relativement élevée comprise entre 240 et 320 µS/cm (p<5%).

Pour les MFG, le groupe des diatomées centriques unicellulaires et filamenteuses > à 30 µm, est caractéristique des retenues de moyenne montagne peu profondes non calcaires.

Le MFG comprenant les diatomées pennées > à 30 µm est indicateur des plans d'eau présentant une résistance thermique relative très faible 0 à 5 (p<10%), soit une température homogène sur la totalité de la colonne d'eau, indiquant une probable période de brassage.

Les FG $_{D,}$ typique des milieux « shallow turbid waters including rivers » (Reynolds et al., 2002), et le FG $_{B}$ caractéristique de milieux « mesotrophic small- and medium sized lakes to large shallow lakes with species sensitive to the onset of stratification » sont représentatifs (p<10%) des lacs plats (Indice de creux moyen entre 0,1 à 0,5 (Meybeck, 1995)). Ces deux FG contiennent de nombreuses diatomées, principalement *Actinocyclus normanii, Ulnaria angustissima, Skeletonema* spp., *Stephanodiscus hantzschii,* pour *D,* et *Aulacoseira subarctica, Cyclotella atomus, Stephanodiscus minutulus,* pour *B*.

Le FG *C* caractéristique des milieux « eutrophic small- and medium sized lakes with species sensitive to the onset of stratification. » indique les plans d'eau présentant la classe de concentration en orthophosphates la plus élevée, > à 0,08 mg/l (p<5%). L'assemblage *C* est constitué de *Asterionella formosa, Aulacoseira ambigua, Aulacoseira distans* et *Cyclotella meneghiniana.*

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Mots clés

phytoplancton, diatomées, groupes morpho-fonctionnels, paramètres environnementaux, classification

Présentation orale

Impact d'un assec sur un biofilm de mésocosme : conséquences pour les communautés algales et bactériennes et sur les indices utilisés (IBD/IPS) en routine

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Principaux points de l'étude

Un biofilm est soumis à différentes durées d'assec dans un canal artificiel. L'assec, même court, a un impact sur les communautés algales et bactériennes qui le composent. Cependant, en termes de fonctionnement, le biofilm revient à l'état initial en 2 semaines de ré-immersion.

Introduction

Dans un contexte de changement climatique, les cours d'eau de premiers ordres, généralement non permanents, sont très nombreux et influencent fortement les cours d'eau situés en aval d'un bassin versant (Benda et al., 2005). De plus, les actions humaines affectent les écosystèmes de ces cours d'eau, notamment par des prélèvements d'eau importants (Sabater, 2008). L'augmentation du nombre de cours d'eau asséchés, particulièrement durant la période estivale, pose problème dans le suivi de la qualité biologique imposée par la Directive-Cadre sur l'Eau (Parlement Européen, 2000). En effet, le protocole de prélèvement pour l'application des indices biologiques utilisés en France (IBD/IPS) est normé et les cours d'eau en assec sortent de son champ d'application (AFNOR, 2003).

Par l'étude d'un biofilm dans un mésocosme, nous souhaitons répondre aux questions suivantes : Quel est l'impact d'un assec sur les communautés algales et bactériennes ? Comment évoluent ces communautés lors de la remise en eau ? Quelles sont les conséquences sur la bioindication (IBD/IPS) ?

Dans ce but, nous avons travaillé avec des biofilms matures sur des substrats artificiels en polyéthylène (10cmx5cm). Ces substrats ont été disposés dans un canal artificiel (20cmx20cmx400cm) soumis à un courant continu, une température et un éclairement stables. Les biofilms ont subi des durées d'assèchement différentes (1, 2, 4 et 8 semaines) et ont ensuite été remis en eau durant 13 jours dans des aquariums séparés, de façon à n'observer que la repousse à partir du biofilm sec, i.e. en s'affranchissant des phénomènes de dérive.

Résultats et discussion

Différents paramètres ont été suivis et mesurés à l'état initial, à la fin de l'assec, et après la remise en eau. Pour l'étude de la diversité fonctionnelle bactérienne, des Biolog ont été réalisés. L'état physiologique et la biomasse des biofilms ont été estimés via des mesures effectuées avec un analyseur de fluorescence (PhytoPAM) et des dosages de chlorophylle a/phéophytine. La composition globale des communautés a été suivie par l'intermédiaire du PhytoPAM, celle des diatomées en particulier a été appréhendée par des comptages dans le but de tester les notes indicielles.

Résultats

Initialement, le biofilm est dominé par les cyanobactéries (Phormidium et Leptolyngbia). Après remise en eau, des signaux de fluorescence spécifiques des diatomées et des algues vertes sont détectés, celui des diatomées étant corrélé positivement à la durée de l'assec (›95% pour l'assec de 8 semaines).

L'état physiologique du biofilm a été estimé par la mesure de l'efficacité maximale du photosystème II (FPSII). Pour les cyanobactéries, cette efficacité devient quasi nulle lors des 8 premières heures d'assèchement. Lors de la remise en eau, la fluorescence reprend principalement la 2e semaine pour les 3 groupes algaux. Le FPSII des diatomées est celui qui domine plus largement, d'autant plus que la longueur de l'assec augmente. De plus, l'assec provoque une forte diminution du ratio chlorophylle a/phéophytine dès une semaine d'assec, ce ratio demeurant ensuite constant (environ 1,8).

La quantité de chlorophylle a diminue progressivement avec la durée d'assec, la phéophytine suit la même tendance, sauf pour la première semaine. Durant la remise en eau, on observe une évolution négative de la quantité de chlorophylle a pour les premières semaines d'assec alors qu'elle devient largement positive après 8 semaines (204% contre 37% pour les témoins).

Les communautés de diatomées sont dominées majoritairement par 4 espèces qui réagissent différemment à l'assèchement, induisant une modification de la structure des communautés. Les communautés ré-immergées divergent fortement des communautés n'ayant pas subi d'assec. L'IBD n'est pas modifié durant toute la durée de l'expérience alors que l'IPS diminue lors de la remise en eau (perte de deux points).

Enfin, la diversité fonctionnelle potentielle des bactéries semble affectée par l'assèchement alors qu'en fin de remise en eau, on retrouve une situation similaire à la situation initiale.

Discussion

L'assec provoque une modification marquée des communautés algales avec une transition des cyanobactéries vers les diatomées.

La perte de biomasse observée durant l'assec est liée à la mortalité (dégradation des pigments). Plus la durée de l'assec est longue, plus la reprise du biofilm est importante lors de la remise en eau, ces résultats très marqués sont certainement corrélés à la forte croissance des diatomées.

Cependant, même si la diversité des diatomées est faible, l'assec modifie les communautés et on n'observe pas de retour à la situation initiale suite à la remise en eau, du moins en 13 jours. Il est difficile d'interpréter l'évolution des notes indicielles car la diversité est très faible et deux des quatre espèces majoritaires n'ont pu être clairement identifiées, ce qui biaise fortement le calcul car elles ne sont pas prises en compte dans le calcul de l'IBD et sont peu représentatives pour l'IPS.

Enfin, au regard des communautés bactériennes, l'assec a un effet sur la diversité fonctionnelle, associé à une résilience lors de la remise en eau.

Cette expérience a permis de mettre en évidence l'effet de l'assec et de sa durée sur les composantes phototrophe et hétérotrophe d'un biofilm, en s'affranchissant des apports liés à la dérive dans la colonne d'eau lors de la remise en eau.

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Mots clés

biofilm, diatomées, mésocosme, assec, indices biologiques

Présentation orale

Utilisation des diatomées pour l'évaluation des lâchers d'eau d'un système d'installations hydroélectriques d'une vallée alpine: le cas de la rivière Varaita (Région du Piémont, Italie du nord-ouest)

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Principaux points de l'étude

Diatomées épilithiques de la rivière Varaita (Italie)

Didymosphenia geminata

Ecosystème aquatique alpin

Evaluation des effets des installations hydroélectriques

Indice diatomique de perturbation physique

Introduction

L'ARPA Piemonte fait partie d'un comité technique qui a pour objectif d'évaluer l'acceptabilité des lâchers d'eau expérimentaux d'un complexe d'usines hydroélectriques déjà existantes situées dans la partie supérieure du bassin de la rivière Varaita. En plus du monitoring des caractéristiques chimiques et des paramètres hydromorphologiques entrepris par la compagnie d'électricité, des échantillons de diatomées benthiques ont été prélevés par l'ARPA dans 7 stations pendant les années 2011 et 2012 à un niveau déterminé de lâchers d'eau, inférieur à celui qu'il serait nécessaire d'envisager pour une nouvelle installation. Les diatomées ont été échantillonnées au cours de l'été et à l'automne 2011 et 2012 à un niveau déterminé de lâchers d'eau, inférieur à celui qu'il serait nécessaire d'envisager pour une nouvelle installation. La rivière Varaita, dans la dernière partie de la zone d'étude, a un débit annuel moyen de 7,5 m^3s^{-1} et une valeur de lâcher théorique juridique de 1,4 m^3s^{-1}. Pendant les deux premières années de l'expérimentation, les lâchers étaient égaux à 100% des valeurs théoriques pour des nouvelles centrales. Au cours des deux années suivantes (2011-2012), les lâchers étaient égaux

aux deux tiers du niveau théorique. Les échantillons ont été traités selon les procédures standardisées et des lames permanentes ont été réalisées pour l'observation microscopique des frustules. Les valves ont été examinées au microscope optique et les taxons ont été identifiés au niveau spécifique à l'aide de clés et d'ouvrages appropriés. A partir des données taxonomiques ont été calculées les valeurs des indices de qualité EPI-D et IPS, en plus de l'indice de diversité de Shannon, l'indice trophique de Rott et un indice quantitatif de perturbation physique, le DIPI (Diatom Index of Physical Impact - Indice Diatomique d'Impact Physique), basé sur la proportion d'individus des genres *Navicula sensu lato*, *Nitzschia sensu lato*, *Surirella* et *Didymosphenia* par rapport à l'ensemble de la communauté de diatomées, dérivé de l'indice NNS (qualitatif) et NNS' (quantitatif), basé sur les taxons motiles (Battegazzore et al., 2005), à son tour dérivé de l'indice non-quantitatif d'envasement (« Siltation Index ») de Bahls (1993). L'indice NNS', qui n'inclut pas le genre *Didymosphenia*, a été utilisé dans plusieurs études de cours d'eau régulés (Lai et al., 2012 ; Gallo et al., 2013). La raison d'inclure le genre *Didymosphenia* parmi les taxons indicateurs de perturbation physique et donc parmi ceux qui constituent l'indice DIPI est justifiée par la littérature scientifique (Spaulding & Elwell, 2007).

Résultats et discussion

Dans les 35 échantillons prélevés, 141 taxons de diatomées ont été identifiés. L'espèce la plus abondante était *Achnanthidium pyrenaicum* (Hustedt) H. Kobayasi. *Diatoma ehrenbergii* Kützing, *D. vulgaris* Bory et *Gomphonema elegantissimum* E. Reichardt & Lange-Bertalot étaient aussi des espèces fréquentes et abondantes. L'évolution des valeurs moyennes des deux indices de qualité a montré un minimum dans une station située en aval du barrage de Sampeyre, qui s'est avéré être un site relativement plus critique. En outre, dans la partie centrale du même tronçon étudié de la rivière Varaita des abondances significatives de l'espèce potentiellement invasive *Didymosphenia geminata* (Lyngbye) M. Schmidt ont été observées pendant la campagne estivale. Cette espèce avait déjà été observée dans la rivière Varaita et le fleuve Po en 2006 par Battegazzore et al. (2007).

L'allure des valeurs de l'indice DIPI le long du cours d'eau Varaita est très similaire à celle de l'abondance de *D. geminata*, surtout pour la campagne d'été, avec les valeurs les plus élevées dans le tronçon sujet à une régulation artificielle du débit. En automne 2011 les valeurs les plus élevées de l'indice DIPI ont été déplacées plus en aval, tandis qu'en automne 2012 des valeurs très élevées n'ont pas été détectées. Durant les mois d'été, coïncidant avec des valeurs élevées de l'indice de perturbation physique, on a observé les plus fortes abondances de *D. geminata*. Pendant les autres saisons, où cette espèce est beaucoup moins présente à cause de facteurs naturels limitants (température, luminosité), en présence de perturbation physique elle est remplacée en partie ou entièrement par des diatomées motiles, appartenant principalement aux genres *Navicula (sensu lato)*, *Nitzschia* (*sensu lato*) et *Surirella*.

En utilisant les données quantitatives taxonomiques et en incluant le genre *Didymosphenia*, l'indice DIPI semble être un bon outil pour l'évaluation rapide du degré de perturbation physique (en particulier hydrologique) dans le cas de la rivière Varaita.

Le comité technique a accepté de poursuivre l'expérimentation en 2013, en planifiant les lâchers d'eau et en particulier en augmentant le lâcher d'eau du barrage de Sampeyre durant les mois d'été à une valeur proche de celle plus élevée qui serait théoriquement nécessaire pour un nouveau barrage. De cette façon, nous espérons que la qualité en aval du barrage pourra devenir plus stable et s'améliorer. Le monitoring des effets des nouvelles conditions de lâchers est en cours de réalisation et les résultats serviront à établir les niveaux définitifs et écologiquement acceptables des lâchers d'eau pour le futur.

Compte tenu des problèmes dus aux développements massifs de *D. geminata* signalé dans différentes régions du monde (Blanco & Ector, 2009), en 2013 et pendant les années à venir il sera important de surveiller la présence de *D. geminata* dans la rivière Varaita, afin de pouvoir suivre son évolution par rapport à la régulation du débit d'eau et des lâchers d'eau de la centrale hydroélectrique.

Il est important d'insister sur le fait que, parmi les différentes approches méthodologiques, les diatomées et les macroinvertébrés ont permis d'identifier des aspects environnementaux relativement critiques liés aux faibles niveaux des lâchers d'eau. Cette étude montre en particulier comment les diatomées, outre leur utilisation en routine dans les réseaux nationaux de surveillance de la qualité des rivières, peuvent également être employées pour le monitoring des cours d'eau dans des situations particulières comme c'est le cas des rivières régulées à des fins hydroélectriques.

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Mots clés

barrage hydroélectrique, cours d'eau alpin, débit régulé, *Didymosphenia*, indice de perturbation physique

Présentation orale

Ecologie des mares II - mesure de la qualité des eaux : essai

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Principaux points de l'étude

La nature des mares nécessite l'application d'un double indice basé sur un choix restreint de paramètres. L'application de la formule de Zelinka est basée sur la répartition asymptotique des occurrences et des abondances des taxons. La comparaison des indices IMsa et IMso avec une AFC des récoltes et des types de mares valide en partie cette nouvelle méthode.

Introduction

Dans le cadre de l'étude des micro-zones humides (Bertrand et al., 2007) et pour compléter les travaux antérieurs sur les mares soumises à la pression anthropique (Bertrand et al., 2010, 2013a, b), les auteurs abordent ici la qualification des eaux de 130 mares de la Région Centre (Orléanais) classées dans 13 types différents. Le choix des paramètres physico-chimiques a été dicté par la nature particulière de ces lieux extrêmement divers, certains apparemment vides de végétaux, mais le plus souvent envahis par ces derniers. L'impossibilité d'utiliser tous les paramètres incluant l'oxygène (O_2, O_2 % sat., DBO5, DCO, COD) nous à conduits à retenir en priorité NO_3^-, PO_4^{2-}, NH_4^+, NO_2^- et pH pour la qualification elle-même. Nous avons ajouté les SO_4^{2-}, Fe, Ca^{2+}, HCO_3^- et CO_2 pour tenir compte de la nature des terrains sous-jacents régionaux et éliminé les MES (souvent uniquement minérale). Les répartitions des occurrences des diatomées dans les mares et des nutriments suivant des lois asymptotiques ont été déterminantes pour l'application de la formule de Zelinka. Les différentes classes des valeurs indicatrices « v » et les calculs des indices de polluosensibilité « s » ont tenu compte de ces répartitions. La nature particulière des mares (milieu clos accumulant de grandes quantités de matière organique détritique formant la vase) nous ont conduits à adopter un indice double IMsa (indice anthropique) et IMso (indice organique). La comparaison avec les indices doubles de Rott n'a pu être faite par manque de données de celui-ci de même que celle avec l'indice de Leclercq (1995). Les indices IMsa ont été calculés en prenant NO_3^-, PO_4^{2-} et pH (par tri automatique) et simultanément les espèces de diatomées de chaque récolte ; les indices IMso ont été calculés en prenant NH_4^+, NO_2^- et pH. Le choix du pH a été dicté par la nécessité d'avoir un paramètre commun indépendant qui permette le tri en l'absence de nutriments. L'application de la formule de Zelinka sur chaque récolte des 130 mares nous a donné 288 x 2 indices (IMsa et IMso), regroupés en un tableau, permettant de juger de la pertinence de ces calculs en comparaison avec l'indice IPS du CEMAGREF (1982).

Résultats et discussion

La totalité des indices IMsa, IMso et IPS des 288 récoltes montrent que la moyenne générale des IPS (moyenne 14,62 écart type 4,28) est nettement supérieure à celles des IMsa (moy. 10,16 e.t. 2,1) et IMso (moy. 10,43 e.t. 2,42), et montrent aussi une plus grande variabilité des IPS, ceux-ci atteignant très souvent la note de 19,5 à 20, alors que les IM culminent à 14,8 pour IMsa et 15,2 pour IMso.

Le classement des IMsa en valeurs progressives des indices associés aux IMso correspondants, s'ajuste à une courbe polynomiale d'ordre 4 qui coupe celle des IMso à l'extrémité supérieure (vers 70% des récoltes). Cette partie des récoltes englobe 85% des mares de la zone dite « forestière » (Bertrand et al., 2013b).

Il est notable que les indices IMsa et IMso peuvent fournir des résultats opposés puisqu'ils décrivent deux phénomènes différents. Si on examine dans le détail les indices des récoltes des 16 premières mares, on constate que 75% des indices de cette zone de basse qualité sont similaires au sein de chaque mare. Toutefois ils montrent des incohérences entre le système des IM et celui des IPS. Ainsi, sur la première mare les deux indices IM sont équivalents et décrivent une mare fortement polluée alors que les IPS sont inversés et décrivent en moyenne une mare de bonne qualité.

Une analyse plus ciblée réunissant des mares extrêmement polluées et des mares dites de bonne qualité (certaines reposant sur une seule récolte et d'autres sur 4 récoltes), classées par ordre croissant des IPS, nous montrent que 52% des récoltes ont un IPS compris entre 18 et 20, alors que les IM ne dépassent pas 15,2. Une analyse des données de toutes les récoltes des 5 mares dont les IPS sont les plus élevés montrent que ces récoltes sont constituées d'*Eunotia* et de *Pinnularia* en grande quantité. Or les espèces de ces genres sont indicés pour l'IPS avec un « s » égal à 5 (conditions physico-chimiques des rivières ou rareté ?), soit la note la plus élevée ; alors que les « s » des IM sont plus bas répondant aux conditions physico-chimiques plus dégradées que nous trouvons dans les mares.

Réalité ou artefact ? Un premier point permet de comprendre cette différence : l'indépendance des flores diatomiques entre les rivières et les mares (6 espèces communes seulement pour 80% de l'abondance, Bertrand et al., 2013b). Et en particulier l'existence de peuplements importants de 2 genres, *Eunotia* et *Pinnularia,* communs dans les tourbières.

Les indices IM des diverses récoltes dans les types de mares correspondantes, projetés sur l'AFC des récoltes et des types de mares (Bertrand et al., 2013b) confirment dans l'ensemble la position des types sur le graphe. Toutefois si l'on prend la position des IMsa, les types « Taillis » devraient se placer sous les « Résineux ». Le type « Extérieurs de bâtiments » devrait se situer sous le type « Routes » et le type « Champs » au-dessus du type « Prairies ». Par contre si l'on prend les IMso le type « Taillis » est en bonne place mais le type « Feuillus » devrait se situer sous le type « Chemins ». Et les types « Prairies » et « Champs » devraient se situer au-dessus du type « Extérieurs de Bâtiments ».

Conclusion

La projection des indices IM sur les types de mares et les peuplements diatomiques montre une correspondance globalement satisfaisante. Ils ne se calquent pas complètement, car les deux approches sont totalement indépendantes. Nous pensons que cet essai de la mesure de la qualité des eaux des mares, basée sur un nombre restreint de données et sur les récoltes de tous les types de supports rencontrés (Bertrand et al., 2013a) peut cependant servir de base pour une étude plus large. Elle donne, semble-t-il, une assez bonne idée de la qualité des mares comparée aux réalités du terrain, contrairement au système IPS inadapté pour les mares.

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Mots clés

mares, écologie, diatomées, qualité, indice

Présentation orale

Apports des diatomées fossiles à l'histoire paléoenvironnementale des lacs d'altitude du massif du Mercantour (France) sur les 10 derniers millénaires : premiers résultats

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Points importants de l'étude

Ce travail porte sur les interactions Homme/Climat/Environnement durant l'Holocène à travers l'étude des assemblages fossiles de diatomées contenues dans deux séquences lacustres des Alpes du sud françaises.

Introduction

En région méditerranéenne, les 10000 dernières années ont été marquées par d'importants changements environnementaux : modifications du couvert végétal, occurrence des feux, fluctuations climatiques ; et par un développement précoce des sociétés humaines (Mocci et al., 2008). Cette exploitation des territoires jusque dans les hauts massifs alpins (depuis 5000 ans environ) rend difficile l'évaluation de la part respective du climat et des activités humaines dans la modification des écosystèmes. Dans les Alpes du sud, cette difficulté est accrue par le manque de données paléoenvironnementales permettant d'évaluer directement la variabilité climatique (Roberts et al., 2011). Face à cette problématique, les diatomées fossiles contenues dans les sédiments lacustres représentent une archive naturelle intéressante. Une double approche portant sur l'étude des assemblages de diatomées couplée à la mesure de la composition isotopique en oxygène ($\delta^{18}O$) de la silice des frustules est développée afin d'évaluer la réponse des lacs d'altitude méditerranéens aux changements de l'environnement (climat et/ou Homme). Cette double approche est appliquée sur deux profils sédimentaires prélevés dans le lac Petit (2200 m d'altitude) et le lac d'Allos (2200 m) tous deux situés dans le Mercantour. Ces deux sites bénéficient d'un solide corpus pluridisciplinaire (analyses palynologiques, géochimiques et sédimentologiques) qui permettra de reconstruire en détail l'évolution des environnements montagnards méditerranéens, depuis 13000 ans au lac d'Allos, et depuis 5000 ans au lac Petit.

Résultats et discussion

Au lac Petit, les 53 échantillons étudiés ont révélé une microflore riche et abondante constituée de 111 espèces de diatomées réparties en 39 genres. Les assemblages de diatomées sont principalement dominés par des espèces appartenant à la famille des Fragilariaceae. Elles représentent sur l'ensemble de la période de 65 à 90 % des assemblages. Parmi elles, les espèces dominantes sont *Staurosirella pinnata*, *Pseudostaurosira robusta*, *Pseudostaurosira brevistriata* et *Pseudostaurosira pseudoconstruens*. Ces espèces sont fréquentes dans les lacs alpins, arctiques et subarctiques (Pienitz et al., 1995) car bien adaptées à des milieux caractérisés par de longues périodes d'englacement, de rapides changements des paramètres physico-chimiques et une faible concentration en nutriments. A l'échelle spécifique néanmoins, la composition des assemblages a présenté d'importants changements sur la période d'étude avec :

- entre 4800 et 4180 cal. BP : une première période, où les assemblages sont peu diversifiés et dominés par *S. pinnata* (dont l'abondance relative est rarement en dessous de 80 %) prenant fin brutalement vers 4180 cal. BP,

- entre 4180 cal. BP et aujourd'hui : des assemblages dominés par *P. robusta* et caractérisés par un développement de *P. brevistriata* et *P. pseudoconstruens*,

- enfin, depuis 2390 ans : le développement des taxons neutrophiles (*Encyonema minutum*, *Navicula radiosa*, *Staurosira construens* var. *venter*, etc.) et méso-eutrophes (*Sellaphora pupula*, *N. radiosa*, etc.) (classification selon Van Dam et al., 1994) lié probablement à une acidification voire une eutrophisation progressive du lac.

La fin de la première période dominée par *S. pinnata* fait suite à une augmentation brutale des apports terrigènes jusqu'au lac entre 3450-4180 cal. BP (Brisset et al., 2012). L'augmentation des eaux de ruissellement a pu être à l'origine, au niveau de la cuvette lacustre d'une hausse de la turbidité des eaux et de la teneur en éléments dissous responsables de la chute de diversité observée dans les assemblages de diatomées. Il est possible que la récurrence d'épisodes orageux peut-être brefs mais intenses ait contribué à la déstabilisation de l'ensemble des versants, des écosystèmes qu'ils abritaient et nécessairement du compartiment lacustre. A cette même période, des hauts niveaux lacustres sont identifiés dans les Alpes du Nord et dans le Jura (Magny, 2004) ainsi qu'une forte activité des crues du Rhône (Delhon, 2005; Berger et al., 2008). Des changements de niveaux lacustres sont également enregistrés vers 4200 cal. BP sur le pourtour méditerranéen (Magny et al., 2012) suggérant un évènement climatique de grande ampleur. Enfin, à partir de 2390 cal. BP, l'augmentation des espèces de diatomées méso-eutrophes suggèrent une intensification des activités humaines sur le bassin versant à l'origine d'un apport en éléments nutritifs. Cette hypothèse est cohérente avec l'analyse pollinique : à cette période on observe un développement de landes à Ericacées (arbrisseaux de type bruyères), des espèces végétales nitrophiles (*Urtica*, *Mentha*) mais également une augmentation sensible des espèces herbacées rudéro-anthropiques qui témoigneraient d'une pression pastorale dans le vallon de Millefonts (Brisset et al., 2012).

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Mots clés

interactions milieu-homme-climat, lacs alpins, diatomées, Alpes du sud, Holocène

Présentation poster

Atlas des diatomées des cours d'eau de la région Rhône-Alpes (France)

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Principaux points de l'étude

Illustrations en microscopie des diatomées des rivières de la région Rhône-Alpes.

Répartition géographie et autécologie des diatomées de la région Rhône-Alpes.

Publication accessible pour tous par diffusion gratuite sur Internet.

Introduction

L'Atlas des diatomées des cours d'eau de Rhône-Alpes regroupe les informations recueillies durant des années de mise en œuvre de l'Indice Biologique Diatomées essentiellement au travers des réseaux réglementaires de suivi de la qualité des eaux superficielles sur les deux bassins hydrographiques de la région (Rhône-Méditerranée et Loire-Bretagne).

Les premiers relevés réalisés par le laboratoire de la DREAL ont été effectués à titre expérimental dès 1997 sur des stations de prélèvements appartenant au Réseau National de Bassin. Dès le début des années 2000, de nombreuses stations du Réseau National de Bassin ont été échantillonnées en routine par le laboratoire. A partir de 2003 et jusqu'à 2006, le laboratoire a assuré en régie l'ensemble des relevés diatomiques du Réseau National de Bassin en Rhône-Alpes. Cette collecte de données pour le Réseau National de Bassin a permis au laboratoire d'échantillonner plus de 500 stations dont le matériel diatomique et les listes floristiques ont été utilisés pour la réalisation de l'Atlas.

Quelques stations du Réseau National de Bassin correspondant aux suivis du fleuve Rhône et de la rivière Saône ont également été prises en compte pour la réalisation de l'Atlas. En outre, la mise en œuvre de la Directive Cadre Européenne sur l'Eau a ensuite permis au laboratoire de la DREAL d'intégrer dans l'Atlas l'ensemble des données collectées sur les stations du réseau de Référence, de Contrôle de Surveillance et de Contrôle Opérationnel. De nombreux échantillonnages complémentaires aux programmes d'échantillonnage annuels sur les réseaux de suivi ont également été réalisés par les diatomistes du laboratoire. Il s'agit de prélèvements effectués dans le cadre d'études particulières (évaluation de l'impact des vendanges sur les cours d'eau du Beaujolais, examen des communautés de diatomées du ruisseau de Saint Martial, etc…) ou de prélèvements réalisés à l'initiative des agents du laboratoire (par exemple prélèvements sur la retenue de l'Allement, ou échantillonnage par expression de bryophytes en complément d'échantillonnage sur galets). Des milieux particuliers ont également été échantillonnés tels qu'un contre-canal du fleuve Rhône, un exutoire de marais et des lentilles d'eau. Ces données « hors réseau » ont été bancarisées et ont également contribué aux illustrations en microscopie optique de l'Atlas. Près de 300 échantillons ont fait l'objet d'un examen complémentaire au microscope électronique à balayage, dans le but de pouvoir confirmer les identifications de certaines espèces dont certains critères ne sont pas visibles en microscopie optique.

Résultats et discussion

L'Atlas des diatomées des cours d'eau de la région Rhône-Alpes présente les espèces observées dans le cadre des opérations détaillées ci-dessus dans l'introduction. Au total, plus de 500 taxons ont été illustrés, répartis parmi les 6 tomes suivants :

Tome 1 – CENTRIQUES (*Actinocyclus*, *Aulacoseira*, *Conticribra*, *Cyclostephanos*, *Cyclotella*, *Discostella*, *Ellerbeckia*, *Melosira*, *Pleurosira*, *Puncticulata*, *Skeletonema*, *Stephanodiscus*, *Thalassiosira*), MONORAPHIDÉES (*Achnanthes*, *Achnanthidium*, *Cocconeis*, *Eucocconeis*, *Karayevia*, *Lemnicola*, *Planothidium*, *Platessa*, *Psammothidium*).

Tome 2 – ARAPHIDÉES (*Asterionella*, *Ctenophora*, *Diatoma*, *Distrionella*, *Fragilaria*, *Fragilariforma*, *Hannaea*, *Meridion*, *Pseudostaurosira*, *Punctastriata*, *Stauroforma*, *Staurosira*, *Staurosirella*, *Tabellaria*, *Tabularia*, *Ulnaria*), BRACHYRAPHIDÉES (*Eunotia*).

Tome 3 – NAVICULACÉES : NAVICULOIDÉES (*Adlafia*, *Amphipleura*, *Aneumastus*, *Anomoeoneis*, *Berkeleya*, *Brachysira*, *Caloneis*, *Cavinula*, *Chamaepinularia*, *Craticula*, *Diadesmis*, *Didymosphenia*, *Diploneis*, *Eolimna*, *Fallacia*, *Fistulifera*, *Frustulia*, *Geissleria*, *Gyrosigma*, *Hippodonta*, *Kobayasiella*, *Luticola*, *Mayamaea*, *Naviculadicta*, *Neidiomorpha*, *Neidium*, *Nupela*, *Oestrupia*, *Parlibellus*).

Tome 4 – NAVICULACÉES : NAVICULOIDÉES (*Navicula*, *Pinnularia*, *Placoneis*, *Prestauroneis*, *Pulchella*, *Sellaphora*, *Stauroneis*).

Tome 5 – NAVICULACÉES : CYMBELLOIDÉES (*Amphora*, *Cymbella*, *Cymbopleura*, *Delicata*, *Encyonema*, *Encyonopsis*, *Halamphora*, *Rhoicosphenia*), GOMPHONÉMATOIDÉES (*Gomphoneis*, *Gomphonema*, *Gomphosphenia*, *Reimeria*).

Tome 6 – BACILLARIACÉES (*Bacillaria*, *Denticula*, *Hantzschia*, *Nitzschia*, *Simonsenia*, *Tryblionella*), RHOPALODIACÉES (*Epithemia*, *Rhopalodia*), SURIRELLACÉES (*Cymatopleura*, *Stenopterobia*, *Surirella*).

Les dernières avancées en matière de taxonomie ont conduit à de nombreuses évolutions quant à la désignation de plusieurs espèces : les identifications apparaissant dans cet ouvrage correspondent à la description la plus récente au regard de la bibliographie consultée.

Chaque fiche de l'Atlas présente une liste des publications relatives à l'espèce présentée avec indication en couleur des illustrations correspondant au matériel type. Ces références bibliographiques sont complétées par la désignation de l'espèce, au fur et à mesure de l'évolution de la systématique, éventuellement du basionyme et des synonymes.

Une synthèse des caractéristiques morphologiques de l'espèce et quelques données relatives à son écologie sont également indiquées : elles proviennent généralement des ouvrages référencés sur la fiche.

Des valeurs de notes indicielles sont également indiquées : elles résultent de l'application de l'Indice Biologique Diatomées (IBD) de décembre 2007 et de l'Indice de Polluo-sensibilité Spécifique (IPS) sur la base d'un cortège diatomique de 400 unités systématiques unités de comptages (valves) correspondant à une abondance relative de 100% de l'espèce présentée.

Des commentaires sont formulés concernant la distribution de l'espèce en région Rhône-Alpes. Une carte régionale de répartition propose une représentation permettant de localiser rapidement l'emplacement des stations sur lesquelles l'espèce a été échantillonnée au moins une fois entre 1997 et 2009 et la taille du cercle sur la carte traduit l'abondance maximale relevée pendant cette période d'échantillonnage.

Chaque espèce est illustrée par une ou plusieurs séries de photos d'individus provenant de divers échantillons, ce qui permet de mieux apprécier la variabilité de l'espèce au sein d'un même échantillon et ainsi que la variabilité de l'espèce entre deux sites distincts.

La majorité des illustrations provient des échantillonnages réalisés de 1997 à 2009 ; quelques illustrations ont cependant été réalisées à partir d'échantillons plus récents en raison de la présence d'une espèce qui n'avait pas été inventoriée précédemment, ou bien en raison de la présence d'une population remarquable permettant une illustration de meilleure qualité.

Afin de garantir une large diffusion de cette mine d'information iconographique, biogéographique et écologique, l'Atlas des diatomées des cours d'eau de la région Rhône-Alpes sera disponible gratuitement sur Internet et il sera également publié en 6 tomes principaux disponibles pour consultation auprès de la DREAL Rhône-Alpes.

Mots clés

Atlas iconographique, diatomées d'eau douce, Indice Biologique Diatomées, rivières, Rhône-Alpes

Présentation orale

Présentation d'un outil de valorisation des données hydrobiologiques

Exemples de valorisation des données diatomées produites dans le cadre de la surveillance liée à la Directive Cadre sur l'Eau en région Centre

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Principaux points de l'étude

La DREAL Centre a fait développer un logiciel pour la valorisation des données diatomées permettant notamment de communiquer sur l'évolution des notes IBD et des principaux taxons rencontrés.

Introduction

Les diatomées font partie des éléments de qualité biologiques utilisés en France pour évaluer l'état écologique des cours d'eau conformément aux exigences de la Directive Cadre européenne sur l'Eau (DCE) d'octobre 2000. Entre 2005 et 2010, avec la mise en place successive des différents réseaux de la DCE (réseau de référence, réseau de contrôles de surveillance et réseau de contrôles opérationnels), le nombre de stations suivies sur les cours d'eau s'est régulièrement accru ainsi que le nombre de données produites annuellement pour chaque élément de qualité biologique. Bien qu'une banque nationale de données soit en cours de développement pour les eaux de surface continentales, le producteur de données ne dispose d'aucun outil d'analyse et de valorisation des données hydrobiologiques. Un outil conforme au Système d'Information sur l'Eau français permettrait des échanges avec les banques de bassin déjà existantes ou la banque de données nationale à venir.

La DREAL Centre, dont le laboratoire d'hydrobiologie est accrédité pour les analyses diatomées et macro-invertébrés participe pleinement à l'acquisition de données sur les réseaux de la DCE et souhaite exploiter ces données pour améliorer sa connaissance des cours d'eau, communiquer sur l'état écologique des cours d'eau et son évolution et aider à la prise de décision. Elle a fait développer par la société AQUASYS, un logiciel de valorisation des données hydrobiologiques à partir d'un outil déjà existant pour les données physico-chimiques : SIQ = Système d'Information sur la Qualité des eaux - volet hydrobiologie. Nous proposons de présenter, à partir des données diatomées produites sur la région Centre, les principales fonctionnalités de SIQ-hydrobio et ses intérêts, qui dépassent l'exploitation des seules données de la DCE.

Résultats et discussion

Les résultats obtenus en région Centre lors d'une analyse IBD (indice biologique diatomées) selon la norme NF T90-354 sont constitués par trois fichiers :

- la fiche de terrain, établie selon le modèle national de l'Institut national de recherche en sciences et technologies pour l'environnement et l'agriculture (IRSTEA) et décrivant le site et les conditions de prélèvement,

- la liste floristique éditée grâce au logiciel Omnidia (Lecointe et al., 1993) après détermination,

- et les indices eux-mêmes (IBD et IPS notamment) calculés par Omnidia (Lecointe et al., 1993) et reportés dans un tableur excel afin d'être bancarisés par les agences de l'eau.

SIQ-Hydrobio permet d'intégrer automatiquement ces fichiers, en les agrégeant en une base de données où les informations sont structurées en réseaux, stations, sites, prélèvements et résultats (indices et listes floristiques). Toutes les données intégrées sont codifiées conformément au référentiel national français des données sur l'eau.

Il est également possible d'associer à la base ainsi constituée des photos des stations et des sites de prélèvement, ainsi que des extraits de cartes de localisation et des schémas. Le logiciel permet l'édition automatique de documents à partir des données figurant en base, notamment des fiches station avec photos et carte de localisation. Cette fonctionnalité simplifie les échanges d'information avec les prestataires intervenant sur le terrain et avec les agences de l'eau.

Les exports de données sont possibles soit vers d'autres utilisateurs disposant également de SIQ, soit vers des banques de données ou simplement vers un tableur.

Les recherches dans la base sont simplifiées par des filtres qui peuvent s'appliquer selon différents critères (géographiques, hydroécologiques, critères de dates…). Sur ces stations présélectionnées, les recherches peuvent être affinées par des requêtes portant sur les résultats ou sur les listes floristiques. Il est possible par exemple de rechercher les taxons dominants sur un groupe de stations ou de comparer les taxons dominants d'une station au cours du temps. L'outil est également intéressant pour rechercher facilement l'occurrence d'un taxon ou d'un ensemble de taxons, par exemple des espèces invasives. Les premières utilisations de SIQ-hydrobio nous ont ainsi permis d'établir une liste des espèces de diatomées rencontrées en région Centre depuis 2007 et de cartographier la présence d'une espèce invasive *Eolimna comperei* (Coste & Ector, 2000) en région Centre sur les stations suivies dans le cadre de la surveillance liée à la DCE.

SIQ-hydrobio permet également d'exploiter les résultats IBD : il calcule les classes d'état écologique conformément aux valeurs seuils définies dans l'arrêté évaluation du 25 janvier 2010 et les édite sur une carte de la région Centre.

A l'heure où les réseaux liés à la Directive Cadre sur l'Eau sont pleinement opérationnels et où la quantité de données produites chaque année se fait conséquente, il est important d'avoir une vision synthétique des résultats obtenus et de pouvoir déceler des tendances, à la fois pour affiner la production des données mais également pour évaluer les politiques publiques. SIQ-hydrobio ouvre ainsi de nombreuses perspectives d'analyses critiques, de valorisation des données et d'amélioration de nos connaissances.

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Mots clés

logiciel, données, valorisation, diatomées, état écologique

Présentation poster

Les diatomées bryophytiques de la région antarctique maritime

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Principaux points de l'étude

Présentation de la région étudiée et de ses végétations de mousses

Analyse de la diversité des diatomées présentes dans les bryophytes

Analyse des communautés des diatomées bryophytiques

Introduction

La végétation dans la Région antarctique maritime (située dans l'Océan atlantique australe) est très appauvrie et ne compte que quelques espèces d'Angiospermes. Les parties avec de la végétation, situées pour une bonne partie dans les endroits les plus humides en basse altitude, sont alors complètement dominées par une centaine d'espèces de mousses et de lichens (Ochyra et al., 2008). Ces végétations présentent un habitat favorable pour des micro-organismes dont les diatomées forment un des groupes principaux (Broady, 1986). Les diatomées bryophytiques sont très rarement étudiées dans la Région antarctique même si ces communautés peuvent fournir des indications quant à la survie des diatomées endémiques durant les périodes de refroidissement en Antarctique.

Durant deux expéditions (Péninsule de Byers, Ile Livingston, été austral 2009 et Péninsule d'Ulu, Ile James Ross, été austral 2012), 85 échantillons de mousses ont été récoltés. L'Ile de Livingston appartient à l'archipel des Iles Shetland du Sud et se trouve 150 km au nord du Péninsule antarctique. La partie occidentale de cette île est constituée d'une grande zone sans glace qui s'appelle Péninsule de Byers. Au contraire, l'Ile James Ross est une île assez large et isolée située dans la partie nord-ouest de la Mer de Weddell, très proche de la Péninsule antarctique, sur la frontière entre la Région maritime-antarctique et le Continent Antarctique. La plupart de cette île (75%) est couverte de glace en permanence avec uniquement dans le nord de l'île une partie sans glace.

Résultats et discussion

Dans les 85 échantillons, une flore de diatomées bien développée a été trouvée avec un total de 128 taxons, appartenant à 39 genres. L'aplatissement (vers la fin) de la courbe d'accumulation des espèces pour l'Ile Livingston indique que ces échantillons contiennent une grande partie du nombre total de diatomées théoriquement présent, ceci contrairement aux jeux d'échantillons pris sur l'Ile James Ross pour lequel encore un nombre considérable d'échantillons serait nécessaire pour avoir un jeu de données représentatif de la flore diatomique.

Une analyse biogéographique des taxons présents montre qu'environ 53% de tous les taxons observés présentent une distribution typiquement antarctique avec même 79% de ces taxons restreints à la Région antarctique maritime. Uniquement 43 taxons (32% de tous les taxons observés) peuvent être considérés comme cosmopolites. *Fragilaria capucina* Desm., *Navicula gregaria* Donkin, *Pinnularia borealis* Ehrenb. et *Nitzschia gracilis* Hantzsch ne sont que quelques exemples de cette catégorie. Une différence remarquable a été trouvée dans la diversité entre les deux îles étudiées : sur l'Ile Livingston, en moyenne 25 taxons ont été trouvés par échantillons, contrairement à 16 taxons pour l'Ile James Ross. Cette différence peut être facilement expliquée par les caractéristiques climatiques et écologiques de ces deux îles avec l'Ile James Ross nettement plus sèche que l'Ile Livingston.

L'analyse des communautés confirme bien cette séparation des deux îles. Les échantillons de l'Ile James Ross présentent plutôt une flore terrestre dominée par *Pinnularia borealis*, *Hantzschia amphioxis* (Ehrenb.) Grunow, *Hantzschia abundans* Lange-Bert. et *Diadesmis arcuata* (Heiden) Lange-Bert. Contrairement, sur l'Ile de Livingston, trois assemblages différents apparaissent sur les analyses multivariées, dont la première peut être encore subdivisée en deux, formant un assemblage de diatomées bryophytiques influencées par des mammifères et oiseaux marins (dominé par *Psammothidium germanii* (Manguin) Sabbe, *Nitzschia homburgiensis* Lange-Bert. et *Pinnularia antarctica* var. *elongata* (Manguin) Van de Vijver & Le Cohu) et un assemblage avec des échantillons des endroits plutôt pionniers et isolés.

A part ces deux communautés très spécialisées, le reste des échantillons de l'Ile Livingston est groupé en deux assemblages : un premier groupant les échantillons de mousses humides mais terrestres dominées par *Psammothidium incognitum* (Krasske) Van de Vijver, *Gomphonema* spp. et *Planothidium rostrolanceolatum* Van de Vijver et al. Un deuxième groupe compte une majorité d'échantillons provenant des végétations de mousses aquatiques récoltées dans les lacs et les mares. La flore dans ces échantillons est caractérisée par plusieurs espèces de *Nitzschia* comme *Nitzschia gracilis* et *N. paleacea* Grunow.

En conclusion, cette étude montre bien que les végétations de mousses sur les îles dans la Région antarctique maritime forment un habitat favorable pour les diatomées non-marines qui présentent une diversité assez large. La composition des communautés de diatomées est déterminée par le type d'habitat, l'humidité des mousses et l'influence biotique de la faune marine.

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Mots clés

Région antarctique maritime, diatomées, diversité, analyse des communautés

Présentation orale

Les diatomées holocènes des dépôts lacustres de l'Erg Er Raoui (nord-ouest du Sahara algérien) et leur signification paléoécologique

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Principaux points de l'étude

Une étude détaillée a été réalisée le long d'une coupe correspondant à une sédimentation calcaire (de 1,50 m d'épaisseur), située à 104 km au Nord de la ville de Tabelbala et se présente sous forme d'une butte témoin au centre d'une dépression inter-dunaire de l'Er Er Raoui (NW du Sahara algérien). Le traitement et l'analyse des sédiments le long de cette coupe, nous a permis d'établir un inventaire détaillé de la flore diatomique et suivre la variation verticale quantitative et qualitative des diatomées pour un essai de reconstitution paléoenvironnementale de ces dépôts.

Introduction

En bordure NO-SE de l'Er Er Raoui (NW du Sahara algérien) et sur plus d'une centaine de kilomètres apparaissent de nombreuses dépressions inter-dunaires occupées d'une sédimentation lacustre d'âge holocène et représentées généralement par des carbonates blancs biogéniques à aspect diatomitique. Ces dépôts lacustres ou palustres d'âges holocènes ont été signalés pour la première fois dans les années 70 par Alimen et al. (1070) et Baudrimont (1973) en étudiant un certain nombre d'échantillon provenant d'une butte témoin à proximité d'un puits connu sous le nom de Hassi Manda.

Lithologiquement, la coupe est constituée de bas en haut : d'un niveau détritique argilo- sableux de 30 cm d'épaisseur, stérile en diatomées mais riche en ostracodes, en charophytes et en gastéropodes ; un deuxième niveau calcaire (1,50 m) représenté par des carbonates blancs biogéniques à diatomées, dont les 40 premiers centimètres (éch. Tab B1 à Tab B6) semblent être stériles en diatomées tandis que les 1,10 m qui suivent (éch. Tab B7 – Tab B14) sont diatomifères. Les résultats présentés dans ce travail reposent sur le traitement des échantillons : Tab B7 à Tab B14 ayant livrés des diatomées appartenant aux niveaux diatomifères. A l'issue des traitements physico-chimiques, les autres échantillons (Tab B1 à Tab B6) se sont révélés stériles.

L'abondance relative des taxons de diatomées rencontrés est établie à partir d'un comptage sur lames observées au microscope optique. Au terme de ces comptages, la fréquence de chaque taxon par rapport à l'ensemble des individus contenus dans un échantillon est calculée. La détermination et les principales données paléoécologiques et écologiques sont établies à partir de plusieurs travaux dont les principaux sont : Hustedt (1930, 1959), Alimen et al. (1970), Baudrimont (1973), Ehrlich (1973), Servant-Vildary (1973, 1978), Servant & Fontes (1978), Germain (1981), Krammer & Lange-Bertalot (1986, 1988), Gasse et al. (1987), Lange-Bertalot & Krammer (1987), Round et al. (1990), Gasse (2002).

Résultats et discussion

La microflore de diatomées analysée a fourni 21 espèces réunies en 13 genres, dont trois taxons en nomenclature ouverte, traduisant ainsi une microflore siliceuse peu diversifiée. Il est à noter que nombreux individus sont dissous, ne permettant pas une bonne détermination.

Outre les espèces cosmopolites ou à nomenclature ouverte, plusieurs espèces ont été regroupées en différents groupes écologiques selon le mode de vie (habitat) et la salinité des eaux en se basant sur les travaux de Gasse et al. (1987) et Gasse (2002) :

- planctonique littoral : *Cyclotella kuetzingiana*, *Gomphonema acuminatum* et *Rhopalodia gibba* ;

- périphytique *s.l.*, regroupant les formes épipiliques, épiphytiques et les aérophiles : les épipliques sont représentées par : *Anomoeoneis sphaerophora*, *Epithemia argus*, *Mastogloia smithii* var. *lacustris*, *Mastogloia smithii s.l.*, *Navicula oblonga*, *Navicula radiosa*, *Nitzschia denticula*, *Pinnularia maior* et *Pinnularia viridis*, les épiphytiques sont représentées par *Epithemia zebra*, *Eunotia arcus*, *Eunotia pectinalis* et *Rhopalodia parallela* tandis que les aérophiles correspondent au seul taxon *Diploneis ovalis* ;

- eau douce : *Cyclotella kuetzingiana*, *Epithemia argus*, *Eunotia arcus*, *Gomphonema acuminatum*, *Pinnularia maior* et *Rhopalodia parallela* ;

- eau douce-oligosaline : *Diploneis ovalis*, *Epithemia zebra*, *Navicula oblonga*, *Navicula radiosa*, *Pinnularia viridis* et *Rhopalodia gibba* ;

- eau oligosaline : *Anomoeoneis sphaerophora* et *Nitzschia denticula* ;

- oligo-mésosaline : *Mastogloia smithii s.l.* et *Mastogloia smithii* var. *lacustris*.

Tout au long de la coupe, à l'exception des niveaux stériles en diatomées, l'assemblage diatomique est caractérisé par l'abondance des diatomées périphytiques *s.l.* avec une fréquence dépassant les 92% en moyenne, suggérant ainsi un milieu de sédimentation lacustre de très faible bathymétrie. La rareté des formes planctoniques littorales et leur faible fréquence ne dépassant guère les 6% en moyenne permet par conséquent de supposer que le milieu de dépôt n'a, à aucun moment de son histoire, atteint de grande profondeur.

La sédimentation semble évoluer d'un milieu palustre (niveaux argilo-détritiques stériles) riche en ostracodes et charophytes vers un milieu lacustre (niveau à carbonates blancs biogéniques). Dans ce dernier, de bas en haut et en fonction des espèces dominantes et espèces accompagnatrices, quatre assemblages à diatomées ont été définis : 1. Assemblage à *Navicula radiosa* et *Epithemia argus* ; 2. Assemblage à *Mastogloia smithii s.l.* et *Navicula radiosa* ; 3. Assemblage à *Eunotia arcus* et *Mastogloia smithii* var. *lacustris* et 4. Assemblage à *Diploneis ovalis* et *Navicula oblonga*) traduisant ainsi un milieu en général d'eau douce à oligosaline et alcaline soumise à des périodes de légère acidification attestée par la présence plus ou moins significative des formes liées à un pH acide ou acido-alcalin. Un milieu évoluant en général en deux phases de sédimentation (fluctuation du plan d'eau) :

- une phase peu profonde (éch. Tab B7 – Tab B11) à forte turbulence des eaux et à tranche d'eau à caractère eau douce à oligosaline où prédominent les formes épipéliques, correspondant à une période de forte précipitation (Holocène humide) ;

- une deuxième phase très peu profonde (éch. Tab B11a – Tab B14) à dominance respectivement de formes aérophiles et épiphytiques et à tranche d'eau calme à caractère généralement d'eau douce à oligosaline soumise à des périodes épisodiques d'évaporation attestée par la présence notable de formes oligo-mésosalines (*Mastogloia smithii s.l*. et *Mastogloia smithii* var. *lacustris*). Cette phase pourrait correspondre à une période d'évaporation (Holocène aride).

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Mots clés

Erg Er Raoui, dépression, Holocène, lacustre, diatomées, assemblages

Présentation orale

Aperçu sur la structure systématique des diatomées épilithiques et qualité biologique de l'Oued Derdouse (affluent de l'Oued Chélif, Algérie)

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Principaux points de l'étude

Les communautés diatomiques épilithiques de plusieurs stations de l'Oued Derdouse (un des affluents de l'Oued Chélif) ont fait l'objet d'une étude basée essentiellement sur leur structure systématique.

Introduction

Dans le but de compléter le diagnostic sur la qualité physico-chimique de l'eau, d'autres méthodes basées sur des bio-indicateurs (diatomiques entre autres) peuvent être appliquées dans les cours d'eau. Les communautés de diatomées épilithiques regroupent une grande variété d'espèces présentant des niveaux de tolérance différents vis-à-vis de la pollution. Pendant l'année 2012, ces communautés épilithiques de plusieurs stations de l'Oued Derdouse (un des affluents de l'Oued Chélif), ont été étudiées dans le but d'évaluer la qualité biologique de l'eau au moyen des indices diatomiques IPS et IBD et de connaître leur applicabilité dans les oueds du bassin du Chélif. Ces deux indices ont été choisis car ils intègrent divers types de pollution : l'Indice de Polluo-sensibilité Spécifique -IPS- est considéré comme une méthode de référence en Europe et l'Indice Biologique Diatomées -IBD- est utilisé régulièrement en France depuis sa normalisation par l'AFNOR (2000). Cette étude préliminaire des communautés diatomiques épilithiques de l'Oued Derdousse, vise à donner un aperçu sur leur structure systématique afin d'appliquer ultérieurement les méthodes des indices diatomiques.

Les sites étudiés se situent à la bordure occidentale du Bassin du Bas Chélif. Ce dernier est un grand bassin hydrographique caractérisé par des réseaux d'eaux superficielles, constitués de l'Oued Chélif et ses affluents. Le site concerné par cette étude est l'Oued Derdouse (un des affluents de l'Oued Chélif). Cinq stations ont été suivies dans le cadre de la campagne d'échantillonnage en 2012.

La méthodologie européenne a été respectée pour la récolte et le traitement des échantillons ainsi que pour la préparation des lames, les comptages des inventaires et l'archivage des données.

Résultats et discussion

La systématique adoptée dans ce travail est celle proposée par Round et al. (1990). L'étude microfloristique nous a permis d'inventorier 35 espèces et variétés réparties en 9 genres. La microflore diatomique est représentée par les Pennatophycidées. En outre, bien que cette flore diatomique récoltée soit spécifiquement riche, elle est numériquement mal répartie entre les genres et les familles :

Embranchement des Chromophytes
- Classe des Diatomophyceae (Bacillariophyceae)
- Sous classe des Pennatophycidées
- Ordre des Bacillariales

° Sous-ordre des Fragilariineae
Famille des Eunotiaceae
Genre : *Eunotia*
Eunotia asterionelloides Hustedt
Famille des Fragilariaceae
Genre : *Asterionella*
Asterionella formosa Hassall
Genre : *Fragilaria*
Fragilaria brevistriata Grunow
° Sous-ordre des Bacillariineae
Famille des Cymbellaceae
Genre : *Amphora*
Amphora commutata Grunow
Amphora montana Krasske
Amphora normanii Rabenhorst
Amphora veneta Kützing
Amphora sp.
Famille des Naviculaceae
Genre : *Gomphonema*
Gomphonema angustatum (Kützing) Rabenhorst
Gomphonema parvulum Kützing
Gomphonema productum (Grunow) Lange-Bertalot & E. Reichardt
Gomphonema pseudoaugur Lange-Bertalot
Genre : *Navicula*
Navicula accommoda Hustedt
Navicula halophila (Grunow) Cleve
Navicula halophila f. *robusta* Hustedt
Navicula pseudohalophila Cholnoky
Navicula radiosa Kützing
Navicula saprophila Lange-Bertalot & Bonik
Navicula sp.
Genre : *Pinnularia*
Pinnularia leptosoma (Grunow) Cleve
Famille des Bacillariaceae
Genre : *Nitzschia*
Nitzschia amphibia Grunow
Nitzschia capitellata Hustedt
Nitzschia dissipata (Kützing) Grunow
Nitzschia intermedia Hantzsch
Nitzschia minuta Bleisch
Nitzschia subcapitella Hustedt
Nitzschia tryblionella Hantzsch
Nitzschia tryblionella var. subsalina (O'Meara) Grunow
Nitzschia palea (Kützing) W. Smith
Nitzschia palea var. *debilis* (Kützing) Grunow
Nitzschia paleacea Grunow in Van Heurck,

Nitzschia pusilla (Kützing) Grunow
Nitzschia umbonata (Ehrenberg) Lange-Bertalot
Genre : *Hantzschia*
Hantzschia amphioxys (Ehrenberg) Grunow in Cleve & Grunow

Tableau 1: Proportion des espèces de diatomées par genre.

Genre	Abondance
Amphora	2,90%
Asterionella	0,30%
Eunotia	0,50%
Fragilaria	0,60%
Gomphonema	9,35%
Hantzschia	0,05%
Navicula	50,35%
Nitzschia	35,85%
Pinnularia	0,10%

L'inventaire microfloristique est dominé par deux genres (*Navicula* et *Nitzschia*), qui comptent un total de 21 espèces et variétés, soit un taux de 86,2% de la structure spécifique (Tableau 1) du milieu prospecté. Cette prédominance de ces deux taxons engendre un déséquilibre systématique. Concernant ce déséquilibre systématique, la différence des conditions écologiques exigées par chacune des espèces et variétés semble être la cause principale. En effet, il est connu que chez les diatomées, ce sont les conditions physico-chimiques exigées par les différents taxons qui déterminent la structure spécifique des communautés diatomiques. Les résultats montrent que les taxons inventoriés n'ont pas tous les mêmes affinités écologiques : *Nitzschia palea* est considérée comme l'une des meilleures indicatrices de pollution organique (Turoboyski, 1973; Kawecka, 1981). Elle domine également dans les eaux très riches en azote (Schoeman, 1976) ainsi que dans les eaux contaminées par les rejets d'eau usée domestique (Besch et al., 1972; Kawecka, 1981). D'autres espèces caractérisent des eaux marquant la phase finale de l'auto-épuration d'un cours d'eau (Butcher, 1947) ou des eaux oligotrophes (Schoeman, 1973) telles que *Gomphonema angustatum* et *Amphora veneta*. D'autres espèces sont caractérisées par un large spectre écologique tel que *Gomphonema parvulum* qui peut vivre en eaux polluées et eaux de bonne qualité (Kawecka, 1981). L'étude de la structure spécifique de la communauté algale diatomique de l'Oued Derdouse contribue à la constitution d'une banque de données des communautés diatomiques. Ceci permettra l'utilisation des méthodes des indices diatomiques et par conséquent une évaluation très fiable de la qualité biologique de ce cours d'eau.

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Mots clés

systématique, communauté diatomique, épilithique, Oued Derdouse

Présentation orale

L'indice EPI-L pour l'évaluation de la trophie des lacs profonds par les diatomées benthiques

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Principaux points de l'étude

Discussion d'un nouvel indice pour évaluer la trophie des lacs profonds

Introduction

Les diatomées benthiques ont été utilisées pour évaluer la pollution organique ou générale (p.ex. AFNOR, 2007) ainsi que la trophie (p.ex. Kelly & Whitton, 1995; Rott et al., 1999) des rivières. Certains de ces indices ont été adaptés aux lacs, et présentent une bonne capacité d'indiquer leur trophie (Bennion et al., 2012; Schaumburg et al., 2004).

Toutefois, dans les lacs profonds italiens il y a une faible corrélation entre les indices existants et la concentration moyenne de phosphore totale epilimnétique (TP) et ces indices ne permettent pas de distinguer les lacs pollués des sites de référence. Pour ces raisons, Marchetto et al. (2013) ont proposé un nouvel indice diatomique pour l'évaluation de la trophie des lacs italiens (EPI-L).

EPI-L est basé sur la formule des moyennes pondérées proposée par Zelinka & Marvan (1961), optimisé sur le logarithme du TP (logTP). La valeur indicatrice de chaque espèce est calculée à son tour à partir de la moyenne du logTP des lacs où cette espèce a été retrouvée, pondérée sur son abondance relative. La base de données utilisée comprend 70 échantillons prélevés dans 53 lacs, dont 6 lacs de barrage. Les 32 lacs profonds échantillonnés, incluent aussi les 7 grands lacs volcaniques d'Italie centrale.

Résultats et discussion

Le coefficient de corrélation entre les différents indices diatomiques et les valeurs de logTP dans l'ensemble des lacs échantillonnés se situe entre 0,04 et 0,49. Généralement, le coefficient de corrélation pour les lacs de moins de 15 mètres de profondeur (0,06 – 0,66) est meilleur que pour les lacs plus profonds (0,01 – 0,58). Une grande partie des corrélations sont statistiquement significatives, mais la différence dans la distribution des valeurs des indices entre les lacs oligotrophes et eutrophes n'est pas statistiquement significative.

Seulement deux des indices européens (Steinberg & Schiefele, 1988; Hürlimann & Niederhauser, 2007), montrent une meilleure corrélation pour les lacs profonds, toutefois sans permettre de différencier les lacs les plus pollués des sites de référence.

Au contraire, la corrélation de l'EPI-L avec le logTP, n'est pas influencée par la profondeur des lacs (*r* = 0,67 pour les lacs profonds et *r* = 0,65 pour les lacs moins profonds) et la séparation entre les lacs eutrophes et oligotrophes est statistiquement significative.

Comme les indices optimisés pour les rivières, même s'ils ont été adaptés aux lacs, ils ne séparent pas de manière significative les lacs de différents niveaux trophiques, les valeurs indicatrices des espèces incluses dans l'EPI-L ont été comparées avec celles des deux indices qui reflètent mieux le gradient de trophie des lacs italiens, c'est-à-dire l'Indice de Polluosensibilité Spécifique (IPS: CEMAGREF, 1982) et l'Indice Suisse des Diatomées (DI-CH : Hürlimann & Niderhauser, 2007).

Les 80 espèces les plus abondantes dans les lacs profonds italiens (au moins 1% pour 3 lacs) sont toutes incluses dans la liste des espèces de l'IPS. Par contre, 23 de ces espèces ne se trouvent pas dans la liste du DI-CH. Il ne s'agit pas d'espèces rares, car leur abondance relative peut atteindre plus de 20%. C'est le cas exemple pour *Fragilaria perminuta* (Grunow) Lange-Bertalot, *Eunotia microcephala* Krasske, *Encyonopsis microcephala* (Grunow) Krammer, *Staurosira brevistriata* (Grunow) Grunow.

Dans le cas de l'IPS, toutes les espèces retrouvées dans les lacs oligotrophes ont des valeurs élevées de sensibilité (4-5), mais un certain nombre d'espèces considérées comme sensibles sont aussi communes dans les lacs mésotrophes et eutrophes, comme par exemple *Amphora inariensis* Krammer, *Rhopalodia gibba* (Ehrenb.) O.Muller et *Eunotia microcephala* Krasske.

Aussi dans le cas du DI-CH, certaines espèces relativement communes dans les lacs eutrophes sont considérées comme sensibles (p.ex. *Encyonema caespitosum* Kützing, *Epithemia adnata* (Kützing) Brébisson et *Gomphonema olivaceum* (Hornemann) Brébisson). Dans le cas contraire, les espèces tolérantes, retrouvées principalement dans des lacs oligotrophes, ne concernent que quelques espèces moins abondantes, comme par exemple *Ulnaria ulna* (Nitzsch) Compère var. *acus* (Kützing) Lange-Bertalot et *Gomphonema parvulum* (Kützing) Kützing.

En conclusion, les indices diatomiques basés sur la formule des moyennes pondérées (Zelinka & Marvan, 1961) sont capables d'indiquer la trophie des lacs, mais les valeurs indicatrices des espèces doivent être adaptées, surtout pour les lacs profonds. Dans le cas de l'EPI-L, les valeurs indicatrices ont été obtenues directement de la base de données des lacs italiens avec la méthode des moyennes pondérées.

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Mots clés

Indice diatomique, trophie, lacs profonds, Italie, phosphore

Présentation orale

Impact de stress multiples sur les communautés de diatomées

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Principaux points de l'étude

Cette étude se propose d'évaluer si le cumul de stress de différentes natures augmente la vulnérabilité des communautés de diatomées, et leur réponse potentielle à l'apparition de nouvelles perturbations.

Introduction

L'exposition chronique à des facteurs de stress non létaux, survenant progressivement (dans l'espace ou le temps), peut engendrer des impacts cumulatifs. Ces derniers peuvent s'avérer aussi (voire plus) importants que les impacts d'une exposition critique, mais occasionnelle, à l'un de ces contaminants isolément. Les effets délétères de ces stress peuvent être durables, voire s'intensifier et devenir problématiques au cours du temps et / ou à des niveaux trophiques supérieurs.

Les diatomées des cours d'eau peuvent, par exemple, subir ce type de stress cumulatif le long d'un gradient amont-aval de contamination d'origine naturelle et humaine, tel qu'on peut l'observer dans les bassins versants anthropisés. Dans cette étude menée sur cinq ans, nous avons suivi les changements structurels et fonctionnels de communautés diatomiques estivales le long de la rivière Riou-Mort (Sud Ouest de la France), en trois points correspondant à un site amont (Firmi), considéré comme référence, un site intermédiaire (Decazeville) exposé à des concentrations en nutriments élevées, et un site aval (Joanis) caractérisé par une pollution à la fois trophique et métallique (notamment cadmium et zinc).

Résultats et discussion

Les impacts cumulés des nutriments et des métaux se traduisent par une diminution progressive de la richesse spécifique, de l'hétérogénéité locale des communautés, et de la diversité des traits.

Ainsi, la distribution des échantillons par analyse factorielle des correspondances, basée sur les abondances relatives des espèces, traduit le gradient amont-aval (Axe 1) et une variabilité de structure des communautés (inter-échantillon, et inter-annuelle) qui tend à diminuer avec le cumul des pollutions (Axe 2). De même, la richesse (R) et la diversité (D) spécifiques diminuent le long de ce gradient : R=46±3 espèces à Firmi (D=2,4±0,2), R=33±3 à Decazeville (D=2,1±0,1) et R=34±3 à Joanis (D=1,8±0,1).

Ce gradient s'observe également très clairement sur la distribution des traits spécifiques aux contaminations considérées :

- les distributions basées sur les préférences/tolérances de Van Dam et al. (1994) indique, dès le site de Decazeville, une prédominance des formes alpha-méso- à polysaprobes, se maintenant à l'aval ;

- la classification des espèces selon leurs tolérances aux métaux établie par Morin et al. (2012), marque nettement le site aval (Joanis), où dominent les espèces traditionnellement typiques de milieux fortement impactés par les métaux.

La perte de diversité, pour chacun de ces traits, est notable à Joanis, suggérant une perte de redondance « fonctionnelle ». Nous avons donc cherché à déterminer la capacité potentielle de ces communautés à faire face à des contraintes supplémentaires, par exemple celles liées au changement global. L'une des conséquences attendues du réchauffement climatique est une diminution de l'oxygénation des eaux (e.g. Hari et al. 2006). Or, nos résultats indiquent, à partir d'un indicateur simple tel que les exigences en oxygène des espèces de Van Dam et al. (1994), que la diversité des classes de tolérances (équilibrée à Firmi), se réduit vers l'aval, et que la classe de tolérance à une disponibilité très faible en oxygène (<10%) disparaît quasiment à Joanis.

Les communautés subissant des stress multiples sont par conséquent potentiellement très vulnérables aux changements environnementaux prévus. Dans un objectif de préservation de la ressource (en lien, notamment, avec la DCE), il est donc recommandé de considérer le cumul de contraintes s'exerçant sur les maillons biologiques liés à des fonctions-clés de l'écosystème, en particulier compte tenu des changements attendus dans le climat mondial.

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Mots clés

Pollution trophique, pollution métallique, cumul de stress, traits, vulnérabilité

Présentation orale

Modélisation de la Distribution de Sensibilité des Espèces (SSD) pour évaluer le risque environnemental lié aux pesticides en milieu aquatique

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Points importants de l'étude

De longues séries de tests dose/effet ont été réalisés sur 11 espèces de diatomées et 5 herbicides différents (diuron, terbutryne, isoproturon, atrazine, métolachlore)

Les résultats de ces tests permettent de définir des concentrations à risque pour les biofilms dominés par les diatomées, et de définir le rang de toxicité de chacun de ces 5 herbicides

Introduction

Les modèles de distribution de sensibilité des espèces (ou SSD en anglais) permettent de dériver des seuils d'effets de substances sur des assemblages d'espèces et de proposer des concentrations maximales protégeant x% de cet assemblage. Une des faiblesses actuelles de cette méthode est le manque de données permettant d'établir ces modélisations de façon robuste et représentative.

Résultats et discussion

Afin de déterminer les concentrations en herbicides à risque pour les communautés de diatomées benthiques, nous avons réalisé une longue série de bioessais monospécifiques, sur 11 espèces de diatomées exposées à 5 herbicides possédant différents mode d'action (diuron, terbutryne, isoproturon, atrazine, métolachlore). Les relations doses-réponses obtenues ont permis d'extrapoler des CE5 et CE50 (concentration efficace) pour chaque couple espèce-molécule, d'en tirer des courbes SSD permettant de déterminer les valeurs de concentration à risque (HC, Hazardous Concentration) pour chacun des herbicides étudiés.

Le rang de toxicité déterminé par les SSD était le suivant : diuron > terbutryne > isoproturon > atrazine > métolachlore. Pour les herbicides inhibiteurs du photosystème II (PSII), les diatomées ont montré un regroupement corrélé à leur mode trophique et à leur guilde écologique. Les N-hétérotrophes et les espèces mobiles étaient plus tolérantes aux inhibiteurs du PSII. A l'inverse les N-autotrophes et les espèces faiblement mobiles étaient plus sensibles. Le seuil HC5 (qui affecte 5% des espèces de l'assemblage) déterminé par nos SSD est atteint pour des concentrations fréquemment trouvées dans les milieux aquatiques (au moins en France), en particulier pour la terbutryne et le diuron.

Mots clés:

ecotoxicologie, herbicide, concentration efficace, concentration à rique, distribution de sensibilité des espèces

Présentation poster

Flore diatomique des bassins versants de l'Agnéby et de la Mé (Côte d'Ivoire)

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Principaux points de l'étude

L'étude présentée vise à décrire les communautés diatomiques des bassins de l'Agneby et de la Mé, dans l'optique d'une création d'indice biologique adapté au contexte de la Côte d'Ivoire.

Introduction

L'hydrosystème de la Côte d'Ivoire constitue un bien économique qui doit être correctement géré, compte tenu des multiples utilisations dont il fait l'objet. La préservation de ces écosystèmes aquatiques s'avère indispensable tant pour les communautés qui y vivent que pour les populations humaines riveraines qui utilisent ces eaux pour divers usages (baignade, boisson, pêche, lessive, vaisselle…).

En Côte d'Ivoire, l'évaluation de la qualité des écosystèmes aquatiques est principalement basée sur l'analyse des paramètres physico-chimiques et des bioindicateurs tels que les insectes aquatiques (Williams & Smith, 1996; Clarke et al., 2002) et les poissons. Concernant les diatomées benthiques peu de travaux exploratoires ont été menés (Ouattara et al., 2001), si bien que ce maillon biologique demeure inexploité. A noter que de récents travaux se sont intéressés aux flores phytoplanctoniques (Adon, 2013).

Ainsi, à l'instar de certains pays Africains comme l'Afrique du Sud, le Maroc, l'Algérie, l'utilisation des diatomées pour la caractérisation des eaux doit se développer en Côte d'Ivoire. Ce pays possède plusieurs grands fleuves (Cavally, Sassandra, Bandama, Comoé) et rivières (Agnéby, Mé, Boubo, etc.), subissant de plus en plus des menaces en lien avec les exigences du développement (Gourène et al., 1999).

L'étude présentée ici porte sur 96 relevés diatomiques effectués sur 20 stations situées sur les bassins de l'Agnéby et de la Mé. Sur chaque bassin 10 stations ont été visitées au cours de quatre campagnes d'échantillonnages (septembre 2011, décembre 2011, février 2012 et juillet 2012), une station parmi celles-ci ayant été visitée mensuellement d'août 2011 à juillet 2012.

Résultats et discussion

L'Agnéby et la Mé serpentent sur un substrat géologique constitué de schistes et de granites, à travers un bassin versant forestier dégradé par les empiètements de cultures (bananes, cacao, café). Le régime hydrologique est lié à un climat équatorial fortement soumis au régime de la mousson. Au niveau physico-chimique, les eaux de l'Agnéby et de la Mé présentent une température élevée (22 à 28,5°C), et se caractérisent par des pH très acides à faiblement basiques (4,7 à 7,6) ainsi que des conductivités faibles à modérées (28 à 277 µS.cm^{-1}). Les concentrations maximales en nutriments classiques laissent présager des situations d'eutrophisation et/ou de pollution organique importantes ($[NH_4]_{max}$ = 2,30 mg.l^{-1}; $[NO_3]_{max}$ = 42,6 mg.l^{-1}, $[PO_4^{3-}]_{max}$ = 2,5 mg.l^{-1}). La turbidité est également souvent élevée (jusqu'à 66,2 NTU).

Les premiers résultats floristiques disponibles présentent de nombreuses espèces, certaines cosmopolites, d'autres tropicales, dont plusieurs non encore déterminées à ce jour notamment deux *Planothidium*, deux *Cocconeis* et un *Stauroneis* (décrits sur le poster). Ces *Planothidium* et *Cocconeis* sont les espèces dominantes, associées au genre très abondant des *Eunotia*.

Cocconeis sp1*,* d'allure proche du type *scutellum,* présente un nombre de stries par 10 µm compris entre 10 et 11 sur la valve sans raphé, et entre 19 et 20 sur la valve avec raphé. Il semble, d'après ses dessins et la diagnose associée, que Foged (1966) ait rencontré cette espèce au Ghana, sans toutefois lui attribuer de nom.

Planothidium sp1 possède 10-11 stries en 10 µm sur la valve avec raphé, et présente un repli en fer à cheval sur la valve sans raphé. Sa comparaison avec les lames de référence de Carter & Denny (1982) concernant *Achnanthidium miotum*, ainsi que de nombreux clichés pris au microscope électronique à balayage, ont abouti à considérer ce *Planothidium* comme une espèce nouvelle.

Planothidium sp2, proche de *Planothidium rostratum,* présente une forme rostrée, environ 11 stries par 10 µm sur la valve avec raphé ainsi qu'un repli en fer à cheval sur la valve sans raphé. Au microscope électronique à balayage, cette espèce se distingue de *Planothidium rostratum* par la présence de rangées de 5 aréoles par stries sur la valve avec raphé.

Enfin sur l'ensemble des stations échantillonnées, une se distingue par la forte abondance de *Bacillaria paxillifera* pendant la saison sèche (janvier-avril). La présence de cette espèce, typique d'eaux saumâtres, est étonnante à cette station située à 20 km de la lagune Ebrié et hors de la zone d'influence des marées (5°29'33.1"N 3°57'14.4"O). Ce phénomène pourrait s'expliquer par la forte pression anthropique exercée par les cultures intensives à cet endroit.

Cette étude constituera un travail préliminaire à la création d'un indice diatomique adapté au contexte tropical de la Côte d'Ivoire.

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Mots clés

Côte d'Ivoire, diatomées, indice biologique.

Présentation poster

Une nouvelle espèce de diatomée fossile du genre *Entomoneis* dans les sédiments de la mer de Marmara

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Principaux points de l'étude

Une nouvelle espèce de diatomée fossile comportant une carène bien developpée et une ligne de junction continue appartenant au genre *Entomoneis* est décrite.

Introduction

Les principales caractéristiques morphologiques du genre *Entomoneis* sont: des cellules bilobées et sigmoïdes, une carène en forme d'aile au-dessus du corps de la valve, des fissures raphéennes externes droites au centre et aux pôles, des stries bi- ou multiponctuées et de nombreuses bandes connectives (Round et al., 1990). Une autre caractéristique du genre, en microscopie optique, est la présence d'une ligne de junction. Celle-ci est formée par une série de fibules basales proéminentes qui séparent la surface de la valve de l'aile (Patrick & Reimer, 1975; Paddock & Sims, 1981; Poulin & Cardinal, 1983; Osada & Kobayasi, 1985).

Chez les *Entomoneis*, la fissure raphéenne débouche toujours dans un canal raphéen de forme tubulaire délimité à sa base par une série de fibules basales. Néanmoins, le canal raphéen peut être double chez *E. paludosa* (W. Smith) Reimer et *E. pseudoduplex* Osada & Kobayasi (Osada & Kobayasi, 1990a, b, c). Bien que dans la plupart des taxons la ligne de jonction soit généralement continue, bi-sinueuse et légèrement concave, elle présente aussi une certaine variabilité morphologique : uniquement présente aux extrémités apicales de l'aile chez *E. punctulata* (Grunow) Osada & Kobayasi ou totalement absente chez *E. aequabilis* Osada & Kobayasi. Les fibules raphéennes sont toujours présentes chez les *Entomoneis* car elles délimitent la base du canal raphéen sur l'aile. Les fibules basales, elles, qui forment la caractéristique ligne de jonction, sont presque toujours présentes sauf chez *E. aequabilis* où elles sont absentes et chez *E. vertebralis* Clavero, Grimalt & Hernández-Mariné où elles sont uniquement présentes près du nodule central (Clavero et al., 1999). Les fibules carinales (fibules intermédaires) sont absentes chez *E. kjellmanii*

(Cleve) Poulin & Cardinal, ou très variables selon les taxons comme chez *E. alata* (Ehrenberg) Ehrenberg var. *japonica* (Cleve) Osada & Kobayasi ou *E. centrospinosa* Osada & Kobayasi (Osada & Kobayasi, 1985, 1990a).

Des spécimens du genre *Entomoneis* présentant les caractéristiques décrites ci-dessus ont été trouvés dans des sédiments fossiles de la mer de Marmara.

Résultats et discussion

Les valves sont fortement comprimées latéralement, légèrement tordues, linéaires-lancéolées, bombées de part et d'autre du nodule central avec des extrémités étroites et arrondies, de 75 à 100 µm de long. En vue connective, les frustules sont fortement étranglés au niveau du nodule central formant ainsi une aile carénée fortement développée et bilobée qui ressemble à des oreilles d'âne de 70 à 80 µm de haut. Du fait de la hauteur de la valve, les frustules n'ont pas été observés en vue valvaire. Aucun spécimen présentant les deux valves connectées n'a été observé. Par contre, des valves appartenant à 2 individus différents se retrouvent interconnectées, tête bèche, les lobes de l'un s'interpénétrant au-dessus et en dessous avec les lobes de l'autre. L'aile portant à son bord extérieur la carène, est grande et se subdivise en deux lobes de formes variées plus ou moins concaves vers l'extrémité de la valve. En microscopie électronique la structure de la valve est complexe. Dans le plan transapical, elle apparaît complètement repliée sur elle-même le long du raphé, formant d'abord une carène tubulaire soutenue par les fibules raphéennes et par les fibules carinales, puis fusionnant sous le double canal raphéen formant la structure fibrillaire de l'aile pour se réouvrir largement sous la ligne de jonction jusqu'au bord de la valve créant ainsi la cavité valvaire. La carène bilobée, qui ressemble à des oreilles d'âne, s'élève au-dessus de la totalité de la longueur de la valve sauf aux extrémités. Au niveau du nodule central, là où les deux lobes fusionnent, la cavité valvaire est élargie, pyramidale et se prolonge latéralement pour fusionner avec les cavités de forme conique des lobes alors qu'aux apex, la cavité valvaire est réduite à un léger renflement. En vue connective, la cavité valvaire a donc la forme d'un chapiteau à trois mats. Cette espèce se caractérise par un canal raphéen périphérique à la carène, bien silicifié et de section elliptique. Le canal raphéen est formé à sa base par des fibules raphéennes de forme tubulaire qui sont portées sur chaque côte de la carène et qui joignent les parois latérales formant ainsi une échelle horizontale.

Sous les fibules raphéennes se trouvent le canal subraphéen de section elliptique mais plus grand que le canal raphéen. Les canaux raphéen et subraphéen communiquent par l'espace interfibulaire (échelle). Le canal subraphéen se ferme à sa base par les fibules carinales (= fusion des côtes des deux parois opposées). Sous la carène tubulaire, la striation de la valve est délicate et presque fibrillaire. Elle résulte de la fusion des 2 parois de silice, chacune ornée de côtes et de lignes d'aréoles. Cette structure fibrillaire est délimitée, en haut par les fibules carinales et à la base par la ligne de jonction à la surface de la valve. Les stries sont formées par une simple rangée d'aréoles ovoïdes. Entre le milieu des deux lobes, les stries sont radiantes et atteignent la base de la carène. Du milieu des lobes jusqu'aux extrémités les stries sont convergentes.

La structure de *cet Entomoneis* est très similaire à celle d'*Amphiprora* sp. 3 *sensu* Paddock & Sims (1981, figs 78-85) et d'*Amphiprora oestrupii* Van Heurck (Plancke & Bailleux, 1976b). *Entomoneis aureasini* possède un double canal raphéen comme *E. paludosa* and *E. pseudoduplex*. Il ressemble à *E. kjellmanii* et à *Amphiprora kufferathii* Manguin (Plancke & Bailleux, 1976a) mais en ayant les lobes beaucoup plus developpés.

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Mots clés

diatomée, *Entomoneis*, mer de Marmara, fossile, nouvelle espèce

Présentation orale

Mise en place d'un outil en ligne communautaire pour une détermination et un comptage des diatomées efficaces ainsi qu'une communication améliorée sur les microalgues

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Principaux points de l'étude

Présentation d'un nouvel outil en ligne pour aider au comptage et à la détermination des diatomées ainsi que pour améliorer la communication et la diffusion d'informations entre diatomistes

Introduction

En plus du travail de terrain, de laboratoire ou d'observation microscopique, les diatomistes travaillent de plus en plus sur des outils informatiques leur permettant de simplifier la détermination, le comptage et la communication entre eux. Afin de pallier la vétusté et le manque de support de ces outils, un prototype d'outil en ligne est mis en place à l'initiative de BECQEAU et en collaboration avec un expert en technologies web. Les objectifs sont :

- Moderniser les outils existants en les rendant à la fois plus ergonomique, efficace et fiable ;
- Les rendre indépendants des systèmes d'exploitation utilisés (Windows XP, 7 ou 8, Mac OS X ou Linux) ;
- Les porter directement sur l'internet pour profiter de la synchronisation avec certains référentiels et pour permettre une meilleure interopérabilité ;
- Améliorer la communication au sein de la communauté en intégrant des fonctionnalités de partage d'actualités, évènements, forums, annuaires, etc. ;
- Et enfin, bénéficier de technologies récentes permettant une meilleure évolutivité, maintenabilité et permettant d'envisager l'intégration de fonctionnalités innovantes, notamment autour de la détermination.

Résultats et discussion

Avant de présenter le logiciel en ligne, un tour d'horizon rapide des outils existants en France et à l'étranger sera effectué. Il s'agit principalement de base de données qui se sont constituées au fil de l'eau. Le but de ce nouvel outil n'est pas de recréer une autre base de diatomées mais plutôt d'utiliser toutes celles déjà disponibles, de les synchroniser au moins partiellement et de les utiliser. Parmi ces bases, on retrouve notamment le Sandre, Algaebase ou Omnidia.

Puis les 3 modules principaux du nouvel outil seront présentés :

- Module de détermination : il s'agit du plus expérimental des modules, mais aussi du plus intéressant. Il propose 5 méthodes pour identifier ou retrouver une espèce :

    - Une recherche par code ou par nom qui intègre la plupart des bases de données existantes ;
    - Le parcours de l'arbre taxonomique, qui n'est en fait qu'une reprise de l'arbre du Sandre ;
    - Une identification manuelle par un système innovant de tri par efficacité des clés taxonomiques et par l'assistance d'un réseau neuronal ;
    - Une identification automatique qui pourra, sur la base d'une photographie de microscope, reconstruire géométriquement les caractéristiques morphologiques et ainsi proposer une discrimination des espèces correspondantes ;
    - Une identification communautaire : si l'ensemble des méthodes précédentes se révèle inefficace ou inadapté, il est possible de demander une aide à la communauté en publiant une photographie de microscope.

- Module de comptage : il s'agit de pouvoir facilement créer un comptage, et obtenir les principaux indicateurs de qualité de l'eau (IBD notamment) ;
- Module communautaire : il s'agit de proposer un service de publications d'actualités, d'évènements et de partage d'informations de contact aux principaux acteurs du milieu.

L'utilisation de l'outil en expérimentation chez BECQEAU montre une amélioration notable de l'efficacité notamment au niveau du module de comptage :

- Absence de problèmes liés au fonctionnement de l'outil sur des anciens systèmes d'exploitation, et réactivité importante dans la correction des problèmes rencontrés ou des besoins spécifiques ;
- Meilleure intégration des résultats pour un travail en parallèle de plusieurs diatomistes ;
- Une meilleure ergonomie dans le comptage a permis là aussi des gains de temps significatifs.
- En plus des résultats ci-dessus, cet outil présente des perspectives intéressantes :
- Des gains de temps considérables sur la détermination ;
- Une grande interopérabilité avec d'autres services en ligne (Sandre, Naiades) ;
- Une approche simple et accessible de la détermination pouvant être utilisée en complément des méthodes génétiques (DNA barcoding) ;
- Un élargissement au comptage et à la détermination d'autres classes taxonomiques (phytoplancton)
- Des fonctionnalités communautaires, qui, en fonction du nombre de participants, peuvent permettre de rendre plus concrète la communauté des diatomistes.

Il est également intéressant de pouvoir facilement tester un tel outil de manière automatique. Ainsi, les données et les formules de calcul peuvent faire l'objet de validation sans effort particulier. Ceci est rendu possible par la puissance et la robustesse de technologies récentes.

Toujours à l'état de prototype, il sera intéressant d'obtenir un retour de la communauté sur

- l'intérêt d'un tel outil ;
- son potentiel d'adhésion ;
- les grandes lignes de sa feuille de route.

Mots clés

outil, informatique, détermination, comptage, communication

Présentation orale

Etude approfondie de l'espèce *Thalassiosira faurii* (Gasse) Hasle dans le système lacustre Ziway-Shalla (Ethiopie) : implications pour les reconstitutions paléoclimatiques

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Principaux points de l'étude

Diatomée dominante dans un lac tropical alcalin

Variabilité de la structure fine des valves

Approche expérimentale vs empirique de sa tolérance à la salinité

Espèce-clé pour l'interprétation paléoclimatique d'une carotte

Introduction

La connaissance des préférences écologiques des diatomées fossiles des sédiments permet de reconstituer les variations paléo-environnementales dans un hydrosystème. Elle est généralement obtenue par l'étude de la distribution des diatomées modernes dans des gradients environnementaux actuels. En supposant la constance des caractéristiques autoécologiques des espèces à l'échelle de temps considérée (principe d'actualisme), des fonctions de transfert permettent d'établir quantitativement les variations de certains paramètres environnementaux au cours du temps. En milieu tropical, les changements de salinité d'un lac reflètent généralement les variations du bilan précipitations-évaporation (P-E) qui constitue une caractérisitique importante du climat (Gasse et al., 1997).

Le système lacustre Ziway-Shalla est un ensemble endorhéique de quatre lacs situé dans la vallée du rift éthiopien à environ 1600 m d'altitude. L'étude des diatomées d'une carotte de sédiments extraite d'un des lacs avait montré des variations importantes de salinité depuis la fin du Pléistocène (14 ka cal. BP), et mis en évidence une transition importante dans la région à environ 5,5 ka cal. BP (Chalié & Gasse, 2002). Cette étude s'appuyait sur une fonction de transfert pour la conductivité établie à partir d'une base de données de référence regroupant des échantillons d'Afrique de l'Est, du Nord et du Niger (Gasse et al., 1995). La reconstitution paléolimnologique comportait quelques incertitudes liées à la présence dans la carotte d'espèces peu représentées dans la base de données de référence. *Thalassiosira faurii* était l'une de ces espèces. Décrite par Gasse (1975) à partir d'échantillons d'une carotte prélevée en Afar central (Djibouti), *T. faurii* était considérée comme typique des eaux hyperalcalines de conductivité supérieure à 5000 µS.cm^{-1}.

Nous avons observé l'espèce dans le système Ziway-Shalla et mis une souche en culture au laboratoire. L'examen de la morphologie, la biologie et une expérimentation pour caractériser l'autoécologie de l'espèce, ont permis de revisiter les reconstitutions paléo-environnementales déjà réalisées.

Résultats et discussion

Les pièges à sédiments relevés mensuellement pendant la saison humide ont révélé une forte dominance de *T. faurii* dans les communautés de diatomées planctoniques du lac Langano, alors que la conductivité de l'eau était inférieure à 1800 µS.cm^{-1}. L'abondance relative de l'espèce était d'environ 50-60% et chacune des autres espèces représentait moins de 10% des individus dans les communautés échantillonnées.

Le diamètre des valves de *T. faurii* dans les populations naturelles variait de 17 à 47 µm. La densité des aréoles et des processus marginaux étaient de 14-17 et 4-7 par 10 µm respectivement. La morphologie des frustules correspondait à la description faite par Hasle (1978), hormis le nombre et la disposition des processus renforcés centraux, très variables, y compris entre les valves d'un même individu. Cette variabilité rend difficile la distinction avec l'espèce d'eau douce *Thalassiosira duostra* Pienaar, de morphologie très proche de *T. faurii* (Kiss et al., 1984, 2012; Pienaar & Pieterse, 1990). Une reproduction sexuée oogame a été observée dans une culture monoclonale suite à un changement d'éclairement. Elle s'est opérée à partir de cellules ayant un diamètre de 15-20 µm. Les cellules initiales produites après auxosporulation mesuraient 45-50 µm de diamètre.

Un test de tolérance à la salinité a été réalisé sur la souche monoclonale de *T. faurii*. La croissance de la diatomée était complètement inhibée à 2000 µS.cm^{-1} et les cellules ne survivaient pas à partir de 4000 µS.cm^{-1}. La souche s'est donc avérée beaucoup plus sensible à la salinité que ce qu'il était admis. Les résultats expérimentaux sur la souche locale ont permis de définir un nouvel optimum de salinité pour *T. faurii*. L'ancien optimum 'empirique' était beaucoup plus élevé car l'espèce avait été observée en forte abondance dans des milieux salés du Niger où la conductivité dépassait 10000 µS.cm^{-1}. Il s'agissait peut-être d'un autre écotype, très proche sur le plan morphologique. Une analyse biométrique comparée a montré que les populations du Niger avaient un diamètre plus petit et une densité d'aréoles et de processus marginaux légèrement plus élevée que les populations du lac Ziway-Shalla actuelles et fossiles.

L'étude des assemblages fossiles de la carotte du système Ziway-Shalla avait révélé pour la période 13.5-12 ka cal. BP, deux pics d'abondance de *T. faurii* dans les sédiments (>60%), interprétés comme deux pics de conductivité correspondant à un climat plus sec (Chalié & Gasse, 2002). En remplaçant l'optimum de salinité de *T. faurii* par sa nouvelle valeur expérimentale dans la fonction de transfert, la conductivité inférée pendant cette période a été ramenée à un niveau proche de celui qui suit pendant l'Holocène inférieur (12-6 ka cal. BP), effaçant ainsi les indices de perturbations climatiques importantes sur le bassin. Diverses études en Afrique nord tropicale ont pourtant montré que la transition Pléistocène-Holocène était marquée par un climat plus sec (Gillespie et al., 1983; Shanahan et al., 2006; Marshall et al., 2009). Il est possible que cette période n'ait pas été bien enregistrée dans la carotte ou que les populations fossiles de *T. faurii* avaient une tolérance à la salinité supérieure à celle des populations actuelles.

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Mots clés

Diatomée, paléoclimatologie, salinité, taxonomie, *Thalassiosira faurii*

Présentation orale

Métabolisme carboné et intensité lumineuse chez les diatomées - Une approche transcriptomique

Carbon metabolism and light intensity in diatoms - A transcriptional approach

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Bullet points

- The highest growth rate was obtained with light intensity of 300 µmol photons $m^{-2}.s^{-1}$

- Gene expression of several pathways (especially shikimate and glycolysis) was significantly higher by shifting the cells from optimal light to high light (1000 µmol photons $m^{-2}.s^{-1}$) or low light (30 µmol photons $m^{-2}.s^{-1}$) intensities

Introduction

Diatoms are a diverse group of eukaryotic unicellular microalgae that account for up to 40% of the total marine primary production in the ocean. In addition to photoautotrophic growth, some diatoms store carbon in the form of valuable compounds (polysaccharides, lipids, polyunsaturated fatty acids, pigments, biofuels…) (Mimouni et al., 2012*)* while they have high plasticity in adapting to variable environmental condition such as different light intensities (Depauw et al., 2012).

Light is an essential source of energy for life on Earth and one important signal that organisms use to obtain information from the surrounding environment (Lemoine & Schoefs, 2010). Actually, wavelength and intensity can affect cell regulation (Fan et al., 2013; Li et al., 2013). Diatoms display a suite of sophisticated responses to optimize photosynthesis and growth under changing light conditions. Unfortunately, the biochemical and regulatory networks controlling cell functions are still largely unknown (Valenzuela et al., 2012) and there is still much work to be done to fully understand how enzymes and genes are linked together while cell undergo stress (Heydarizadeh et al., 2013). Understanding how these networks are linked and work under nonstress and stressful conditions is important for both the comprehension of diatom ecology and the success of biotechnologies because stresses trigger reorientation of the metabolism leading to the production of commercially interesting compounds.

Material and methods

A total of 30 enzymes involved in carbon metabolism pathways were selected (Martin-Jézéquel, et al. 2012) and the corresponding genes coding for each enzymes were searched in genomic data published by Kroth et al. (2008) and available at http://www.diatomcyc.org. The expression of a total of 70 genes (including 12 housekeeping genes) from the diatom *Phaeodactylum tricornutum* (UTEX 646) grown in f/2 medium made with artificial seawater (Kester et al., 1967) under 30 (low), 300 (medium) and 1000 (high) µmol photons $m^{-2}s^{-1}$ (12/12h, 20°C) was recorded in this study. In a second set of experiments, cells grown under medium light intensity were shifted to low or high light intensity at the early exponential phase. The cultures were performed in 500 mL erlenmeyers containing 200 mL of medium, inoculated with 10^5 cell/mL. Biomass concentration was estimated by measuring culture absorbance at 750 nm.

For mRNA preparation, diatom sampling (150×10^6 cell) was performed during early, middle and late exponential phase (3 biological replicates). The samples were filtered on 25 mm GF/F Whatman filters. mRNA extraction was performed using the Spectrum Plant Total RNA kit (sigma). Amplified cDNAs were obtained using M-MLV reverse transcriptase and qPCR performed on a StepOne Plus apparatus Applied Biosystems).

ANOVA (Analysis of variance) was done using SAS (Statistical Analysis System) and PCA analyses performed by SPSS (Statistical Package for the Social Sciences).

Results

Under the three light intensities, diatom growth curves presented typical early (stage 1), middle (stage 2) and late (stage 3) growth phases. The fastest growth rate was obtained with medium and high light intensities (0.9 ± 0.025, 0.89 ± 0.038 d^{-1}, respectively). Under low light intensity, the growth rate was severely slowed down (1.33 ± 0.022 d^{-1}).

Gene expression level was defined by comparison with that of 3 housekeeping genes (*tbp, ubi*, *rps*). A particular evolution of several gene expressions was found when comparing the different stages at light intensities 300 and 1000 µmol photons $m^{-2}s^{-1}$ but not at 30 $m^{-2}s^{-1}$ (Table 1). Shifting the cells after their adaptation from optimal light to low light and high light intensity, resulted in increased expression of genes involved in several pathways. In particular, genes coding for proteins involved in mitochondrial glycolysis, pyruvate metabolism and shikimate pathways are up-regulated.

Table 1. Different genes are expressed under changing light intensity, and growth phase.

Light intensity	Genes with highest expression level at stage 1 and lowest expression level at stages 2 and 3	Genes with highest expression level at stages 2 or 3 and lowest expression level at stage 1
300 or 1000	*tpi2* (Calvin), *pgam6*, *gapc1*, *pk2* (glycolysis),*shidehy* (shikimate), *pyc2* (pyruvate), *gdcp*(photorespiration)	*fbpc2*, *fbpc3*, *fbac5, pgdh* (Calvin), *fba4, pgam2*,*gapdh* (glycolysis), *g6pi1* (glycolysis, gluconeogenesis), *pyc1*, *ppdk, pepck* (pyruvate),*gdct1, hpr* (photorespiration), *ms* (pyruvate, glyoxylate)
From 300 to 30 and 1000		*tpi1, fbpc4* (Calvin), *ca1*, *ca7*, *me1* (carbon metabolism), *pk3*, *pk6, gpi*, *g6pi3, pgam5, gapc4*(glycolysis), *aroa*, *arob, epspsy* (shikimate) *ppdk, pyc1*(pyruvate),

Conclusion

Up-regulation of several genes is found when shifting cells to high or low light intensity (300 to 30 or 300 to 1000 µmol photons $m^{-2}s^{-1}$) and in particular genes involved in glycolysis and shikimate pathways, suggesting that shifting cells to either high or low light intensity would promote respiration and synthesis of amino acids. The shikimate pathway is particularly interesting because it links metabolism of carbohydrates to biosynthesis of aromatic amino acids such as flavonoids and alkaloids while the glycolytic network may provide an essential metabolic flexibility that facilitates cell development and acclimation to environmental stress.

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Keywords

Phaeodactylum tricornutum, light stress, carbon metabolism, enzyme, gene expression

Présentation orale

Preuve fondée sur les algues siliceuses de l'augmentation du niveau d'eau et du refroidissement à court terme autour de 9.2-ka dans les Carpates du Sud, Roumanie

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Principaux points de l'étude

L'analyse haute-résolution des diatomées sur les sédiments de l'Holocène du Lac Gales révèle une augmentation marquée du niveau d'eau entre 9500-9000 ans cal BP dans les Carpates du Sud.

Introduction

Une étude paléoécologique portant sur le Quaternaire final (PROLONG projet), des enregistrements de sédiments ont été récoltés dans quatre lacs de montagne dans les montagnes Retezat entre 2007 et 2008. Parmi les quatre lacs, le Lac Brazi a d'abord été analysé en detail, en utilisant divers marqueurs biotiques, comme les plantes macrofossiles, les pollens, les cladocères, les chironomides et des analyses géochimiques. Plusieurs articles ont été publiés en ce concentrant principalement sur la période tardiglaciaire et l'Holocène ancien (Korponai et al., 2011; Magyari et al., 2011, 2012; Buczkó et al., 2012; Tóth et al., 2012). Les résultats sédimentologiques de l'analyse des algues siliceuses ont été publiés récemment et couvrent toute la séquence du Lac Brazi (Buczkó et al., 2013). Par ailleurs, un unique enregistrement de 13.600 ans daté avec les isotopes de l'oxygènes et par les diatomées est également disponible (Magyari et al., 2013).

Le Lac Gales est le deuxiéme lac étudié dans le versant nord de la montagne Retezat en utilisant des méthodes paléoécologiques 'multi-proxies'. Une réponse rapide de la végétation pendant la période tardiglaciare et l'Holocéne ancient a été reconstruit sur la base des analyses haute-résolution des pollens, des stomates des conifères et des plantes macrofossiles (Magyari et al., 2012). Pour mieux comprendre les changements induits par le climat, les algues siliceuses (les diatomées et les cystes de Chrysophycées) ont été analysés dans une séquence de sédiments de 328 cm de longeur (Gales-3, 45°23'6"N, 22°54'33"E; altitude 2040 m; superficie 3.68 ha; profondeur maximale 20 m). Pour les analyses des diatomées, les échantillons ont été préparés en utilisant des procédures de digestion standards (Battarbee, 1986) tous les 4 cm. Environ 300 valves ont été comptés à partir de chaque échantillon. L'enregistrement des diatomées a été zoné en utilisant CONISS (analyse de clusters contrainte par la stratigraphie) mis en œuvre dans le programme Psimpoll 3.00 (Bennett, 2005). La taxonomie suit Krammer & Lange-Bertalot (1986-1991), Lange-Bertalot & Krammer (1989), Lange-Bertalot & Metzeltin (1996), Lange-Bertalot (2001), Schmidt et al. (2004).

Résultats et discussion

Les résultats de la datation au radiocarbone, de la stratigraphie de sédiments, des mesures de la teneur en matière organique (loss on ignition, LOI) ont été décrits (Magyari et al., 2009). Les changements dans les assemblages de diatomées ont mené à la délimitation des 10 zones d'assemblages de diatomées. Dans la Zone-1 qui correspond en gros à l'Interstadiaire de Bølling/Allerød, l'abondance des diatomées benthiques est faible, mais augmente continuellement, suggérant la formation d'un lac peu profond et permanent. Au début du Dryas récent (Zone-2) environ 12,910 ans cal BP un changement brusque peut être détecté dans les compositions de diatomées: l'augmentation de l'abondance relative des taxons aérophytes inférée par l'aridité saisonnière ou le dessèchement du lac. Entre 12,500-11,500 ans cal BP des diatomées benthiques et périphytiques sont dominantes, suggérant une augmentation mineure du niveau d'eau après la première partie du Dryas récent et les conditions lacustres peu profondes dans la deuxième partie du Dryas récent. Environ 11,500 ans cal BP, probablement coïncidant avec le début de l'Holocène une augmentation rapide par la productivité lacustre et de la végétation terrestre (teneur en MO augmente de 2,5 vers à 37%) et des assemblages d'algues siliceuses diversifiés ont été détectées.

Les changements les plus remarquables par les données de diatomées ont été détectés entre 9,500-9,000 ans cal BP: une diatomée rubannée et légèrement silicifiée *Fragilaria gracilis* devient dominante et atteint plus de 70% à 9,210 ans cal BP. Nous devons souligner que deux échantillons indépendants ont été datés à 179 cm de profondeur (une aiguille de *Pinus* et restes de Cladocera). Leurs âges évalué avec le radiocarbone sont en bon accord puisque les deux dates sont identiques et à l'intérieur de l'erreur-type de la mesure de ^{14}C: 9199±127 et 9155±163 ans cal BP respectivement. La LOI, se déduisant de la teneur en MO montre un minimum local (de 20% à 14%) et les rapports C:D diminuent également à cette période. Nous en déduisons que le niveau du lac est élevé, l'érosion augmente, et la productivité lacustre diminue. Ceci est probablement à relier à l'augmentation de l'humidité en hiver et au printemps ainsi qu'au refroidissement pendant ce court laps de temps. Ce pic de diatomée est unique, particulier et bien daté. Nous supposons qu'il peut être lié à l'anomalie climatique généralisée -à 9.2-ka- et déclenchée par une importante fonte des glaces dans l'Atlantique Nord. Beaucoup d'études à haute-résolution 'prouvent le refroidissement à cause de ce ralentissement de la circulation thermohaline aux latitudes hautes et moyennes dans l'Hémisphère Nord (Fleitmann et al., 2008). Nous suggérons que le changement dans les données de diatomées et de LOI du Lac Gales peut être relié à cette courte anomalie climatique qui dans les Carpates du Sud ont conduit une augmentation de l'humidité en hiver et au printemps et à une baisse de la température. Après 9,150 ans cal BP les fréquences relatives des espèces d'*Aulacoseira* augmentent progressivement est sont remplacées par des taxons de *Fragilaria*. Autour de 7,100 ans cal BP les taxons monoraphides à petites cellules deviennent plus abondants. La fréquence élevée des taxons benthiques suggère un faible niveau d'eau. Plus tard, les changements les plus remarquables dans les assemblages de diatomées ont été observés vers 3,700 ans cal BP pendant l'Holocène: les diatomées planctoniques deviennent dominantes indiquant l'augmentation du niveau d'eau pendant les 3700 dernières années.

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Mots clés

diatomées, niveau d'eau, Carpates du Sud, lac

Presentation orale

Premier programme national suisse d'observations coordonnées des eaux de surface (NAWA) : résultats préliminaires des indications fournies par les diatomées

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Points importants de l'étude

Les objectifs et les différents aspects du programme coordonné d'étude de la qualité des rivières sur tout le territoire helvétique sont présentés, ainsi que les premiers résultats des analyses de diatomées.

Introduction

Dans le contexte décentralisé de la Suisse, la surveillance légale de la qualité des eaux est assurée principalement par les cantons. Chaque Etat, en fonction de ses besoins locaux, de ses possibilités financières et des compétences disponibles, a mis sur pied depuis les années 1970, un programme de surveillance des rivières incluant progressivement des aspects chimiques, biologiques et d'aspect général liés à ses problèmes particuliers. Il résulte de ce fait des disparités régionales, tant dans les méthodes utilisées, que dans les objectifs de chaque canton ou encore dans l'intensité des études. Ces différences limitent les comparaisons d'une région à l'autre et limitent aussi les projets d'assainissement ou de renaturation, car les bassins versants ne correspondent pas aux frontières politiques des cantons.

Pour réduire ces disparités, l'Office fédéral de l'environnement développe depuis près de 15 ans, en collaboration avec les cantons, des méthodes standardisées d'analyse sous la désignation de Système Modulaire Intégré ou SMG (OFEFP, 1998). Les critères de diagnostic de ces méthodes sont définis par la loi suisse (OEaux, 1998). Ce corpus est destiné à guider les Offices cantonaux de protection des eaux dans leurs activités de surveillance pour qu'une certaine unité d'approche se réalise entre les régions.

D'autre part, la Confédération a initié en 2011 une surveillance de l'ensemble du réseau suisse (programme TREND) pour mettre en évidence les lignes générales de la qualité des eaux courantes. Les analyses chimiques sont réalisées mensuellement depuis 2011 dans 111 stations à l'aval des principaux bassins versants. Les aspects biologiques ont été abordés en 2012 par des prélèvements coordonnés de macrofaune benthique et des diatomées en mars et avril, des plantes aquatiques en été et de la faune piscicole en automne. Ce programme va être poursuivi (avec sans doute des aménagements) sans remplacer les suivis variés cantonaux. Des prélèvements et analyses croisés ont aussi été prévus pour assurer un contrôle de qualité. En parallèle, des problèmes particuliers de certains bassins versants sont étudiés en détails (programme SPEZ). Ces deux volets constituent le programme NAWA (observation nationale de la qualité des eaux de surface) dont le concept sera publié cette année.

Résultats et discussion

Pour la partie concernant les diatomées, 5 opérateurs ont réalisé les analyses : Arielle Cordonier, Margrit Egloff, Pius Niederhauser, Joachim Hürlimann et François Straub. Ils ont procédé selon la norme de l'indice suisse DI-CH (Hürlimann & Niederhauser, 2007). Cet indice intégré de 8 points (1 = excellent, 8 = très mauvais) a été étalonné à l'aide de paramètres saprobiques et trophiques. L'échelle de huit points est fractionnée en cinq classes de qualité selon le tableau I.

Tableau I : Evaluation de l'indice des diatomées et attribution d'une couleur aux cinq classes d'état de santé retenu par le SMG.

Indice diatomique DI-CH2006	1	2	3	4	5	6	7	8
Limites des classes	1.0-1.49	1.5-2.49	2.5-3.49	3.5-4.49	4.5-5.49	5.5-6.49	6.5-7.49	7.5-8.0
Système d'état selon le système modulaire gradué	très bon	très bon	très bon	Bon	moyen	médiocre	mauvais	mauvais

Les valeurs < 4.5 correspondent aux objectifs écologiques légaux, c'est-à-dire au pire, à des eaux légèrement eutrophes et moyennement b-mésosaprobes. Les formes tératologiques ont en plus été relevées.

Sur l'ensemble des valeurs de DI-CH obtenues en 2012 à 89 stations (dont 8 visitées deux fois), 88 % des valeurs indiquent des eaux qui correspondent aux objectifs écologiques de la législation (Oeaux, annexe 1). Seules 12% des valeurs indiquent des eaux de qualité moyenne à médiocre, qui demandent un assainissement complémentaire.

La répartition géographique de ces valeurs est assez logique. Les eaux de moindre qualité se situent sur le Plateau suisse, fortement urbanisé et agricole. Par contre les eaux de très bonne qualité se trouvent essentiellement dans les Alpes et les Préalpes. Dans le Jura contrairement à notre attente, les eaux en aval des bassins versants sont de bonne, voire très bonne qualité. Il est intéressant de constater, que les eaux exportées à l'étranger satisfont les objectifs écologiques légaux suisses.

A priori ces résultats sont encourageants, mais ils cachent sans doute une partie de la réalité. Les prélèvements ayant été réalisés en fin d'hiver, lorsqu'une partie des eaux sont partiellement de meilleure qualité qu'en été ou en automne (le choix des fenêtres de prélèvement a été fait en connaissance de cause pour que les conditions biologiques soient identiques pour les invertébrés et les diatomées, aussi pour limiter les coûts). Par ailleurs les stations choisies se situent en aval des bassins versants où la dilution est maximale. En amont, dans bien des cas on peut trouver des eaux de moindre qualité, comme le montrent les programmes cantonaux.

Dans 60% des communautés, des formes tératologiques ont été observées, mais seulement dans 9,4% d'entre elles avec des abondances relatives ≥ 1%. Le taux de ces déformations augmente légèrement en fonction de la dégradation des eaux. Une analyse détaillée des résultats des premiers relevés du programme NAWA complet sera publiée en 2015 environ.

Pour développer le contrôle de qualité des analyses, tous les opérateurs se rencontrent une fois par année dans un atelier de microscopie destiné à harmoniser leurs conceptions taxonomiques et clarifier en particulier certains groupes de taxons, souvent associés dans la banque de donnée qui a servi à l'étalonnage du DI-CH en 2007. Malgré cet effort, les analyses croisées de routine ont soulevé des incertitudes, en particulier chez *Achnanthidium*, *Amphora pediculus/indistincta/inariensis*, *Diatoma moniliformis/problematica*, *Encyonema* (particulièrement dans les Alpes), *Gomphonema* du groupe *pumilum*, *Mayamaea saprophila/pelliculosa* et dans le groupe autour de *Navicula antonii* et *N. cryptotenella.*

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Mots clés

Suisse, rivières, coordination, indication, tératologie

Présentation poster

Etude de l'influence des changements climatiques et environnementaux sur les diatomées du lac de Cadagno (Tessin, Suisse)

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Principaux points de l'étude

Ce travail a pour but d'évaluer l'impact des changements climatiques, de part une analyse de différents paramètres physico-chimiques mesurés au niveau du lac de Cadagno mais également par une étude des diatomées contenues dans les sédiments.

Introduction

Depuis plusieurs années maintenant, une hausse de la température moyenne globale est observée. De 1995 à 2006, on dénombre onze années comptant « parmi les douze années les plus chaudes depuis 1850 » (IPCC, 2007). Dans les Alpes, ces changements de la température sont plus importants qu'à l'échelle globale ou à l'échelle de l'hémisphère. Au cours du 20ème siècle, la température de l'air a augmenté de plus de 2°C dans certaines régions alpines. Ce réchauffement s'explique entre autre par une forte diminution de la moyenne des précipitations en été, ainsi que par un apport plus élevé de flux radiatifs solaires à la surface de par l'absence de nuages. Et cela malgré une légère hausse de la moyenne des précipitations en hiver (Beniston, 2006). Situé à 1923 m a.s.l au cœur du Val Piora dans les Alpes Centrales de Suisse, le lac de Cadagno est un petit lac méromictique d'origine crénogénique (Del Don et al., 2001). La chimie de ses eaux est influencée par la lithologie du bassin versant et les sources qui alimentent le lac, mais aussi par les réactions métaboliques des communautés bactériennes qui s'y développent. De nombreuses populations bactériennes se retrouvent au niveau de la chimiocline et du monimolimnion où elles forment une couche biologique colorée (Del Don et al., 2001). Si de nombreuses études ont été faites sur les communautés bactériennes du lac, permettant d'observer des changements dans l'abondance de certaines espèces, peu d'études portent sur les diatomées du lac. Les diatomées ont prouvé leur qualité d'indicateur de changements environnementaux dans les systèmes aquatiques marins ou d'eaux douces et dans diverses régions comme le milieu alpin. L'assemblage des diatomées et les processus écologiques qui leur sont associés dépendant de plusieurs facteurs comme l'altitude, la profondeur et la chimie de l'eau (Bigler et al., 2006).

Résultats et discussion

La station météorologique la plus proche du site d'étude se trouve à Piotta (Tessin, Suisse), à une altitude de 1007m. Les données de températures moyennes pour le lac de Cadagno (1923 m a.s.l) ont été obtenues par interpolation. L'analyse de ces données montre une évolution positive de la température avec un réchauffement annuel d'environ 0.3°C sur 21 ans, à une altitude de 1923m. Ce réchauffement annuel est moindre à plus basse altitude. Les valeurs de températures extérieures peuvent être utilisées pour obtenir le profil de la température de l'eau en surface du lac (Livingstone & Lotter, 1998). Ainsi, pour la période concernée, on peut estimer qu'il y a bien une légère hausse de la température de l'eau en surface du lac de Cadagno. Les premières analyses des paramètres physico-chimiques que sont la température, la concentration en oxygène, le pH, la conductivité et la concentration en sulfates confirment les profils déjà établis (Del Don et al., 2001). En été, les valeurs de température et de concentration en oxygène, constantes en surface, chutent rapidement entre 6 et 10 m de profondeur. Les valeurs de conductivité et la concentration en sulfates augmentent avec la profondeur. Pour ces différents paramètres, nous n'avons pas observé de variation significative dans le temps. De même qu'il n'est pas observé de perturbation de la chimiocline dans le temps. Il faut prendre en compte que par l'absence de suivi, les analyses sont faites sur des données éparses, parfois peu représentatives des valeurs moyennes réelles.

A partir des échantillons de sédiments provenant d'une carotte faite en 2009, une première observation des diatomées nous a permis d'identifier la présence des taxons *Stephanodiscus, Cyclotella, Navicula, Pinnularia* et *Fragilaria*, déjà observés dans des précédentes études (Güttinger & Straub, 1998; Riccardi et al., 2012). L'étude de Güttinger et Straub cherchait en partie à déterminer si le caractère méromictique du lac pouvait influencer la composition en diatomées en comparaison de celles d'autres lacs alpins alcalins. Les résultats obtenus dans cette étude n'ont pas montré de différences signifivatives. Dans le cadre de nos analyses nous avons également pu mettre en évidence la présence de nombreux kystes de chrysophycées. Il s'agit de premières observations des sédiments dont une étude plus complète est en cours.

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Mots clés

méromictique, chimiocline, diatomées, température, Alpes

Présentation orale

Effets de la température sur la croissance et les teneurs en acides gras polyinsaturés à longue chaîne (oméga-3) chez *Odontella aurita*, une diatomée marine

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Principaux points de l'étude

La croissance, l'activité photosynthétique et les teneurs en acides gras ont été quantifiés chez la diatomée *Odontella aurita* cultivée à différentes températures : 8 °C, 16 °C et 24 °C.

Introduction

Les stress thermiques ont le plus souvent des effets variables sur l'activité photosynthétique mais aussi sur la composition biochimique des microalgues. Chez les diatomées, la diminution des teneurs en lipides est corrélée à l'augmentation de la température (De Castro Araújo & Tavano Garcia, 2005). Par contre, une acclimatation aux basses températures peut se traduire par un enrichissement en acides gras polyinsaturés (série oméga-3) de certaines fractions lipidiques (Yongmanitchai & Ward, 1991; Roush et al., 2003), conduisant à une augmentation de la fluidité membranaire (Jiang & Gao, 2004). L'espèce étudiée *Odontella aurita* (Lyngbye) Brebisson (souche : CCMP1796) fait déjà l'objet d'une exploitation industrielle (Braud, 1997). Elle est commercialisée depuis plusieurs années comme complément alimentaire riche en oméga-3 (Mimouni et al., 2012). Dans un essai préliminaire, deux paramètres liés à l'activité photosynthétique de cette microalgue ont été mesurés par fluorimétrie modulée afin d'évaluer rapidement l'effet des températures imposées : le rendement quantique maximal ou F_v/F_m (mesuré sur des échantillons maintenus à l'obscurité) et le rendement quantique effectif du PSII ou Phi de PSII (mesuré sur des échantillons soumis à l'éclairement utilisé lors des cultures). Pour cela, un stress thermique court (5 h au milieu de la photopériode) dans une gamme de températures comprises entre 4 et 32 °C a permis de mettre en évidence que, chez cette espèce, les valeurs de F_v/F_m ne varient pas significativement entre 16 °C et 28 °C. En revanche, pour FPSII, un maximum est obtenu entre 20 °C et 24 °C.

Résultats et discussion

Lors des expérimentations, deux températures (8 °C et 24 °C) encadrant la température de maintien des souches au laboratoire (16 °C) ont été retenues. Des cultures en batch ont été réalisées sous un éclairement saturant (300 µmol m^{-2} s^{-1}) avec une photopériode de 14 h de jour pour 10 h de nuit. La croissance a été suivie par numération et pour l'analyse des lipides, deux récoltes ont été effectuées, l'une pendant la phase exponentielle de croissance et l'autre pendant la phase plateau.

Les courbes de croissance obtenues montrent que la température la plus basse (8 °C) induit un stress important. En effet, le taux de croissance en phase exponentielle est réduit de 60 % par rapport aux conditions optimales (16 °C) et la densité cellulaire maximale à la récolte n'est plus que de 15 %.

Lorsque les microalgues sont récoltées au cours de la phase exponentielle de croissance, la diminution de la température (8 °C), par rapport à la température de contrôle (16 °C), induit une augmentation significative du taux des acides gras polyinsaturés (AGPI, 20:5n-3 et 22:6n-3) avec, en parallèle, une diminution du taux des acides gras saturés (AGS, 14:0 et 16:0). Une augmentation de température (24 °C) a un effet inverse : une très forte diminution de la teneur en AGPI d'un facteur d'environ 3 et 4 par rapport aux résultats obtenus à 16 et 8 °C respectivement et, une augmentation du taux d'AGS d'un facteur voisin de 2, par rapport aux deux autres températures testées. En ce qui concerne les teneurs en acides gras de la série n-3, la variation des teneurs en EPA (20:5n-3) suit le même profil que celui observé pour les teneurs en AGPI, alors que seules les teneurs en DHA (22:6n-3) diminuent à 24 °C.

L'analyse de la composition des lipides totaux en phase stationnaire montre des profils comparables à ceux observés en phase exponentielle de croissance, avec cependant, un effet moins marqué (AGPI) voire absent (AGS) de la température la plus élevée (24 °C) par rapport au contrôle (16 °C). Les plus fortes teneurs en acides gras monoinsaturés (AGMI, 16:1n-7 et 18:1n-9) sont observés à 16 °C, avec une diminution de leurs teneurs à 8 °C et une augmentation à 24 °C.

Pour conclure, les résultats montrent une acclimatation de O. aurita aux basses températures par une augmentation de la synthèse de l'EPA et du DHA résultant de plusieurs étapes de désaturation et d'élongation précédemment mises en évidence chez d'autres microalgues (Mimouni et al., 2003; Guihéneuf et al., 2013). Ces mécanismes de régulation assurent une certaine fluidité des membranes contenant des phospholipides et des galactolipides dans lesquels sont incorporés l'EPA et le DHA.

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Mots clés :

Lipides, photosynthèse, oméga-3, EPA, DHA

Présentation poster

Nouvelles espèces fragilarioides de la Région antarctique maritime

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Points importants

Révision taxonomique des genres *Staurosira* et *Staurosirella* dans la Région antarctique maritime

Description de plusieurs nouveaux taxons

Analyse ultrastructurale de la morphologie de plusieurs taxons fragilarioides

Introduction

Les plus anciennes observations de diatomées de la Région antarctique remonte au début du 20ème siècle (a.o. Van Heurck, 1909; West & West, 1911; Carlson, 1913) quand les diatomées ont été recueillies durant les expéditions polaires anglaises, belges et allemandes. Dans ces rapports d'expédition, des nouvelles espèces de diatomées ont été régulièrement décrites en soulignant le caractère unique de la flore diatomique dans les échantillons antarctiques. Bien que des publications ultérieures de Germain (1937), Bourrelly & Manguin (1954) ou de Flower et al. (1996) ont augmenté le nombre d'espèces typiquement antarctiques, la majeure partie des diatomées signalées dans la région antarctique présente vraisemblablement une distribution cosmopolite. Les 15 dernières années cependant, un projet ambitieux a commencé visant à réviser entièrement la flore diatomique antarctique. Cela a abouti à ce jour dans les révisions approfondies de plusieurs genres de diatomées raphidées comme *Stauroneis*, *Luticola* ou *Pinnularia*. Tous ces résultats indiquent qu'une flore très spécifique et dans la plupart des cas, même endémique de diatomées est présente sur les localités étudiées, contredisant clairement toutes les observations précédentes.

À l'heure actuelle, une révision des diatomées araphidées présentes dans la Région n'a pas été faite. Par le passé, quelques nouvelles espèces ont été décrites dans les îles sub-antarctiques comme *Fragilaria maillardii* Le Cohu (Lange-Bertalot & Le Cohu, 1985) ou *Staurosira jolinae* Van de Vijver (Van de Vijver & Beyens, 2002). Malgré ce plutôt faible nombre de nouveaux taxons, des taxons fragilarioides sont désormais fréquemment rapportés de la Région antarctique. Sur base de la liste complète des publications antarctiques, faite par Kellogg & Kellogg (2002), il est clair que la plupart des taxons déclarés comme *Staurosirella* (*Fragilaria*) *pinnata* (Ehrenb.) D.M.Williams & Round montrent une distribution cosmopolite, ce qui fait de ce groupe une révision hautement nécessaire.

Résultats et discussion

Lors de la révision actuelle de la flore antarctique de diatomées de l'île Livingston (îles Shetland du Sud) et de l'île James Ross, situées dans la Région antarctique maritime, trois taxons fragilaroides appartenant aux genres *Staurosira* (1 taxon) et *Staurosirella* (2 taxons) ont été trouvés. Ces taxons ont été souvent rapportés comme *Staurosira* (*Fragilaria*) *alpestris* (Krasske) Van de Vijver ou *Staurosirella* (*Fragilaria*) *pinnata* (dans Kellogg & Kellogg, 2002). Une analyse approfondie de leur ultrastructure utilisant un microscope à balayage très performant (Zeiss Ultra dans le Musée d'Histoire naturelle à Londres), a montré que ces trois taxons ne pouvaient pas être identifiés avec la littérature actuellement disponible et ces espèces seront alors décrites comme des espèces nouvelles. Jusqu'à présent, ces trois taxons n'ont pas été trouvés hors de la région antarctique maritime. Les relations entre ces nouveaux taxons en comparaison avec d'autres taxons des genres *Staurosira* et *Staurosirella* est discutée et des notes sur leurs préférences écologiques sont présentées.

Staurosira sp1 forme parfois des populations importantes dans les lacs de l'île Livingston. Cette espèce se présente presque toujours en grandes colonies en forme de bande. Les frustules sont bien interconnectés par des épines marginales spatulées et fortement développées. Les valves sont linéaires ou faiblement linéaires-lancéolées avec des bords souvent resserrés et des extrémités rostrées à subcapitées. La longueur maximale ne dépasse jamais 25 µm. Les stries sont composées d'aréoles assez étroites, rectangulaires et continuent sur le manteau. Chaque apex porte un champ de pores apical assez visible en MEB, composé de 3-5 rangées de pores. Des rimoportules n'ont jamais été observées.

Staurosirella sp1 est rarement trouvé en grande colonie attachée. Les frustules sont interconnectés par des épines solides et spatulées. Les valves sont lancéolées à étroitement ovoïdes, faiblement à ostensiblement hétéropolaires et avec des extrémités subrostrées et largement arrondies. Deux champs de pores apicaux sont présents mais plus développés sur l'extrémité étroite. Les stries sont composées d'aréoles en forme de fente et continuent sur le manteau.

Staurosirella sp2 est plus rare sur les îles étudiées et se distingue nettement de l'espèce précédente par une forme plus étroite et plus héteropolaire. Les champs de pores apicaux ne montrent pas des différences morphologiques entre eux et sont composés de 4-5 rangées de pores assez courtes.

Sur le poster, la répartition de *Staurosirella pinnata* dans la Région antarctique basée sur les données de littérature est également montrée en illustrant quelques populations. Ces illustrations montrent bien que toutes ces populations doivent être révisées et vraisemblablement appartiennent à des espèces non-décrites à présent.

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Mots clés

Région antarctique, *Staurosira*, *Staurosirella*, taxonomie, morphologie

Présentation orale

Le genre *Planothidium* dans la région antarctique

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Principaux points

Liste de toutes les espèces du genre *Planothidium* dans la Région antarctique

Analyse du matériel type de *Planothidium lanceolatum*

Description de plusieurs nouvelles espèces

Introduction

En 1996, Round & Bukhtiyarova ont décrit le genre *Planothidium* pour y mettre un groupe d'espèces autrefois placées dans le genre *Achnanthes sensu lato*. Toutes ces espèces sont caractérisées par des valves plutôt fortement silicifiées, la présence des stries larges, généralement composées de plusieurs rangées de petites aréoles arrondies, occlues à l'intérieur par des hymens perforés, et un raphé proéminent avec des fissures distales nettement courbées et des terminaisons proximales du raphé souvent élargies. Chez de nombreuses espèces, principalement du complexe autour de *Planothidium lanceolatum* (Brébisson ex Kützing) Lange-Bertalot, une dépression sous forme de fer de cheval typique est visible alors que, dans certains cas, elle peut être partiellement fermée à l'intérieur par une structure interne en forme de coiffe. À l'heure actuelle, plus de 100 taxons sont inclus dans ce genre assez important, récensé dans tous les milieux aquatiques et de distribution mondiale.

Planothidium lanceolatum et *P. haynaldii* (Schaarschmidt) Lange-Bertalot sont deux espèces typiques et communes dans les communautés de diatomées aquatiques de la région antarctique. Selon la liste de Kellogg & Kellogg (2002), ces deux espèces ont été recensées dans presque toutes les localités antarctiques étudiées. Néanmoins, une analyse minutieuse des différentes populations révèle cependant des différences considérables entre les différentes observations nécessitant une révision urgente de ces populations.

Afin de faciliter la comparaison des différents morphotypes dans la région antarctique avec des taxons déjà établis, le matériel type de plusieurs espèces a été étudié.

Résultats et discussion

Après vérification des espèces de *Planothidium* rapportées dans la littérature et dans nos échantillons, un total de quinze espèces de *Planothidium* a été observé dans la région antarctique. La plupart des espèces (12) ont été trouvées sur les îles sub-antarctiques tandis que dans la Région antarctique maritime, seulement sept espèces ont été répertoriées. Une partie restreinte des espèces est connue aussi hors de la Région antarctique comme *P. frequentissimum* (Lange-Bertalot) Lange-Bertalot.

Malheureusement, dans la littérature, un grand nombre de noms figurent comme *P. linkei* (Hustedt) Lange-Bertalot ou *P. robustum* (Hustedt) Lange-Bertalot, résultant probablement d'une identification trop vague ou de l'application d'un concept taxonomique trop large. Un des noms les plus souvent cités est *Planothidium lanceolatum* (57 citations dans Kellogg & Kellogg, 2002), apparemment une espèce cosmopolite qui nécessite cependant une analyse plus approfondie. Le type le plus important qui a été analysé pour cette étude a été *Achnanthidium lanceolatum* (transféré en 1999 dans le genre *Planothidium*). La morphologie et l'ultrastructure ont été analysées en utilisant la microscopie optique et électronique à balayage. Les résultats de cette analyse indiquent que presque toutes les populations antarctiques appartiennent à deux espèces de *Planothidium* jusqu'à présent non décrites. Deux espèces ont été décrites récemment comme nouvelles pour la science: *P. rostrolanceolatum* Van de Vijver, Kopalová & Zidarova et *P. subantarcticum* Van de Vijver & C.E. Wetzel. Les nouvelles espèces peuvent être séparées sur base de différences dans les contours de la valve ainsi que dans la forme et la taille de l'aire centrale. Établir l'identité de *Planothidium* cf. *haynaldii* en Antarctique s'est avéré plus problématique car le type de *A. haynaldii* était considéré comme perdu. Il a cependant finalement été découvert dans un échantillon prélevé par Sodiro à Antisana en Equateur. Comme le type a montré des différences importantes avec les populations antarctiques, il est clair que ces deux taxons ne peuvent pas être considérés comme conspécifiques. Afin de révéler l'identité correcte, le type d'une autre variété d'*Achnanthes lanceolata*, *A. lanceolata* var. *capitata* O. Müller récolté dans le sud de la Patagonie, a aussi été étudié. Ce dernier a montré des similarités avec les populations de *P.* cf. *haynaldii* de l'Antarctique mais également des différences.

Durant les analyses, une petite espèce a aussi été trouvée dans quelques échantillons de bryophytes sur l'île de Livingston située près de la Péninsule antarctique. Cette espèce montre des similarités avec *P. renei* (Lange-Bertalot & R. Schmidt) Van de Vijver, une espèce typiquement antarctique, mais aussi avec *P. granum* (M.H. Hohn & Hellerman) Lange-Bertalot, considérée plutôt comme un taxon cosmopolite. La comparaison morphologique a démontré qu'il s'agit d'une nouvelle espèce à décrire.

Cette présentation montrera les différentes espèces de *Planothidium* répertoriées dans la Région antarctique, discutera de leur biogéographie et présentera les résultats des analyses morphologiques des différents types analysés.

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Mots clés

Planothidium, Région antarctique, taxonomie, morphologie, nouvelles espèces

Présentation orale

Quelques nouvelles espèces de *Planothidium* et comparaison avec plusieurs matériels types

On some new widely overlooked *Planothidium* species and comparison with several type materials

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Bullet points

Description of new widely distributed *Planothidium* species from temperate and tropical regions.

Comparison of new species with type materials of *Achnanthidium lanceolatum* Kützing, *Achnanthes lanceolata* var. *dubia* f. *minuta* Grunow in Van Heurck, *Achnanthes rostrata* Østrup, *Achnanthes lanceolata* var. *rostrata* Hustedt, *Achnanthes lanceolata* var. *robusta* Hustedt and *Achnanthes biporoma* M.H. Hohn & Hellerman using LM and SEM.

A thorough search on published illustrated literature as a basis for a worldwide distribution map of the new taxa previously identified under several different names.

Introduction

A large number of species currently placed within the genus *Planothidium* Round & Bukhtiyarova were formerly described in the genera *Achnanthes* Bory, *Achnanthidium* Kützing or *Microneis* Cleve along with several other smaller genera. *Planothidium* cells are usually solitary, heterovalvar, with a slightly concave raphe valve and a convex rapheless valve. Valves are mostly elliptic to lanceolate, with rounded, rostrate or capitate apices and multiseriate striae.

The genus has ca. 90 species, subspecies and varieties from different freshwater, brackish and even marine environments with several species showing a worldwide distribution.

Planothidium lanceolatum (Brébisson) Lange-Bertalot as the generitype was first defined by Round & Bukhtiyarova (1996) and three years later formally defined by Lange-Bertalot (1999). In the species complex around *P. lanceolatum*, the horseshoe-shaped structure located in the central area is a simple depression called *sinus* whereas in other taxa [e.g. in the group of *Planothidium frequentissimum* (Lange-Bertalot) Lange-Bertalot] a hollow chamber covers the horseshoe-shaped structure in the valve interior for which the name *cavum* is used.

In the present work we present three new *cavum*-bearing species misidentified in the published literature and compare them with the type materials of the species usually confounded with.

Results and discussion

We illustrate here three new species that were already illustrated in previous publications (e.g. Lange-Bertalot & Krammer 1989) usually based on a broad species concept or with a certain degree of uncertainty. The results of our work attempts to clarify the identity of these common species, frequently reported from temperate and tropical regions.

Planothidium biporomum (M.H. Hohn & Hellerman) Lange-Bertalot was originally described as *Achnanthes biporoma* from the Savannah River, a major river in the Southeastern United States (Hohn & Hellerman, 1963) and belongs to the group of species having an asymmetrical central area on the rapheless valve and internally bearing the so-called *cavum*. The species was transferred to the genus *Planothidium* by Lange-Bertalot (1999) lacking any justification and a detailed analysis of the type material, although at least two morphotypes are considered under the name *A. biporoma* in Krammer & Lange-Bertalot (1991). Apart from some recent unpublished reports (i.e. Lowe & Cody 2002), detailed observations of the taxon were made by Potapova (2010) who illustrated the type material of *P. biporomum* using both light (LM) and scanning electron microscopy (SEM) in the “Diatoms of the United States” online flora (Spaulding et al. 2010) using a broad species concept which includes in fact a second species that we formally describe here from two populations from France and southern Brazil. The new species differs from *P. biporomum sensu stricto* by having more rostrate apices and by differences in the number of areola per stria. The new species was previously often recorded in the literature under several different names around the world, being present in several latitudes (tropical, subtropical and temperate regions) except for the Arctic and Antarctic regions. Some of the names applied prior to Krammer & Lange-Bertalot (1991) are as follows: *Achnanthes lanceolata* var. *rostrata* Östrup, *A. lanceolata* var.*rostrata* (Östrup) Hustedt, *Achnanthes lanceolata* f. *rostrata* (Østrup) Hustedt, along with *sinus*-bearing species such as *Achnanthes lanceolata* var. *dubia* Grunow and *Achnanthes lanceolata* which are here explained and illustrated. None of the investigated type materials of the latter taxa corresponds to our new species.

The second new species is a *cavum*-bearing species described from populations of southern Brazil usually identified as *Achnanthes lanceolata* (=*Planothidium lanceolatum*), *Planothidium frequentissimum* or *Achnanthes lanceolata* var. *dubia* (e.g. Ludwig & Flores, 1995; Ferrari & Ludwig, 2007; Bes et al., 2012 ; Bartozek et al., 2013). The new species shows quite some similarities to *P. frequentissimum* explaining the confusion since it also possesses a *cavum* (unlike *P. lanceolatum*) and an elliptic valve outline. However, it is much smaller and has a different striation pattern in the raphe valve. The species is widely reported in rivers and lakes from the southern Brazilian regions (usually in large abundances) and its ecological preferences are also detailed.

The third species comes from the tropical region (Java, Indonesia) and is related to *Planothidium robustius* Lange-Bertalot (≡*Achnanthes lanceolata* var. *robusta* Hustedt) and *Planothidium abbreviatum* (Reimer) Potapova. Differences amongst the species are related to cell dimensions and striation patterns. While *P. robustius* seems to occur in the tropical region, *P. abbreviatum* is known up to date only from North America (U.S.A. and East Canada; Potapova, 2012 and Lavoie et al., 2008, respectively). Registers of *P. robustius* from Mediterranean region (Balkans by Miho & Lange-Bertalot, 2004; Levkov & Williams, 2007) lacks illustrations and could not be confirmed.

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Keywords

Planothidium, type material, taxonomy, morphology, new species

Abstracts

of the

CE-Diatom meeting

Oral presentation

Morphological diversity of *Fragilaria* s. str. in central Portugal

Speaker: ALMEIDA Salomé F.P.

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Bullet points

Fragilaria s. str. is common and frequent in Portuguese rivers but not abundant

Need for taxonomic clarification by comparison with published type micrographs

Use of morphometric geometry, morphology and ultrastructure

Introduction

Diatom assemblages have been included in monitoring, characterizing and assessment studies of streams from the central region of Portugal. These studies were either part of national scientific projects or part of Ph'D working plans. A common problem was detected during the diatom studies related to the identification of taxa belonging to the genus *Fragilaria* s. str. This genus is quite frequent in streams but never very abundant, which might be one of the reasons for the lack of taxonomic and ecological studies. Another reason might be the few morphological characters available for identification, some of them only observed with electron microscope. Three river basins (Vouga, Mondego and Lis) and a total of 107 samples, from different years were analysed and about 20 different *Fragilaria* species were distinguished. In only two samples relative abundance of *Fragilaria* species was above 8%, but in most cases average relative abundance was below 3%. Diatoms were analysed under the light (LM) and scanning electron (SEM) microscopes. Measurements were taken of at least 30 specimens per species (length, width and number of striae/10µm), ultrastructural analysis of areolae types in striae, number and placement of rimoportulas and apical pore fields were checked with SEM photographs, and geometric morphometry (Rohlf & Slice, 1990; Dujardin et al., 2010) was used to test for significant differences between taxa and/or populations including published type material, based on valve shape.

Tuji, Williams and other co-workers have published taxonomic papers concerning several species of *Fragilaria* s. str. (Tuji & Williams, 2006 a, b, 2008; Tuji, 2007), nevertheless many doubts persist and more studies are still needed not only for taxonomic clarification but also to increase ecological data on these species.

Results and discussion

The methods we used to clarify taxonomy required a large number of specimens for measurements and valve shape analysis, so only the most abundant *Fragilaria* taxa were submitted to further analysis, which in the present study includes 5 taxa.

In order to avoid homonymy with *Fragilaria capitellata* Lauby 1910*,* Lange-Bertalot & Metzeltin in Metzeltin et al. (2009) changed the name of *F. capitellata* (Grunow in Van Heurck) Petersen 1946 to *F. recapitellata*. Two Portuguese populations of *F. recapitellata* Lange-Bertalot & Lange-Bertalot in Metzeltin, Lange-Bertalot & Nergui were compared with type material of *Fragilaria capitellata* (Grunow in Van Heurck) J.B. Petersen 1946, *Synedra capitellata* var. *cymbelloides* Grunow, and *Synedra capitellata* f. *striis-distantioribus* Grunow. Concerning valve shape the two Portuguese populations were similar and fitted the type material of *F. capitellata*, nevertheless, our specimens were consistently smaller, wider and with lower striae density. SEM pictures of Portuguese populations were still compared with SEM pictures of *F. capitellata* in Tuji & Williams (2008) and similar ultrastructural characters were registered (1 rimoportula and 2 rectangular APF – apical pore fields - per valve and no spines).

Valve shape analysis of another *Fragilaria* species observed in different sites, revealed that all populations corresponded in fact to the same morphotype. The shape analysis of the Portuguese morphotype was more similar to that of *F. perminuta* (Grunow) Lange-Bertalot and significantly different from *Fragilaria capucina* Desmazières and *F. nevadensis* Linares-Cuesta & Sánchez-Castillo. Concerning dimensions and number of striae some differences were noted between our taxon and *F. perminuta* (ours was wider and with a lower striae density). No SEM photos of type material were available for comparison with SEM photos of our taxon which revealed 1 rimoportula and 2 APF per valve and no spines. Further analysis of type material is needed, but in the meantime it will be referred as *F.* aff. *perminuta*.

Fragilaria aff. *rumpens* was one of the most frequent *Fragilaria* taxa (counted in ca. 45% of samples) which allowed the comparison of several populations which corresponded to the same morpho-species, based on valve shape analysis. This morpho-species was compared with type (LM) micrographs of *F. rumpens* (Kützing) G.W.F. Carlson, *F. rumpens* var. *meneghiniana* (Grunow) Gandhi, *F. gracilis* Østrup, *F. fragilarioides* (Grunow) Cholnoky, *Synedra familiaris* f. *major* Grunow in Van Heurck, and showed to be most similar to *F. rumpens*. Nevertheless, most Portuguese populations were smaller despite similarity of striae density between all populations and *F. rumpens*. Other differences between our taxon and *F. rumpens* were: absence of spines and ribbon-like colonies formation in opposition to the presence of spines and ribbon-like colonies according to the description of type material; it was described from brackish waters while ours was found in freshwater streams showing an average conductivity around 100 μScm^{-1}). So despite morphological resemblances of our taxon with *F. rumpens* it might be different from it as Tuji & Williams (2006b) have pointed out before.

Two other taxa remain nameless; one has resemblances with *F. vaucheriae* (Kützing) J.B. Petersen while the other reminds us of *F. socia* (J.H. Wallace) Lange-Bertalot, which was never identified in Europe. In none of these 2 taxa were there sufficient similar characters for even considering them as having affinity with either one of the mentioned species.

The major problem encountered during this study of freshwater Portuguese *Fragilaria* s. str. was the lack of LM and SEM micrographs from type materials for comparison. Some taxa were named but in no case was there a confident identification.

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Keywords

Fragilaria s. str., taxonomy, freshwaters, streams

Poster presentation

Impact of drying-out on diatom communities and the consequences for their use in bioindication in river Maureillas (Pyrénées-Orientales, France)

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Bullet points of the study

We conducted a drying experiment on the French river Maureillas with 4 drying durations and 3 types of treatments. Drying duration has an effect on diatom mortality, diatom index values and community dynamics.

Introduction

In a context of climate change, small-order channels, mainly non permanent streams, are widely distributed and strongly influence the downstream section (Benda et al., 2005). Moreover, human impacts affect these ecosystems, particularly by important water withdrawals (Sabater, 2008).

The increase of dry streams, especially during periods of low water, is problematic for the biomonitoring required by the Water Framework Directive (European Parliament and Council, 2000). Indeed, the sampling protocol is standardized (AFNOR, 2003) for index application and dry streams are outside the scope. The index used in routine is BDI (Biological Diatom Index; Coste et al., 2009), a biological index based on pollution sensitivity of diatom species.

Since non permanent streams received only a recent interest, few data are available and it is thus necessary to collect information on diatom community dynamics before, during and after a dry episode. The increase of knowledge may conduct to an adaptation of biomonitoring tools to ensure the management of these particular streams.

The objective of this study was to understand how a drought episode impact diatoms communities in a perspective of their use in bioindication.

For this purpose, we have conducted a study on the river Maureillas (South of France). We tested 3 drying durations (1, 2 and 4 weeks) on 3 types of pebbles of the riverbed: control pebbles, left in the river throughout the experiment; dry pebbles, placed on the riverside during dry period before rewetting; cleaned up pebbles, removed and cleaned with ethanol and metallic brush before rewetting). After each dry episode, dry pebbles and cleaned-up pebbles were rewetted and sampled at 5 times (0, 1, 4, 8, 18 and 28 days) with control pebbles 3 pebbles that have been pooled for each sample.

Results and discussion

For each pebble, we have measured the scraped area to further infer cellular densities from cell counts data. Diatoms have been fixed with glutaraldehyde 1% to distinguish valves with chloroplasts (potentially alive cells) from empty valves (dead cells) under an inverted microscope. The final data were cellular density, BDI scores on dead valves and potentially alive valves, and species abundance for each sample.

We observed that drying induced a certain mortality rate, estimated with the number of full and empty valves. This mortality rate was stable and did not seem to depend on the duration of dry episode.

BDI scores have been done with empty and full frustules and there was no significant difference between both methods. The index revealed a “medium quality” with an important presence of cosmopolitan species such as *Nitzschia amphibia* or *Planothidium lanceolatum*. The maximum deviation observed was 2.2 points during the two months of the experiment. The average deviation of the control (pebbles not submitted to dry period) and dry biofilm scores, in absolute value, increased with the duration of dry period without significant consequences on the estimation of biological quality.

Regarding communities, they slightly varied during the experiment, particularly during the first weeks of the experiment. If we consider data with full valves, the routinely used method, communities of dry biofilm are always significantly different from control communities. 28 days after flow resume, the communities did not return to their original composition whereas the diversity of cleaned up pebbles was stabilized after a few days (exogenous diversity contribution). We observed that cleaned up pebbles and dry biofilm pebbles were more similar than control pebbles, which emphasizes the importance of drift compared to regrowth from dry biofilm. However, cleaned up pebbles and dry biofilm pebbles were different in the case of long dry episode (4 weeks). Even if we noted differences of composition in treatments, the communities from all pebbles followed a similar trajectory.

Drought induced an additional mortality which was stable whatever its duration. This result was unexpected but we could not find a reason to explain a loss of empty valves. The re-immersion induced a modification of diatom communities without an impact on the BDI scores, in the conditions of the experiment. This may be linked to thepresence of cosmopolitan and tolerant species and the absence of any important disturbance during the experiment. The difference observed between the cleaned up pebbles and the dry biofilm pebbles in the case of long dry episode (4 weeks) may be explained by the evolution of communities in the river during the dry period. In addition, drift and dry biofilm have a role for diatom regrowth and the history of biofilm seemed to be highly important. We obtained different results when we considered only valves with chloroplasts, which suggest that protocols used in routine could induce biases in interpretations of diatom inventories. To conclude, even a short dry period has an impact on community structure without a return to initial situation. However, in our study, it does not impact scores of BDI. It may be interesting to test this experiment in a river of better quality, with numerous sensitive taxa.

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Keywords

diatoms, drying episode, bioindication, community dynamics

Oral communication

Diatoms used for the evaluation of the effects of experimental water releases from hydroelectric power plants in alpine river systems: the case of the Cairasca-Devero basins (NW Italy)

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Bullet points

Water quality monitoring of alpine rivers

Benthic diatom communities

Impact of hydroelectric plants

Didymosphenia geminata

Introduction

Diatom communities are relatively well-known component of aquatic ecosystems, used in numerous countries as a component of monitoring networks of watercourse quality and also for more specific and refined monitoring purposes. In application of Italian legislation, following the construction of a new hydroelectric plant in the upper Cairasca basin, in 2009 an experimental program of releases from recent and old hydroelectric plants in two rivers began, for the evaluation of the effects of the different release regimes on the aquatic ecosystems and the individuation of environmentally acceptable release levels. The Cairasca and Devero are two adjacent alpine rivers; water is abstracted in the upper part of both, deviated to a reservoir, then to a power plant in the lower part of the Devero basin, where it is finally released into this same river. A "reference" sampling station (C1) was situated in the Cairasca river upstream of the new abstraction point situated in a Natural Park (characterized by an annual average natural discharge of ca. 2000 l s-1), other two stations (C2 and D1) were situated downstream of the abstraction points on the Cairasca and Devero rivers, respectively, while the lowermost station (D2) was situated on the R. Devero below the hydroelectric system re-emission point. Experimental barrage releases from the new abstraction point were planned in the form of four 2-year steps ranging between 100 and 170% of the legal minimum flow. In the other abstraction points, which were already existing, in the same 2-year periods, flow levels of releases ranged between 50 and 130% of the legal minimum flow were planned. Alongside physical, chemical and other approaches (including methods based on macroinvertebrates, fish and microhabitat, Botta et al., 2012), diatoms were adopted to evaluate the environmental effects of the releases.

Samples of epilithic diatoms were taken in the Summer of each year and treated according to standardized procedures, permanent slides were produced, frustules were observed with a light microscope and taxa were identified (counts of ca.400 individuals for each sample). The EPI-D index was calculated for all samples, and expressed in the 1-20 scale of increasing water quality (Dell'Uomo, 2004).

Results and discussion

The number of species in each sample ranged from 13 to 35. Some very abundant species, such as *Achnanthidium pyrenaicum* (Hustedt) H.Kobayasi and *A. minutissimum (*Kützing) Czarnecki, were present in both river basins. Others, like *Encyonema silesiacum* (Bleisch) D.G.Mann and *Diatoma ehrenbergii* Kützing, tended to be more abundant in the Devero stations, while yet others like *Fragilaria arcus* (Ehrenberg) Cleve tended to prefer the Cairasca stations. Among other reasons, these differences can be explained by the differences in ecology of the rivers and in the geological characteristics of the two basins.

In terms of water quality, the study showed that all stations were characterized by relatively high values of EPI-D index (also see Botta et al., 2012). However, some trends in the data were observed. The average value of the EPI-D index for the entire study period was highest in the reference site (17.4) and lowest in station D2 (16.4). A temporal trend was not evident for the reference site, while for the 3 stations subjected to hydrological regulation the average values observed from 2009 to 2012 increased progressively from 16.1 to 17.6. This last value is exactly the same as the one (17.6) calculated for the reference site in the same year 2012. An explanation we give for this is that in 2012 there was no effect on the diatom community due to regulation because water was not abstracted from the rivers due to technical problems.

In the stations subjected to water regulation – especially D1 and D2 - there was a progressive increase of water quality expressed by the diatom index, while in the reference site this trend was not observed. However, from 2009 to 2012, a progressive and apparently exponential increase in the abundance of the potentially invasive species *Didymosphenia geminata* (Lyngbye) M.Schmidt was observed in station D2, which in this study represents the stretch of watercourse most strongly influenced by hydrological regulation. Abundance of this species passed from 2% in 2009 to 4.5% in 201 to 9% in 2012. *D. geminata* is characterized by a much greater individual biomass than most other diatom species. In 2012 *D. geminata* also appeared in station D1 for the first time, while in the Cairasca stations it was always absent. In several parts of the world the species was previously absent but in recent years severe blooms have been reported (Blanco & Ector, 2009), while in NW Italy there is historical evidence of its pre-existing presence (Battegazzore et al., 2009). The increase observed in this study is a cause for concern and attention should be given to the trend of this species in the course of the monitoring which will continue in the coming years.

The connection between the increase in numbers of *D. geminata* and the type of regulation operated on the releases from the hydroelectric plants should be better understood. The level of ecologically acceptable discharge to be released into the Cairasca and Devero rivers will be established integrating the biological and habitat monitoring (Petts & Maddock, 1994), following the conclusion of the monitoring program due in 2016.

The study confirms that diatoms, besides river quality monitoring networks, can also be successfully employed in situations where it is necessary to evaluate more specific effects of certain activities on the riverine ecosystems, for which the national monitoring networks are not appropriate.

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Keywords

Ecology of alpine rivers, monitoring of hydroelectric plants, water quality indices, benthic diatom communities, *Didymosphenia geminata*

Oral presentation

First results of a study done on a cut-off meander deepened at its confluence using diatom community: a sedimentology approach (Allier River, France)

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Bullet points

A pluridisciplinary study using geomorphology, sedimentology and hydrobiology was initiated on a site that was deepened at its confluence to increase the connectivity with the main channel.

Introduction

Before the last two to three decades, the wetlands were considered as unhealthy areas and were usually drained. Actually, as they sustain different hydrological roles and appeared to be diversified, a consensus has been reached to protect and restore them. Indeed, they allow retention of sediments and nutritive elements, attenuation of flood-peaks and groundwater recharge (Adamus & Stockwell, 1983). They also enhance the diversity of riverine habitats (Décamps & Naiman, 1989) and provide habitats for a diversity of wildlife. Many works were done to outline the diversity of forms, sizes and dynamics of these meander cut-offs or to understand their functioning by studying their hydrological exchanges (Amoros & Bornette, 2002; Le Coz, 2007). Many other studies focused on the importance of abiotic factors on aquatic plant diversity (Bornette et al., 1996, 1998), planktonic organisms (Rossetti et al., 2008), on periphyton distribution (Pan & Stevenson, 1996; Pan et al., 2000; Mayer & Galatowitsch, 2001; Gell et al., 2002; Gaiser et al., 2005; Wang et al., 2006; Zheng & Stevenson, 2006; Lane & Brown, 2007), on macroinvertebrates distribution (Castella et al., 1991; 2007; Foeckler et al., 1994; Paillex et al., 2007) or on the recruitment of young fishes (Nunn et al., 2007). However, to our knowledge, no studies have focused on meander cut-offs by linking geomorphology, sedimentology and hydrobiology. In this way, the aim of the present study was to analyze the spatial distribution of the benthic diatoms in a parapotamal cut-off meander using sediment traps. For this purpose, relationships between diatoms and the main physical and chemical characteristics were studied all along the studied site. For this, the Lindes site was retained that was deepened at its confluence to increase the connectivity with the main channel. This cut-off meander was only connected to the main channel by its downstream end and only during flood events, upstream was connected. This site is located in the small subsidence basin of Brioude at 153 km from the source and located about 400 m above sea level. The catchment area is gnessic/granitic, essentially covered by pastures, fields and alluvial forest and, the main anthropogenic pressure was agricultural activities (cereals production and cattle farming).

Results and discussion

The physical and chemical analyses done throughout one hydrological cycle along with the water temperature monitoring, showed that the upstream water temperature evolved independently of the main channel. Moreover, when the water discharge and groundwater levels were low, the conductivity was high upstream (≈800 µS/cm) as well as the ionic concentrations. The upstream – downstream differences were important even if the downstream concentrations were also different from the main channel. During high water discharge and groundwater level, upstream – downstream differences were more important as the downstream concentrations were very similar to that of the main channel. These observations underlined the inputs of the alluvial groundwater into the meander cut-off and particularly upstream as observed by other authors in other places (Fraser & Williams, 1997).

Using the sediment traps (installed in July 2010), the more important deposits were observed downstream. The sediments traps collected sand and silt along with 25% organic matter. The organic matter deposits were more important at both ends of the cut-off meander. This type of sedimentation, typical of backwater lakes, was described by Citterio & Piégay (2000) for other sites along the Ain River. In Lindes, as the connection was reinforced by the deepening, sediments were transported more upstream. The organic matter was composed of leaves from ripisylve all along the site, as observed by Chergui (1989) in other places. It was also transported by the main channel and deposited downstream after flood (Amoros & Petts, 1993).

Whatever the campaign, the lowest densities of diatoms (sampled from the sediment traps) were observed upstream and at the downstream ends. During the first campaign, done during low water level, three different groups appeared: upstream, intermediate and downstream end (at the confluence). Upstream, epiphytic taxa as *Cocconeis euglypta* Ehrenberg and *Planothidium frequentissimum* (Lange-Bertalot) Lange-Bertalot were observed (Van Dam et al., 1994; Taylor et al., 2007). There were also brackish taxa as *Tabularia fasciculata* (Agardh) Williams & Round and *Craticula buderi* (Hustedt) Lange-Bertalot underlining the groundwater inputs (Van Dam et al., 1994; Lange-Bertalot, 2001). In the intermediate part, there were *Pseudostaurosira brevistriata* (Grunow in Van Heurck) Williams & Round and *Staurosira venter* (Ehrenberg) Cleve & Möller, two freshwater species considered as epiphytic by different authors as Stančikaite et al. (2009), and known to live in relatively deeper-water (Winsborough et al., 2012). At the downstream end, different *Navicula* and invasive species, well represented in the main channel, were observed as *Achnanthidium subhudsonis* (Hustedt) H. Kobayasi and *Gomphoneis minuta* (Stone) Kociolek & Stoermer var. *minuta* (Coste & Ector, 2000). During the high water level (flood period), there was a progressive evolution from up- to downstream and the same dominant taxa as in the first campaign were observed. However, *Achnanthidium subhudsonis* was present in all the sediment traps and particularity at the upstream and downstream ends underlining the upstream water inputs of the main channel during flood.

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Keywords

sediment traps, physical and chemical analysis, density, diatoms

Oral presentation

Magnitude and specific responses of diatoms to climate warming versus local stressors in anthropogenized lakes

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Bullet points of the study

Our results demonstrated that lake diatoms vulnerability and responses to climate warming are modulated by lake geomorphology but also trophic status.

Introduction

Climate change is increasingly acknowledged as an important driver of lake ecosystems (IPCC, 2001). While diatom communities were shown to strongly respond to current climate warming in remote lakes, evidences are still equivocal for lakes under strong local human pressures. To forecast the effects of climate warming in the context of multiple local human perturbations is yet difficult (Jeppesen et al., 2010): climate effect could be blurred by the relative strength of other impacts and climate may interact with other environmental pressures (Battarbee et al., 2012).

The temporal dynamics of the planktonic diatom communities as reconstructed from paleolimnological approaches were re-explored for three sub-alpine lakes (Berthon et al. in press). These lakes have been undergoing substantial changes in their phosphorus concentrations and fisheries management practices the last century. Alric et al. (in press) showed that long-term changes in the cladoceran communities significantly responded to changes in fisheries management practices, in addition to nutrient and climate. Changes in grazing zooplankton composition could cascade down to phytoplankton, and thus diatoms, through a top-down effect (Carpenter et al., 1996).

A first objective was to assess whether climate warming had been a significant structuring factor of the diatom communities and to which extent. A second objective was to address diatom specific responses to climate change and whether they varied according to lake local pressures. In that purpose, generalized additive models were used to develop a hierarchical understanding of the respective roles of local stressors and climate warming in structuring diatom communities.

Results and discussion

Although changes in phosphorus concentrations were the major driver of the diatom community structure over the last 100 years in these lakes, their diatom trajectories over the latest 30 years have been responding to a new set of environmental forcings. Although seldom explored, top-down control, through fisheries management practices, has exerted a minor, yet significant, impact on the diatom community structure, by favoring larger species that are less vulnerable to grazing.

A significant impact of climate, through increased air temperature, could be detected on the diatom trajectories for all three lakes. However, the magnitude of the climate influence differed between lakes, partly because of their geomorphological characteristics. Besides, the diatom specific responses to warming also varied, *Cyclotella* being favored in the most oligotrophic lake while warmer climate promoted larger diatom species such as Fragilaria crotonensis in the more eutrophic ones.

Our results demonstrated that lake diatoms vulnerability and responses to climate warming are modulated by lake geomorphology but also trophic status.

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Keywords

diatoms, additive model, climate change, nutrients, fisheries

Oral presentation

Marine biofilm communities colonizing antifouling paints

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Bullet points

Low diversity at early colonization stage.

Environmental conditions are shaping communities as time goes.

Coatings are structuring microbial communities.

Diatoms are key colonizers favoring later fouling.

Introduction

When immersed in sea water, any substrate would be rapidly colonized by micro and then macroorganisms (Wahl, 1989). This complex natural process called biofouling induces economic and ecological prejudices, especially talking about ship hull or aquaculture nets. Antifouling (AF) coatings are required to prevent the colonisation of ship hulls. Increasing attention is paid to biofilms that develop on coatings (eg Dobretsov & Thomason, 2011), firstly because their presence directly increases frictional resistance and consequently fuel consumption, and secondly, because biofilms have been shown to influence the secondary settlement of invertebrate larvae and/or algal spores (Hadfield, 2011). Biofouling is a natural process of colonization of submerged surfaces, involving a wide range of organisms, from bacteria to invertebrates. Among these microorganisms, microphytobenthos is mainly represented by diatoms and especially pennates. This study aims to assess the variation of microbial communities that colonize different AF coatings for ship hull at various sites and stages of colonization. Different coatings were compared, including untreated surfaces and commercial AF paints. For each coating, panels were immersed in sea water in triplicate during two weeks (experiment 1, Briand et al., 2012) and one month (experiment 2, Camps et al., submitted) in coastal sites in North-Western Mediterranean Sea. In complement, immersions were performed one month at each four seasons, in two contrasted temperate French coastal sites (Toulon bay - North-Western Mediterranean Sea and Lorient bay, Atlantic Ocean) (experiment 3). The structure of microbial communities was analysed using complementary tools: PCR-DGGE, flow cytometry and inverted microscopy.

Results and discussion

Specific effects could be observed on biofilm communities for each coating. In addition, these effects varied according to sites and time of colonization. In the first experiment (2 weeks), communities at a pioneer stage were characterized by a low diversity and a high similarity between samples (sites, surfaces). However a clear structural effect is already obvious on diatom communities between untreated and AF treated surfaces. The former exhibits efficiency against diatom colonization which is increasing with increasing surface hydrophobicity. For the latter, the structural effect depends on both biocide composition and location.

As time goes on and the biofilm matures (experiments 2 & 3), its diversity increases and its composition becomes more and more related to its environment. However, biofilm communities were more rapid to diversify on untreated than on AF coatings, probably due to biocide diffusion. Diatoms, the only microphytobenthic class identified, displayed the lowest densities among other microbial organisms. *Licmophora*, *Navicula* and *Nitzschia* were determined as the dominant diatom genera. Diatom dominance but also diversity patterns appeared to vary significantly from one coating to another. Globally, richness and abundance increased whereas diversity (H') did not clearly changed with the increasing time of immersion.

Among tested coatings, some are failing to prevent the colonization of one specific group, diatoms or heterotrophic bacteria, but only one (A3S) could be considered as able to control the whole microbial community. One AF coating with no copper (NEX) was especially colonized by one diatom species, *Thalassionema* sp. (85%), which indicated a high sensitivity to copper for this species.

We were also able to underline a significant correlation between the similarity matrices of the prokaryotic communities (DGGE) and the diatom communities (in cells/cm^2 $r=0.49$, $p<0.0001$, $n=20$). This seems to indicate that the ways these communities were controlled by coatings are related, and probably qualitatively more than quantitatively. This relationship remains to understand.

In experiment 3, preliminary results showed that copper pyrithione (AF coating) was the most efficient biocide whatever site and season. Although they are both significant, site effect seems to be more important than seasonal one on the community structure. The current analysis of the whole data will allow us to precise the specificity of the effect of each parameter (biocides, seasons, sites). Particularly, NGS data will enlighten the prokaryotic community in order to better understand what is beyond their similar patterns with the diatom communities.

All these results highlighted the interest of polyphasic approaches to get a complete image of community structures and of their evolution.

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Keywords

biofilm, diatoms, antifouling coatings, microbial ecology

Oral presentation

Unexpectedly-high diatom biodiversity in spring-habitats of the Emilia-Romagna Region (Italy, EBERs Project), and its hydrogeological and hydrochemical prerequisites

Speaker: CANTONATI Marco

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Bullet points

The study explores diatom spring-habitat biodiversity of a northern Italian Region including mountains (Apennines) and agricultural and industrial lowland.
The limited number of springs that could be investigated was found to host a very-high total number of diatom taxa, including several new or putative-new species, and many Red-list taxa.
The main goal was to assess the hydrogeological and hydrochemical causes of diatom species richness.
A striking variety of lythotypes determines extensive conductivity and pH gradients.
Agriculture and industrial activities in the lowlands cause nutrient enrichment and pollution.
The hydrogeological settings influence diatom-occurrence determinants of outstanding importance, such as morphology of the spring head and of its surroundings, hydroperiod, discharge (and current velocity).

Introduction

Spring habitats possess very peculiar features, and include a variety of types. The reasons for spring habitat peculiarity and biodiversity richness are complex (e.g., marked heterogeneity of characteristics, complex microhabitat mosaic structure, ecotonal environment –transition from surface to groundwater, and from aquatic to terrestrial habitats; Cantonati et al., 2012a). Research on springs as habitats and ecosystems is however still somewhat neglected, and springs are affected by many impacts, first of all water diversion and habitat destruction (tapping). The close relationship between spring diatom assemblages and the geological formations of the aquifers was shown e.g. by Werum & Lange-Bertalot (2004). In some cases the occurrence of individual diatom species appears to be correlated with the dominant lithotype in the spring drainage basin, e.g. dolomite (Cantonati & Lange-Bertalot, 2006). If the importance of environmental factors such as pH, conductivity, and nitrates as determinants for spring diatom assemblages was recognized by several authors (e.g., Cantonati et al. 2012b and references therein), only very few papers addressed the relationship between biota and spring hydrogeology (e.g., van der Kamp, 1995).

EBERs (*Exploring the Biodiversity of Emilia-Romagna springs*) is a three-years-lasting (2011-2013) Project fostered and funded by the Geological Survey of the Emilia-Romagna Region. Among the objectives are a multidisciplinary, exploratory investigation of the habitat and biota of selected Emilia-Romagna springs, and the dissemination of an improved awareness of the role of springs in the territorial and thematic planning. A further focus of this study was to assess the hydrogeological and hydrochemical reasons for spring-habitat diatom species richness.

Sixteen springs were considered for the EBERs Project. Field work was carried out in the summer of 2011 and 2012 (hydrochemistry and biota). Hyrogeological observations and monitoring of selected springs was performed continuously between May 2012 and June 2013.

Results and discussion

The hydrogeological investigations defined the spring geological hydrostructure, and classified the groundwater flow system that discharges next to the outcropping area by using a hydrological-exhaustion-based method (Gargini et al., 2008) to identify the hydrogeological basin, and to bolster the territorial conservation of the capturing structures.

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

Diatom analyses are still ongoing but at present the database already includes almost three-hundred (297) taxa belonging to 60 genera. Four species (in the genera: *Amphora*, *Delicata*, *Eunotia*, *Navicula*) are new to science. In-depth studies on their LM morphology (variability etc.), chromoplast shape and arrangement, SEM ultrastructure, and ecology and distribution are being completed to characterize them. Further several other taxa (7) are putative new species and observations and extensive literature research is being performed to confirm these hypotheses. EBERs confirms seepages to be the spring type richest in species (60 taxa found in the Lago Scuro helocrenic spring). Diatom assemblages evidently react to geogenic variables, such as pH and alkalinity, with low alkalinity springs hosting a high number of mostly acidophilous taxa while mineral springs (Poiano) are colonized by a reduced number of brackish water species. Also the effects of nutrient (nitrate) increases are evident, with the nutrient enriched Fontanile Valle del Re (sun-exposed spring mouth) hosting a few taxa partly overlapping with the saline Poiano spring.

Springs' Associated Limestones (SAL) or petrifying or tufa springs are one of the few spring types indicated as priority habitat by the European Union Habitat Directive (92/43/CEE, EU-HD, 1992). In both SAL springs considered for the EBERs Project we detected free CO_2 which caused variable pH depletion, and traces of the living bio-calcifying desmid alga *Oocardium stratum* (Rott et al., 2012). The diatom assemblages of these two SAL springs are of interest as well, with e.g. a *Delicata* species potentially new to science occurring in one of these.

The biodiversity detected in the relatively small number of springs studied is remarkable from both the quantitative and qualitative standpoints. This is likely to be due to the fact that the springs were carefully selected to be representative of the different geological, hydrogeological, and ecomorphological settings within in the Emilia-Romagna Region, and were thus extremely heterogeneous. Moreover, Emilia-Romagna spring habitats were still relatively unexplored, with only some components of the biota (ostracods, copepods) having been investigated in detail, and only in some spring types (mountain rheocrenes). An integrated hydrogeological-ecological approach is of great relevance to lay the foundations for conservation actions and for the monitoring of springs, understood not as simple points of aquifer-system discharge but as complex GDEs (groundwater dependent ecosystem, Bertrand et al., 2012).

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Keywords

diatoms, hydrogeology, hydrochemistry, Emilia-Romagna, species richness

Poster presentation

Epilithic diatom assemblages of an extremely-low-alkalinity high mountain lake (Adamello-Brenta Nature Park, south-eastern Alps) with special reference to the depth-distribution

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Bullet points

The study investigated the epilithic diatom community of an extremely-low-alkalinity high mountain lake located in the Adamello-Brenta Nature Park (Trentino, Italy).

The taxonomic composition of diatoms was clearly indicative of the hydrochemical and trophic characteristics of the lake, presenting mainly acidophilous and oligotraphentic taxa.

The littoral diatom community did not present major changes (in relative abundances) over the different seasons, suggesting a high adaptability to the changing environmental conditions of the lake.

The depth-distribution study identified three different depth zones, each one characterized by specific taxa. Highest diversity was registered in the upper zone, a slight decrease in the mid-depth zone, and a drop in the deep-water zone.

The species *Microcostatus krasskei* was interestingly found to be dominant in the deep zone, while usually reported as typical of pseudaerial habitats.

Introduction

Near-natural environments in remote areas are suitable sites for studying environmental changes. This is particularly true for high-mountain lakes located on siliceous bedrock. Siliceous rocks have an extremely low solubility, entailing low to very low alkalinity and mineralization values of the water (Psenner, 1989; Cantonati, 1998; Cantonati et al., 2002). As a consequence these sites are highly sensitive to the input of acidic substances and can be considered as early warning systems of acidification processes (Psenner, 1989; Catalan et al., 1993; Tolotti, 2001). Benthic diatoms and in particular, given the prevalence of rocky and stony materials among substrata in high-mountain environments, epilithic ones are abundant and dominant compared to planktic diatoms, often absent in waters of shallow high-mountain lakes (Cameron et al., 1993), and generally missing in waters with pH < 6 (Olaveson & Nalewajko, 1994). The ecological and taxonomic characterization of these organisms and communities is thus relevant in order to infer past conditions of the study environments, and to monitor the present situation and ongoing changes.

We studied Lake Nero di Cornisello (max depth = 33.7 m), located in the Adamello-Brenta Nature Park (Trentino, Italy), with the main aim to increase the knowledge on the diatom biodiversity of this protected area, and to establish a long-term monitoring project using littoral diatoms communities. Knowledge on epilithic diatom depth-distribution, and on the extent of seasonal fluctuations were considered strategic also to this respect. Annual samples were analysed over the period 2004-2009, seasonal ones were collected in 2004 and 2005 while, for the depth-distribution study, samples were collected in September 2004 (depths sampled: 0.5, 2, 4, 6, 9, 12, 15, 18, 21, 24).

Results and discussion

Lake Nero di Cornisello had a very low conductivity (6-10 µS cm^{-1}), low pH (5.4-6.6) and low alkalinity (30-70 µeq L^{-1}). 96 diatom species belonging to 27 genera were identified. Littoral assemblages showed high diversity with an average Shannon-Wiener index of 3.4, with 49% of taxa belonging to threatened categories of the Red List for central Europe. The most species-rich genera were *Eunotia* (23 taxa), *Achnanthes sensu lato* (10 taxa), *Pinnularia* (7 taxa), *Brachysira* (5 taxa), and *Gomphonema* (5 taxa). With respect to pH preferences, 58% of the species were classified, with 52% of them consisting of acidophilous and acidobiontic taxa. For the trophic status 53% could be classified, 48% of them being oligotraphentic. Oligotraphentic and acidophilous + acidobiontic taxa also included the most frequent and abundant species, e.g.: *Eunotia subarcuatoides*, *Eunotia exigua, Psammothidium acidoclinatum, Brachysira intermedia*, *Brachysira brebissonii*. Diatom communities were clearly indicative of low conductivity, pH, and alkalinity.

The littoral diatom community did not present major changes (in relative abundances) over the different seasons, in spite of significant variations in chemical and physical conditions (Tardio et al., 2007), suggesting a high adaptability to the changing environmental conditions of the lake.

The study of epilithic diatom depth-distribution in Lake Nero di Cornisello allowed to identify three different depth zones: the shallow zone (0.5 m), the mid-depth zone (2-12 m), and the deep zone (18-21 m), each one characterized by specific taxa. The Shannon-Wiener index showed the highest diversity in the upper zone (H = 4.06), a slight decrease in the mid-depth zone, and a drop in the deep-water zone (H at 21 m depth = 0.89). According to the Intermediate Disturbance Hypothesis of Connell (1978), moderate disturbance, due to water-level fluctuations, might increase diversity in the shallow zone; the relatively high stability of the mid-depth zone might be the cause of the reduction in diversity; severe disturbance, due to extreme reduction of P.A.R., might be the cause of the drop in diversity in the deep zone.

Interestingly, *Microcostatus krasskei*, almost absent at shallow depth (0.4% at 0.5 m) was more abundant at medium depths (14.4% at 9 m and 14.7% at 12 m) and the dominant species of the deep zone (> 86%). This species is usually reported as typical of pseudaerial habitats (Johansen & Sray, 1998; Wehr & Sheath, 2003; Taylor et al., 2010). The finding of this species in the deep waters of Lake Nero di Cornisello suggests the hypothesis that its occurrence might be linked not only to habitat hydration but also to the degree of light intensity. This might allow a new interpretation of the usual pseudaerial occurrence: it might occur preferentially in pseudaerial habitats, such as the soil surrounding aquatic environments, because of higher competitive abilities in low-light environments.

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Keywords

Epilithic diatoms, high-mountain lakes, extremely-low alkalinity, depth distribution, long-term monitoring

Oral presentation

Diversity and ecology of soil diatoms in urban habitats

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Bullet points

This study is primarily concerned with the diatoms growing on soils in various urban habitats, where a surprisingly diverse soil diatom flora was found.

Introduction

We present preliminary results of the floristic part of an ecological study of soil diatoms from urban habitats. This study is conducted by the Department of Botany & Zoology of the Masaryk University under a project “Biodiversity of Central and Southern European cities: a comparative study of vascular plants, algae, cyanobacteria and molluscs“.

Soil diatoms are influenced by many stress factors, mainly desiccation, irradiance sensitivity, osmotic pressure, pH oscillation and extreme temperature changes (Evans, 1958; Welsch, 2000). It remains unclear, how terrestrial diatoms deal with the desiccation and temperature fluctuations (Souffreau et al., 2010). Evans (1958, 1959) observed vertical movements in the sediment layer and accumulation of oil in the cytoplasm as an adaptation of benthic diatoms from drying ponds. Other microalgae are using different ecological strategies to survive in adverse conditions, such as accumulation of metabolites (Welsh, 2000; Rousch et al., 2004) or excretion of extracellular polysaccharides (Tamaru et al., 2005). Souffreau et al. (2010) proved that vegetative cells of terrestrial diatoms, although having a broader tolerance range to stress conditions, are highly sensitive to desiccation and use resting cells as a strategy to overcome stress conditions in time and space.

The adaptations to stress factors and the presence of stress tolerant resting cells play a very important role in overcoming the adverse conditions during the dispersal. Diatoms, such as other microorganisms, use passive mechanisms of dispersal between localities. Diatoms can be dispersed by animals, wind, by water and humans (Kristiansen, 1996).

The main aims of this ongoing study are to enhance our understanding of diatom diversity of soils in urban habitats, to find out the pattern of diatom species distribution, to determine the main environmental variables influencing the distribution of diatom assemblages and to provide information on the taxonomic composition of particular urban habitat types.

Results and discussion

A total of 116 taxa (including species, varieties and forms) were recorded from the first 84 samples, which is quite high for soil samples.

The genera that showed the highest species diversity were *Nitzschia* with 15 representatives, the second was *Navicula* with 10 members and the third was *Pinnularia* with 8 taxa.

The most abundant taxa were *Hantzschia amhioxys*, *Hantzschia abundans*, *Pinnularia borealis* and *Luticola mutica*.

The highest number of taxa (29) was recorded in a sample “HamPark”, taken in the city park of Hamburg. By contrast, only one taxon was identified in a soil sample “SalzKer” taken in a shrub in an abandoned site in Salzburg.

The mean number of taxa per sample is 9.

The most species diverse samples came from Hamburg and Antwerp, both are cities involved by the oceanic climate. On the contrary the species poorest samples are from Budapest and Krakow - cities with more continental climate.

The CCA diagram (not shown) revealed, that the soil diatom community structure and diversity can be less influenced by environmental factors measured on the sites and that the structure of the samples can be more involved by geographical distances and parameters. This is incompatible with the traditional theory, that communities of small organisms, or those with small propagules, are involved mainly by local niche-based processes, and less by dispersal limitation (Chytrý et al., 2012). Also other recent studies (Telford et al., 2006; Vyverman et al., 2007) convincingly show a reduced local (and even regional) diversity due to dispersal limitation and contradicts the traditional ubiquity hypothesis (Finlay, 2002) and the statement of ubiquitous dispersal (Baas-Becking, 1934) revealing that microorganisms exhibit biogeographic patterns.

The preliminary results of this study can indicate that the diversity and taxonomic composition of local communities result more from factors involving dispersal limitation than from the local environmental variables. Dispersal limitation appears as an important factor determining diatom species diversity and hereby rephrasing the conventional statement onto: “Diatoms can be everywhere, but, the dispersal limitation selects”.

We hope that when this research will be completed, its results will help to clarify this intensively debated problem, and will bring new facts about the dispersal limitation of microorganisms.

A modern elaborate study on soil diatom flora from urban habitats is extremely important and further research is necessary to understand all the conditions involving the soil diatom flora.

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Keywords

soil diatoms, species composition, urban habitats

Oral presentation

Determining water quality with diatom DNA barcodes

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Bullet points

The Hydrochip, based on 18S rRNA, was developed for freshwater diatoms in the Netherlands.

The Hydrochip is currently able to identify 74 diatom taxa and was tested on 188 water and substrate samples.

Introduction

Good quality of surface waters is of essential importance for healthy aquatic ecosystems and various water-dependent sectors such as fisheries, recreation or drinking water production. Water quality in the Netherlands is currently under pressure mainly through eutrophication and water level management. Within the European Water Framework Directive (EWFD) water managers regularly monitor water quality and define purposeful measures to improve the health status of surface waters. One of the most important EWFD pillars is the monitoring of present plants, algae (particularly diatoms), animals and microorganisms. Current ecological monitoring is based on the collection and analysis of numerous field samples by specialists following national manuals, and national and international rules (NEN and CEN standards). However, classic analysis of field samples based on the presence of biota requires well-trained specialists and is labour, time and cost intensive. A less expensive and more objective approach for fast identification of biota in field samples would be a beneficial upgrade of currently applied methods.

DNA technologies are getting state-of-the-art in many applications, for example, crime detection or the source determination of microbial food contaminators. New molecular technologies are also applied in the taxonomic determination of organisms and deciphering of their evolutionary history. One of these approaches, known as DNA barcoding, might be one of the most powerful techniques for looking objectively at the species richness of field samples.

In the Hydrochip project a microarray was developed for quick and reliable identification of diatom taxa in water and substrate samples from the Netherlands (Jaspers et al., 2013). Users of the Hydrochip will be able to get a quick indication of the trophic status of the studied surface waters. This paper gives an overview on the development status of the Hydrochip.

Results and discussion

Development of the Hydrochip

The Hydrochip was developed for freshwater diatoms and is based on the 18S rRNA gene.

18S rRNA probes for the various diatom taxa on the chip were collected from available data bases (e.g., gen bank) and through a single-cell approach. The latter approach includes isolation of a single diatom cell with a micromanipulator, extraction of DNA from this cell, identification of the base sequence of the 18S rRNA gene, and taxonomic identification of the valves of this cell. With the current Hydrochip version 74 taxa representing 35 diatom genera can be detected. Genera with most taxa include *Navicula* (10 taxa), *Nitzschia* (10 taxa), *Gomphonema* (5 taxa), *Fragilaria* (4 taxa) and *Pinnularia* (4 taxa).

Application of the Hydrochip

The power and limitations of the Hydrochip have been tested on 188 water and substrate samples from various surface waters in the Netherlands. For all samples the trophic state indicator value was determined by applying both the Hydrochip and classic light microscopic analyses. Calculations were based on 200 valve counts or probe hits, respectively, and further on species specific indicator values for trophic state as reported in Van Dam et al. (1994). The trophic state indicator value for each sample was calculated following Bijkerk (2010; chapter 9, p. 25, 26). The comparison of sample trophic state indication values based on the two methods shows that in the mesotrophic-eutrophic range (indicator value of 4 to 5) the results of the Hydrochip analysis are confirmed by microscopic analysis. Reason for this observation is that the majority of surface waters in the Netherlands is meso- to eutrophic and accordingly, the most frequent diatom taxa are indicative of nutrient rich conditions. On the other hand there is a clear mismatch between the results of the Hydrochip and microscopic approaches in the oligotrophic and oligo-mesotrophic range of the trophic state scale. This mismatch is based on the under-representation of diatoms being indicative of nutrient poor surface waters on the Hydrochip.

Future challenges

First tests of the Hydrochip indicate the potential and advantages of gene-based approaches in biomonitoring. The current version of the Hydrochip yields reliable results in part of the trophic spectrum. However, to establish the Hydrochip as a fully reliable tool in surface water monitoring it has to be improved in the coming years. Improvements include selection and sequencing of additional diatom taxa, especially those representing the oligotrophic and oligo-mesotrophic spectrum, but also making better use of available molecular techniques for water monitoring. For example, so-called new generation sequencing methods could enhance the potential to characterize water quality of a large set of water and substrate samples based on water-type specific barcodes of organisms. In future, biomonitoring would then be based on the presence or absence of indicative gene sequences rather than single algae, animal or microorganism taxa.

Acknowledgements

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Keywords

diatoms, biomonitoring, water quality, microarray technology, mass sequencing

Keynote speaker

Coupling paleolimnology and molecular tools to reveal the long-term dynamics and diversity of planktonic assemblages: focus on diatoms and cyanobacteria

Speaker: DOMAIZON Isabelle

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About the speaker

Isabelle Domaizon is a researcher at the CARRTEL research unit (INRA Thonon-les-Bains, France). She leads a team of seven people working on lake microbial ecology and a network for long-term monitoring of lakes in France. She is a limnologist, and her main research interests deal with (i) the role and diversity of microbial communities in lacustrine food webs (ii) the dynamics of lacustrine food webs and the effects of regulating factors (local and global) on microbial compartments. She commonly applies molecular approaches in her work to answer questions regarding the diversity of protists and phytoplankton. She has recently published studies analyzing DNA archive in lake sediment (for instance, reconstructing the dynamics/diversity of cyanobacteria over the last century, in a deep peri-alpine lake).

Abstract

This talk will provide an overview of the potential, methods, and applications based on the coupling between paleolimnological approach and analysis of sedimentary DNA. This area is an emerging field as recent techniques are opening up avenues for novel studies of sediment record.

The presentation will start by providing a brief introduction to paleolimnology with an emphasis on how DNA studies can expand this field. Information on the sources of DNA preserved in lake sediments, genetic markers and molecular methods used, will then be provided.

A second half of the talk will be focused on recent applications of sedimentary DNA analyses 1) to study phytoplanktonic taxa, mainly diatoms and cyanobacteria, over long-term time scales 2) to uncover community-wide changes within protistan assemblages especially by applying NGS techniques to the nucleic acids originating from dated sedimentary records.

Finally, the potentials and limits of this ‘molecular paleolimnological’ approach will be discussed, focusing on the opportunity of such multidisciplinary approach for (i) providing a long-term temporal view of the diversity of lacustrine plankton, and, investigating the relative importance of regulating factors on these taxa (ii) analyzing co-occurrence of microbial taxa including taxa recently revealed in lacustrine food webs, and, exploring biotic interactions (e.g. parasitism revealed from past communities…) (iii) revealing past diversity and unravel the resilience and tipping points of lake biodiversity.

Oral presentation

Phylogenetic and ecological study on *Skeletonema potamos* (Weber) Hasle

Speaker: DULEBA Mónika

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Bullet points

Skeletonema potamos is the only freshwater species in the genus

Its relative abundance correlated with temperature

Its closest relative is *S. subsalsum*

No intraspecific variability was observed

Introduction

The diatom species *Skeletonema potamos* is the only one in *Skeletonema* genus that lives in freshwater habitats and it has been reported from several rivers worldwide.

It was first recorded in the Danube river in a sample taken at the end of the 1950s. It became abundant in Hungarian stretch of the river at the end of the 1960s, simultaneously with the increase of eutrophication. The abundance and biomass of phytoplankton in River Danube have been monitored since 1979 and based on these data changes in quantity of *S. potamos* can be followed.

Skeletonema potamos occurs also in River Tisza, but in lower abundance.

Despite its importance it was not studied with molecular tools until now. Therefore our aim was to determine the phylogenetic position of *S. potamos* using samples from Danube and Tisza rivers.

Alverson et al. (2007) used two nuclear (18S and 28S rRNA genes) and two chloroplast (*rbc*L and *psb*C) markers for the reconstruction of the phylogenetic relationships within the Thalassiosirales order. In their analyses together the rDNA markers proved to provide a good resolution and support for deeper nodes in the phylogenetic trees but to be less informative at lower levels, whereas the chloroplast data proved to be more useful in resolving lower, species-level relationships. So these four markers seemed to be appropriate for identifying the phylogenetic position of *S. potamos*.

Results and discussion

Based on the long term data some tendencies were observed. Even though the total abundance of phytoplankton of Danube river decreased in the last decade, the contribution of *S. potamos* increased.

When looking at the seasonal variation during the years, the abundance of *S. potamos* generally starts to increase in May-June and reaches maximum in July-September. However, during the last more than ten years, this increasing period took place earlier than in the previous years: the increasing of abundance happened rather in May than June and reaching the maximum happened rather in July than August or September.

Its relative abundance to the total phytoplankton showed a positive correlation with water temperature during the years. The relative abundance showed weak negative correlation with the water discharge during the vegetation period of several years. According to the daily observations in 1991 and 1992 by Kiss et al. (1994) the main factors influencing the quantities of *S. potamos* are the floods and temperature. They observed that the population growth started in June when the temperature was at about 15^{o}C and decreased in September-October below the temperature of 14-16^{o}C. During the floods density of the population was about zero. So they concluded that this species was warm stenothermic with high light demand.

Isolated *S. potamos* cells from Danube and community sample from Tisza were analysed in order to determinate the phylogenetic position of the species. Primers specific to *Skeletonema* genus were designed to amplify and sequence the four chosen markers. Using the primers designed all the four markers were acquired from Danube but because of the specificity of the primers only 18S rDNA and 28S rDNA sequences were acquired from Tisza.

According to the phylogenetic trees based on both the single genes and all genes *S. potamos* was placed within the *Skeletonema* genus and *S. subsalsum*, a species living mainly in brackish waters proved to be its closest relative. This lineage showed that a cross of the barrier between the freshwater and marine habitat happened within this genus. However, dating of this event (or divergence of *S. potamos* and *S. subsalsum*) seemed to be difficult.

Both the 18S rDNA and 28S rDNA sequences from the Danube and Tisza samples were identical and the sequences were clear, not mixed. This indicated the lack of intragenomic or intraspecific variability in 18S rDNA in *S. potamos* that is characteristic to other *Skeletonema* species (Alverson & Kolnick, 2005). This genetic invariability of *S. potamos* is accompanied by low level of morphological variability.

Interestingly, these sequences were identical to those of Japanese brackish water samples described as *S. subsalsum* in the GenBank. Although *S. subsalsum* can be occasionally recorded from River Danube and Tisza, the amplification of sequences *S. subsalsum* instead of *S. potamos* was not probable. Either light or scanning electron microscopic investigation of the samples did not show frustules of *S. subsalsum*.

Our study supplemented the knowledge on *S. potamos* that proved to be not only ecologically important but interesting in evolutionary view.

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Keywords

Skeletonema potamos, Danube, Tisza, phylogeny, ecology

Poster presentation

DiaDem EU - Implementing DNA Barcoding into the Water Framework Directive: standardisation of sampling, taxonomic validation and data storage

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Bullet points

DNA barcoding uses short DNA fragments to identify taxa

Next Generation Sequencing (NGS) enable getting millions barcodes from environmental samples

Use of NGS and DNA barcoding is promising for diatom biomonitoring, this poster present a European initiative in this area

Abstract

As diatom species composition changes according to the environmental conditions, they are widely used to indicate organisms for water quality and play an important role in assessment of ecological status around Europe. Phytobenthos (i.a. benthic diatoms) are included in the European Water Framework. The standard monitoring approach is to identify and count a defined amount of cells using light microscopy. With the advancement of next generation sequencing techniques (NGS) DNA barcoding has the potential to be a time and cost efficient alternative to light microscopy.

DNA barcoding uses a short fragment of a DNA sequence to identify a taxon. After obtaining the target sequence through DNA isolation followed by PCR and sequencing it is compared to barcodes stored in a database to assign an organism name to it. NGS permits large numbers of sequences (ca. 10 000 – 500 000) to be obtained from a single environmental sample and is potentially cheaper than optical microscopy.

The quality of data in the reference database is the key to the success of the analysis.

In order to standardise all steps of the sample processing, data analysis (e.g. bioinformatics applications) and data storage DiaDem EU aims to set up best practice guidelines and moves for creating norms within CEN (Comité Européen de Normalisation). All reference sequences that are deposited in the database as original barcodes should be linked to voucher specimens in order to provide a complete chain of evidence back to the formal taxonomic literature. DiaDem EU aims to preserve the physical samples and their derivatives in collections in order to guarantee long-term storage and their accessibility in future.

Poster presentation

Metal tolerance in *Nitzschia palea*: intraspecific differences

Speaker: ESTEVES Sara

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Bullet points

Different isolates of *Nitzschia palea* present different tolerances to metals. Metal toxicity is consistent across isolates.

Introduction

The taxonomic definition of species does not fully encompass their physiology and biochemical variability. Thus, differences in these parameters are to be expected between isolates of the same species, when stress conditions are present. This variability is vital to organisms, enabling adaptive responses to sub-lethal stimuli. Metals are one of the most toxic agents known, due to persistence, bioaccumulation and biomagnification properties. Among these, copper, cadmium and lead are some of the most harmful to freshwater ecosystems. To assess the environmental implications and effects of these contaminants, the use of organisms to act as a biomonitoring tool is paramount. Diatoms, by presenting an ubiquitous distribution, species richness, well documented taxonomy and ecology, along with short generation time, fast reaction to environmental changes and specific sensitivity to several environmental stressors such as metals, are particularly useful for such studies. However, information regarding metal tolerance in diatoms is still scarce. This work was designed to identify possible differences in metal tolerance of *Nitzschia palea* isolates from several sampling sites and to evaluate underlying biochemical mechanisms. By studying oxidative stress levels and antioxidant responses involved in mechanisms of metal tolerance in diatoms, this work has the potential to help and clarify the existence of phenotypic and epigenetic differences in isolates of the same species, responsible for different responses to the same stress agent. The integration of both ecological and biochemical data might be further used in the management of freshwater ecosystems.

Results and discussion

Several studies on metal polluted rivers have shown that metal contamination can apply a selective pressure that might alter algal communities' diversity (Harding & Whitton, 1976; Foster, 1982; Kelly & Whitton, 1989; Almeida, 1998). Natural selection may occur in metal contaminated environments, driving the species descendants to be more tolerant (Gustavson & Wangberg, 1995). The degree of toxicity depends mainly on the metallic element and its bioavailability. Laboratory toxicity assays using defined artificial media, where all or most of the metal is bioavailable, present an overestimation of the effects when compared to the effect of the same metal concentrations found in the field. Here, a large number of conditions such as the presence of organic matter or particles interact with metals, reducing their bioavailability (Dobson, 1992). However, laboratory assays allow for specific, controlled and reproducible conditions, essential to data and hypothesis validation. To test the geographic differences in the metal tolerance of *Nitzschia palea*, five isolates from different sites in central continental Portugal were sampled and subjected to long term (10 days) chronic assays, based on growth curve data. For every isolate, five replicates were made to investigate the effects of five concentrations of three different metals (Pb, Cu and Cd).

Results show that there were differences in the tolerance to metals between isolates, demonstrating intraspecific variation. The metal tolerance between isolates does not overlap across them, differentiating the isolates from the more resistant to the less resistant independently of the metal. Regardless of the isolate, copper was the most lethal and lead was the least toxic: Pb<Cd<Cu. Hormesis, a biphasic dose response to an environmental agent characterized by low dose stimulation or beneficial effect and a high dose inhibitory or toxic effect (Mattson, 2008) is observed in copper. However this response is compatible with metal chelation, thus reducing its bioavailability. In cadmium, [Cd] 0.15 mg L^{-1} presented a significant decrease in toxicity. This result is supported by the capability of frustulins, a family of proteins found on the frustule surface, to chelate metals (Santos et al., 2013). A similar result was documented by other authors, in which, some species increased growth under high Zinc and Cadmium concentrations, while others were almost completely inhibited (Ivorra et al., 1999, 2000; Morin, 2003). Another possible factor contributing to different metal tolerances is cell size. Isolates presented visible size difference between them. It is possible that due to the higher area/volume ratio of the smaller diatoms, the contribution of frustulins in reducing metal bioavailability is enhanced, making them more tolerant than the larger ones, as observed (Santos et al., 2013).

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Keywords

Nitzschia palea, metal tolerance, geographic isolates, oxidative stress, metal bioavailability

Keynote speaker

Barcoding as a data analysis problem

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About the speaker

FRANC Alain is working at INRA (National Institute for Agricultural Research) in Bordeaux (France) in a team studing population genetic of higher plants. His scientific activities focus on biological diversity, ecology of communities. After a phD in biostatistics he mostly devoted his skills in forestry ecology. He wrote several major papers about metapopulation dynamics, ecosystem funtion and managment in European forests. More recently, he addressed questions about taxonomy, phylogeny and molecular biology. FRANC Alain is leading the french network of barcoding (Rsyst) and of a ntework about numerical taxonomy (Rtanumo) gathering mathematicians, ecologist and taxonomists. Diatom taxonomy and phylogeny are since a few years in his study area with recent developments in metabarcoding.

Abstract

Molecular imprints of evolution have permitted the development of barcoding, which aims at identifying taxonomic status of unknown specimen from specific molecular markers. Barcoding has experienced an exponential impetus since the early 2000’s, and has been sometimes bitterly discussed. A fluent link between evolutionary biology, integrative taxonomy, and barcoding still is an open challenge.

Here, I discuss some methodological points in domain of data analysis, studying whether it is relevant or not to be confident in a molecular based taxonomic assessment. Therefore, a couple of case studies will be presented, where there exists simultaneously a molecular based and a phenotypic based taxonomic assessment: diatoms, and trees in French Guiana. The aim of the game is to establish a dictionary between both approaches. The question is not whether each is true or false, but to quantify similarities and discrepancies between both: how to classify.

Molecular systematics has been an established field of knowledge and research for decades, in connection with molecular phylogenies. The simple idea is that, for a given set of markers, the older a common ancestor between two specimen, the larger the discrepancy between sequences. The difficulty is to quantify: how large? Link between time and genetic distances really is a complex domain: for example, dating a phylogeny still remains a challenge.

Barcoding bypasses these difficulties, targeting towards one aim: how far is it possible to go in molecular taxonomy working with appropriate markers? The key notion is to quantify a distance between two sequences, and to use distances to classify. As it is a clustering problem, I present some well-known methods of supervised clustering (when a reference is known), and unsupervised (when no reference exists). Unsupervised clustering of sequences on rather large data sets of both trees in French Guiana and diatoms in Geneva Lake will be presented, and compared with taxonomy as established by botanists or diatomists. This will be performed in cases where global alignment is

impossible or unreliable. Some cases will be discussed in more details (cases of match and mismatch between both approaches).

Markers widely used for diatoms and trees are plastidial: chloroplastic DNA. In trees, at least broadleaved trees, it is transmitted maternally. A well-known difficulty in systematics is the existence of species complexes, where gene flows between species can lead to stable phenotypic differences between species, but hybridization in nuclear genome. This can lead to a discrepancy between nuclear and chloroplastic genome, and questions the relevance of barcoding on chloroplasts for trees. A result over 200 tree genera in French Guiana from pairwise distances between trnH references obtained by local alignments will be presented. This leads to an estimate at about 20% for the fraction of species which share a similar chloroplastic haplotype, but in limited number of families, liable to come from chloroplastic capture or incomplete lineage sorting. A similar result on chloroplast barcodes for Carrtel's freshwater diatoms database will be presented.

Finally, a tool built from an application of Bayes theorem will be presented, where identification is given for each likely reference as a likelihood or probability taking into account all the best hits, bypassing the need to interpret a phylogeny with the query and closest neighbors. Some results on database of trees in French Guiana or freshwater diatoms will be presented, showing that existence of species complexes often lead to similar probabilities between two species at most, sharing the haplotype of the query.

All these examples will converge towards one aim: showing that methodological questions raised by barcoding are a challenge for data analysis, and that much progress can be expected from long term collaboration between people involved in taxonomy, evolutionary biology, and data analysis.

Oral communication

Diatom community response to simulated variations of water pollution

Speaker: GOMÀ Joan

Author

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Bullet points

Diatom communities from unperturbed places are more resistant to change suffering a quality worsening than diatom species adapted to eutrophicated waters subjected to improvement. Time reaction of Diatom Biological indices is slower when there is a worsening.

Introduction

Diatoms are being routinely used as biological indicators of water quality in rivers (Ector et al., 2004). However there is little information on the time needed for a diatom community to reflect a change in environmental conditions (Lavoie et al., 2008; Rimet et al., 2009). In order to evaluate the sensitivity and integration time of diatom communities against environmental variations, there has been made a transfer experiment with epilithic biofilms from streams with different levels of disturbance. Experiment was conducted in 4 rivers from a geologically homogenous basin (La Tordera basin-Catalonia), which had an increasing load of nutrients and urban pollution. Stoneware artificial substrates were placed to be colonized for 30 days in each river. Two types of translocation were done: from the reference river to the three rivers with progressive degree of pollution, and from the three disturbed rivers to the reference one. First we aimed to check the effects of a sudden worsening of water quality and second to assess a sudden improvement. Once transferred, tiles were sampled every 30 days for 3 months and diatoms were analyzed under light microscopy.

Results and discussion

All diatom assemblages changed due to new environmental conditions, but their evolution differ depending on the type of transfer made. Both the original specific composition and the degree of eutrophication are important elements conditioning the speed of change of the community towards the new conditions. In all cases diatom communities integrated environmental variability of a period longer than one month, this agreed with other studies (Ivorra, 2000; Rimet et al., 2009). However, the responses have been different: disturbed river communities subject to improvement have changed faster and in a month almost resembled the reference community. By contrast, the reference river community exhibited greater resistance to change when growing in loaded waters. Species adapted to high nutrient concentrations decline faster when living in water with nutrients below their threshold requirements, because they simply starve. Conversely, species from low nutrient waters do not have problems to live in enriched waters, and they are only displaced when the better adapted species from eutrophic conditions overgrow them. And this process takes longer.

Most of the Diatom Biological Indices of transferred communities equate to the values of the host communities in two months. However there have been different sensitivities of the various indexes such as the IPS (Indice de Polluosensibilité Spécifique) being more sensitive than the IBD (Indice Biologique Diatomées). The integration time of the IPS index is also different whether it faces an improvement or a worsening: when conditions were improved IPS reflected it in one month or less, whereas in the case of eutrophication after two months IPS values of the translocated community were still far from the value of the host river.

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Keywords

epilithic diatoms, transfer, water quality, bioindication, integration time, ecological guild

Poster presentation

Precision and accuracy of benthic diatom metrics for detecting human-induced impairment of boreal lakes

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Bullet Points

Comparison of different bioindicators for lake water quality

Predictive power of benthic diatoms, phytoplankton and benthic invertebrates

Introduction

Benthic diatoms are commonly used as bioindicators to assess the effects of acidification and eutrophication in freshwaters (e.g. Kahlert et al., 2007; Andren & Jarlman, 2008). In streams, benthic diatom assemblage composition is often better correlated with in-stream water chemistry than many other organism groups commonly used in bioassessment (Johnson et al., 2006). For lakes, information of the predictive power of different taxonomic groups of bioindicators is sparse (but see Cellamare et al., 2012). However, there is a widespread interest for determining the efficacy of different taxonomic groups of bioindicators in order to design robust and cost-effective biomonitoring programs. This study aims to compare the response of different bioindicator groups to eutrophication and acidification. We hypothesize that based on first principle relationship diatoms and phytoplankton are better indicators of nutrient concentration than benthic invertebrates.

Results and discussion

The response of both the benthic diatom and phytoplankton assemblage composition of 68 Swedish lakes to the effects of eutrophication and acidification was determined by regression analysis. Multivariate variables of assemblage composition (NMDS scores) and pH and total phosphorus concentrations, respectively, were analysed and precision was measured as the adjusted R square values. Additionally, the predictive power of acidity and pollution/ eutrophication indices based on benthic diatoms and phytoplankton were tested by regression against pH and total phosphorus concentrations, respectively.

First results indicate that benthic diatom assemblage composition shows a higher precision for acidity compared to phytoplankton assemblages. Also, the Swedish acidity index, based on diatoms (Andrén & Jarlman, 2008), had a higher precision compared to the acidity index, based on phytoplankton (number of species). For elevated nutrient concentrations, both benthic diatom and phytoplankton assemblages had similar precision. In contrast, the Swedish multimetric phytoplankton index (Willén,

2007) had higher precision compared to the diatom based pollution index IPS (Cemagref, 1982) along the eutrophication gradient.

The results will be discussed. Additionally, comparisons between primary producers (benthic diatoms and phytoplankton) and benthic invertebrates will be presented.

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Willén, E., 2007. Växtplankton i sjöar – Bedömningsgrunder, Institutionen för miljöanalys, SLU, Rapport 2007:6 (in Swedish), 37 p.

Keywords

bioindicators, benthic diatoms, lakes, acidification, eutrophication

Oral presentation

The marine planktonic, potentially toxic species, *Pseudonitzschia multistriata* (Bacillariophyta) in the Mexican Pacific: first record, abundance, culture and morphology

Speaker: HERNÁNDEZ-BECERRIL David U.

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Bullet points

This is a study of the abundance and distribution of the marine planktonic, potentially toxic species *Pseudonitzschia multistriata* in coasts of the tropical Mexican Pacific, and also a study of its morphology from culture material.

Introduction

About sixteen species of the planktonic diatom genus *Pseudonitzschia* are now recognized to produce Domoic Acid, a potent toxin producing the Amnesic Shellfish Poisoning (ASP) in humans and also affecting marine animals. Blooms of *Pseudonitzschia* species, which usually form short to long filament chains, are becoming important for the management in the coastal zone around the world, as they may affect fisheries, aquaculture, and human economy and recreation. The marine planktonic diatom *Pseudonitzschia multistriata* (Takano) Takano was originally described from Japan, and then its presence has been documented in warm waters in many places around the world. It has been also revealed that this species produces Domoic Acid. Recent studies are dealing with its ecology (seasonality) and molecular signals.

Results and discussion

This study deals with the presence, as this is the first record of *P. multistriata* in the Mexican Pacific, and abundance, and morphology of the species in culture conditions. The species was found and counted in bottle samples from the zone of Cabo Corrientes, Jalisco, in the tropical Mexican Pacific, during three cruises (2009, 2010 and 2012), yielding maximum densities of 52 500 cells L^{-1} in a "red tide" due to the ciliate *Myrionecta rubra* in 2012; it also occurred in lower numbers in another "red tide" caused by dinoflagellates in 2010. Its maximum densities are generally at subsurface (about 10 m) and then it decreases with depth. No information was obtained on the Domoic Acid concentrations.

Pseudonitzschia multistriata was also cultured from bottle samples of Mazatlán, Sinaloa, Mexican Pacific, and then studied in detail by LM and TEM. The morphology of the species in culture agrees with previous descriptions: cells solitary, or arranged in short to long chains (2-10 cells), sigmoid in girdle view and lanceolate in valve view, absence of central interspace, and measurements were 45-60 µm length, 3.9-4.4 µm width, 18-21 fibulae in 10 µm, 27-29 striae in 10 µm, and 7-8 striae poroids in 1 µm. Domoic Acid produced by the species in culture will be measured, and some molecular sequences will be obtained in the next future.

Keywords

cultures, Mexican Pacific, morphology, phytoplankton, *Pseudonitzschia multistriata*

Poster presentation

Morphological and ecological investigations of *Achnanthidium caledonicum* and related species

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Bullet points

The type of *Achnanthes microcephala* f. *scotica* J.R.Carter, *Achnanthidium gracillimum* (F.Meister) Lange-Bertalot, and material from the type locality of *Achnanthidium neomicrocephalum* Lange-Bertalot & Staab have been investigated.

A taxon erroneously included in *Achnanthidium caledonicum*, is investigated from various locations in Europe.

The nomenclature, distribution and species associations of these taxa are documented.

Introduction

Oligotrophic freshwaters are typical habitats for *Achnanthidium caledonicum* (Lange-Bertalot) Slate & R.J.Stevenson (basionym: *Achnanthes microcephala* f. *scotica* J.R.Carter (Carter & Bailey-Watts, 1981), *Achnanthidium gracillimum* (F.Meister) Lange-Bertalot and some related taxa. Whether or not these taxa are distinguished from each other and from the group of species similar to *Achnanthidium minutissimum* (Kützing) Czarnecki during monitoring exercises clearly varies from country to country. The current knowledge about their ecology, however, suggests that these taxa might be good indicators of chemical conditions in waters least affected by nutrient enrichment and acidification.

After several nomenclatural changes J.R. Carter's *Achnanthes microcephala* f. *scotica* is currently referred to *Achnanthidium caledonicum*; this taxon has been illustrated by a number of authors (e.g. Wojtal et al., 2011). However, when Lange-Bertalot (1993) elevated this taxon to species rank followed by the introduction of the new name *Achnanthes caledonica* Lange-Bertalot in Lange-Bertalot & Moser

(1994) he refers to specimens from the lectotype slide from Scotland and specimens from a Bavarian lake. Recently collected material from the lake in Bavaria was investigated in LM and SEM. It is now clear that the specimens from Scotland and some from Bavaria belong to two different taxa (Lange-Bertalot & Krammer, 1989, pl. 55, figs 4-12). New material of a related species, *Achnanthidium neomicrocephalum* Lange-Bertalot & Staab in Krammer & Lange-Bertalot (2004), re-collected from its type locality, was documented in SEM. Original material of *A. gracillimum* from the Alptal, Switzerland, from the Meister Collection, was investigated in LM.

The distribution and species associations of *A. caledonicum* and the taxon erroneously depicted under this name are presented for Scotland using samples collected since 2011.

Results and discussion

The recently collected material from the Bavarian lake 'Brunnsee' contained three taxa; *Achnanthidium neomicrocephalum*, *A. caledonicum* and a third related taxon (Lange-Bertalot & Krammer 1989, pl. 55, e.g. fig. 4 showing two species). The smaller taxon erroneously included in *A. caledonicum* has been known for a long time, but was recorded by different authors under various names, for example as *Microneis microcephala* Cleve. It occurs frequently in Europe, often at higher altitudes or latitudes. In the investigated monitoring dataset from Scotland this taxon did not occur in association with *A. caledonicum*. *Achnanthidium neomicrocephalum* and *A. gracillimum* were likewise recorded from several localities in Europe particularly in habitats having a high water quality.

These four species can be distinguished by valve outline, shape of the cells in girdle view, size, and stria and areola arrangement in LM and SEM. In LM they are distinct from other species showing a similar ultrastructure, including *A. minutissimum*, although identification of the smallest valves might be difficult.

Several populations from different locations in Europe are illustrated and compared with taxa similar to *A. minutissimum* from oligotrophic habitats. The use of names by other authors for species that most likely belong to the four studied taxa is documented. We also suggest a collaborative project across Europe to study live and preserved material of these taxa to construct a more accurate map of their distribution and to elucidate their ecology.

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Keywords

Achnanthidium, morphology, type, oligotrophy, distribution

Oral presentation

Environmental thresholds for changes in diatom communities in Swedish streams

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Bullet points

Environmental thresholds for changes in diatom communities
pH most important driver of change, followed by total phosphorus
Examples of environmental thresholds for individual taxa

Introduction

Much research has been done on the environmental factors driving diatom community composition in freshwaters, and many indices have been developed and are in use for biomonitoring today (Kelly et al., 2009; Birk et al., 2012; Rimet, 2012). However, little is known about the environmental thresholds at which diatom community changes.

Understanding and quantifying these thresholds will have profound implications in biomonitoring and restoration. For example, ecosystems may shift between alternative states and be difficult to restore to previous conditions if they overcome or go below critical values. In this study, we use community and species distribution models (gradient forest, Ellis et al., 2012) to investigate the role of environmental variation on the turnover patterns of diatom assemblages in 230 boreal streams distributed over Sweden. In particular, we quantify the importance of 20 variables (regional, catchment and local scale), identify critical thresholds at which community composition changes and discuss the implications that this may have for biomonitoring. Additionally, we also evaluate the response of individual species along the environmental gradients.

Results and discussion

The study comprised a large variety of streams: humic as well as clear oneas (water colour 5 to 350 Pt l^{-1}), low to high alkaline ones (-0,07 to 6,6 meq l^{-1}), streams in lowland areas and in the mountains (0-800 m.a.s.l.), small streams and large rivers (1-3800 km^2 catchment area), streams with up to 40% wetland in the catchment, but also some with no wetlands at all, some catchments with a large impact of agriculture (up to 92%), and some without, pH ranging from 4,5 to 9, total phosphorus (TP) from 2 to 268 µg l^{-1}, total nitrogen from 67 to 11225 µg l^{-1}, conductivity from 1 to 87 mS m^{-1}. The number of taxa was over 600 in the original file, but we restricted the analysis to the most dominant 194 taxa (mostly species) to achieve a stable model.

Overall, pH and TP were the main drivers of compositional changes in the diatom communities of streams. Along the pH gradient, larger changes in community composition occurred at about pH 5.6 and again at pH 7.3.

The changes were larger at the pH 5.6 threshold when the relative abundance of the diatom taxa was taken into account than for presence/absence data. Examples for individual species changing substantially with pH are *Eunotia rhomboidea* Hustedt and *Fragilaria gracilis* Østrup which both changed steeply between pH 5.6 and 5.7, *E. rhombiodea* decreasing with pH, *F. gracilis* increasing. For the TP, changes in species composition usually corresponded to small changes in TP concentration (between 0 and 20 µg TP l^{-1}), but we also detected rapid changes at 75 µg TP l^{-1}. Among species that changed at low TP concentrations were *Navicula cryptocephala* Kützing with steep changes at 15 µg TP l^{-1}*. N. tripunctata* (O. Müller) Bory changed instead at higher TP concentration (75 µg TP l^{-1}). Whereas some taxa could show quite steep changes in their abundance, the overall diatom community composition changed rather gradually with most of the studied environmental variables.

In the study, we also discuss critical values along other environmental variables and discuss the potential interactions between variables. Regarding biomonitoring, our results suggest for example that water management in Sweden with the aim to reduce eutrophication should aim to set a threshold 75 µg TP l^{-1} to achieve a significant change from an eutrophic diatom assemblage to a less impacted one, and at about 20 µg TP l^{-1} to achieve a change to a diatom assemblage nearly unimpacted by nutrients. However, we want to stress the point that these results are still preliminary, and that especially the interactions between variables will probably have a large impact on these thresholds – they might not be the same in all geographical regions of Sweden, for example.

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Keywords

stream diatoms, environmental threshold, community turnover, distribution models, species distribution models

Oral presentation

Linking diatoms polluo-sensibility to phylogeny: New perspectives for aquatic ecosystems bioassessment

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Bullet points

Diatoms are powerful bioindicators but most of the protocols require species identification level. This hinders the widespread use of diatoms in environmental surveys. New phylogenetic tools may help to simplify such protocols.

Introduction

Diatoms are ubiquitous and include a great diversity of taxa with a large range of ecological preferences. For these reasons, diatoms are widely used as bioindicators by national and international programs to assess and monitor the ecological quality of rivers and lakes (Stevenson et al., 2010). However, many ecological indices based on diatoms require a species level identification of the samples. Such accuracy is costly, time consuming and requires highly qualified operators and inter-calibration exercises. Moreover, a substantial inter-analyst variability remains at species and subspecies identification level (Prygiel et al., 2002; Besse-Lototskya et al., 2006). One solution to this issue might be to work at lower taxonomic resolution. Genus level for instance, seems to guarantee a low information loss (Kelly et al., 1995; Chessman et al., 1999; Rimet & Bouchez, 2012) although some authors insist on the importance to work with the most precise accessible information (Round, 1991; Kociolek, 2005; Ponader & Potapova, 2007). This raises the question of the optimal tradeoff between taxonomic resolution and bioassessment quality. The new set of tools provided by phylogeny seems promising to explore the variability within and between taxonomic levels and to make new proposals for efficient biomonitoring groups. Studies have been recently conducted in this framework for macroinvertebrates (Buchwalter et al., 2008; Carew et al., 2011). Authors focused particularly on phylogenetic signal (Blomberg & Garland, 2002) which is the tendency for related species to be similar to each other. Phylogenetic signal for ecological preferences is an indispensable condition to regroup sets of species and simplify bioassessment protocols. This work is an attempt to explore the phylogenetic signal and improve our understanding of the relationship between the ecological preferences and phylogeny for freshwater diatoms.

Results and discussion

We reconstructed a phylogeny of diatoms from 18S gene sequences extracted from the public databases NCBI and the TCC (Thonon Culture Collection). Our final phylogeny includes 422 species or subspecies. We also used count data extracted from biomonitoring surveys conducted in the East of France between 2001 and 2008. These data were used to estimate an optimum value of 20 environmental parameters (e.g. NO3, PO4, DOC, Na, BOD, pH, temperature…) for 484 diatom species. Thus, we analyzed jointly the phylogeny and the ecology of 125 diatom species. Analysis of the phylogenetic signal with the Moran's I autocorrelation index (tested with a variety of phylogenetic distances, see Münkemüller et al., 2012) shows that ecological preferences of freshwater diatoms are strongly constrained by phylogeny. A visual inspection of these preferences mapped onto the phylogeny tends to confirm these results with clades as *Fragilaria* or *Gomphonema* genera which present important contrasts with others as for instance the *Nitzschia* genus. We also explored our data and the phylogenetic signal with a new and promising multivariate analysis, the pPCA (Jombart et al., 2010) which is a phylogenetically constrained principal component analysis. This method highlights patterns of species which are phylogenetically closely related and share similar ecological niches.

These results suggest the presence of a signal above the species level and a possible simplification of the indexes requiring the species identification level. It appears that the phylogenetic signal can be variable depending on the considered part of the tree. A powerful and efficient index has to take this variability in consideration by mixing taxonomic levels in function of the signal for the trait of interest. Phylogeny allows working at the highest precision and to discuss about evolutionary process but methods have to be developed further for a complete integration of the biomonitoring context. As an alternative, taxonomy may be used for this purpose (Carew et al., 2011). Finally, the presence of a phylogenetic signal can also be used to make prediction about the ecological niche of a species on the basis of its phylogenetic position in the tree (Guénard et al., 2011).

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Keywords

phylogeny, biological monitoring, phylogenetic signal, ecological preferences, diatoms

Oral presentation

Comparing aspirations: intercalibration of ecological status concepts across European lakes using littoral diatoms

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Bullet point

A pan-European study permits harmonisation of high/good and good/moderate ecological status boundaries for lakes using benthic diatoms

Introduction

European environmental legislation such as the Water Framework Directive (WFD) operates within a system of governance known as "subsidiarity", which leaves the details of implementation up to individual member states. One consequence is that a large number of methods have been developed around Europe to assess ecological status, varying in their approach and potentially leading to discrepancies in the objectives set by national governments for water management. In order to prevent this the WFD requires all member states to participate in a series of intercalibration exercise. Eleven countries participated in an intercalibration exercise to harmonise diatom-based methods used for status class assessments in lakes. Participating countries extended from Scandinavia in the north to Italy and Slovenia in the south, and from Ireland in the west to Hungary in the east. Intercalibration followed standard procedures developed for the European Commission which ensures that outcomes of this exercise are compatible with those from intercalibrations of other types of biota in both freshwater and marine water bodies throughout Europe.

Results and discussion

Lakes were divided into low (≤ 0.2 meq/L), medium (>0,2,≤1 meq/L) and high (>1 meq/L) alkalinity types for this exercise although it was not possible to perform a full intercalibration on the low alkalinity lakes due to the short gradient length and confounding influences of pH and humic substances. Values of the Trophie Index of Rott et al. (1999) were computed for all samples in order that all datasets could be expressed on a common scale. Not all participating countries had reference sites against which national methods could be standardised and, therefore, a Generalised Linear Modelling approach was used to control the effect of national differences in datasets. These steps enabled the position of high/good and good/moderate status boundaries to be expressed on a common scale for all participating countries and for deviations beyond ± 0.25 class widths (± 0.5 EQR units, assuming equal distances between all class boundaries) to be identified. Those countries which had relaxed boundaries for either high/good or good/moderate status class boundaries were required to adjust their boundaries to within ± 0.25 class widths whilst the intercalibration rules allowed those countries with more stringent boundaries to retain these.

Four of the eleven countries which took part used metrics originally developed for rivers. Correlations between these metrics and total phosphorus were generally as strong as those where a method had been developed specifically for lakes. This may reflect physical, chemical and biological similarities between conditions in lake littoral zones and in shallow reaches of rivers. Occasionally, taxa characteristic of a region’s lakes are missing from river metrics; however, this problem is no greater than that for any situation where a diatom metric is applied outside the region of origin. Despite biogeographical and typological differences between participating countries, there was broad agreement on the characteristics of high, good and moderate status diatom assemblages, and the intercalibration exercise has ensured a consistent application of Water Framework Directive assessments around Europe.

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Keywords

lakes, diatoms, monitoring, WFD, ecological status

Oral presentation

James Ross Island: diatom gate to two biogeographical zones

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Bullet points

Presentation of the study area

Analysis of the diatom flora of James Ross Island

Comparison with a typical Maritime Antarctic Island

Position of the island in the Antarctic biogeography

Introduction

(Bio-) geographically interesting locations such as Antarctic and Arctic environments currently receive considerable attention with growing interest towards global Climate changes. Diatoms (Bacillariophyta) are one of the principal algal groups in the freshwater and terrestrial ecosystems of the Antarctic Region. Sabbe et al. (2003) showed that their communities are significantly influenced by their environment. Due to their specific cell morphology, they can be used as perfect indicators of these environmental changes. Until recently, most of the non-marine diatom species were believed to have a cosmopolitan nature with a low level of endemism, although recent studies indicate that the islands in the Maritime Antarctic and sub-Antarctic Regions inhabit a highly specific Antarctic diatom flora (Kopalová et al., 2012; Van de Vijver et al., 2011; Zidarova et al., 2012). One of these islands is James Ross Island. This island belongs to the Maritime Antarctic Region but due to its position in the northern Weddell Sea, just south of the northern tip of the Antarctic Peninsula, it becomes an interesting gateway for Antarctic Continental diatoms. The geographical position of the island seems to play an interesting role in determining the composition of the diatom communities, apart from the impact of the environmental conditions on their diatom communities. The presence of a permanent (Czech) Antarctic base provides sample opportunities for a detailed study of this diatom flora.

In comparison, a second island in the Maritime Antarctic Region was studied. Livingston Island, the second largest island of the South Shetland Islands, is located north of the Antarctic Peninsula, where the influence of the Antarctic Continent is less obvious. The present study compares both islands and places them in a broader biogeographical framework.

Apart from lacustrine diatom communities, a dataset of moss-inhabiting diatoms (see poster) was added to complete the diatom biodiversity of both islands.

Results and discussion

The present lecture discusses the results of a thorough study of the diatom communities living in various freshwater habitats such as lakes and seepage areas on the Ulu Peninsula, a large ice-free area in the northern part of James Ross Island (Weddell Sea) in relation to ecological factors determining their composition and diversity (Kopalová et al., 2012, 2013). A diverse diatom flora of 125 taxa was observed and the results from the similarity and diversity analysis suggest that the diatom flora of James Ross Island is composed of taxa from the Maritime Antarctic Region and the Antarctic Continent, presenting a unique situation in the entire Antarctic Region. Taxa such as *Luticola gaussii* (Heiden) D.G.Mann and *Achnanthes taylorensis* D.E.Kellogg et al. have never been found outside Continental Antarctica, but were regularly present in low abundances on James Ross Island. Diatom communities present in streams and seepage areas could be clearly distinguished from those in lakes, the latter being much more species rich. Based on the multivariate analysis, conductivity and nutrients were selected as the two main environmental factors determining the diatom composition in the Ulu Peninsula lakes. The obtained results allowed the construction of a transfer function for lake conductivity that can be applied in further paleo-ecological research Kopalová et al. (2013).

On Livingston Island, diatom and water chemistry samples were collected from 49 lakes, pools and rivers on Byers Peninsula (Livingston Island, South Shetland Islands) during the austral summer of 2009. A diverse diatom flora of 143 taxa was found. *Fragilaria capucina s.l.* Desmazières, *Psammothidium papilio* (Kellogg et al.) Kopalová & Van de Vijver, *Navicula dobrinatemniskovae* Zidarova & Van de Vijverand several *Nitzschia* taxa dominated the flora. The biogeographical analysis showed that more than 55% of all observed taxa presented a restricted Antarctic biogeographic distribution and only 30% had a cosmopolitan distribution, contrary to previously published data. Cluster analysis and Principal Component Analysis were used to classify the samples based on their chemical characteristics, revealing that nutrients and specific conductance were the main factors dividing the samples into four groups: young lakes, coastal lakes, larger lakes on the central plateau and smaller, temporary pools. Diatom communities corresponded well to this division and were strongly influenced by salinity and nutrients (Kopalová & Van de Vijver, 2013).

The comparison of the diatom communities on both islands shows clear differences between the islands. Nevertheless, these differences are smaller than the differences between both islands and the other Antarctic sub-regions such as the sub-Antarctic islands and the Antarctic Continent. The former have much higher diatom diversity with up to 250 species whereas on the latter, a more impoverished flora is present. The availability of microhabitats which is higher on the sub-Antarctic islands but lower on the Antarctic Continent plays in this case a determining role.

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Keywords

Maritime Antarctic Region, James Ross Island, Livingston Island, biogeography, ecology

Poster presentation

Benthic diatoms and implementation of Water Framework Directive in Croatia

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Bullet points

Due to the great importance of running waters as one of the most valuable natural resources, it is necessary to have adequate tools for assessment and monitoring the water quality.

Introduction

With the EC Water Framework Directive (WFD; Directive 2000/60/EC, European Union, 2000), a new legal structure for the assessment of all types of water bodies in Europe is defined. The focus of the WFD in stream assessment is the use of biotic indicators (phytoplankton, phytobenthos, macrophytes, benthic invertebrates, and fish) together with hydromorphological and chemical elements. Current approaches for using phytobenthos for monitoring European rivers generally focus on a representative diatoms taxonomic groups sampled from a representative habitat (Kelly et al., 1998; Prygiel et al., 2002; Rott et al., 2003; King et al., 2006). The purpose of this paper is to present diatom assemblages in Croatian rivers and streams, to access the relationship between diatom species composition and environmental variables and to set boundaries for water quality classes using the Croatian diatom trophic index. Investigations were performed during spring and summer in 2006, 2007 and 2009. Three-year research Twinning project financed by EU and project by the Croatian water company, Hrvatske vode. Altogether, samples were collected on 141 sampling points on 92 different rivers and streams in Croatia. For additional analyses dataset with physical and chemical properties (water temperature, pH, conductivity, oxygen, oxygen saturation, nitrate, nitrite, ammonia, orthophosphate and total phosphorus) of investigated sites was also used. Values of water temperature, pH, conductivity, oxygen concentration, and oxygen saturation were measured using WTW Multi 340i handheld meter along with sampling of diatoms. Concentrations of nitrate, nitrite, ammonia, orthophosphate and total phosphorus were determined from water samples collected at the same time and measured in laboratory using standard methods (APHA, 1995). For abiotic typology, water types system B was used to describe 24 different water types (Mihaljević et al., 2011).

Results and discussion

Altogether 182 diatom species were noted and used for the analysis. Cluster analysis was employed to group the samples and 10 groups emerged. ANOVA revealed that among SOM groups there was, according to environmental parameters, a statistically significant difference ($F=2.15952$, $p<0.001$). To single out parameters that contributed towards statistical significance, post hoc Tukey hsd test was performed. It revealed that group 6 is statistically different ($p<0.05$) from all other groups concerning concentrations of ammonia, nitrates, orthophosphates and total phosphorus. ANOVA on diatom abundance data set revealed that groups statistically significantly differ one from another ($F=138.08$, $p<0.001$). Ind-val analysis was used to find characteristic species for each group. Each group was represented with at least one (groups 4 and 1) species and group 8 with 12 different species. Composition of diatom communities and the characteristic (indicator) species from this set of Croatian samples closely corresponded to those observed in other geographical areas (Tison et al., 2005; Tornés et al., 2007). Diatom assemblages are influenced by many factors including those that are site specific at various temporal and species scales (DeNicola et al., 2004) as well as those that reflect human interventions in the environment. Those factors include chemical properties of the water (Potapova, 1996), nutrient load (Rott, 1995) and also flow velocity and type of substrate (Plenković-Moraj et al., 1989).

Canonical analysis of principal coordinates (CAP) showed that there were some strong and significant correlations between the diatom abundance and the environmental variables ($P=0.001$). First canonical correlation was 0.74 and second one 0.67. CAP axis 1 was correlated with oxygen saturation ($r=-0.924$) and CAP axis 2 with total P ($r=0.571$) and NO_3^- ($r=0.490$). It seems that nutrients, especially phosphorus, have the most important role concerning diatom assemblages when we look at the data at a regional scale. As published in many other studies (Stanley et al., 1990) phosphorus, both as orthophosphate and total phosphorus, has been shown to be an important factor in the development of benthic diatom community. Phosphorus and nitrogen fractions have been generally considered to be the most critical factors (Hutchinson, 1967). Because of such a strong influence of phosphorus on diatom assemblages, a trophic index was chosen as a metric for estimation of water quality in running waters in Croatia. For each species, indication and sensitivity values were adopted for Croatian geomorphology using simple linear regression between diatom species abundance and total phosphorus concentration. Ecological preferences of typifying species revealed by Ind-val were used to set boundaries for different groups of stream types and reference sites were chosen for further testing.

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Keywords

benthic diatoms, Water Framework Directive, Croatia

Workshop presentation

Species composition and morphology of recent and fossil small fragilarioid diatoms from Lake Baikal (Russia)

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Bullet points

We discuss species composition and morphology of small fragilarioid diatoms from three genera *Pseudostaurosira, Staurosirella* and *Staurosira*. New species described by us from fossil and recent samples are discussed with special attention to the evolution of this group in ancient Lake Baikal.

Introduction

Lake Baikal is the world's deepest lake and contains the world's largest volume of surface freshwater (Kozhov, 1963). The lake's basin is situated in the so-called Baikal Rift Zone. Formation of the rift zone began during the Oligocene and is dated back to over 30 million years BP. The lake basin crosses southeastern Siberia, between 51°28'–55°47'N and 103°43'–109°58'E. Although by far most lacustrine basins are as young as the geological phenomena that created them, and their origin is related in large part to the deglaciation of the Sartanian (Vistulian) ice sheets ca. 14-10 ka in the late Pleistocene (Kuzmin et al., 2009), there exist ancient lakes whose origin dating back to the Tertiary. Examples of such lakes include e.g. Baikal, Biva in Japan and Ohrid in Macedonia, East African rift valley lakes including Lake Victoria and Tanganyika, and Titicaca in South America (Martens, 1997, Kuzmin et al., 2009). Amongst these ancient lakes the oldest is Lake Baikal (Mackay, 2007; Kuzmin et al., 2009).

Diatoms are the integral part of not only recent but also the ancient paleoecosystem of Lake Baikal. They are widely used for paleoenvironmental reconstruction and biostratigraphical subdivision of Upper Cenozoic sedimentary strata of the ancient basin (Kuzmin et al., 2009). For these reasons precise identification of species and knowledge about its ecology are important.

The aim of this study is an investigation of morphology and taxonomy of small fragilarioid diatoms from Lake Baikal. Results are based on the examination of samples collected by A.P. Skabitschewsky on July 20th of 1965 from bottom deposits surrounding Ushkaniy Islands in Lake Baikal. Fossil taxa are studied from the sediments of Lake Baikal from cores BDP-96 and BDP-98.

Results and discussion

Our results show that diatom flora of Lake Baikal includes high diversity of fragilarioid diatoms from genera *Pseudostaurosira* D.M. Williams & Round, *Staurosira* Ehrenberg and *Staurosirella* D.M. Williams & Round.

The recent flora includes more than 30 species of fragilarioid diatoms. The genus *Pseudostaurosira* is most diverse, with twenty species described by us as taxa new for science. Species from this genus are divided into two morphological groups, based on morphology and especially on areolae structure. One group comprises taxa with large areolae covered by closing plates (see Morales, 2003). The second group includes very small taxa with single uncovered areola in every striae. Taxonomical position of species from second group needs clarification. It is possible that this group is an independent genus that will be described by us in future.

Five species described by us as new for science taxa belong to the genus *Staurosirella*. This group includes closely related taxa with similar morphology but they differ in numerical data and the shape of their valves. Three new species are described from the genus *Staurosira*.

According to fossil assemblages, a rather high content of shallow-water benthic fragilarioid diatoms occurs in the lower part of the BDP-98 section (in upper Miocene sediments of the 600-480 m interval belonging to a distal deltaic facies formed by Paleo-Barguzin River). Among them, side by side with the presence of specimens of *Staurosira construens* Ehrenberg, *Staurosirella leptostauron* (Ehrenberg) D.M. Williams & Round, *S.* cf. *martyi* (Héribaud) E. Morales et Manoylov, *S.* cf. *pinnata* (Ehrenberg) D.M. Williams & Round, *Pseudostaurosira* cf. *bicapitata* (A. Mayer) D.M. Williams & Round, *P.* cf. *brevistriata* (Grunow) D.M. Williams & Round, *P.* cf. *parasitica* (W. Smith) E. Morales, *Fragilariforma virescens* (Ralfs) D.M. Williams & Round. In Pliocene, Pleistocene and Holocene sediments the abundance of fragilarioid diatoms was not higher. A few new species of small fragilarioid diatoms are described by us.

Study of fossil species allows us to discuss some points of the evolution of araphid diatoms in ancient Lake Baikal. For example, presence of species flocks in genera *Pseudostaurosira* and *Staurosirella*. Previously, species flocks were observed for *Navicula lacusbaikali*-group, which are endemic for the Lake Baikal (Mann, 1999; Kulikovskiy et al., 2012). With our results in published monograph we enlarge the pool of existing species flocks by identifying *Cymbella stuxbergii*-group, some closely related species of *Navicula*, and in *Geissleria* (Kulikovskiy et al., 2012).

The research we have performed seems to be a strong support of the hypothesis of Lake Baikal being an evolutionary hotspot for araphid diatoms. It is supported by the large number of new species described by us and many unidentified taxa.

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Keywords

Fragilarioid diatoms, new species, morphology, taxonomy, Baikal.

Poster presentation

Ecophysiological and morphological differentiation between *Navicula perminuta* Grunow strains isolated from different biogeographic regions

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Bullet points

Detailed analysis of morphology of almost identical *Navicula perminuta* strains isolated from different biogeographic regions and of their adaptation mechanisms and tolerance to changes of environmental factors

Introduction

Navicula perminuta is a frequently identified taxa, nevertheless, because of its small dimensions and the fact that it is almost impossible to observe all the morphological details in light microscope, it is probably often misidentified and confused with similar and probably closely related taxa (Busse & Snoeijs, 2002), which could potentially belong to the same complex of cryptic species. *N. perminuta* is often described as cosmopolitan marine species. However, it has been equally often identified in brackish waters, among others in the Baltic Sea (e.g. Busse & Snoeijs, 2002; Ulanova et al., 2009). Moreover, laboratory experiments carried out on strains isolated from the Baltic Sea revealed wide tolerance of this taxon to changes of environmental factors like salinity (it grows well in salinity ranging from 2 to 32 PSU), temperature (5-25 °C) and PAR intensity (10–290 µmol photons$\cdot m^{-2} \cdot s^{-1}$) (Lemke et al., in preparation). It also occurs in habitats with extremely fluctuating salinities such as running waters receiving saline discharges (Busse & Snoeijs, 2002).

The aim of this study was to carry out a thorough taxonomic revision of morphologically almost identical organisms isolated from distant regions differing in physico-chemical conditions, using both light and scanning electron microscopy. Due to quite numerous reports on exceptional adaptation abilities of *N. perminuta* (e.g. Waring et al., 2006; McLachlan et al., 2009), as well as biomonitoring value of diatoms, examination and comparison of ecophysiology, tolerance to changes of environmental factors and adaptive mechanisms of selected strains was also one of the main aims of the study. The results of the study could help to verify the hypothesis of cosmopolitan nature of *Navicula perminuta*, as well as bring new relevant information on long-lasting discourse on endemic or cosmopolitan character of microorganisms in general, and in particular diatoms (e.g. Broady, 1996; Jones, 1996; Vanormelingen et al., 2008).

Results and discussion

The analyses were carried out on strains isolated from the Baltic Sea and now maintained at the Culture Collection of Baltic Algae (CCBA, University of Gdansk, Poland), as well as on diatoms isolated from the Atlantic coast of the USA and mudflats at Arlesford Creek, Essex, UK. Performed analyses enabled to describe some subtle and more evident morphological differences between the strains. The research also made possible the observation and documentation of morphological variability and phenotypic plasticity within particular cultures. The results of the study proved statistically significant influence of salinity on valve morphometry, but depending on the strain it affected both length and width or just one of the dimensions. Moreover, it was difficult to observe one common trend for all the strains when the exponential and stationary phase were compared, thus it seems that the variability of valve morphology is dependent on more complicated interrelation of reproduction and life cycle of cells, although there are some studies supporting the idea that salinity indeed has some influence on valve formation. Variation in valve morphometry was observed more often than differences in general valve outline or striation pattern. In some cases, malformations and teratological forms were observed, especially in less favourable salinity conditions and stationary growth phase.

So as to examine and compare ecophysiological response of diatoms towards changes of salinity (0-32 PSU), PAR intensity (10–290 µmol photons·m^{-2}·s^{-1}) and temperature (5-25 °C), series of factorial experiments were performed on chosen strains. Growth rates, concentrations of photosynthetic pigments and chlorophyll *a* fluorescence were analysed in each experimental set. The results of factorial experiment enabled determination of the range of tolerance and growth optima of the strains. Euryhaline and marine-brackish character of the strains was confirmed. They grew best in 8-32 PSU, with the exception of strain CCMP1117 which had slightly higher growth optimum - 16-32 PSU. The analysed organisms differed mostly in tolerance to fresh water and the strains isolated from the Baltic Sea proved to be the most tolerant to lower salinities. On the whole, moderate temperature and higher PAR intensities were the most favourable for growth. Nevertheless, the combination of extreme temperature and irradiance conditions had clear inhibitory effects, especially in less favourable salinities. The main fluorescence parameters were more significantly influenced by light conditions than temperature and salinity. Generally, the differences between F_v/F_m and ΦPSII values measured in cultures grown in different salt concentrations were the most pronounced in the lowest temperature tested. The experiments demonstrated great adaptability of the strains to changing salinity, irradiance and temperature. Although, the same adaptation mechanisms (e.g. changes in the ratios of photosynthetic pigments) were observed in all the analysed strains, the differences in growth optima and tolerance to changes of the tested parameters undoubtedly can provide some information on the efficiency of these mechanisms.

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Keywords

Navicula perminuta, (pseudo)cryptic species, salinity, ecophysiology, morphological variation

Keynote speaker

Impact of environmental factors on diatom silicification capability and morphogenesis

Speaker: LOPEZ Pascal Jean

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About the speaker

LOPEZ Pascal Jean is working at the Muséum National d'Histoire Naturelle (Paris, France). He is responsible of a team of about 15 researchers working on the evolution of biomineralisation. Since several years, his research focuses on silicon metabolism in diatoms. Indeed, silicon the 2nd most abundant element in the Earth's crust, is an essential element for diatoms growth and morphogenesis. His laboratory is developing pluridisciplinary approaches, form imaging to genomics, to better understand the impacts of environmental factors on biomineralization and the development. Lopez Pascal Jean was also involved in the full-genome sequencing and development of functional genomic approaches for the model species *Phaeodactylum tricornutum* for which the genome had revealed novel feature that might help to explain the incredible diversity and success of the diatoms in contemporary oceans.

Abstract

We have developed several approaches from single-cell to cell-population levels to address the effect of environmental factors on diatoms silicification capability and morphogenesis. An important factor that we have studied is the consequences of an external pH acidification on cell growth, and intracellular silicic acid and biogenic silica contents. Measurements have also revealed that extracellular pH modifications lead to intracellular acidosis. To further understand how variations of the acid-base balance affect silicon metabolism and theca formation, we have developed novel imaging techniques to measure the dynamics of valve formation. We could demonstrate that the kinetics of valve morphogenesis, at least in the early stages, depends on pH. Analytical modeling results suggest that acidic conditions alter the dynamics of the expansion of the vesicles within which silica polymerization occurs, and probably its internal pH. Morphological analysis of valve patterns reveals that acidification also reduces the dimension of the nanometric pores present on the valves, and concurrently the overall valve porosity. Variations in the valve silica network seem to be more correlated to the dynamics and the regulation of the morphogenesis process than the silicon incorporation rate. Similarly the potential role of long-term and short-term acclimatization and of other environmental variables will be discussed.

Oral presentation

Unconventional diatom collections

Preserving cytological, reproductive and ecological detail

Speaker: MANN David G.

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Bullet points

Most of the material used by Lothar Geitler to produce his many diatom papers is available in the herbarium of the University of Vienna, and represents a remarkable resource.

Cytological preparations last many decades and can preserve protoplast structure, mating patterns, and even ecological community structure.

Modern LM imaging gives new possibilities for studying and documenting diatom cell structure.

Introduction

The most familiar kinds of diatom collection are (1) preparations of cleaned diatoms on microscope slides (as strews or picked specimens), often accompanied by unmounted cleaned material that can be used to prepare further slides or allow examination by electron microscopy, and (2) culture collections. If treated carefully, cleaned diatoms can last indefinitely, but of course they give information on only one aspect of cell structure – the silica frustule – since all other parts of the cell are destroyed by the cleaning process. In contrast, cultures can be used to study any aspect of cell structure and function, but they have the crippling disadvantage that they are costly and difficult to keep (though cryopreservation may help) and may require planned breeding programmes for long-term maintenance. They may also display culture artifacts, and must necessarily be restricted to a few clones, which may or may not be representative of the species they are supposed to exemplify. For all these reasons, it may be desirable to preserve and store material and information in 'unconventional' ways, to facilitate study of cytological features and processes such as sexual reproduction.

Results and discussion

The longevity of cytological preparations, stained using traditional colour-dyes, is less and also less certain than that of cleaned diatoms, but in favourable circumstances (with the right choice of fixative, stain and mountant; storage in the dark away from acid fumes, etc) cell structure can be preserved in a life-like condition for many decades and probably at least a century. This can be illustrated by the remarkable collection of slides made by Lothar Geitler and preserved at the University of Vienna, which span almost the whole of Geitler's long research career, from slides of periphyton collected at

Lunz in the 1920s through to rough cultures and further Lunz periphyton made almost 60 years later. Some of the staining has faded with time, but many preparations from the 1920s and 1930s are still bright and can be used to check or amplify Geitler's cytological observations, or to make new observations, as well as to revise Geitler's identifications, which were made in the context of a quite different taxonomic framework (Hustedt's) than is used today. For example, it is possible to re-investigate the diatom Geitler called '*Cymbella lanceolata*' (which should now most likely be called *C. neolanceolata*) in a classic study of diatom meiosis (Geitler, 1927) and check aspects of the three-dimensional structure of the nucleus that are not recorded in Geitler's excellent drawings; some of these drawings can themselves be checked, since they too survive in Vienna. Or again, the existence of the remarkable auxospore envelope recorded by Geitler (1932, in photographs that can be shown to have been 'touched up') in what he called *N. fonticola* can be confirmed using his original Lunz slides and new information can be added, e.g. that the zygotes and auxospores contain two unfused gametic nuclei and four chloroplasts. Furthermore, studies of the original material show that Geitler's *N. fonticola*, which was allogamous, differs morphologically from the paedogamous *N. fonticola* studied by Trobajo et al. (2006).

Suitably prepared, e.g. by embedding and sectioning, stained material can reveal periphyton community structure in a way that complements popular SEM methods, and can also preserve important spatial information in sexually reproducing populations.

Finally, image collections should be mentioned, since these allow potentially permanent recording of three-dimensional detail that is often ephemeral. In Geitler's time, photography was rather expensive (in time and materials) and was not a practical way to record three-dimensional or time-series data on diatom cells. Consequently, observations of cell structure or processes like cell division or auxosporulation were recorded by drawing (summarizing 'significant' detail from different focal planes and times) or a select few snapshots. It is now possible to record multidimensional images as $\{x{:}y \times z\}$ or $\{x{:}y \times t\}$ or $\{x{:}y \times z \times t\}$ stacks (where z and t indicate extent in depth and time, respectively), though storage is currently a not inconsiderable constraint. However, attention needs to be given to how image collections can best be kept and made available, given the ease with which digital records can be lost or rendered unusable.

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Keywords

auxosporulation, collections, cytology, images, stained preparations

Poster presentation

Periphytic diatom communities of four subtropical environments with different trophic status

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Bullet points

Diatoms were sampled regularly in four reservoirs of various trophic status. Diatoms abundance and life-forms responded satisfactorily to local environmental conditions; species abundance better agreed with abiotic data. Oligotrophic and hypereutrophic reservoirs presented distinct assemblages, whereas eutrophic and mesotrophic were similar.

Introduction

Periphytic diatom communities have been successfully used to characterize water quality especially with regard to eutrophication (Kitner & Poulíčková, 2003), saprobity (Salomoni et al., 2011) and acidification (Battarbee & Charles, 1987). Eutrophication is the most common pollution problem in lentic environments due to nutrient inputs from anthropogenic activities that artificially enrich lakes and streams, affecting biological diversity, environmental quality and health of aquatic ecosystems. Iguaçu river basin is one of the most important of Paraná State, Southern Brazil. Piraquara and Iraí rivers belong to the Upper Iguaçu river basin, and Itaqui and Passaúna rivers are tributaries of the right margin of Iguaçu River. The reservoirs formed by those rivers dam, Piraquara (oligotrophic), Passaúna (mesotrophic) and Iraí (eutrophic), are used for urban water supply, and the Itaqui reservoir (hipereutrophic) is intended to recreation and is overgrown with the floating macrophyte Pistia stratiotes L. Iraí and Itaquí's eutrophic conditions reflect the high input of industrial and domestic effluents drained to the reservoirs. Diatom community composition and growth changes reflect the sensitivity of these organisms against environmental alterations. Diatom species have distinct autoecological requirements in different geographical areas (Álvarez-Blanco et al., 2011), and little is known about their environmental tolerances in Brazilian subtropical systems. This study assess the relationship between the periphytic diatom community sampled in those four lentic subtropical reservoirs with different trophic status in order to list potential diatoms that could act like bioindicators of the trophic status in Brazilian ecosystems. Glass slides as artificial substrate were sampled seasonally (spring, summer, fall and winter) after 30 days of colonization. Biofilms were scraped and oxidized to mount permanent slides. The quantitative analyses have been provided with three 600-valves replicates.

Results and discussion

Quantitative analysis identified 130 diatom species considering all four reservoirs. Higher densities were registered in summer and spring and a remarkable peak was observed in the mesotrophic reservoir (*Achnanthidium minutissimum* (Kütz.) Czarn., *Encyonopsis subminuta* Krammer & E. Reichardt and *Punctastriata mimetica* E. Morales). Density values were log transformed (log ϰ +1) for statistical analysis (densities > 5%). PCA explained 32.5% of variance ($p<0.01$) in first axis, showing a gradient from hypereutrophic to oligotrophic environment. Hypereutrophic reservoir had a distinct assemblage correlated to *Nitzschia palea* (Kütz.) W. Sm. (-0.92), *Lemnicola hungarica* (Ehrenb.) Grunow (-0.89), *Gomphonema parvulum* Kütz. (-0.88), *Eunotia bilunaris* (Ehrenb.) Mills (-0.81), *Aulacoseira italica* (Ehrenb.) Simonsen (-0.77), *Sellaphora seminulum* (Grunow) D.G. Mann (-0.77), *Eolimina minima* (Grunow) Lange-Bert. (-0.70). Oligotrophic assemblage was correlated to *Navicula cryptotenella* Lange-Bert. (0.84), *Encyonema neomesianum* Krammer (0.75), *Encyonopsis spicula* (Hust.) Krammer (0.75), *Brachysira neoexilis* Lange-Bert. (0.70), *Aulacoseira ambigua* (Grunow) Simonsen (0.71). Second axis (26.2%; $p<0.01$) revealed an important similarity between eutrophic and mesotrophic environments due to *A. minutissimum* (-0.78) abundance. Pearson's correlation revealed *A. italica* (0.96), *Fragilaria parva* (0.82), *E. bilunaris* (0.81) were correlated with total phosphorus, and *E. bilunaris* (-0.59), *A. italica* (-0.54) and *G. gracile* (-0.53), with photic zone. Applying Twinspan analysis (Hill, 1979), first division evidenced hypereutrophic reservoir with *A. italica* as indicator. This species has not been previously recorded in hypereutrophic environments and could be considered as tolerant. Second division places mesotrophic reservoir with *E. subminuta* as indicator. The presence of this species was correlated with conductivity (0.72); the abundant *P. mimetica* (0.59) and *A. minutissimum* (0.58), also showed correlations with conductivity. The third division separated oligotrophic reservoir indicated by *B. neoexilis*, typical of low TP (Van Dam et al., 1994; Blanco et al., 2004). *Eunotia* species commonly occur in low-nutrient environments (Gómez & Licursi, 2001) however Brazilian studies have found *E. bilunaris* tolerant and indicator of organic pollution (Salomoni et al., 2006, 2011). *Fragilaria parva* was recorded in oligotrophic and hypereutrophic reservoirs, and could be considered tolerant to TP, as observed by Hofmann (1994). Life forms (according to Rimet & Bouchez, 2011), were used to perform a two-way cluster analysis. Even considering seasonality, the samples of the same reservoir were clustered together. Pedunculate and motile life-forms were essentially found in the eutrophic reservoirs, due their specialized structures for competition for resources, such as light (Peterson, 1996). Planktonic life-forms occur in oligotrophic and mesotrophic environments; however hypereutrophic reservoir also presented great density, maybe due to *P. stratiotes* overgrown favoring planktonic community interaction. Mesotrophic environment presented heterogeneous assemblage.

Diatoms abundance and life-forms responded satisfactorily to local environmental conditions. The influence of seasonality was detected among the samples of a specific environment, but did not influence diatom communities at spatial scale. Species abundance better agreed with abiotic data, revealing that oligotrophic and hypereutrophic reservoirs presented distinct assemblages, whereas in eutrophic and mesotrophic they were more similar. Once species showed preferences to environmental conditions, knowing species autoecology could contribute to better understand their dynamics. Naturally, problems with diatom identification are frequent, so life-forms could be a great tool for ecological inferences, especially in bioassessment studies.

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Keywords

Bacillariophyceae, bioassessment, bioindication, total phosphorus, water quality

Poster presentation

Precipitation and wind model succession and dynamic of periphytic diatoms in a large subtropical shallow lake

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Bullet points

The colonization of macrophytes by periphytic diatoms is followed during 60 days in situ. Different intensities of disturbances caused by precipitation and wind favored different life-forms of diatoms. Diatoms start to contribute in biomass after 15 days of colonization and 60 days were not enough for periphyton stabilization.

Introduction

Succession process consists in progressive changes of several stages from simple to complex communities (Krebs, 1972). Colonization of submerged substrata by benthic communities occurs due to availability of propagules in water in a linear process by passive settlement of cells (Biggs, 1996; Stevenson, 1996). Periphyton dynamics comprises formation of organic matrix and bacterial flora followed by opportunist diatoms, pedunculate diatoms and then filamentous green algae (Hoagland et al., 1982; Biggs, 1996). Disturbance events are determinant for community structure (Peterson & Stevenson, 1992), both in their intensity and their frequency.

Mangueira Lake is a large shallow oligo-mesotrophic system under continuous wind influence (from NE direction, during all seasons, and SW during the cold fronts) situated between Atlantic Ocean and Mirim Lake, placed in the Taim Hydrological System (THS), southern Brazil, site 7 of the Long Term Ecological Research of the Brazilian network (LTER=PELD –CNPq). The lake interfaces wetlands in northern and southern part, with large areas covered by macrophytes. Wind driven hydrodynamics can play an important role as on plankton communities in large subtropical shallow lakes (Cardoso et al., 2012). In a previous study on periphytic diatoms, a longitudinal gradient of diatoms distribution in Mangueira Lake was revealed from North to South (Matias de Faria et al., 2012). Attached diatoms in southern area of that lake seem to be more susceptible to wind action (Matias de Faria, in prep.) In this framework, we studied successional dynamic of the periphytic community in the South part of the Mangueira Lake during the summer 2012, during 60 days (from January 18 to March 18), to understand how hydrodynamics influences colonization process. Macrophytes (*S. californicus*, n=240) were scraped with soft sponge to clean these natural substrata in two banks of macrophytes. They were marked and denominated as ‘day one’. Biofilms (n=2) were scraped on days 3, 6, 9, 12, 15, 20, 30, 45 and 60 of succession, and quantified (Utermöhl).

Results and discussion

The south part of the lake was characterized by high transparency (76.33±10.33 cm), high pH (8.62±0.10) and low N:P ratio. Wind direction was constant (N-NE) with high mean velocity during all summer (15.4±9.25 m.s^{-2}). Precipitation range was low (2.7±9.25 mm^3) with two peaks on 20th (46.7 mm^3) and 36th (32.9 mm^3) days, being constant and moderate until 60th day. Biomass was strongly correlated with richness (r 0.93) and total density (r 0.71). Shannon-Wiener diversity was low, with high values on days 15 (2.21) and 60 (2.12). Diatoms start contribution to periphytic biomass after 15 days of colonization, attached by prostrate forms (*Epithemia* spp, *Cocconeis* spp; 54% of diatom community) and with pedunculate or mucilage stalks (*Ctenophora*, *Fragilaria* spp, *Achnanthidium* spp, *Rhoicosphenia* spp; 34%). Biomass peak was on 20th day, and precipitation (r 0.9) favored prostrate forms (62% of biomass), declining on 30th day (erect grown diatoms reached 82%). Community on 45th day was formed by almost 59% of motile guild (*Nitzschia* spp) and not attached diatoms (*Synedra*). Peaks of richness (25) and density (322 ind.cm^{-2}) occurred on 60th day; erect forms returned to grow and diatoms reached 79% of periphyton total biomass. Wind velocity favored prostrate diatoms (r 0.83). Size classes (Rimet & Bouchez, 2011) revealed that 90% of the biomass was formed by diatoms with a biovolume greater than 1500 µm^3, in all samples. Pioneer species in Mangueira Lake with high succession rate were cells of Cyanobacteria, Chlorophyceae and Zygnemaphyceae (Matias de Faria et al., in prep.). Our results disagree with the literature, since pioneer diatoms were not the first to colonize substrata in this lake. Prostrate life-form was essentially represented by *Epithemia* spp adapted to fast-flowing areas (Potapova & Charles, 2002). Their dynamics were better related to environmental conditions, once they are nitrogen-fixing diatoms. Penduncculate and motile forms grew with input of total nitrogen (r 0.78, r 0.75, respectively). Smaller forms (biomass < 99 µm^3) began to be quantitatively important after 15th day. Higher values were registered on 60th day whereas *A. minutissimum* started to contribute in biomass (499µm.cm^{-3}). Previous study realized by Matias de Faria et al. (2012) during two summers (2006 and 2008) in Mangueira Lake showed that Southern community was dominate by *A. minutissimum* (22 478 ind.cm^{-2}) which was resistant to physical disturbances, as water turbulence (Passy, 2007). Current study revealed lower richness and total density. Sixty days of colonization in a turbulent and oligo-mesotrophic environment were not enough to periphytic community stabilization. Disturbance caused by precipitation interfered in succession rates, and different intensity of these disturbances favored different life-forms. Wind could be a stressor modeling periphytic community in Mangueira Lake and offering resistance to colonization by r-strategist diatoms as pioneer in other systems. Probably disturbance caused by changes in wind direction and velocity, as during the cold fronts, could be an important stressor in this shallow lake to test Intermediate Disturbance Hypothesis on structure of the periphytic colonization. To confirm this hypothesis we suggest that future studies evaluate longer periods of succession to identify how intensity and frequency of disturbs can model periphytic community.

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Keywords

Bacillariophyceae, natural substrata, water turbulence, wetland, wind

Poster presentation

On the symbiotic relationship between *Microcystis aeruginosa* Kützing - *Nitzschia palea* (Kützing) W. Smith in Alalay Pond, Cochabamba, Bolivia

Speaker: ECTOR Luc

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Bullet points

Alalay Pond is an urban, hypereutrophic ecosystem.

Colonies of *Microcystis aeruginosa*, during a bloom in 2013, contained *Nitzschia palea* and bacteria.

The reasons for the association are explored.

Introduction

The symbiotic relations between freshwater diatoms and cyanobacteria have been documented (Drum & Pankratz, 1965; Floener & Bothe, 1980; DeYoe et al., 1992), but the associations of *Nitzschia* with cyanobacteria are less known (Bradbury, 1973; Burgis et al., 1973). The consortium *Microcystis aeruginosa* Kützing - *Nitzschia palea* (Kützing) W. Smith was reported only twice (Gessner, 1956; Flower, 1982), but the implications for both organisms have been little explored. It is assumed that the diatom benefits from the nitrogen fixing capabilities of the cyanobacterium, but *Microcystis* lacks this capability (Bergman et al., 1997). Therefore, other must be the reasons driving the association and the cyanobacterium might also be benefiting.

In April, 2013, a bloom of *M. aeruginosa* with attached bacteria and *N. palea* was observed in Alalay Pond, an urban, shallow, hypereutrophic system. The phosphorous load in the water is high, but forms of soluble nitrogen are below the limit of detection, which has been attributed to rapid uptake by macrophytes (Ayala et al., 2007). This hypothesis disregards the contribution of epiphyton and plankton in such a process. In the case of the plankton, the contribution to nitrogen uptake might be high due to frequent blooms. In the present work, we discuss that the alliance *M. aeruginosa* - *N. palea* could be extracting and important part of the nitrogen and other nutrients from the water, but that also enzymatic activity within extracellular polymeric substances (EPS) from both algae and accompanying bacteria help keep a continuous bloom. In addition, *N. palea* could be benefiting from the *Microcystis* colony buoyancy to keep in the photic zone, where access to nutrients and light is better.

Results and discussion

Colonies of *M. aeruginosa* were especially abundant in the southern, southwestern and northern regions of Alalay Pond. There, the relative proportion of *M. aeruginosa* to *N. palea* was approximately 33:1 cells. Within some colonies, cells of *N. palea* tended to be grouped in mucilage spaces lacking cyanobacterial cells, but in others, *Nitzschia* cells were peripherical. Although, we did not count them, coccoid and bacillary bacterial cells were readily observable in all parts of the colonies and were visibly more abundant than the *N. palea* cells.

Substantial information exists on *M. aeruginosa* autecology and biology, allowing the elaboration of a hypothesis concerning the dynamics of the relationship with *N. palea* and bacteria in Alalay Pond. *Microcystis aeruginosa* is a typical plankton bloomer in lentic eutrophic systems, remaining at the surface aided by cytoplasmic gas vesicles. Strong light exposure is blocked by the chromatoplasm, a thylakoid-dense zone beneath the cytoplasmic membrane. It recovers dissolved organic and inorganic nitrogen and phosphorous effectively, but it also uses bacteria as an extra source of these nutrients (Hoppe, 1981; Paerl et al., 1985; Bergman et al., 1997; Dziga et al., 2009). *Nitzschia palea* is also known as a eutraphentic bloomer. Hofmann (1994) and Van Dam et al. (1994), consider *N. palea* as a hypereutraphentic, polysaprobic species requiring high amounts of organic nitrogen. Cholnoky (1962) further states that it is more abundant in alkaline eutrophic systems. In addition, it is known to utilize a series of organic compounds as source of nutrients (Tuchman, 1996).

Alalay pond has all the characteristics required by both *M. aeruginosa* and *N. palea*, except for the very low concentrations of all forms of dissolved nitrogen. The pond has alkaline waters, low dissolved oxygen and receives high organic matter inputs, but since these latter molecules are fairly large, they need enzymatic breakage before their use. *Microcystis*, bacteria, and especially *N. palea* secrete extracellular enzymes for recovery of non-conservative essential elements (Francoeur & Wetzel, 2003; Tuchman et al., 2006; Dziga et al., 2009; Limei et al., 2009). Consequently, their association could be very effective in organic compound removal from the water column. Thus, it is possible that macrophytes and benthic communities are very effective in sequestering dissolved nitrogen in Alalay pond, but the extracellular enzymatic action within the EPS, ensures the persistence of microalgal blooms in both benthos and plankton communities. With the proximity of bacteria and *N. palea*, *M. aeruginosa* ensures a constant supply of nitrogen for cell survival, division and permanent production of gas vesicles (Klemmer, 1991). *Nitzscha palea* might be benefiting from this extracellular digestive action, but also might be assured a proper environment for photosynthesis at the surface, were it is protected from excessive sunlight by a crowding effect by *Microcystis* and bacterial cells.

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Keywords

symbiosis, *Microcystis aeruginosa*, *Nitzschia palea*, Alalay Pond, Bolivia

Poster presentation

A re-analysis of Scottish material studied by Haworth (1975) containing abundant araphid diatom taxa (Bacillariophyceae)

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Bullet points

Elisabeth Y. Haworth published a seminal paper in 1975 illustrating with SEM araphid diatoms from late-glacial sediments.

We re-studied some of the material looking for a bauplan for *Staurosirella pinnata* that would resolve the taxonomy of the complex.

Some taxonomic remarks are drawn.

Introduction

Haworth´s (1975) study of late-glacial sediments from Scotland was one of the first works on araphid diatoms based on scanning electron microscopy information and a pioneer in cross referencing with type material. The samples she used from 3 of the 4 studied lochs contained dominant araphid assemblages, part of which, were several species that she identified based on the information available at that time (literature and some permanent preparations from two different herbaria). The discussions presented in this work were detailed and put in evidence the tremendous shortcomings that still pervade araphid diatom taxonomy today.

A light microscopy study of the type of *Fragilaria pinnata* Ehrenberg (Ehrenberg, 1854) was recently presented by Morales et al. (2013), study that showed that taxonomic drift led to the widespread conception of this taxon as an araphid diatom, when in reality it belongs to the genus *Denticula*. One of the most obvious implications of this latter work is that hundreds of literature records are linked to a name originally devised for a completely different diatom. A review of the published records for *F.*

pinnata or its current synonym, *Staurosirella pinnata* (Ehrenberg) D.M. Williams & Round (Williams & Round, 1987), shows that there are at least a dozen morphological variants that have been given these names and therefore it is a complex rather than a discrete, easily recognizable population (Gaul et al., 1993; Henderson & Reimer, 2003). This prompted our search for a population that would best represent the current concept of *Fragilaria* (=*Staurosirella*) *pinnata*, and since Haworth´s work contained sufficient detail and corresponds to one of the first illustrations of "*pinnata*" under scanning electron microscope (SEM), we initiated our search in her late-glacial material.

Results and discussion

Most of the diatoms reported in Haworth (1975) were found during our SEM analyses, and the preservation of the material was rather good. Populations of different araphids were well-developed, which allowed for a detailed illustration from different angles of the key diagnostic features. Haworth did not have access to type material of *F. pinnata*, so she chose to look at the iconotype in Ehrenberg (1854), which she deemed "uninformative". She observed material from one of the localities studied by Ehrenberg from which he reported to have found this taxon, but she was unsuccessful in proving its presence. She then used the description in Hustedt (1959): "Frustule elliptic to linear with convex, parallel or slightly concave sides and rounded ends. Striae large, rib-like, usually radially arranged towards the ends. Pseudoraphe linear or slightly lanceolate, central area absent; 3-35 µm long, 2-6 µm wide, striae 10-12 in 10 µm, longitudinal lines (on striae) 20 in 1 µm" (translated by Haworth, 1975) to describe her own population. However, she pointed out two main things 1) Hustedt had a broad concept of *F. pinnata*, an observation further detailed by Morales et al. (2013), and 2) she found it difficult to discern with ease between her *F. pinnata* individuals and representatives of *Fragilaria lapponica* Grunow in Van Heurck present in the material, especially at the SEM level. Haworth (1975) also brought *Odontidium mutabile* W. Smith (Smith, 1856) into the *F. pinnata* discussion, saying that slides of the type in the Smith´s collection were an assemblage of different morphological variants that would intergrade with *F. lapponica* as observed from the type slide in the Grunow Collection. She also discussed that the *F. pinnata* populations in the Scottish material contained morphologies that resembled *F. lapponica*.

We also found the same intergradation of forms between *F. pinnata* and *F. lapponica*, especially in valves larger than ca. 10 µm. As pointed out by Haworth (1975), the striae and features of the spines and axial area are difficult to differentiate in these valves. We have found it easier to discriminate valves shorter than 6 µm in length. In the small *F. pinnata*, a narrower zigzagging axial area (due to alternating striae from opposite sides) with raised virgae delimit much narrower striae composed of short lineolae alternated with shorter vimines. The volae appear to be more delicate and are less profuse than in *F. lapponica*. The spines, girdle bands and apical pore fields are essentially the same in all specimens, regardless of size.

Based on this study, we can preliminarily conclude: 1) it is difficult to isolate a population from the Scottish material that would serve as a reference for *F. pinnata*. 2) The smaller forms present in the late-glacial sediments can be distinguished from *F. lapponica*-like variants, principally based on features of axial area and striae. 3) We cannot clearly discern a population with a full size range series based on the Scottish material. 4) It becomes imperative to study the type material of *F. lapponica* and compare it with the study of type material of *O. mutabile* (Morales et al., in prep.) to solve the problem of morphological intergradation in the material from Scotland.

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Keywords

Araphid diatoms, Bacillariophyta, taxonomy, late-glacial, SEM

Oral presentation

Assessing the identity of freshwater araphid diatoms (Bacillariophyceae) by studying their type materials: an ongoing task with mixed results

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Bullet points

Araphid diatom taxonomy is not well-resolved
Detailed studies of type material of several taxa are presented
Solving the taxonomy of several taxa is not straightforward

Introduction

The taxonomy of freshwater araphid diatoms is ill-defined and taxonomic drift has derived in plain misinterpretation of the original concept of several taxa (Edlund et al., 2006; Cejudo-Figueiras et al., 2011; Morales et al., 2013). The taxonomic history has become so entangled that each of these cases takes a considerable time, effort and investment of resources to be solved. In addition, the task becomes even more cumbersome when type material is difficult to obtain or has been destroyed. We present here studies of several types, including *Odontidium harrisonii* W. Smith, *Odontidium harrisonii* var. *beta* Roper in W. Smith, *Odontidium mutabile* W. Smith, *Odontidium tabellaria* W. Smith, *Odontidium tabellaria* var. *beta* W. Smith, *Odontidium parasiticum* W. Smith, *Odontidium parasiticum* var. *beta* W. Smith (taxa published in Smith (1856)) and *Fragilaria brevistriata* Grunow in Van Heurck (published in Van Heurck (1881, 1885)). By means of morphological comparisons with published material, we show that concept drift has been dramatic among some of these taxa.

Results and discussion

As we revised type materials, it became evident that 1) some taxa had been described more than once, 2) taxonomic drift had occurred, 3) solutions were not straightforward, and 4) type material for morphologically related taxa has to be analyzed to provide these solutions.

Odontidium harrisonii is conspecific with *Staurosirella lata* Levkov & D.M. Williams (Levkov & Williams, 2011). Based on Morales et al. (2013), it could also be conspecific with *Staurosirella leptostauron* (Ehrenberg) D.M. Williams & Round (Williams & Round, 1987), but to show this, type material of *Biblarium leptostauron* Ehrenberg (Ehrenberg, 1854) must be analyzed. *Odontidium harrisonii* var. *beta* is highly similar to *Staurosira pinnata* Ehrenberg (Ehrenberg, 1854), but studies of its type material are not yet available. *Staurosira pinnata* has indeed been considered a synonym of *Biblarium leptostauron* by Hustedt (1931), but this seems incorrect.

Odontidium mutabile is considered a synonym of *Staurosirella pinnata* (Ehrenberg) D.M. Williams & Round (Hofmann et al., 2011), but Morales et al. (2013) showed that the basionym *Fragilaria pinnata* Ehrenberg (Ehrenberg, 1854) is not an araphid diatom, but a *Denticula* species. It becomes necessary to study type material of *Fragilaria lapponica* Grunow in Van Heurck (Van Heurck, 1881, 1885), with which *O. mutabile* is highly similar.

Odontidium tabellaria is conspecific with *Fragilaria hungarica* Pantocsek (Pantocsek, 1902; now Staurosira grigorszkyi Ács, E. Morales & Ector (Ács et al., 2009)). *Odontidium tabellaria* var. *beta* is similar to *Fragilaria construens* var*. binodis* (Ehrenberg) Grunow and to solve this, type material of *Fragilaria binodis* Ehrenberg (Ehrenberg, 1854) has to be analyzed. A complication arises because Index Nominum Algarum relates *F. binodis* to *Navicula binodis* Ehrenberg (1841), while the Catalogue of Diatom Names cites *Navicula binodis* Ehrenberg (1840) as the basionym for *Fragilaria construens* var*. binodis. Navicula binodis* is also the basionym for *Neidium binodis* (Ehrenberg) Hustedt (Hustedt, 1945) and the recent *Neidiomorpha binodis* (Ehrenberg) Cantonati, Lange-Bertalot & Angeli (Cantonati et al., 2010).

For *Odontidium parasiticum*, LM and SEM features of individuals found in type material are similar to what it is now reported as *Fragilaria parasitica* (W. Smith) Grunow in Van Heurck (Van Heurck 1881; 1885) or as *Pseudostaurosira parasitica* (W. Smith) E. Morales (Morales, 2003). The variety *beta* of this taxon was described by Smith (1856), but seems to have been redescribed as *Fragilaria parasitica* var*. subconstricta* Grunow in Van Heurck (Van Heurck 1881, 1885). Therefore, the transfer *Pseudostaurosira parasitica* var*. subconstricta* (Grunow in Van Heurck) E. Morales (Morales, 2003) needs reassessment.

The morphological variability of *Fragilaria brevistriata* Grunow in Van Heurck (Van Heurck, 1881, 1885) in the type is narrower than currently conceived and a thorough assessment of the literature and types of the multiple varieties must be performed.

It is obvious then that proper nomenclatural treatment respecting the rules of the International Code of Nomenclature for algae, fungi, and plants (McNeill et al., 2011) is required in several of these cases and for this endeavor much additional work is needed.

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Keywords

araphid diatoms, Bacillariophyta, taxonomy, type material, SEM

Poster presentation

A new fossil species of *Entomoneis* from the Turkish Marmara Sea sediments

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Bullet points

A new fossil diatom with a well-developed raphe-bearing keel and continuous junction line in the strongly bilobated wings belonging to the genus *Entomoneis* is described.

Introduction

The main features depicting the genus *Entomoneis* consist of well-developed sigmoid, bilobate-shaped cells that show the expansion of a wing-like keel elevated from the valve body, straight external central and polar raphe endings, bi- or multiseriate striae, and numerous girdle bands (Round et al., 1990). In addition, another obvious feature of the genus is the presence of a junction line visible in light microscopy which consists in a series of prominent basal fibulae disposed internally between the wing-like projections and the valve surface (Patrick & Reimer, 1975; Paddock & Sims, 1981; Poulin & Cardinal, 1983; Osada & Kobayasi, 1985). In *Entomoneis*, the raphe fissures always open into a tubular raphe canal supported by a series of raphe fibulae with, however, a double raphe canal present in *E. paludosa* (W. Smith) Reimer and *E. pseudoduplex* Osada & Kobayasi (Osada & Kobayasi, 1990a, b, c). The junction line also shows some morphological variability, but it is generally continuous and bi-sinuous to slightly curved in most taxa, while it is restricted to the corner of the wing in *E. punctulata* (Grunow) Osada & Kobayasi and totally absent in *E. aequabilis* Osada & Kobayasi. In *Entomoneis*, the raphe fibulae are always present and delineate the raphe canal on the wings and the basal fibulae also tend to be always present forming the characteristic junction line, except in *E. aequabilis* and *E. vertebralis* Clavero, Grimalt & Hernández-Mariné where they are absent and restricted near to the central nodule, respectively (Clavero et al., 1999). In the case of the keel fibulae, some species lack them as in *E. kjellmanii* (Cleve) Poulin & Cardinal, while they show some variation between species like in *E. alata* (Ehrenberg) Ehrenberg var. *japonica* (Cleve) Osada & Kobayasi or *E. centrospinosa* Osada & Kobayasi (Osada & Kobayasi, 1985, 1990a).

Specimens presenting the general characteristics of *Entomoneis* were found in fossil sediments from the Marmara Sea.

Results and discussion

The valves are strongly compressed laterally slightly twisted, linear-lanceolate, bulged on each side of the central nodule with broad elongated rounded ends, 75 to 100 µm in length. In girdle view, valves are deeply constricted at center forming a strongly bilobated keel resembling donkey ears, and elevating 70 to 80 µm above the valve surface. They were never observed in valve view due to the highly elevated keel. The orientation of the cells in valve view is that the lobes of one valve fit perfectly well by passing above and below the lobes of the other adjacent valve. The winged-keel is prominent, wide and is divided into two distinct variously shaped lobes that are more or less laterally concave before reaching the valve's apex. In SEM, the valve structure appears highly complex. In the transapical plane, the valve is tightly folded on itself along the raphe, firstly forming the tubular keel held together by the raphe and keel fibulae, then fusing underneath to produce the fibrillar structure of the keel lobes, before reopening broadly after the basal fibulae above the valve margin to form the valve cavity. The strongly bilobated keel, mimicking donkey ears, is raised above almost the entire valve length, except at the central nodule. In the central nodule region, at the meeting point of the two lobes, the fan-shaped valve cavity is broad and extends laterally to join the conical cavities of the lobes, while near the apices the valve cavity is reduced to a small bulge. In girdle view, the entire valve cavity resembles a narrow, elongated three-masted tent.

A marked rod-like, strongly silicified keel, elliptical in cross-section characterizes this species. The raphe canal is supported at the base by tubular-shaped raphe fibulae occurring on each opposing keel costae and traversing the gable like a ladder-shaped structure. Under the raphe fibulae, the subraphe canal is elliptical in shape and wider than the raphe canal: both the raphe and subraphe canals communicate through interspaces.

Under the tubular keel, the striation tends to be fibrillar in structure resulting from the fusion of two delicate siliceous membranes adorned with costae and lines of areolae. This structure is delineated by the row of keel fibulae at the top of the lobe and by the junction line at the valve surface. The striae are formed by a single row of ovoid areolae. In between the middle of each lobe striae are radiate and reach the base of the keel. From the middle of the lobes to the apices, striae are convergent and join the base of the keel.

The structure of *this new Entomoneis* is very similar to that of *Amphiprora* sp. 3 *sensu* Paddock & Sims (1981, figs 78-85) and *Amphiprora oestrupii* Van Heurck (Plancke & Bailleux, 1976b). *Entomoneis aureasini* had a double raphe canal like *E. paludosa* and *E. pseudoduplex*. It ressembles *E. kjellmanii* and *Amphiprora kufferathii* Manguin (Plancke & Bailleux, 1976a) albeit less lobate.

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Keywords

diatom, *Entomoneis*, Marmara Sea, fossil, new species

Poster presentation

Cocconeis pinnata Gregory ex Greville from type material (Arran Island, Scotland) and from Tahiti Island (South Pacific, Society Archipelago)

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Bullet points

The morphology of *Cocconeis pinnata* Gregory ex Greville 1859 is poorly known. The study of the type material and of South Pacific materials permits to emend its description.

Introduction

A marine *Cocconeis* (Bacillariophyta) from coral reef lagoon of Tahiti Island (South Pacific, Society Archipelago) was identified as *Cocconeis pinnata* Gregory *ex* Greville (Greville, 1859). From the original description, neither drawings nor micrographs of the raphe valve of *C. pinnata* are known. Several descriptions concord with the original one (Grunow in Van Heurck, 1880-1885; Cleve, 1894; Peragallo & Peragallo, 1897-1908; Schmidt, 1877-1958; Jorgensen, 1905; Foged, 1975), while some other more or less recent (Hustedt, 1931-1959; Frenguelli & Orlando, 1958; Romero & Rivera, 1996; Riaux-Gobin & Romero, 2003; Al-Handal et al., 2010; Leterme et al., 2012) completely differ from R.K. Greville's description. The type material (Arran Island, Firth of Clyde, Scotland) is examined with light microscope (LM). A sample collected in tropical coral reefs is studied under LM and scanning electron microscope (SEM).

Results and discussion

The LM study of three W. Gregory's type slides annotated 'Arran 57' (R.K. Greville's collection, Natural History Museum, London, U.K.) permitted to study 13 specimens of *C. pinnata* and to complete its characterization, originally based only on the sternum valve (SV) (Greville, 1859). The raphe valve (RV) has a dense striation as previously stated by Grunow (in Van Heurck 1880-1885, no illustration, no RV stria number mentioned) who referred to a stria pattern close to that of *C. pseudomarginata* Gregory. The lectotypification of *C. pinnata* is proposed. Since the raw material used by W. Gregory was not found, SEM observation of the type material was not possible.

The LM observation of a Tahiti taxon allows concluding that the SV and the stria arrangement of the RV match the type of *C. pinnata*. The SV and the RV of *C. pinnata* highly differ from that of *C. costata*

Gregory (Gregory, 1855, 1857a). As revealed by SEM, the RV of *C. pinnata* has a dense striation (22–27 in 10 µm) and no internal marginal rim; its overall morphology highly differs from that of *C. pseudomarginata* (Gregory, 1857b, RV illustrated as *C. major*; Peragallo & Peragallo, 1897-1908; De Stefano & Romero, 2005). Both valves of *C. pinnata* have areolae with a complex external ornamentation, i.e., remarkable spines that may be a new feature for *Cocconeis*. An emended description of *C. pinnata* is proposed. *C. pinnata* is cosmopolitan, from temperate-cold to tropical areas.

Several taxa have been formerly assigned to *C. pinnata* while they are probable varieties of *C. costata*.

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Keywords

Cocconeidaceae, coral reefs, Tahiti Island, R.K. Greville's Collection

Oral presentation

Cryptic diversity in diatom species: case study of a good water quality indicator, *Nitzschia palea* (Kützing) W. Smith

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Bullet points

Strains were isolated worldwide and sequenced for several DNA markers. No criterion was found to objectively choose a cut-off DNA distance in order to define cryptic species in this complex.

Introduction

Diatoms are extremely diverse. Their diversity was estimated at 10,000 based on morphological criteria (Guillard & Kilham, 1977). But, on the basis of mating experiment, this estimation raised to 200,000 (Mann & Droop, 1996). Molecular techniques opened the hunt for hidden diatom species in the last decade (Alverson, 2008) and many species were divided into many new. This problem is crucial in relation to DNA barcoding, a recently developed technique in which short sections of genes are used to identify species (Hebert et al., 2003). Barcoding, in association with next-generation sequencing, opens new perspectives for biomonitoring to achieve routine, automated identification of diatoms (Kermarrec et al., 2013).

The questions we wanted to address in the present study are closely related to the use of DNA barcoding in applied environmental sciences. Several questions were addressed:

Are there objective criteria for defining a cut-off distance for a given molecular marker and a given group of species? Is it possible to predict how many pseudocryptic and cryptic species should exist within a particular species complex, using a given marker at a given level of similarity? Is the sampling strategy appropriate to assess the cryptic diversity for a given species complex, since this assessment will be affected by whether diatom species are all distributed worldwide, is there a geographical structure as a result of dispersal constrain or ecological restriction?

For this purpose, a species complex, already known to display a cryptic diversity, was chosen: *Nitzschia palea* (Trobajo et al., 2009, 2010). Strains were isolated from 44 sites of various water bodies worldwide. They were sequenced for 3 different markers, one from the chloroplast (*rbc*L), on from the mitochondria (*cox*1) and on from the ribosomal DNA (28S).

Results and discussion

Are there objective criteria for defining a cut-off distance for a given molecular marker in *N. palea*?

For this purpose, after alignment of the sequences of each marker, OTU (operational taxonomical units) were defined with DOTUR program. The objective of taxonomy is to maximize the internal taxa homogeneity (molecular or morphological). Then in order to measure the OTU homogeneity, intra/inter sequence distances were calculated. For *rbc*L and *cox*1, this ratio decreased gradually when the cut-off distance increased (and so when the number of OTU decreased). No brutal change was observable. The data are structured into groups at all homology level. For 28S, there is an evident structure into 2-3 groups or into 7-8 groups.

In any case this criterion of intra/inter OTU distance did not help in finding an objective cut-off threshold.

Is it possible to predict how many pseudocryptic and cryptic species should exist within a particular species complex, using a given marker at a given level of similarity?

For this purpose, Chao index were calculated: this is a measure of taxa (or here OTU) richness if the sampling is limitless. Chao indices were calculated for each marker at different homology. It appeared that the Chao index was highly predictable depending on marker homology: taxa richness followed a logarithmic trend when homology between sequences increased.

Moreover, we observed that, for a given homology, *cox*1 displayed a higher diversity than *rbc*L and 28S, which is in accordance with former studies (e.g. Evans & Mann, 2009). *Rbc*L displayed a higher diversity than 28S, only for homologies above 99%.

Is the sampling strategy appropriate to assess the cryptic diversity for a given species complex, since this assessment will be affected by whether diatom species are all distributed worldwide, is there a geographical structure as a result of dispersal constrain or ecological restriction?

Cryptic diversity assessment in *N. palea* depends on how representative is the sampling. Chao index assessment are made on the assumption that of random distribution of taxa and individuals. Even if some authors showed that semi-cryptic taxa can be dispersed worldwide (e.g. Veselá et al., 2009), several other examples showed that some cryptic (or semi-cryptic) taxa are geographically restricted to an area (e.g. Veselá et al., 2012; Kermarrec et al., 2013).

We observed on *N. palea* that the more geographically distant the strains were, the more likely genetically distant they were. This confirms that there is a geographical limitation to its dispersal. Nevertheless, we also observed that some genotypes were dispersed at a global geographical scale, and that at a local geographical scale, different genotypes -genetically very different- can co-exist.

Conclusions

This study show that the objective definition of distance threshold inside *N. palea* species complex is tricky and the selected methods did not helped. We observed that diversity inside *N. palea* is highly predictable with marker homology and is related to geography.

In a biomonitoring framework, the question we will need to answer is: what is the taxonomical precision needed for a river pollution assessment? We believe that future will be to study the relations between phylogeny and ecology of diatoms.

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Keywords

Nitzschia, geography, genetic distance, cryptic species, DNA marker

Poster presentation

Paleoenvironmental interpretation of intra-sample autecological heterogeneity in fossil diatom assemblages: the case of conductivity reconstruction from intertropical lake sediments

Speaker: ROUBEIX Vincent

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Bullet points

Reconstructing diatom-inferred water chemistry

Statistical splitting up of diatom assemblages in sediments;

Tool for exploring the mean state of climate seasonality and past hydrological connections.

Introduction

Transfer functions have been extensively used to infer limnological parameters from diatom records (Birks et al., 1990; Mills & Ryves, 2012). The most common one (two-way weighted average, ter Braak & Barendregt, 1986; Birks et al., 2010) requires the determination of species preferences regarding a variable of interest, using a modern training-set. An optimum and a tolerance level, derived for each species, are then used to infer the conditions in which a fossil assemblage developed. Generally, only one value of the environmental variable under study is reconstructed per sediment sample, and considered as the mean annual value over the time spanned by the sample sediments. In intertropical regions, lake water conductivity might present important seasonal variations, affecting living communities, especially diatoms, because of their short lifespan. In some cases, the heterogeneity of diatom autecology in a fossil assemblage might indicate environmental variability at a time scale inferior to sampling resolution.

In order to extract intra-sample paleoenvironmental variability contained in fossil diatom assemblages from sediments, we propose two methods based on the dispersion of fossil species' optima for conductivity, derived from standard weighted averaging transfer functions: (1) Calculation of a Variability index (V) equivalent to a weighted standard deviation of the optima of the diatom species in an assemblage, and (2) a 'two-average method'. The latter implies the determination of two diatom-inferred conductivity values: a low (x_1) and a high (x_2) weighted average, for two extracted groups of diatom species obtained by splitting (using statistical criteria) a diatom assemblage. The two methods were applied to modern and fossil sediment samples from the intertropical site of the Ziway-Shalla lake system (Ethiopia, Kebede et al., 1994), using a transfer function based on an extensive modern African training set (Gasse et al., 1995).

Results and discussion

Surface sediment of a deep salted lake: seasonal signal

In a surface sediment sample from lake Shala (a closed, salted, deep lake), the distribution of the optima of diatom species in the assemblage was bimodal. This can represent seasonal variations. During the rainy season, freshwater taxa can grow in the lake epilimnion that is diluted by rainwater. The lake mixing during the dry season restores a high salinity at the surface, allowing the growth of salt tolerant species only. The weighted average conductivity of the whole diatom assemblage showed a value in between the two modes, and closer to the higher one, because most diatoms were salt tolerant. The important dispersion of species optima resulted in a variability index of 0.49. The higher conductivity value (25.8 $mS.cm^{-1}$) was close to the one measured today during the dry season. In this example, the lower conductivity, and the percentage of the associated diatom species, gave an estimate of the mean importance of the rainy season during the time integrated in the sediment sample.

Mid-Holocene sediments: variability at different timescales

We investigated a sediment sequence from lake Abiyata recording the transition from the ‘African Humid Period’ to a dryer climate at ~5.5 cal. kyr BP (Chalié & Gasse, 2002). The 1 cm-thick sediment samples integrated a period of 10-20 years. The mean annual conductivity reconstructed for the lake was low and constant before a sudden peak at 5.7 cal. kyr BP and a progressive rise to its modern value, onwards. Before 5.7 cal kyr BP, the 4 residual lakes of the present-day system were unified in a large freshwater lake. The apparently sharp increase of the mean conductivity was probably due to a threshold hydrological effect, and the isolation of lake Abiyata, which became a terminal lake. The variability index increased about 500 years before the mean conductivity peak. This suggests an increase of climate variability and/or a progressive decrease in lake volume. The two-average method also showed a higher variability several centuries before the mean lake conductivity changed. We reconstructed an equal level of the low conductivity value x_1, before and after the separation of lake Abiyata. This indicated a constant autochtonous production of freshwater diatoms during very humid seasons or years (implying a high variability of the mixed shallow lake), or more likely, the input of diatoms from an upper freshwater lake (Ziway).

Conclusion

The two methods are powerful tools to reveal short-term variability of a system. They are particularly suitable to investigate the seasonal to interannual variability when sediment homogeneity precludes direct access to variations at such frequencies. The variability index V considers the overall variability, in a symmetric way. The two-average method quantifies two mean states which, in favourable cases, define the seasonal to interannual amplitude. Attention must be paid to the representativeness of the two averages, and abundance of the species in the separated groups. The methods can also reveal the hydrological connections of a lake with another water body having a different salinity.

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Keywords

diatoms, paleoenvironments, paleohydrology, seasonal variability, sediment

Oral presentation

Functional ecology of marine intertidal diatoms: linking photophysiology to community ecology

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Introduction

Despite sharp and dynamic gradients in light availability, physical disturbance and biogeochemistry, intertidal sediments belong to the most productive ecosystems on Earth. In temperate regions, they are typically inhabited by dense benthic diatom communities, which are highly diverse. Ecological studies have revealed the presence of a number of distinct growth forms. Three main groups can be distinguished: (1) the epipelon comprises large motile diatoms which move freely in between sediment particles; (2) the epipsammon, which groups smaller diatoms which live attached to (or otherwise closely associated with) individual sand grains; and (3) the tychoplankton, an ill-defined and enigmatic consortium of largely non-motile diatoms which presumably have an amphibious life style (both sediment and water column). Within the epipelic group, further distinctions are made on the basis of cell size, while within the epipsammic group, adnate, stalked and small motile (raphid) forms can be found. All growth forms show distinct distribution patterns in time and space, suggesting pronounced (micro)niche differentiation. We hypothesize that this niche differentiation is related to functional features of these growth forms. More specifically, we hypothesize that the largely immotile epipsammic life forms are better able to cope with pronounced and rapid changes in light intensity at the physiological level than the motile epipelic forms which can actively position themselves in the sediment light gradient.

Results and discussion

Diatoms have evolved many physiological processes in order to acclimate to the changing light climate and especially to resist stressful light conditions. Non-photochemical quenching of chlorophyll fluorescence (NPQ) and the associated xanthophyll conversion (XC) from diadinoxanthin (DD) to diatoxanthin (DT) are believed to be one of the most important short-term photoprotective processes. The aim of this study was to compare the photoprotective capacity (NPQ and XC performance and kinetics) of different epipelic and epipsammic diatom species. In addition, we investigated NPQ and XC performance and kinetics in one epipelic (*Seminavis robusta*) and one immotile epipsammic (*Opephora* sp.) species during one hour of excess light stress (2000 µmol photons m^{-2} s^{-1}) and one hour of recovery.

NPQ and XC performance and kinetics of 15 diatom species (5 epipelic, 3 tychoplanktonic, 4 motile epipsammic and 3 immotile epipsammic) were measured by performing light curves of different intensities up to full sunlight (2000 µmol photons m^{-2} s^{-1}). Epipsammic forms show a higher NPQ than epipelic ones. Interestingly, the NPQ of the small motile epipsammic species appeared to be intermediate between the epipelic and immotile epipsammic forms. This is in accordance with their ecology: they can move across individual sand grains (e.g. into slightly more shaded crevices) but are unable to migrate into the upper sediment layers (like epipelic species do) and thus position themselves in the sediment light gradient.

The 1hr excess light and 1hr subsequent recovery experiment revealed that DT is produced slowly by *Seminavis robusta* during excess light and epoxidation (DTàDD) during subsequent recovery occurs slowly as well, resulting in the sustained presence of DT and NPQ. In *Opephora* sp., DT is produced rapidly, resulting in high NPQ. Recovery during one hour of low light is also rapid, resulting in almost full epoxidation and NPQ dissipation.

Our results suggest that differences in growth form and behavior (motility) have driven functional adaptations (i.c. photoprotective capacity and strategies) of benthic diatoms to their respective microhabitats, and that these functional differences contribute to the structuring and dynamics of intertidal benthic diatom communities.

Keywords

benthic, marine, photophysiology, non-photochemical quenching, xanthophyll cycle

Oral presentation

Diatoms from different freshwater habitats of El-Farafra Oasis (Egypt), with special attention to wells and hot springs

Speaker: SABER Abdullah

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Bullet points

- This study represents the first work on diatom biodiversity of different freshwater habitats in El-Farafra Oasis, Western Desert, Egypt.

- During summer 2011 and winter 2012, 18 different water resources (9 wells, 4 hot springs, 2 lakes, an agricultural drainage and ditch, and a sample from a drinking-water treatment plant) were investigated.

- This explorative study on these diverse water resources of El-Farafra Oasis allowed to document a high number of diatom taxa, including many taxa new for the Egyptian algal flora.

- The relationships between the physical and chemical characteristics of these aquatic habitats and the diatom assemblages colonizing them was also studied.

Introduction

Freshwater diatom research in Egypt is traditionally focused on the main course of the River Nile, with some concern with lakes, pools, and drainages, but disregarding remote geographic areas (Shaaban, 1994; Saleh, 2003, 2010; Hamed, 2008; Shaaban et al., 2012). Literature devoted to the diatom biodiversity of oases is limited (Shaaban & El Habibi, 1978; Shaaban, 1985; Shaaban et al., 1997; Ahmed, 2004; Hamed, 2008). El-Farafra Oasis is one of the aforementioned places that have not been the subject of comprehensive phycological studies, although it is rich in many diverse water resources, specifically drilled wells and thermal springs. Springs (and wells) tend to be relatively isolated and "azonal" systems. This is especially true in the context of hyperarid climates as shown e.g. by Keleher & Rader (2008) for the metaphyton of desert springs of the Bonneville Basin in Utah (U.S.A.). Additionally, they possess very peculiar features, and include a variety of types (Cantonati et al., 2012).

El-Farafra Oasis is a natural depression that has an irregular, triangle shape and is located in the hyperarid region of the Western Desert, Egypt. It covers a total area of about 20000 km^2 and lies about 500 km southwest of Cairo, between longitudes 27° 10` and 28° 50` E and latitudes 26° 25` and 27°

40` N. The floor of the depression is excavated in the soft carbonate of a chalk formation. The oasis is characterized by desert climate with scarce precipitation (Ayyad & Ghabbour, 1986; Vivian, 2002; Saafan et al., 2011).

The main goal of the present research is the analysis the highly-interesting phycological biodiversity of extremely isolated freshwater habitats such as the El-Farafra Oasis, and to lay foundations for the use of benthic algae (with a focus on diatoms) for the bioassessment of these particularly-precious water resources.

Results and discussion

Overall, 31 diatom samples were collected: 13 during the summer season 2011, and 18 in winter 2012. Benthic colored mat growths of algae (dark bluish green and brown patches) on the cemented walls and the ground of outlet channels of wells and thermal springs representing phytobenthic samples were scraped using a sharp blade shovel, while attached algal filaments were collected by hand. Epiphytic samples were scraped from leaves, stems and roots of different types of higher plants.

The habitats of the El Farafra Oasis cover a very wide conductivity gradient. Hot springs have conductivities that vary from 291 µS cm^{-1} to 15290 µS cm^{-1} (algal flora in this high-conductivity environment is very reduced, and represented by some sparse diatoms only). In wells conductivities vary from 210 to 756 µS cm^{-1}. As regards pH, values are mostly circumneutral. Concerning nitrate (as NO_3^--N), it ranged between 40 and 5400 µg L^{-1} in the summer season, and between 50 and 7500 µg L^{-1} in winter. As regards soluble reactive phospshorus (SRP), it ranged between 38 and 420 µg L^{-1} in the summer season, while in the winter season, it varied between a few micrograms found in most wells to the maximum value of 60 µg L^{-1}. Thus, the values of the nutrients can be very high, but it should be considered that the study habitats included also agricultural ditches and shallow lakes.

Up to now 99 diatom taxa belonging to 28 genera were identified. Many taxa are new for Egypt, and the material includes also several taxa of special interest that are under in-depth study.

El-Farafra Oasis occupies the heart of the Egyptian Western Desert. Populations inhabiting the oasis depend mainly on the underground water of the Nubian Sandstone Aquifer System as the sole resource of freshwater for drinking, domestic and agricultural purposes. This water discharges either from natural thermal springs or from drilled wells. The algal biodiversity of the waters of El-Farafra Oasis and its relationships with the physico-chemical characteristics haven't been studied before. Firstly, it is necessary to fill gap of knowledge about the algal flora of El-Farafra Oasis, especially because it was completely neglected until now in Egypt and worldwide. The El-Farafra Oasis represents an extremely isolated complex of freshwater habitats. A detailed analysis of the phycological biodiversity and a comparison with suitable habitats worldwide (e.g., Mediterranean, tropical and subtropical freshwaters etc.) will be carried out. A particularly promising occasion for an analytic comparison will be possible by the fortunate availability of diatom materials from spring-fed pools in the stony desert (hamada) of Algeria, kindly made available by Prof. Horst Lange-Bertalot.

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Keywords

diatoms, wells, hot springs, freshwater, El-Farafra Oasis.

Oral presentation

High light stress in diatoms - Induction of nonphotochemical quenching (qN), its relaxation kinetics and three components

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Bullet points

Nonphotochemical relaxation kinetics can be fitted with three components *i.e.* fast, medium and slow components

Medium component follow a sigmoid kinetics while the two other components are of exponential nature

The intermediate component is completely annihilated by ΔpH dissipator NH_4C but only partially with DTT, an inhibitor of the xanthophyll cycle.

The slow component is strongly slowed down by DTT

Introduction

More than 70% of Earth is covered by oceans in which diatoms represent the major group of microalgae (Round et al., 1990). Diatoms play crucial roles in several biogeochemical cycles as well as in the food web as primary producers (Field et al., 1988; Smetacek, 1999; Raven & Waite, 2004). Along days and seasons, diatoms experience fluctuations of light intensity due to turbulent water movements (MacIntyre et al., 2000). Upon exposure to high light, the overexcitation of the photosynthetic apparatus results in the formation of radical oxygen species. To cope with the high light stress, diatoms have developed mechanisms to tune the balance between energy utilization and dissipation, including dynamic dissipation of the absorbed energy into heat, indicated as nonphotochemical quenching of the chlorophyll fluorescence (Rohácek et al., 2008; Goss & Jakob, 2010). The main mechanism involved in the nonphotochemical quenching is the xanthophyll cycle (Bertrand, 2010; Moulin et al., 2010). This cycle consists in the reversible deepoxidation of diadinoxanthin (DD) to diatoxanthin (DT). The deepoxidation is catalyzed by a lumen-localized deepoxidase of which activity is ΔpH-dependent (Bertrand, 2010; Goss & Jakob, 2010). A deeper insight and knowledge in the functioning of the nonphotochemical quenching is necessary to understand both diatom physiology and ecology as the intensity of the nonphotochemical quenching has been recently taken as a functional trait of the diversity of algae (Goss & Jakob, 2010).

This contribution deals with analysis of the nonphotochemical chlorophyll fluorescence quenching (qN not NPQ, Rohácek, 2002) obtained from records of the long-term chlorophyll fluorescence induction kinetics (FIK) recorded on the cultures of *Phaeodactylum tricornutum* treated with different kinds of metabolic inhibitors, namely NH_4Cl, and dithiothreitol (DTT). This approach made possible a deeper insight in mechanisms involved in qN formation and its subsequent dark relaxation. This way, understanding of three types of fluorescence quenching forming the overall qN was possible. For recognition of the corresponding quenching components, the original method of nonlinear regression analysis of the qN relaxation kinetics (Rohácek, 2010) was applied (see below).

Material & methods

The qN-quenching was triggered by exposition of predarkened (for 15 min) algae to white actinic light (PFD of 1000 µmol m^{-2} s^{-1}) for 7 min. Immediately after this light period, the dark relaxation phase started, in the course of which the actual qN values were probed using a set of saturation flashes. From corresponding FIK, the basic fluorescence levels were obtained describing the states of initial dark adaptation (F_M, F , F_V), light acclimation (F_M', F ', F_V'), and dark relaxation (set of F_M'', F '', F_V'' for increasing time of relaxation t_r). Based on numerical values of these levels, the nonlinear regression procedure was started resulting in a best fit of the multicomponent qN relaxation kinetics within experimental data. Using this method, three components were identified in *P. tricornutum*. The fast (qN_f, s time-range) and slow (qN_S, h time-range) components can be fitted with monoexponential curves. However, the intermediate component (qN_i, min time-range) could only be fitted with a sigmoid. Taking this fact in account, the corresponding general nonlinear equation has been modified to the form:

$$\frac{F_V''(t_r) - F_V'}{F_V} = qN_f\left(1 - e^{B^f \cdot t_r}\right) + qN_i\left(\frac{1 - e^{-t_r/B^i}}{1 + e^{(X_0^i - t_r)/B^i}}\right) + qN_s\left(1 - e^{B^s \cdot t_r}\right) \quad \text{(Eq. 1)}$$

which differs in a middle part from that applied for higher plants (Rohácek, 2010). These terms define three segments of F_V, which are quenched by processes of the nonphotochemical nature being activated during the high light illumination. The three components of qN are defined as follows:

$$qN_f = \frac{\Delta F_V''^f}{F_V},\ qN_i = \frac{\Delta F_V''^i}{F_V},\ \text{and}\ qN_s = \frac{\Delta F_V''^s}{F_V}. \quad \text{(Eq. 2)}$$

Here, $DF_V''^X$ (x = f,i,s) stands for the magnitude of individual quenching components, the exponents B^f and B^s are related to the half-time of relaxation of corresponding components $t^f_{1/2}$ and $t^s_{1/2}$, respectively, according to the relation:

$$B^x = -\frac{\ln 2}{t^x_{1/2}},\ x = f,s \text{ [11]}. \quad \text{(Eq. 3)}$$

$t_{1/2}$ indicates the time in which an exponential function reaches the half of its magnitude, X_o^i determines position of the inflection point of a sigmoid on the t_r-scale. For a sufficiently long time of the qN relaxation ($t_r \to \infty$), Eq. 1 takes the simple form on:

$$qN = qN_f + qN_i + qN_s \quad \text{(Eq. 4)}$$

This formula represents the important constraint that should be fulfilled by a fitting procedure during the convergence process.

Results and discussion

Identification of the main mechanisms on which each phase of the qN relaxation relies was determined using a set of metabolic inhibitors. NH_4Cl, which cancels the ΔpH completely, suppressed the intermediate component qN_i (see Table 1), demonstrating that this qN_i quenching is due to the ΔpH-relaxation. The diadinoxanthin deepoxidation is being dependent on a lumen acidification, therefore no diatoxanthin formation was expected with NH_4Cl. Pigment content quantification revealed that it was the case (data not shown). To determine if the trans-thylakoidal ΔpH is the only mechanism involved in the intermediate component, algae were treated with DTT, an inhibitor of the diadinoxanthin deepoxidation (Bertrand et al., 2001). The treatment resulted in the absence of diatoxanthin formation and in a reduction of the magnitude of the intermediate component (Table 1), demonstrating the involvement of both quenching mechanisms in qN. Simultaneously, the magnitude of the fast component qN_f increased similarly suggesting that the xanthophyll cycle and/or thylakoid membrane conformation changes (Rohácek, 2010) could be mostly involved in. A participation of the ΔpH cannot be completely excluded as the half-time of relaxation of this component is much longer in the presence of NH_4Cl than with DTT (see Table 1). In contrast, NH_4Cl but not DTT affects the slow component qN_s.

Table 1: Results of the qN analysis for high light stressed samplings of *P. tricornutum* (Control, NH_4Cl and DTT treatments; mean ± StD, n=3-6). For explanation of symbols, see text. Statistical significance between two corresponding means is indicated by asterisks ($p < 0.05$).

	qN	qN,f		qN,i		qN
		A	t1/2 (s)	A	c1/2 (min)	A
Control	0.95±0.02	0.02±0.01	8.1±3.1	0.75±0.09	8.9±2.1	0.18±0.09
+ DTT	0.85±0.05*	0.34±0.07*	22.1±3.5*	0.22±0.08*	4.2±0.5*	0.26±0.01
+ NH4Cl	0.95±0.02	0.30±0.08*	64.6±38.0*	0.00±0.00*	-	0.18±0.03

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Keywords

nonphotochemical quenching, microlagae, stress, photosynthesis, dissipation of photosynthetic pH gradient, xanthophyll cycle, DTT

Poster presentation

Carbon metabolism and light intensity in diatoms - A transcriptional approach

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Bullet points

- The highest growth rate was obtained with light intensity of 300 µmol photons $m^{-2}.s^{-1}$

- Gene expression of several pathways (especially shikimate and glycolysis) was significantly higher by shifting the cells from optimal light to high light (1000 µmol photons $m^{-2}.s^{-1}$) or low light (30 µmol photons $m^{-2}.s^{-1}$) intensities.

Introduction

Diatoms are a diverse group of eukaryotic unicellular microalgae that account for up to 40% of the total marine primary production in the ocean. In addition to photoautotrophic growth, some diatoms store carbon in the form of valuable compounds (polysaccharides, lipids, polyunsaturated fatty acids, pigments, biofuels…) (Mimouni et al., 2012*)* while they have high plasticity in adapting to variable environmental condition such as different light intensities (Depauw et al., 2012).

Light is an essential source of energy for life on Earth and one important signal that organisms use to obtain information from the surrounding environment (Lemoine & Schoefs, 2010). Actually, wavelength and intensity can affect cell regulation (Fan et al., 2013; Li et al., 2013). Diatoms display a suite of sophisticated responses to optimize photosynthesis and growth under changing light conditions. Unfortunately, the biochemical and regulatory networks controlling cell functions are still largely unknown (Valenzuela et al., 2012) and there is still much work to be done to fully understand how enzymes and genes are linked together while cell undergo stress (Heydarizadeh et al., 2013). Understanding how these networks are linked and work under nonstress and stressful conditions is important for both the comprehension of diatom ecology and the success of biotechnologies because stresses trigger reorientation of the metabolism leading to the production of commercially interesting compounds.

Material and methods

A total of 30 enzymes involved in carbon metabolism pathways were selected (Martin-Jézéquel et al., 2012) and the corresponding genes coding for each enzymes were searched in genomic data published by Kroth et al. (2008) and available at http://www.diatomcyc.org. The expression of a total of 70 genes (including 12 housekeeping genes) from the diatom *Phaeodactylum tricornutum* (UTEX 646) grown in f/2 medium made with artificial seawater (Kester et al., 1967) under 30 (low), 300 (medium) and 1000 (high) µmol photons $m^{-2}s^{-1}$ (12/12h, 20°C) was recorded in this study. In a second set of experiments, cells grown under medium light intensity were shifted to low or high light intensity at the early exponential phase. The cultures were performed in 500 mL erlenmeyers containing 200 mL of medium, inoculated with 10^5 cell/mL. Biomass concentration was estimated by measuring culture absorbance at 750 nm.

For mRNA preparation, diatom sampling (150×10^6 cell) was performed during early, middle and late exponential phase (3 biological replicates). The samples were filtered on 25 mm GF/F Whatman filters. mRNA extraction was performed using the Spectrum Plant Total RNA kit (sigma). Amplified cDNAs were obtained using M-MLV reverse transcriptase and qPCR performed on a StepOne Plus apparatus Applied Biosystems).

ANOVA (Analysis of variance) was done using SAS (Statistical Analysis System) and PCA analyses performed by SPSS (Statistical Package for the Social Sciences).

Results

Under the three light intensities, diatom growth curves presented typical early (stage 1), middle (stage 2) and late (stage 3) growth phases. The fastest growth rate was obtained with medium and high light intensities (0.9 ± 0.025, 0.89 ± 0.038 d^{-1}, respectively). Under low light intensity, the growth rate was severely slowed down (1.33 ± 0.022 d^{-1}).

Gene expression level was defined by comparison with that of 3 housekeeping genes (*tbp, ubi*, *rps*). A particular evolution of several gene expressions was found when comparing the different stages at light intensities 300 and 1000 µmol photons $m^{-2}s^{-1}$ but not at 30 $m^{-2}s^{-1}$ (Table 1). Shifting the cells after their adaptation from optimal light to low light and high light intensity, resulted in increased expression of genes involved in several pathways. In particular, genes coding for proteins involved in mitochondrial glycolysis, pyruvate metabolism and shikimate pathways are up-regulated.

Table 1. Different genes are expressed under changing light intensity, and growth phase.

Light intensity	Genes with highest expression level at stage 1 and lowest expression level at stages 2 and 3	Genes with highest expression level at stages 2 or 3 and lowest expression level at stage 1
300 or 1000	*tpi2* (Calvin), *pgam6*, *gapc1*, *pk2* (glycolysis),*shidehy* (shikimate), *pyc2* (pyruvate), *gdcp*(photorespiration)	*fbpc2*, *fbpc3*, *fbac5, pgdh* (Calvin), *fba4, pgam2*,*gapdh* (glycolysis), *g6pi1* (glycolysis, gluconeogenesis), *pyc1*, *ppdk, pepck* (pyruvate),*gdct1, hpr* (photorespiration), *ms* (pyruvate, glyoxylate)
From 300 to 30 and 1000		*tpi1, fbpc4* (Calvin), *ca1*, *ca7*, *me1* (carbon metabolism), *pk3*, *pk6, gpi*, *g6pi3, pgam5, gapc4*(glycolysis), *aroa*, *arob, epspsy* (shikimate) *ppdk, pyc1*(pyruvate),

Conclusion

Up-regulation of several genes is found when shifting cells to high or low light intensity (300 to 30 or 300 to 1000 µmol photons $m^{-2}s^{-1}$) and in particular genes involved in glycolysis and shikimate pathways, suggesting that shifting cells to either high or low light intensity would promote respiration and synthesis of amino acids. The shikimate pathway is particularly interesting because it links metabolism of carbohydrates to biosynthesis of aromatic amino acids such as flavonoids and alkaloids while the glycolytic network may provide an essential metabolic flexibility that facilitates cell development and acclimation to environmental stress.

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Keywords

Phaeodactylum tricornutum, light stress, carbon metabolism, enzyme, gene expression

Poster presentation

Changing diatom associations and preservation as Holocene palaeoclimate indicator in Lake Nam Co (Tibetan Plateau)

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Bullet points

A shift in the monsoonal activity in the area of Lake Nam Co (Southern Tibetan Plateau) about 2,000 cal BP led to changes in the redox conditions on the lake bottom from reducing to oxidizing conditions (Kasper et al., submitted). Although this significantly deteriorates the preservation of diatom valves, the diatom stratigraphy shows essentially the climatic development, reconstructed by geochemical analyzes and ostracod assemblages.

Introduction

Diatom dissolution is an important source of errors in environmental and climate reconstructions, because the quality of valve preservation significantly affects assemblage composition, and the degree of dissolution is uncertain: Does dissolution affect specific species or the entire community?

Diatom preservation depends on both chemical and physical factors. On the Tibetan Plateau (TP), high pH values, high salinity and cation species play a major role. Most samples from short cores collected along a transect of lakes on the southern TP were unsuitable for diatom analysis because most diatom valves were completely dissolved. Lake Nam Co located at 4,718 m a.s.l., characterized by alkaline (pH 9.5) and slightly saline (2.1 g l^{-1}) water (Wang et al., 2009), shows phases with both good and poor diatom preservation during the past 4,000 years. This offers the possibility to investigate (1) causes of dissolution and (2) the potential of poorly preserved diatoms for climate reconstruction in a multi-disciplinary study.

Results and discussion

A 114 cm long sediment core covers the environmental and lake development of the last 4000 years. Due to the poor preservation of diatom valves, only a total of 66 diatom species were identified. From 86 to 5 cm (~1900 to 0 cal BP) diatom concentrations were comparatively low with values ranging between 0.47 • 10^5 and 7.56 • 10^5 valves per gram. Higher diatom concentrations with 61.31 – 400.00 • 10^5 valves per gram were calculated in the lower part of the record from 114 to 86 cm (~3760 to ~1900 cal BP). Within the upper five cm the concentration is 23.59 • 10^5 valves per gram. The diatom development is characterized by a high relative frequency (41.8 – 89.1%) of *Cyclotella ocellata* Pantocsek in the whole core. This planktonic species is one of the most widespread species on the entire TP (Wang et al., 2011).

From 114 cm to 98 cm (~3760 to ~2440 cal BP) the record is dominated by the planktonic *Cyclotella ocellata* Pantocsek (71.9 – 81.1 %). Other planktonic diatoms, such as *Cyclotella atomus* Hustedt, *Stephanodiscus minutulus* Grunow and *Stephanodiscus medius* Håkansson are present, with *C. atomus* being present in only this segment of the core. Benthic and facultative planktonic (tychoplanktonic) diatom taxa are rarely found. From 98 to 86 cm (~2440 to ~1900 cal BP) *C. ocellata* is still dominant with a maximum relative frequency of 80.3 – 86.5 %. The abundance of benthic and tychoplanktonic species is low, but increases gradually to the top of this section. *C. atomus* and *S. minutulus* are absent. The first phase of development with good diatom preservation is characterized by high productivity as shown by high numbers of diatoms and ostracods. Under anoxic conditions, pyrite is being formed in presence of reactive iron and sulfur. The formation of pyrite leads to a rather low pH value (Álvarez-Iglesias & Rubio, 2012) favoring a better preservation of diatom frustules during this phase. The high abundance of planktonic diatom species also suggests a deep-water habitat and the ostracod-based water depth transfer function (TF) reveals a rather high lake level.

From 86 to 46 cm (~1900 to ~990 cal BP) abundances of planktonic taxa, particularly of *C. ocellata,* decrease. The tychoplanktonic species *Staurosira brevistriata* (Grunow) Grunow and *Staurosira pinnata* Ehrenberg as well as benthic diatoms, especially *Amphora inariensis* Krammer, increase in abundance. From 46 to 30 cm (~990 to ~450 cal BP), the composition of diatom assemblages is similar to those from 98 to 86 cm. Planktonic diatoms, mainly *C. ocellata*, increase, whereas the relative abundances of benthic and tychoplanktonic species remain low. From 30 to 5 cm (~450 to 0 cal BP), abundances of planktonic diatoms are high but show a decreasing trend, and more benthic and tychoplanktonic species occur. The record of the upper 5 cm (0 cal BP to present day) is again more dominated by planktonic species (*C. ocellata*, *S. medius*). The uppermost sample shows increased absolute diatom concentration with ~23.59 • 10^5 valves per gram.

A sudden decrease in monsoonal precipitation caused a drop in lake level at ~2000 cal BP and led to the oxygenation of the sediment-water interface, enhanced decay of organic matter and a cessation of pyrite formation. Since about 1,700 cal BP monohydrocalcite (MHC) was detected continuously until present day. MHC forms when pH values are below 8 (Li et al., 2008). An environment which favors MHC formation and preservation is hostile for the development and the preservation of diatoms (Gell et al., 1994).

In general, the ratio between planktonic and non-planktonic diatoms shows a good correlation with the water-depth reconstruction based on ostracod assemblages. A wet spell between ~1500 cal BP and ~1150 cal BP is not reflected by diatoms.

Although poor diatom preservation limits taxonomy during certain periods, the quality of preservation provides clues about climate-driven environmental change. Poor diatom preservation is indicative of low lake levels and thus low effective moisture on the TP, whereas excellent diatom preservation depicts phases characterized by high effective moisture and high lake levels.

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Keywords

diatom preservation, climate, pyrite, Tibetan Plateau, lake level variations

Oral presentation

A few important factors effecting on the ecological status of a Hungarian large river (River Danube) based on phytobenthos

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Bullet points

The water discharge is one of the most important factors affecting periphyton abundance and diversity in large rivers. Furthermore it has an important role to explain the changes of the ecological status of the water bodies.

Introduction

There are a lot of publications explaining the fluctuations of large rivers in the respect of composition of the bottom material or nutrient content (inorganic contamination) (Williams, 1989; Restrepo & Kjerfve, 2000). However, at present fewer studies are known to study the large rivers in this framework (Ács & Kiss, 1993; Passy, 2007), though according to the WFD it would be necessary to conduct such kind of surveys.In this survey focus on how the changes of the water discharge influence the values of a diatom index (IPS index - Indice de Polluosensibilité Spécifique) for the Hungarian section of the Danube River and how these discharge modification influence the benthic algal composition. We studied the alteration of some physico-chemical variables (here phosphate content is enhanced) and runoff.

Results and discussion

Samples were collected from the River Danube at Göd every month (except when floods were extraordinarily high) during three years, from 2010 to 2012. The studied years proved to be interesting because significant differences could be found in the runoff of the river either in the frequency or in the amplitude in each year. Comparing the average water discharge values per year, the highest average fall (2100 $m^3 \times s^{-1}$) with respect to the vegetation period was in 2010 but about 1400 $m^3 \times s^{-1}$ is typical of this section of the river. In the vegetation period of the other two years, values of the water discharge were not so high as in 2010 (1360 $m^3 \times s^{-1}$ in 2011 and 1655 $m^3 \times s^{-1}$ in 2012), however, the runoff values of the last two years also vary from each other. These differences were displayed in the phosphate (PO_4^{3-}) concentration among measured nutrients and physico-chemical variables although as opposed to the water discharge phosphate concentration was higher in 2011 (33,5 mg/m^3) than in 2012 (28,6 mg/m^3).

Using canonical correspondence analysis it could be seen that, even in such a large river like the River Danube, the amount of phosphate content could determine how the diversity and abundance of the species of the benthic biofilm would change and due to all these the IPS index values, i.e. the values of the ecological water quality, were altered. After running the statistics, samples showed a good separation along the phosphate content gradient. Those ones that did not reach the threshold between moderate and good water quality indicated strong positive correlations with phosphates concentration in contrast with those that have had higher IPS values. Passy (2007), when studying the Mesta River, revealed positive correlations of phosphates with the high profile and motile guilds and negative with the low profile guild, furthermore the relationships with nitrates were very similar. Although, while Passy investigated more parts of the Mesta River detecting nutrient and organic contamination from the inflow into the main river branch, in our study samples were taken only from one point. In our samples, traces indicating nitrate contamination could not be detected. Only concentrations of phosphates increased in some of them and in these samples, species such as *Nitzschia* and *Navicula* spp., which are the indicators of nutrient loaded environment appeared in higher abundance. Based on guilds distribution it cannot be stated unambiguously what relationships species belonging to a certain guild show against the nutrients because in the case of such a large river it is the water discharge that determines the appearance and dominancy. But in the respect of the dominant species it can be assessed that the most abundant species in our study belong to the motile guild. There are fewer species grouped into the low profile guild. Almost every sample contained the high profile and the planctic guild in the least ratios during the three years. Consequently, species in the high profile guild are not capable to adapt to big fluctuations of the water discharge (characterized the Danube River). One of the causes may be that high profile guild includes species characterized e.g. stalked attaching strategy. These species can easily be removeable from the biofilm. (Anyway other investigations if there was bigger abundance of high profile guild planktic guild also increased. It can be related to the slow current velocity near the bottom when planktic species could sediment and "hitched" into the layer of the overhanging high profile species.) Because of big floods (and as River Danube is a large river) the ratios of low profile and planktic guild were the highest. It can be explained by that low profile guild has well developed adherence strategy to surfaces. Consequently, this group can resist high disturbances more efficiently.

The diversity of the samples also confirmed it, namely the species replacement. The species number was smaller; similarity and richness difference were higher in 2010 compared with the other two years. Besides in the vegetation period the big floods (change of the water discharge > 1200 $m^3 \times s^{-1}$) those ones which are smaller but they follow each other in a short time, can cause the decrease of the IPS values. It can also decrease the diversity of the diatom assemblages supported the relevance of the intermediate disturbance theory (Ács & Kiss, 1993).

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Keywords

large river, water discharge, periphyton, guild, water quality

Poster presentation

Square openings in the outer cell wall of an aerophilic *Diploneis* Ehrenberg ex Cleve from Zambia

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Bullet points

A diatom species, new to science, has been discovered from Zambia, this diatom belongs to the genus *Diploneis* and is characterised by square openings in the valve face in the longitudinal canal.

Introduction

African benthic diatoms and especially central and southern African diatoms have received relatively little scientific attention given the scale of these territories. Recently samples have been collected from two of the largest and most under-studied catchment basins in Africa – the Zambezi and the Congo. The Zambezi catchment basin has in particular received very little attention in terms of the study of rivers and streams with only three studies in the last 60 years or so (Cholnoky, 1954, 1970; Compère & Delmotte, 1988). Compère & Delmotte (1988) also bemoaned the scarcity of diatom records from Zambia. A country wide survey of the diatoms of Zambia was recently undertaken and included both the Zambezi and Congo River drainage basins. The chief focus of the EU ACP funded SAFRASS project (www.safrass.com) was sampling rivers and streams with the aim of developing a diatom-based monitoring protocol for the inference of water quality, however, samples were also collected from unusual habitats such as waterfalls and their associated spray zones as well as other moist or periodically wetted habitats associated with streams. It was in one of these samples from the spray zone of a waterfall that a species of *Diploneis* new to science was identified with the chief distinguishing character of having square openings in the outer cell wall in the longitudinal canal adjacent to the raphe. The genus *Diploneis* has a world-wide distribution and is found in both freshwater and marine habitats, but with the majority of species in marine habitats. *Diploneis* is in particular characterised by having very complex striae which change across the valve and are composed of loculate areolae. On each side of the raphe there is a continuous longitudinal canal within the valve structure whose inner wall projects into the cell. The canal is not apparently open to the cell interior but may open to the exterior (Round et al., 1990). This canal is usually easily visible in LM and is one of the key distinguishing features of the genus *Diploneis*. It is in this longitudinal canal that we discovered the characteristic regular square openings in the outer cell wall; the nature of these square openings is discussed and illustrated.

Results and discussion

The characteristic square openings on the longitudinal canal of this *Diploneis* can be easily be distinguished under the light microscope when samples are mounted in a high refractive index media. *Diploneis finnica* Ehrenberg also possess square opening on valve face (Idei & Kobayasi, 1989). However this taxon can be distinguished from that under discussion by the presence of these square openings, they are present in the alveolate region in former and not in longitudinal canal region as in latter. The number of square openings in *D. finnica* ranges from 0-4 whereas the Zambian species has 4-14 square openings per valve and none were found without these characteristic openings. *Diploneis marginestriata* can be easily distinguished from the new taxon by valve shape and longitudinal canal outline. The openings known to occur in *D. marginestriata* are rectangular or triangular in shape and occur only near the central area (Idei & Kobayasi, 1988, Figs 3, 8, 11). In LM the Zambian taxon can be easily distinguished from *D. marginestriata* (16-18/10 µm) and *D. finnica* (9-12/ 10 µm) by valve shape and outline and with as well as striae density.

Idei & Kobayasi (1989) mentioned the square opening cannot be considered as dissolved valve structures or artifacts from, for example, parasitism as the boundaries of the openings are clearly demarcated with small areolae like structures. Gordon & Brodland (1990) proposed that these square holes might be due to accumulation of cubic crystals during silica deposition and the later dissolution of crystal leads to the formation of an opening. However, their hypothesis was based on the fact that the square openings of *D. finnica* were found near the valve mantle, in their opinion this gave evidence that, as the valve was deposited out from the axial region, extraneous substances formed crystals near the valve margin. In our taxon from Zambia the crystals are found adjacent to the axial area and thus are formed early on during valve morphogenesis. It is difficult to speculate on the origin and function of these square openings at this stage, however culturing of this diatom and observation under laboratory conditions might reveal more information on these square openings.

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Keywords

Central Africa, Zambia, *Diploneis*, aerophilic, square openings

Poster presentation

Two species of *Achnanthidium* Kützing from Kolli Hills, Eastern Ghats, India

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Bullet points

Two new species of *Achnanthidium* Kützing from waterfalls located in Kolli Hills of Tamilnadu part of Eastern Ghats

Introduction

Members of the genus *Achnanthidium* are known to occur commonly in mountainous (>1000 meters) aquatic environments on the Indian subcontinent (Jüttner et al., 2010). From the Indian subcontinent most of the species belonging to *Achnanthidium* have gone unnoticed due to their small size or masked under the name *Achnanthes minutissimum sensu lato* group (Wojtal et al., 2010). Recently few species belonging to this genus were described from Himalayas (Jüttner et al., 2011; Jüttner & Cox, 2011) and Central India (Wojtal et al., 2010). Species of *Achnanthidium* are often numerous and can be a good indicator of environmental condition and hence could be potentially used widely across the sub-continent in pollution monitoring practices. The description of novel species along with their environmental preferences will eventually add to the reliability of diatom-based biomonitoring techniques. In the present study we present two new species of *Achnanthidium* from Masilla water falls in Kolli Hills, Namakkal District, Tamilnadu, South India.

Results and discussion

Achnanthidium sp1 and *Achnanthidium* sp2, both which can be loosely grouped with those taxa similar in shape to *A. minutissimum* are presented and discussed based on light and scanning electron microscopy observations.

Achnanthidium sp1 belongs to the group of *Achnanthidium* taxa with terminal raphe fissures curved to one side of the valve. This taxon is characterized by a distinctive fascia, raphe extending to the valve margin, enlarged distal raphe ends and 2 - 4 linear areola per striae.

Achnanthidium sp2 belongs to the group of *Achnanthidium* taxa with terminal raphe fissures curved to opposite side of the valve. This species is characterized with presence of occulated areolae near margin, striae angle and deflected internal distal ends of raphe.

Both species discussed here are known only from the type locality and prefer oligotrophic environments.

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Keywords

Achnanthidium, diatoms, Masilla waterfalls, Peninsular India, Monoraphids

Poster presentation

Ring-test exercise on identification and counting protocols of benthic rheophilous diatoms of Trento Province (Italy)

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Bullet points

Provide information on the most recent diatom nomenclature.

Assess if differences in counting protocol and diatom identification conventions can influence the response of the diatom index ICM-I (Mancini & Sollazzo, 2009; D.M. 269/2010).

Introduction

The aim of Water Framework Directive/60/2000/ EC is to assess the ecological status of the rivers using different biological indicators. For this purpose, the efficiency of diatoms as bioindicators has been shown in many studies, among them Prygiel et al. (1999) and Ector et al. (2004, 2012). The accuracy of biological water quality indication greatly depends on the exact diatom identification and on the correct application of the diatom index. In Italy, many training courses are organized to keep updated specialized operators for biomonitoring rivers using diatoms. In this context, in November 2012 the Environmental Protection Agency of Trento Province (Italy) organized a workshop on benthic rheophilous diatom taxonomy. During this meeting a ring-test was proposed to point out the problematic taxa which can add uncertainty to diatom analyses and to verify if differences in counting protocols and convention in nomenclature of diatom species can influence results provided by the Intercalibration Common Metric Index or ICM-I (Mancini & Sollazzo, 2009; D.M. 260/2010). This ring-test was attended by 23 diatom analysts with different experience levels in diatom identification. Each diatom analyst examined a slide prepared from a single sample of epilithic diatoms collected according to EN 13946 (CEN, 2003) in a station located in the initial stretch of an Apennine watercourse (Tenna river, 1096 m a.s.l., central Italy, Mediterranean typology). Quantitative evaluation of the individual species in the sample, required by the diatomic index used, followed the EN 14407 (CEN, 2004), which stipulates counting up to about 400 valves.

This exercise provided an opportunity to harmonize nomenclature and a practical way of identification of diatom taxa at national level. Information obtained by this ring-test should be useful for future intercalibration documents.

Results and discussion

23 participants (workshop instructors included) identified diatoms as belonging to 69 taxa. 13% of the taxa observed did not attain a relative abundance of 1%. The most abundant species observed by almost all the participants were:*Achnanthidium lineare* W. Smith, *A. minutissimum* (Kützing) Czarnecki, *A. pyrenaicum* (Hustedt) H. Kobayasi, *Diatoma mesodon* (Ehrenberg) Kützing, *Gomphonema elegantissimum* E. Reichardt et Lange-Bertalot, *G. micropus*Kützing, *G. pumilum* var. *rigidum* E. Reichardt et Lange-Bertalot and *Nitzschia fonticola* Grunow.

The total number of taxa observed is relatively high for a spring and the cause is most likely the different taxa conventions. For example, the majority of operators identified *G. micropus* using the name of *G. angustatum* (Kützing) Rabenhorst and sometimes *G. productum* (Grunow) Lange-Bertalot et E. Reichardt. This is probably due to the fact that monographs of Krammer & Lange-Bertalot (1986-1991) are widely used in Italy for diatom determination. In these monographs *G. micropus* and *G. angustatum* var. *productum* Grunow are included in the large complex of *G. angustatum*, as well as this latter recently named *G. productum*. Some analysts also pooled *Gomphonema elegantissimum* and *G. pumilum* var. *rigidum* into one taxon: *Gomphonema pumilum* (Grunow) E. Reichardt et Lange-Bertalot.

Further SEM analyses were made to verify the identification of the most abundant species of *Gomphonema* and it was found that *Gomphonema pumilum* var. *rigidum* is not present in the sample, but it is always *G. elegantissimum*, which valves of small size can be easily confused with *G. pumilum* var. *rigidum*. Another problem faced by some participants is the difficulty to identify diatoms with similar morphology, such as some species belonging to*Achnanthidium*.

NMDS analysis was carried out to test how nomenclature convention of identification and counting protocol can influence the variation of the results provided by the ICM-I. Results showed that the majority of participants elaborated similar counting and only few cases were very different from reference list.

The values of ICM-I index ranged from 1.00 to 0.78, corresponding to High/Good and Good/Sufficient level respectively. Most of the participants found High/Good level of water quality. ICM-I index data have a normal distribution (Shapiro-Wilk normality test W = 0.9807, p-value = 0.908). Grubbs test individuated only one participant as outlier (p-value = 0.3038). Subsequently, we applied Z-score (Z) to ICM-I to verify the acceptability of all participants. Only one participant had a questionable value (outlier H, $2 \leq |Z| \leq 3$); all other data had a $Z<2$ were acceptable: this means that ICM-I index provides an efficient response in the assessment of water quality even if the operators have different degrees of taxonomic knowledge and follow different identification conventions.

These results are in agreement with other published data (Lavoie et al., 2005; Kahlert et al., 2009, 2012) and demonstrate that differences in counting protocol can affect ICM-I values, and to some extent the classification of water quality.

For this reason, intercomparison and identification exercises and advanced courses on diatom taxonomy should be encouraged and regularly organized in order to harmonize identification skills and keep biomonitoring operators knowledge up to date.

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Keywords

biomonitoring, counting protocol, diatom identification, ring-test, WFD

Oral presentation

Nitzschia: a complex variation pattern has a complex explanation

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Bullet points

There is morphological variation within *Nitzschia inconspicua* and *N. palea* and in both this variation is subtle and forming a continuum.

Molecular phylogeny revealed *N. palea* to be a natural group (monophyletic) whereas *N. inconspicua* to be paraphyletic.

Different salinity responses were found among *N. inconspicua* clones and they seem to be genotype related but not morphological or clade related.

Introduction

Nitzschia is a large genus, widespread in terrestrial, freshwater and marine habitats. Many species are important ecologically. For example, some species areabundant in sites with organic pollution and are important for biomonitoring because they are considered to be indicators of these conditions; some marine species are even obligate heterotrophs. However, the taxonomy of *Nitzschia* is notoriously difficult, especially in the largest group, the section *Lanceolatae*, because most of its species have small cells and delicate structure, and the frustules offer few diagnostic characters in LM (principally valve width, stria density and fibula density, and the presence or absence of a wider separation of the central fibulae, reflecting the presence or absence of central raphe endings).

Results and discussion

We have been making combined morphological, molecular and reproductive studies of species in section *Lanceolatae*, particularly the *N. palea* and *N. inconspicua–frustulum* groups. Molecular data (our *rbc*L and partial LSU rDNA results, and the SSU rDNA data of Rimet et al., 2011) show that the *Lanceolatae* are not monophyletic.The *N. inconspicua–frustulum* group and some other *Lanceolatae*, including *N. amphibia*, *N. fonticola* and *N. soratensis*, belong to a clade that also includes the genera *Pseudo-nitzschia*, *Fragilariopsis* and *Cylindrotheca*, and perhaps also *Denticula*, while *N. palea*, *N. capitellata* and some other *Lanceolatae* belong to a second clade. No morphological markers of these two clades have yet been discovered.

Morphological variation between strains is very subtle in both *N. inconspicua* and *N. palea*. In *palea*, for example, there were no consistent differences in valve ultrastructure between 26 strains studied by Trobajo et al. (2009), and while there were differences in stria density and width, overall there appeared to be continuous variation between 32 and 49 in 10 µm (though each strain exhibited much lower variation, of up to ± 3 striae in 10 µm) and 2.7–5.1 µm, respectively. Nevertheless, molecular data (LSU, *rbc*L some *cox*1) show moderate (*N. palea*) or considerable (*N. inconspicua*) diversity within these two species.

In *N. inconspicua*, 36 isolates from freshwater, brackish and hypersaline sites were cultured and found to contain 7 distinct genotypes, which grouped into three deeply divergent clades (A, B and C), one of which(clade A) also contained *N. frustulum* and a diatom resembling *N. bulnheimiana*. Furthermore, clades A, B and C did not form a monophyletic group, since *N. amphibia* and a diatom identified (in GenBank) as *Denticula kuetzingii* were also contained within the same overall clade as *N. inconspicua* clades B and C. Hence *N. inconspicua* seems to be paraphyletic. Different salinity responses were found among the *N. inconspicua* strains, which were genotype- but not clade-specific; it could therefore be worthwhile to distinguish these genotypes in ecological studies or biomonitoring.However, taxonomic interpretation is difficult, becauseof the reproductive biology of *N. inconspicua*, since all strains seem to be either paedogamous (fusion of gametes within a single unpaired cell) or entirely vegetative (size is restored through vegetative cell enlargement); hence the biological species concept is inapplicable. Evolution of reduced sexuality or asexuality seems to have occurred repeatedly (Mann et al., 2013) and be not uncommon in *Lanceolatae*: our phylogenetic studies indicate independent evolution of paedogamy in *N. inconspicua* and *N. fonticola*, and uniparental (i.e. paedogamous, autogamous or asexual) auxosporulation occurs in *N. soratensis*, *N.* cf. *pusilla ‘N. frustulum* var. *perpusilla’* and at least three further unidentified *Lanceolata* especies from marine and freshwater habitats,and may help explain the taxonomic difficulties of the group, each slightly differentiated population representing an independently evolving ‘microspecies’.

In contrast to *N. inconspicua*, previous studies of *N. palea* (Trobajo et al., 2009, 2010; Rimet et al., 2011) suggested that this morphologically defined species is a natural (monophyletic) group, within which few clearly defined subgroups can be distinguished despite evidence of barriers to free exchange of genes between some strains exhibiting heterothallic sexual reproduction (e.g. between some Belgian isolates and a group of strains from Spain and S America). Deepened sampling of *N. palea* (>80 clones and sequences) has continued to show robust support for monophyly of the species overall but poorly resolved phylogenetic structure within it. Furthermore, some strains have now been found that appear to avoid size reduction and many therefore be asexual.

Taken together, our results suggest that, at least for the *Lanceolatae* groups within *Nitzschia*, formulating rules for molecular species recognition (and DNA barcoding) should be done cautiously. Taxonomic revisions should be informed by an understanding not only of phylogeny, but also functional significance and reproductive biology.

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Keywords

Nitzschia, morphology, molecular, phylogeny, sexual reproduction

Poster presentation

Morphological observation of a poorly described and rare diatom *Licmophora hastata*

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Bullet points

The taxonomy, morphology and ecology of originally poorly described and rare diatom *Licmophora hastata* Mereschkowsky are recorded and re-described using electron microscopy.

Introduction

Diatoms within the genus *Licmophora* C.Agardh are very common and widespread epiphytes of seaweeds in marine and brackish habitats. Species in this araphid genus have a generally spathulate shape in valve view and are cuneate in girdle view. Living cells form colonies attached by mucilage pads or stalks (Round et al., 1990). They have a septum projecting from the centre of valvocopula, extending more or less deeply into the frustule in many, but not all, species (Lobban, 2013). The areolae are arranged in striae on both sides of a central sternum. There is a series of slits on the valve mantle around the foot pole, named multiscissura (Honeywill, 1998). Generally a single frustule has one, two or three rimoportulae.

Today the amplitude of genus *Licmophora* is a completely open question. The number of species within genus ranged between 4 (according Alga Terra dataset, www.algaterra.org) and 241 (according to California Academy Sciences dataset, www.researcharchive.calacademy.org/research/diatoms/names/Index.asp). Taxonomically *Licmophora* is one of the most confusing diatom genera. We believe that results of our studies of some badly described *Licmophora* species is necessary and will finally fill up the huge gap in our knowledge in the establishment and evolution of this genus, and clarify its taxonomy.

Licmophora hastata was described as a new species by a Russian scientist Konstantin Mereschkowsky in 1901. Diagnose was published in the same manuscript together with 40 other new taxons belonging to the *Licmophora* genus. It was stated in the introduction: "…In the following pages I will give a short description or diagnosis of only 41 new forms…" (Mereschkovsky, 1901). Every new form of *Licmophora*, as well as *L. hastata*, in this manuscript was supplied with one original hand drawn image, which means that only shape of valve refracted on the paper, with no details such as type of striation for example. No scale bars were added around images either. Size characteristics were given in millimeters in text of diagnosis. This research was of revolutionary importance for establishment of genus *Licmophora*. But in our time the fate of about 30 Mereschkowskys species are being discussed. Many of them definitely should be seriously revised, like we do for *L. hastata*. Some of these species reported in literature have wrong identification, and some of them have not been reported at all since he described them. The first step to sort out species is always to study the original type material, but it is not possible in case of Mereschkowsky collection because it is missing.

Results and discussion

While the original description of *Licmophora hastata* by Mereschkowsky is easy to find in his manuscript on page 150 (Mereschkovsky, 1901), below we would like to accumulate current information about this very rare and interesting species and give addition description based on SEM observation. The material for this study was collected from coast of the Black Sea, not far from Sotchi in 2010 and 2011. In our research we call this species carefully *Licmophora* cf. *hastata*. Because we are not absolute sure it is exactly what Mereschkowsky ment when he studied his material over hundred years ago.

Morphology features: frustules cuneate in girdle view, valves spathulate, 63-74 µm long, apical pole "pointed", 4 µm wide, basal pole – 2 µm. 30-40 striae in 10 µm near head pole and 30-33 striae in 10 µm near basal pole. 2 rimoportulae per cell, basal rimoportula is at 45º to the valve plane. Areolae slightly elongate in the transapical direction. Multisciccura has 17-19 slits. Valvocopulae has a shallow septum. Copulae consisted of five bands. The lists of morphological features should be much longer, only the most important ones are given here. This species has differs from other species within the genus as having an angular valve in girdle view and diagonally oriented basal rimoportula.

Distribution: Black Sea, Mediterranean Sea, coast of England and Wales. Not in abundant quantities.

Floras: Mereschkowsky (1901, Fig. 10), Hustedt (1959, Fig. 599), Guslyakov et al. (1992, Pl. VIII, Figs 14, 15; Pl. XLI, Figs 1-4), Honeywill (1998, Figs 13a-f).

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Keywords

Licmophora hastata, diatom, morphology, taxonomy.

Oral presentation

Centric diatoms from the Miocene deposits of the Baikal region, Russia

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Bullet points

Studies of diatom assemblages in Miocene deposits from the palaeobasins of the Tunka hollow and Western Transbaikal area are important for understanding the origin of the Lake Baikal diatom flora.

Introduction

The Miocene diatom flora of the Baikal region is known from deposits in the Tunka hollow (Cheremissinova, 1973; Popova et al., 1989; Lupikina & Khursevich, 1991; Khursevich, 1994; Likhoshway et al.,1997), the Vitim Plateau (Khursevich & Chernyaeva, 1994; Khursevich et al., 2004; Chernyaeva et al., 2007; Rasskazov et al., 2007, Usoltseva et al., 2010) and from the bottom sediments of ancient Lake Baikal (Kuzmin et al., 2009).

The aim of this study was to compare the late Miocene diatom flora of Lake Baikal (centric diatoms) with that of the middle-late Miocene palaeobasins of neighbouring areas, using both our own and published data.

Results and discussion

The Tunka hollow is located 60 km west of the southern tip of Lake Baikal. The middle-late Miocene diatom assemblages have been studied using LM (Cheremissinova, 1973; Popova et al., 1989). *Aulacoseiras* from the group "*prae*" and the f. *curvata*, as well as various *Actinocyclus* species were found there. Re-examination of these diatom assemblages by SEM has enabled better descriptions of the morphological features of a number of centric species and identification of new species amongst the extinct flora, including *Actinocyclus tuncaensis* Khursevich, *Alveolophora tscheremissinovae* Khursevich, *Lobodiscus sibericus* Lupikina & Khursevich, *Aulacoseira praegranulata* var.*tuncaica* Likhoshway & Pomazkina, *Cyclotella tuncaica* Nikiteeva, Likhoshway & Pomazkina and *Stephanodiscus tuncaensis* Pomazkina & Likhoshway. The last four species are believed to be endemics.

The Vitim Plateau is situated east of Lake Baikal and is made up of three main palaeovalleys: Khoigot, Atalanga and Amalat. Planktonic diatom assemblages examined from Miocene deposits of the Khoigot and Amalat paleovalleys contain both common and local species. A large diversity of *Aulacoseira* species is characteristic of the Amalat paleovalley: *A. canaden*sis (Hustedt) Simonsen, *A. spiralis*

(Ehrenberg) Houk et Klee, *A. jonensis* (Grunow) Houk et Klee, *A. valida* (Grunow) Krammer, *A. italica* (Kűtzing) Simonsn, *A. ambigua* (Grunow) Simonsen, *A. granulata* (Ehrenberg) Simonsen, *A. pusilla* (F. Meister*)* Tuji et Houk and *A. distans* (Ehrenberg) Simonsen. Species of *Alveolophora* are absent in Miocene sediments within this palaeovalley. Among the *Actinocyclus* species, *A. gorbunovii* (Sheshukova) Moisseeva et Sheshukova and *A. krasskei* (Krasske) Bradbury *et* Krebs have been widely spread in the Miocene lakes of both palaeovalleys. Species of *A. vitimicus* Usoltseva & Khursevich and *A. intermedius* Usoltseva & Khursevich have been found only in the Miocene lacustrine sediments from the Amalat palaeovalley. Recently, *Lobodiscus peculiaris* Usoltseva & Khursevich and *Pseudoaulacosira moisseeviae* (Lupikina) Lupikina & Khursevich have been recorded also from the Miocene lakes of the Amalat palaeovalley.

Other centric diatoms, such as *Concentrodiscus variabilis* Khursevich & Chernyaeva, *Alveolophora robusta (*Khursevich) Usoltseva & Khursevich, *A. tscheremissinovae* and *Mesodictyopsis dzhilindus* (Khursevich) Khursevich, were abundant in the plankton of the Miocene lakes within the Khoigot Valley. Here species of *Aulacoseira* were less diversified, due the absence of *A. valida*, *A. italica*, *A. ambigua.* The latter species have a long ancestry, from Miocene to Recent*.*

Common species for the upper Miocene sediments of Lake Baikal, the Vitim Plateau and Tunka hollow were *Actinocyclus кrasskei*, the ancient taxa of *Aulacoseira* from the group «prae», *A. ambigua* and *A. distans*. During the late Miocene in Lake Baikal, there was not only a great number of species of *Aulacoseira*, but also several other extinct taxa of *Alveolophora*, *Actinocyclus*, *Concentrodiscus*, *Mesodictyon*, *Mesodictyopsis*, and *Cyclotella iris* Brun & Héribaud with varieties. More recently, representatives of *Pseudoaulacosira* and *Lobodiscus* were found to be absent in the upper Miocene deposits of Lake Baikal.

Overall, the preliminary comparison of the dominant planktonic centric diatoms from the middle-upper Miocene sediments of the Tunka hollow, Vitim Plateau and Lake Baikal, showed their unique composition, with the presence of endemics in every Baikal region mentioned above.

Further detailed study of the fossil diatom flora from the Baikal region continues using LM and SEM.

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Keywords

Tunka hollow, Vitim Plateau, Lake Baikal, Miocene, centric diatoms

Poster presentation

The genus *Halamphora* in the Antarctic Region

Speaker: VAN DE VIJVER Bart

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Bullet points

Overview of the historic *Halamphora* records in the Antarctic Region

Taxonomic revision of the genus *Halamphora*

Description of several new taxa

Ultrastructural analysis of the morphology of several taxa with notes on their ecology

Introduction

The genus *Halamphora* (Cleve) Levkov was originally described by Cleve in 1895 as a subgenus of *Amphora* Ehrenberg ex Kützing. In 2009, Levkov finally raised the subgenus to genus level and recombined many *Amphora* taxa that presented all morphological features of the new genus to *Halamphora*. The genus is characterized by moderately to strongly dorsiventral valves with a shallow ventral mantle, uniseriate or biseriate striae comprised of round, elliptical to transversely elongated areolae occluded by hymens, an eccentric raphe system and a girdle composed of numerous open copulae. Important species in this genus are a.o. all species belonging to the species complexes around (the former) *Amphora veneta* Kützing, *A. coffeaeformis* Agardh and *A. normanii* Rabenhorst.

In the Antarctic Region, almost all records of *Halamphora* species were attributed to *H. veneta* (Kützing) Levkov giving this presumably cosmopolitan species that way a very broad biogeographical distribution with records ranging from the Antarctic Continent to the sub-Antarctic islands in the southern Indian and Atlantic Oceans (Kellogg & Kellogg, 2002). It was quickly clear that species drift and force-fitting increased the taxonomic uncertainty about this presumably cosmopolitan species. A first superficial analysis of some of the Antarctic populations revealed however clear differences between some of these populations making a revision of the genus *Halamphora* in all parts of the

Antarctic Region highly necessary, especially in the light of further biogeographical and ecological research.

Results and discussion

The present poster shows the results of the morphological and taxonomical analysis of most *Halamphora* populations that were observed in samples from almost the entire Antarctic Region including material from the islands in the southern Indian Ocean (Ile Amsterdam, Crozet Archipelago, Iles Kerguelen, Prince Edward Islands, Heard Island), the southern Atlantic Ocean (South Shetland Islands, South Georgia, James Ross Island) and the Antarctic Continent (Vestfold Hills and Bunger Hills). In total more than 100 *Halamphora* populations were investigated. Based on the results of the light microscopy analysis, ten populations from various locations, showing clear morphological differences were prepared for further morphological analysis using the ZEISS Ultra Scanning Electron Microscope in the Natural History Museum in London, UK.

The results show that apart from the already described *Halamphora veneta* and *H. oligotraphenta* (Lange-Bertalot) Levkov, several new taxa presented unknown combinations of morphological features that did not allow a correct identification at species level based on the currently available literature. A formal description will be necessary for these species and is at present ongoing.

On the Antarctic Continent, at least two different taxa could be found: one taxon showing valves with broad convex dorsal sides presents some similarities with *H. mira* (Krasske) Levkov and *H. miroides* Levkov whereas the smaller one has a vague resemblance to *H. veneta*. On Livingston Island (South Shetland Islands) and James Ross Island, two other species could be found. On James Ross Island, the observed populations could not be separated from *H. oligotraphenta* and is most likely conspecific but the second species, so far only found on the South Shetland Islands clearly is different from *H. veneta* based on for instance the presence of biseriate striae near the central area, and will be described as new. On the different islands in the Southern Indian Ocean, several large populations of the true *H. veneta s.s.* were found together (on Ile Amsterdam) with some smaller populations of a new species that showed some affinities to *H. fontinalis* (Hustedt) Levkov.

The application of this more refined taxonomy for the genus *Halamphora* allows for a better analysis of the biogeography of Antarctic diatoms and confirms earlier obtained results in other diatom genera (*Luticola*, *Stauroneis*, *Eunotia*, *Navicula*). Moreover, the results of this morphological and taxonomical analysis urge once more the need for a better revision of the Antarctic diatom populations and confirm the unique nature of this flora composed of a lot of endemic species.

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Keywords

Antarctic Region, *Halamphora*, taxonomy, morphology, new taxa

Oral presentation

Freshwater diatoms from the Maritime Antarctic Region: biodiversity hotspot or taxonomical artifact

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Bullet points

Biogeography of lacustrine diatoms in Antarctica

Examples of genera *Eunotia* and *Muelleria*

Effect of taxonomic revisions on the delimitation of the Antarctic subregions

Introduction

The Maritime Antarctic Region comprises the Antarctic Peninsula and several islands and archipelagos in the southern Atlantic Ocean such as the South Shetland Islands and James Ross Island. Although the variation of lacustrine habitats is rather limited compared to the sub-Antarctic Region, the Region presents a sufficient amount of opportunities for the diatom microflora to develop. Diatoms are one of the most abundant and productive algal groups in Antarctic and sub-Antarctic inland waters and terrestrial environments (Jones, 1996; Van de Vijver & Beyens, 1999). For a long time, due to the force-fitting of most taxa into north-American and European names and taxonomic drift, the lacustrine Antarctic diatom flora, was considered to be composed of mainly cosmopolitan taxa such as *Luticola mutica* (Kütz.) D.G.Mann, *Navicula veneta* Kütz., *Pinnularia microstauron* (Ehrenb.) P.T.Cleve and *Amphora veneta* Kütz. During the past decade, significant progress has been made with respect to our knowledge of the diversity and taxonomy of the diatom flora of these regions, with a strong focus on terrestrial diatoms. These studies have resulted in the description of a considerable number of new species, mainly in the genera *Pinnularia*, *Diadesmis*, *Luticola*, *Muelleria* and *Hantzschia*. The past few years however, a similar approach has been adopted to the lacustrine flora with new descriptions in a.o. the genera *Navicula*, *Stauroneis*, *Placoneis*, *Planothidium* and *Craticula*. This thorough revision resulted in a completely different appreciation of the present diatom diversity in the Antarctic Region.

Results and discussion

The taxonomic results obtained so far have a serious impact on our point of view about the biogeography of the diatoms in the Antarctic Region. It is clear that a highly specific diatom flora seems to be present in the Maritime Antarctic Region with a large degree of regional endemism that was observed on most of the investigated locations such as the South Shetland Islands (i.c. Livingston Island, Deception Island, King George Island) and James Ross Island. In most genera, more than 50% of the observed taxa could not be identified using the present-day taxonomic literature and were described as new for science. Typical examples of this revision include the large diversity in the genera *Pinnularia*, *Diadesmis*, *Luticola* and *Navicula*. Several taxa, such as *Neidium nyvltii* Hamilton et al., show a striking resemblance with taxa in the Arctic Region and even present similar ecological conditions but are still separated based on small morphological differences. Whether these taxa have vicariant distributions or represent different taxa occupying similar ecological niches feeds the ongoing debate on the biogeographical distribution of the (Antarctic) diatom flora.

A multivariate analysis based on species composition in more than 500 lake samples from the entire Antarctic Region separates three clearly distinct groups of samples, which can be attributed to the three major biogeographical zones of the Antarctic Region as defined by Chown & Convey (2007). Since most of the actual taxonomic changes rely on the application of a narrower species concept involving a more critical analysis of (sometimes small but clear) morphological differences, it may indicate that this observed high species diversity is more the result of a taxonomical artifact rather than reflecting the true biogeography of the diatoms in the Antarctic Region. Although in other taxonomic groups such as Nematodes, a biodiversity hotspot could be observed in this region, it is unclear, based on the species analysis, whether a similar pattern defines the diatom diversity. Therefore, the same analysis was run using a taxonomical higher, i.c. genus level. The results of that analysis confirm the previous species separating the sub-Antarctic, Maritime Antarctic and Continental Antarctic Region. Moreover, the first molecular results (Souffreau et al., 2013) indicate the presence of a high degree of cryptic and semi-cryptic diversity confirming the classic morphological results.

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Keywords

Antarctic Region, biogeography, lacustrine diatoms, taxonomic revisions, endemism

Oral presentation

Effects of nutrients on the lipid production of the diatom *Pseudostaurosira brevistriata* D.M. Williams and Round (1988) (syn. *Fragilaria brevistriata*)

Speaker : VITUG Lawrence

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Bullet points

The study focuses on the diatom strain *Pseudostaurosira brevistriata* isolated from Laguna de Bay, Philippines

Effects of various nutrients (Na_2SiO_3, Na_2NO_3, Na_2HPO_4) on the lipid production of *P. brevistriata* are studied.

Optimizing the growth, lipid content and lipid productivity of *P. brevistriata* for the production of lipids under different nutrient conditions.

Introduction

The diatom strain *Pseudostaurosira brevistriata* was isolated from Laguna de Bay a freshwater lake in the Philippines. These aquatic microoragnisms are unicellular and have frustules made of silica, found in freshwater environment and currently explored as potential algal species for biofuel. They can survive a variety of environmental conditions, affecting their growth and lipid content (Stockenreiter et al., 2012). When these microorganisms are subject to a stressful environment, such as nutrient starvation, carbon uptake is used for storing energy rather than in reproduction, thus producing more lipids (Pahl et al., 2010). Lipids provide a storage function in the cell that enables microalgae to endure adverse environmental conditions. Optimizing these storage products is utilizing algae's natural process for storing energy in the form of lipids.

One of the factors that influence algal biomass production and lipid content is nutrient limitation which is the most and widely used lipid induction techniques in lipid production. Nutrient limitation leads to higher lipid production in nearly all known microalgae. Several studies had shown that the quantity and quality of lipids within the cell can vary as a result of changes in growth conditions such as in nutrient media characteristics (concentration of nitrogen, phosphates, and silicate, Converti et al., 2009). Hence, microalgae switch carbon allocation from reproduction to oil production (Smith et al., 2010).

Results and discussion

The diatom strain *Pseudostaurosira brevistriata* was subjected via a batch culture experiment at various nutrient concentrations (Silicate Nitrate and Phosphate). The efficiency in the utilization of the different nutrients was found at 10 µM Na_2SiO_3 with maximum growth of 1.8 x 10^6 cells/ml, and 10 µM of Na_2NO_3 and N_2aHPO_4, with maximum growth of 3.8 x 10^6 and 2.05 x 10^6 cells/ml, respectively. Nutrient deficiency, typically nitrogen or silicon deficiency is well known to enhance the lipid content of algae. Lipid accumulation in algae usually occurs during times of environmental stress, including growth under nutrient deficient conditions. The lipid and fatty acid content of microalgae differ according to the culture conditions. It has been found that in some cases, the lipid content can be enhanced by imposing nitrogen starvation (Li et al., 2011).

Pseudostaurosira brevistriata grew well under silicate limited conditions and growth was not inhibited. It was evident that there was an increase of lipid content and lipid productivity under silicate limitation in which 0.1 µM and 0.5 µM concentrations gave the highest lipid content with the value of 0.92 and 0.73 mg/g dry weight, and lipid productivity of 0.026 and 0.023 mg/ml/day, respectively. In the diatom *Cyclotella cryptica,* high levels of lipids were produced due to silicon deficiency (Miao & Wu, 2006). In our study, *P. brevistriata* grew well under nutrient limited conditions and growth was not inhibited. As *P. brevistriata* was exposed to nitrogen limited conditions of 0.1 µM and 0.5 µM concentrations, there was a drastic decrease of lipid content with values of 0.033 and 0.028 mg/g dry weight, respectively, and lipid productivity of 0.0031 and 0.0027 mg/ml/day. The lipid content and lipid productivity of *P. brevistriata* began increasing when subjected to phosphorus limitation at 0.1 µM and 0.5 µM with a value of 0.51 and 0.31 mg/g dry weight, and lipid productivity of 0.028 and 0.026 mg/g dry weight, respectively, which corresponded with the study of a similar diatom species *Phaeodactylum tricornutum* wherein an increase in lipid content was likewise observed during phosphorus limitation (López Alonso et al., 1996).

Nutrient conditions (Na_2SiO_3, Na_2NaO_3 and Na_2HPO_4) had relatively increased the amount of lipids of *P. brevistriata* especially under nutrient limited conditions which was congruent to the study done by (Lynn et al., 2000). In their study the diatom *Stephanodiscus minutus*, had increased lipid accumulation when induced in silicon, nitrogen and phosphorus limitation. All low nutrient conditions, increased the lipid content at the stationary phase during nutrient limitation of *Pseudostaurosira brevistriata*, in which case the results were similar to that of Nigam et al. (2011) who observed lipid accumulation in *Chlorella pyrenodoisa* was higher at stationary phase than at exponential phase. In general, nutrient stresses such as nitrogen, phosphorus, and silicon deficiency had an effect on accumulating lipid content in most known microalgae (Lombardi & Wangersky, 1991).

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Keywords

Pseudostaurosira brevistriata, culture conditions, nutrient limitation, lipid content, lipid productivity

Oral presentation

Holocene palaeoclimate reconstruction in the Eastern Mediterranean: a quantitative diatom study of an approximately 18 m long sediment core from Lake Kinneret (Israel)

Speaker: VOSSEL Hannah

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Bullet points

This study presents preliminary results of a quantitative diatom study of an approximately 18 m long sediment core (composite profile) from Lake Kinneret (Israel). A division into five diatom zones is proposed and the first interpretation of changes in limnology and evolution of the lake basin over the last 8,000 years cal BP is given.

Introduction

Lake sediment cores were collected from Lake Kinneret in March 2010, from the deepest part of the lake (42 m water depth). The study contributes to the SFB-project 806, “Our Way to Europe”, sub-project B3. This project aims to improve understanding of the migration of *Homo sapiens* from Africa to Europe by using anthropogenic, geochemical and palaeontological studies, including diatom analysis of lake sediment cores from the region.

The study area of Lake Kinneret is located in the northern part of the Jordan Rift Valley in the northern part of Israel. The lake is 22 km long, 12 km wide and up to 42 m deep, and lies 210 m below sea level (Baruch, 1986). The Kinneret is mainly fed by the Jordan River (inflow in the North), which also drains the lake southwards to the Dead Sea. The water body of the lake is warm and monomictic. Lake Kinneret is the biggest natural freshwater lake in Israel. The climate of the study area is of the Mediterranean type, which is characterized by mild, rainy winters and hot, dry summers. Lake Kinneret is mainly surrounded by volcanic igneous rocks (basalts in the Golan Heights), which were formed in the Oligocene, Miocene and Pliocene epochs and now form escarpments up to 500 m high around the lake.

This masters by research study comprises a relatively low resolution preliminary study of the 18 m core, by analysis of 19 sediment samples (1 m resolution) for first investigations of the remarkable shifts in the diatom flora of Lake Kinneret over the last ca. 8,000 years. The aim is to clarify why diatom assemblages have changed over time, and to establish whether the results are in accord with (1) previous inferences based on proxies such as pollen and (2) output from the climatological models of the Levant region.

Results and discussion

99 different diatom taxa were identified. Diatoms were preserved in most (16 out of 19) samples, but varying from rare (with signs of dissolution and if present, valves were mainly broken) to abundant (the majority of the valves were well-preserved). In contrast to the sediment lithology, which is quite homogeneous, the diatom flora exhibits marked fluctuations in species assemblage composition, although is dominated by planktonic taxa throughout.

98 % of the diatom taxa can be classified as oligohalobous-indifferent, requiring alkaline water for optimal growth. Five main diatom assemblage zones can be recognised primarily based on visible changes in the composition of the diatom assemblages and distinctive changes in the diatom concentration. This ‘visual’ zoning was verified by a CONISS-analysis afterwards. Changes in the diatom assemblages over the last ca. 8,000 years can be interpreted mainly in terms of productivity shifts, from an oligotrophic flora at the base to hypereutrophic in the modern lake. The trend towards eutrophication accelerates after 3,000 years cal BP, indicating the influence of increased human activity in the catchment. The pollen record also shows an increase in human activity around Lake Kinneret during that time (Schiebel, 2013). There is also some evidence for lake-level fluctuations. Low lake-level stands are characterized by a low diatom concentration and the increasing occurrence of littoral taxa. High lake level stands are marked by the occurrence of planktonic species, such as *Cyclotella ocellata*, in huge numbers and high diatom concentrations. The inferred lake-level oscillations appear to correlate well with output from the climatic models from the Levant region, representing fluctuations in moisture availability (Litt et al., 2012). The results can also be correlated with previous diatom studies from short core material of the littoral zones of Lake Kinneret, which cover the last 3,000 years cal BP (Ehrlich, 1985; Pollinger et al., 1986).

This current study is based on a low sample resolution and gives only a preliminary overview of changes in the diatom flora of Lake Kinneret during the last 8,000 cal yrs. BP. A higher sample resolution, which is planned for the future, is necessary for more detailed interpretation of palaeoecological changes within the lake system of Lake Kinneret. Furthermore palaeoecological analyses have to take geochemical water parameters and surrounding facies conditions in account, which were not treated within the interpretation of this study because of the limited processing time.

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Keywords

diatoms, Lake Kinneret, Holocene, eutrophication, lake-level fluctuations

Oral presentation

Diatom responses to climate variability in temperate Chilean lakes: a combined neolimnological and paleolimnological approach

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Bullet points

This study combines neolimnological and paleolimnological approaches to better understand the effect of climate variability on the behavior of temperate Chilean lakes.

Introduction

The climate of temperate regions in the Southern Hemisphere is strongly influenced by ENSO (El Niño-Southern Oscillation) activity and changes in the position and strength of the Southern Westerlies. Diatom records in sedimentary archives from lakes located in this region reveal significant floristic changes during the Holocene, which can be tentatively linked to long-term changes in water column mixing regime and, more recently, anthropogenic impacts. In order to better understand the environmental drivers of these past changes, the present-day distribution of spring and summer planktonic diatom species was studied in relation to the thermal, optical and chemical properties of temperate Chilean lakes located between 36 and 43 °S and spanning an altitudinal gradient from 20m to 2000m a.s.l. These field studies were combined with ecophysiological experiments to determine the growth response of key species with respect to light and temperature conditions.

Results and discussion

Multivariate analysis revealed four major spring and summer diatom assemblages: group I: *Discostella stelligera*, *Aulacoseira nygaardii*, *Aulacoseira ambigua*, *Tabellaria flocculosa*, *Aulacoseira pusilla*; group II: *Stephanodiscusparvus*, *Aulacoseira granulata* var. *angustissima*, *Asterionella formosa;* group III: *Urosolenia eriensis*; group IV: *Fragilaria crotonensis*, *Discostella pseudostelligera*. The occurrence of these assemblages was statistically related to water column temperature, mixing depth, and lake size. The modeled realized ecological niches of these species in terms of light, temperature and nutrients served as a basis for lab-scale physiological experiments aimed at elucidating the major traits underlying their natural occurrence. Multiple strains from *T. flocculosa*, *A. pusilla*, *A. granulata*, *A. formosa*, and *F. crotonensis* were isolated from the study lakes and were grown in WC medium under controlled laboratory conditions. All strains have been morphologically and molecularly characterized using species-level markers (rbcL, LSU). Prior to the experiments, cultures were kept in early-exponential phase for several generations to achieve common garden conditions. Growth-irradiance curves were obtained by growing strains at nine different light intensities (light intensity range: 3-200 µmol/m².s). In addition, temperature-dependency of growth rate was measured in a temperature gradient experiment with temperatures ranging from 5°C to 33°C, at subsaturating light levels (42µmol/m².s). Strains of *T. flocculosa* and *A. pusilla*, both key species from group I, have high optimal temperatures (25°C and 29°C respectively), which is in accordance with the model predictions. Both species favour high light environments, indicated by high maximal growth rates (μ_{max}), high optimal irradiance (I_{opt}) and a low to intermediate initial slope of the growth-irradiance curve (α). The same light preferences could be inferred for *A. formosa*, a key species of group II, but its optimal temperature was around 20°C. *F. crotonensis*, a key species from group IV, had the highest α value and the lowest optimal irradiance, indicating adaptation to low light environments, which is in accordance with its occurrence in deeply mixed water columns of large lakes. *A. granulata* had the same optimal temperature as *A. formosa*, but seems to be better adapted to lower light conditions. Overall, these preliminary results support the hypothesis that the distribution of planktonic diatoms in these Chilean lakes is primarily bottom-up controlled by physical factors, and hence their use as biological proxies to reconstruct past changes in the physical environment of Chilean lakes.

Keywords

climate change, paleolimnology, neolimnology, planktonic diatoms

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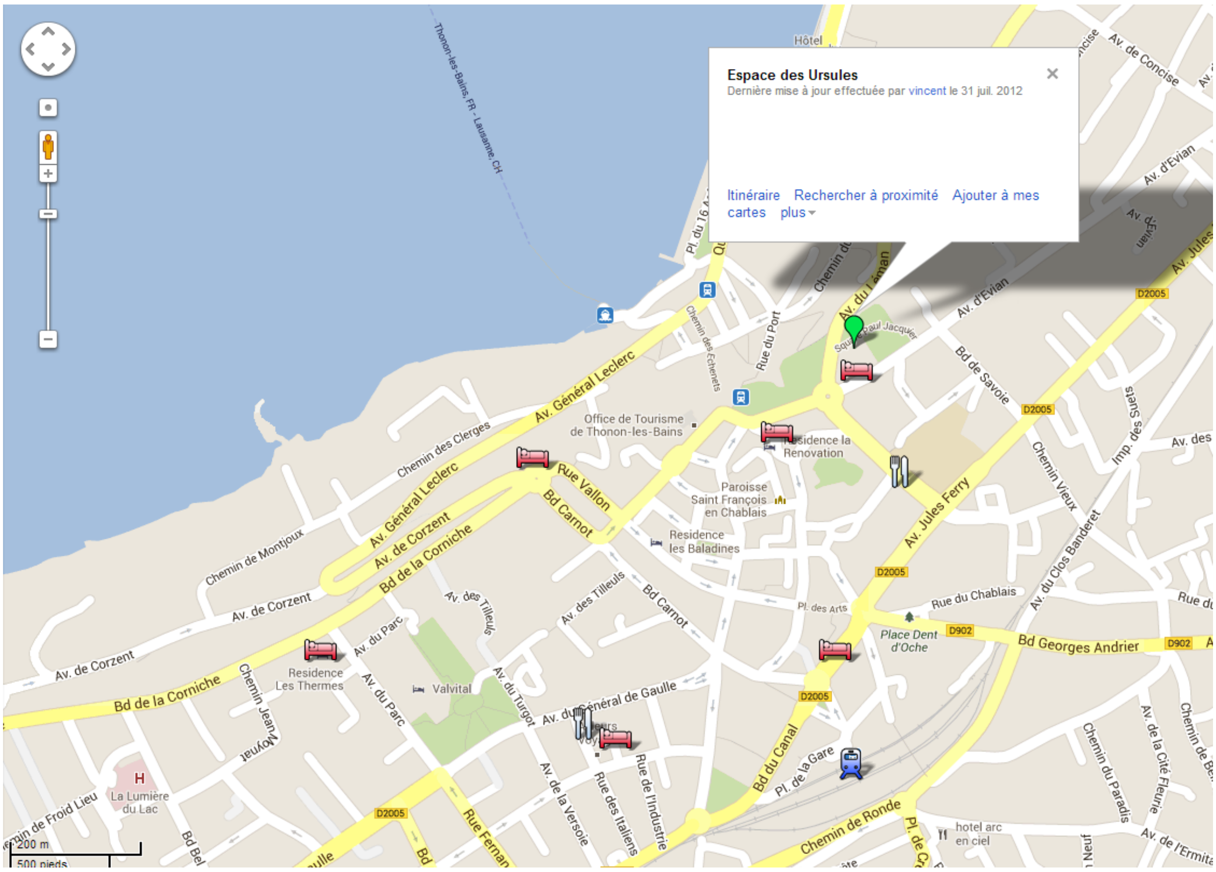

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