

ALQUIBLA

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Asociación
Ibérica de
Limnología

Associação
Ibérica de
Limnologia

AIL



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ALQUIBLA se publica una vez al año por la Asociación Ibérica de Limnología, para distribuir a sus miembros y otros colectivos la información y los trabajos en relación con el agua y sus múltiples facetas, tanto teóricas como aplicadas. Está disponible en formato PDF en la página web de la asociación en <http://www.limnologia.eu> donde también pueden descargarse los números anteriores.

Toda la correspondencia relacionada con este boletín, así como contribuciones al mismo deben enviarse al encargado de Publicaciones de la Asociación, por correo electrónico o bien ordinario:

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Mensaje de la Presidencia de la AIL

Queridas socias y socios de la AIL:

En nombre de la Asociación Ibérica de Limnología, las personas que formamos parte de la Junta Directiva de la Asociación queremos desearos unas felices fiestas y que en 2017 vuestras venturas y aventuras, sean limnológicas o no, os sean muy favorables.

También en 2016, y van 35 años, la AIL ha sido nuestro marco de encuentro con nuestros amig@s y colegas limnológ@s ibéricos, en especial en nuestro XVIII Congreso celebrado en Tortosa entre el 4 y el 8 de julio, donde, tras nuestro sobresalto nutricional inicial, disfrutamos de unos magníficos días de ciencia y camaradería gracias a la estupenda tarea realizada por nuestros compañeros del IRTA y a la colaboración de diversas entidades que, como la Universitat Rovira Virgili, nos brindaron un marco estupendo en el que celebrar nuestro encuentro bienal. Aquellos y aquellas que tenéis la costumbre, buena costumbre, de asistir a nuestros congresos, creo que coincidiréis conmigo en que el nivel científico de la Limnología Ibérica sigue incrementándose, y también en que nuestro congreso tiene esa doble faceta no solo de aprender de nuestros colegas y mostrarles nuestros trabajos, sino también de pasar unos días entre amigos a los que nos une mucho más que nuestra ciencia. En estos últimos años hemos seguido incrementando la familia de limnológ@s ibéricos con más de 150 nuevos socios, 70 de ellos en 2016, en especial jóvenes, lo cual, en estos tiempos en los que la membresía en mayoría de las sociedades científicas está en franco declive, nos hace pelear aun con más entusiasmo en pos de nuestra ciencia, nuestra asociación y sus soci@s, y nuestros ecosistemas acuáticos.

Especialmente emotivas fueron las sesiones en Tortosa en homenaje a nuestra añorada María Rieradevall, que nos recordó su valioso legado científico, pero, sobre todo, a esa amiga que se nos fue, así como la sesión en honor de María Rosa Miracle, que se ha jubilado recientemente, pero sigue trabajando en su querida

Limnología con el mismo entusiasmo de siempre. También, y aprovechando la presencia de su gran amigo William Mitsch, recordamos a nuestro socio de honor Sven Jorgensen, que falleció a principio de este año después de haber dejado su impronta en muchos jóvenes limnólogos ibéricos que a lo largo de los últimos 10 años participaron en los diversos cursos que, de forma totalmente altruista, Sven se brindó a ofrecer para la AIL sobre Modelización Ecológica y Ecología de Sistemas. También queremos tener un recuerdo para otros dos socios de la AIL que se nos fueron, Francisco José Vázquez, conservacionista, fotógrafo naturalista y pescador, y Ruth María Collado, investigadora de la Universidad de La Coruña y especialista en oligoquetos.

Buena parte del empuje de la Limnología ibérica viene de nuestr@s Jóvenes-AIL, de los que nos enorgullece tanto su pujanza científica como nos preocupa su futuro, y con él el de la Limnología Ibérica, que tiene exiliados a una buena parte de nuestros jóvenes talentos cuando lo justo sería que, tanto ell@s como otr@s jóvenes científic@s pudieran contribuir en su propio país al desarrollo de la ciencia y, con ello, de nuestra sociedad. Por ello, y es evidente por nuestras acciones, la AIL no duda en impulsar todas aquellas iniciativas que redunden en beneficio de l@s jóvenes limnológ@s, tanto por ell@s, en primer lugar, como a medio plazo, porque en ello va el futuro de la Limnología en nuestros países ibéricos. Al exitoso proyecto DOMIPEX, primer proyecto colaborativo entre jóvenes limnológ@s desarrollado, quizás, a nivel mundial, en el que participaron decenas de Jóvenes-AIL, le sucede el recientemente iniciado proyecto AGRHYDROM (*A timely look at effects of agriculture on fluvial dissolved organic matter: the role of hydrology*), para el cual hay más de 60 solicitudes de participación de jóvenes limnológ@s. Con estas convocatorias de proyectos la AIL pretende, sobre todo, fomentar la colaboración entre jóvenes investigadores en Limnología, ejemplo que ha sido seguido por la *European Federation of Freshwater Sciences* a iniciativa de la AIL con la aprobación del primer proyecto de investigación colaborativo de jóvenes limnológ@s europeos patrocinado por varias asociaciones miembros de la Federación, entre ellas la AIL. La AIL también ha dotado a 10 Jóvenes-AIL de becas de inscripción a nuestro congreso de Tortosa, de 6 becas de inscripción para el congreso de la Sociedad Internacional de Limnología celebrado en agosto en Turín (Italia), y de 2 becas de inscripción y ayuda de viaje para el 1^{er} Congreso Iberoamericano de Limnología que se celebró en Valdivia (Chile) en noviembre de este año. En ambos congresos internacionales la AIL ha tenido una destacada participación, en especial en el Iberoamericano, que ha sido consecuencia de las colaboraciones que iniciamos hace algunos años con diversas Sociedades Limnológicas Iberoamericanas (Chile, Brasil, Argentina, México,...). A este respecto, entre otras actividades que ya están organizándose, cabe destacar que ya se ha acordado la celebración del segundo y tercer Congreso Iberoamericano de Limnología, el segundo en Florianópolis (Brasil) en 2019, y el tercero en Murcia, en 2020. Este último se celebrará conjuntamente con el XX Congreso Ibérico de Limnología, que junto con el XIX Congreso de la AIL que se celebrará en junio de 2018 en Coimbra, una de las cunas del saber ibérico, ya han sido aprobados por nuestra asamblea y cuyos comités organizadores ya se encuentran trabajando en su preparación. En 2017, organizados por nuestros socios y apoyados por la AIL, se celebrarán la 8th *Conference on Plant Litter Processing in Freshwaters*, en Bilbao, el 21th *Meeting of the Group of European Charophytologists* en Valencia, y la reunión de la *European Pond Conservation Network*, en Faro. Igualmente la AIL, como entidad integrada en la *European Federation of Freshwater Sciences*, participa en el 10th *Symposium of European Freshwater Sciences*, que se celebrará en Olomouc (República Checa) del 2 al 7 de julio próximos. Os invitamos a tod@s a participar en aquellos de estos eventos que se celebrarán próximamente que puedan resultar de vuestro interés.

En nuestro congreso de Tortosa se entregó también el Premio AIL a la mejor tesis doctoral en Limnología del bienio 2014-2015 cuya ganadora fue Anna Lupón, del Departament d'Ecologia de la Universitat de Barcelona por la tesis "*The influence of Mediterranean riparian zones on stream nitrogen dynamics: A catchment approach*", dirigida por Susana Bernal y Francesc Sabater. Así mismo se concedió un accésit a Rosanna Aguilera por la tesis "*Effects of land use and climate variability on the water quality of Mediterranean rivers: Towards a regional vision of global change*", realizada en la Universitat de Girona y dirigida por Sergi Sabater y Rafa Marcé. Siendo éstas las premiadas, el resto de las tesis presentadas fueron también de alta calidad, por lo que felicitamos cordialmente a todos los nuevos doctores y doctoras. Dentro de la AIL, y liderado por miembros del grupo de Jóvenes, también ha seguido trabajando el grupo sobre "Ciencia y género", celebrándose una nueva sesión plenaria al respecto en el congreso de Tortosa, de

la cual partieron diversas iniciativas en las que tenemos que seguir trabajando. Otras actividades organizadas por el grupo de Jóvenes AIL para el congreso fueron los encuentros con investigadores senior y los cursos pre-congreso, todos ellos acogidos con gran interés, y que tendrán continuación con el próximo curso titulado “*Introduction to meta- analysis in Ecology*” que se realizará en Coimbra en abril de 2017.

Otra de nuestras tareas colectivas (editor@s, autor@s, revisor@s), *Limnetica*, se mantiene como una revista de prestigio indexada en el ISI-Thomson SCI, y ha renovado la mención de excelencia de la Fundación Española para la Ciencia y Tecnología, (FECYT). No obstante, seguimos aspirando a atraer los mejores artículos a nuestra revista, y para ello resulta imprescindible que nosotros mismos enviemos nuestros artículos de calidad a *Limnetica*, y también que citemos los artículos publicados en ésta, ya que esto ayuda a tener en un mejor ranking que a su vez hace más atractiva la revista para los mejores trabajos.

En cuanto a las relaciones con otras entidades, cabe destacar que la AIL ha firmado un protocolo de colaboración con la Fundación Biodiversidad para promover intereses mutuos, incluyendo el apoyo a los contactos de nuestros asociados con la Fundación para favorecer el desarrollo de sus proyectos de investigación, así como un posible patrocinio de *Limnetica* por parte de la Fundación. Igualmente seguimos avanzando en nuestras colaboraciones con la Asociación Española de Ecología Terrestre (AEET) y con investigadores del ámbito de la ecología marina para estrechar nuestros lazos científicos y societarios, tal como lo hemos comenzado a hacer también con la Sociedad Ibérica de Ictiología (SIBIC) y el Centro Ibérico de Restauración Fluvial (CIREF), al que tenemos que agradecer que en sus premios del año 2016 galardonaran la actividad de la AIL.

Muchas de estas actividades tienen no sólo un fin científico, sino además un afán de contribuir a la conservación de nuestros ecosistemas y a responder a los retos sociales relacionados con nuestra ciencia. Casos como la iniciativa tomada por nuestros socios para conseguir la protección de los hábitats de un pequeño anostráceo, *Linderiella baetica*, o la adhesión de la AIL como miembro del Pacto Mundial para una mejor gestión de las cuencas, son ejemplos de nuestro compromiso ambiental y social. Cabe destacar también que la AIL ha sido reconocida como organización que maximiza la transparencia en la Plataforma Europea de la Transparencia, a lo que sin duda contribuirá aún más la renovación de nuestra página web que estamos preparando.

No quiero terminar sin seguir pidiendo vuestra colaboración para alcanzar los objetivos de la AIL, y también deciros que no dudéis en pedir el apoyo de nuestra Asociación a vuestras iniciativas para las que, tened por seguro, encontrareis la máxima colaboración posible.

Os deseamos a todos una feliz Navidad y un excelente año 2017.

Desejamos a todos um Feliz Natal e um ótimo 2017

Zorionak eta urte berri on Bon Nadal i bon any

Bo Nadal e feliz aninovo

Toni Camacho, Presidente de la AIL

Mensagem da Presidência da AIL

Estimadas associadas e associados da AIL:

Em nome da Associação Ibérica de Limnologia, os membros da Direção da Associação desejamos-vos Boas Festas e que em 2017 as vossas venturas e aventuras, quer sejam limnológicas ou não, vos sejam muito favoráveis.

Em 2016, já lá vão 35 anos, AIL tem sido um ponto de encontro de amigos e colegas limnólogos Ibérica, particularmente no nosso XVIII Congresso celebrado em Tortosa entre 4 e 8 de Julho, onde, após um sobressalto nutricional inicial, desfrutamos de dias magníficos de ciência e camaradagem graças ao grande trabalho feito pelos nossos colegas do IRTA e à colaboração de diversas entidades que, tal como a Universitat Rovira i Virgili, nos brindaram condições excelentes para celebrar o nosso encontro bienal. Para

aqueles e aquelas que têm por hábito, um bom hábito, assistir aos nossos congressos, penso que concordarão comigo que o nível científico da limnologia Ibérica continua a aumentar, e também que os nossos congressos tem uma dupla facete, não só de aprender com os nossos colegas e mostrar o nosso trabalho, mas também para passar alguns dias entre amigos aos que nos une muito mais do que a ciência em si. Nos últimos anos, temos continuado a aumentar a família limnolog@s Ibéricos com mais de 150 novos membros, 70 dos quais só em 2016. Estes são especialmente jovens que, nestes tempos em que a adesão na maioria das sociedades científicas está em declínio acentuado, nos faz lutar ainda com mais entusiasmo para prosseguir com a nossa ciência, a nossa associação com os seus soci@s, e os nossos ecossistemas aquáticos.

Especialmente emocionantes foram as sessões em Tortosa em homenagem à nossa querida Maria Rieradevall, que nos fez lembrar o legado científico de grande valor, mas acima de tudo, essa amiga que nos deixou; e a sessão em honra de Maria Rosa Miracle, que se aposentou recentemente, mas ainda trabalha na sua amada Limnologia com o mesmo entusiasmo de sempre. Além disso, aproveitando a presença do seu amigo William Mitsch, lembramos do nosso membro honorário Sven Jorgensen que faleceu no início deste ano, depois de ter deixado a sua marca em muitos jovens limnólogos ibéricos. Com efeito, ao longo dos últimos 10 anos os jovens assistiram aos vários cursos que, de forma totalmente altruísta, Sven foi oferecendo para dotar a AIL de conhecimentos em Modelação Ecológica e Ecologia de Sistemas. Também queremos honrar a memória de dois outros membros da AIL que nos deixaram, Francisco José Vázquez, conservacionista, fotógrafo naturalista e pescador, e Ruth Maria Collado, investigadora da Universidade da Corunha e especialista em oligoquetas.

Uma grande parte do impulso da Limnologia Ibérica vem do nosso@s Jovens-AIL, dos quais estamos orgulhosos pela sua força científica, mas que também nos preocupam pelo seu futuro, assim como o futuro da limnologia Ibérica que tem exilados uma boa parte dos nossos jovens talentos quando o justo seria que tanto estes como outros jovens cientistas pudessem contribuir no seu próprio país para o desenvolvimento da ciência e, portanto, da nossa sociedade. Por isso, é evidente pelas nossas ações, que a AIL duvida em incentivar todas as iniciativas que beneficiem @s jovens limnológ@s, porque nel@s está o futuro da limnologia nos nossos países ibéricos. O DOMIPEX, primeiro projeto de colaboração entre jovens limnológ@s foi um sucesso. Foi tal vez o primeiro projeto em colaboração a nível mundial deste tipo e em que participaram dezenas de jovens-AIL. Este projeto foi recentemente seguido pelo AGRHYDROM (A timely look at effects of agriculture on fluvial dissolved organic matter: the role of hydrology), para o qual há mais de 60 pedidos de participação. Com estas convocatórias para projetos, a AIL visa, acima de tudo, incentivar a colaboração entre os jovens investigadores em limnologia, um exemplo que foi seguido pela European Federation of Freshwater Sciences por iniciativa da AIL, com a aprovação do primeiro projeto de investigação colaborativa de jovens limnólogos patrocinado por várias associações europeias da Federação, incluindo a AIL. A AIL também subvencionou a inscrição de 10 jovens-AIL ao nosso congresso de Tortosa, 6 bolsas para o Congresso da Sociedade Internacional de Limnologia realizado em agosto em Turim (Itália), e 2 bolsas para assistir ao 1º Congresso Ibero-americano de Limnologia realizada em Valdivia (Chile) em novembro deste ano. Em ambas as conferências internacionais a AIL desempenhou um papel importante, especialmente o Iberoamericano, que foi o resultado de colaborações que iniciámos há alguns anos com várias associações limnológicas Iberoamericanas (Chile, Brasil, Argentina, México, ...). A este respeito, entre outras atividades já organizadas, destacamos que já se concordou em realizar o segundo e terceiro Congresso Iberoamericano de Limnologia; o segundo será em Florianópolis (Brasil), em 2019, e o terceira em Múrcia, em 2020. Este último coincidirá com o XX Congresso ibérico de Limnologia, que juntamente com o XIX Congresso da AIL a realizar em junho 2018 em Coimbra, um dos berços do conhecimento Ibérico, já foram aprovados pela nossa assembleia e cujas comissões organizadores já estão a trabalhar na sua preparação. Em 2017 e organizados pelos nossos associados e com apoio da AIL, celebrar-se-ão a 8th Conference on Plant Litter Processing in Freshwaters em Bilbao, o 21th Meeting of the Group of European Charophytologists, em Valência, e a reunião da European Pond Conservation Network, em Faro. Da mesma forma, a AIL, como entidade integrante da European Federation of Freshwater Sciences participará no 10th Symposium of European Freshwater Sciences, a realizar em Olomouc (República Checa) em 2-7 Julho. Convidamos a tod@s a participar destes eventos a realizar e que podem ser do vosso interesse.

No nosso congresso Tortosa também foi entregue o prémio AIL para a melhor tese de doutoramento em Limnologia para o biénio 2014-2015 y cujo vencedor foi Anna Lupón do Departament d'Ecologia de la

Universitat de Barcelona. A tese intitulada "The influence of Mediterranean riparian zones on stream nitrogen dynamics: A catchment approach", foi orientada por Susana Bernal e Francesc Sabater. Da mesma forma decidiu-se premiar também Rosanna Aguilera pela sua tese "Effects of land use and climate variability on the water quality of Mediterranean rivers: Towards a regional vision of global change", realizada na Universitat de Girona e orientada por Sergi Sabater e Rafa Marcé. Embora tenham sido estas as premiadas, merece destacar que as teses restantes eram de elevada qualidade pelo que se felicitam cordialmente os novos doutores e doutoras. Dentro da AIL, e liderada por membros do grupo de jovens, tem continuado a atividade do grupo de trabalho sobre "Ciência e Género", celebrando-se uma nova sessão plenária no congresso de Tortosa, e da qual saíram diversas iniciativas nas quais continuaremos a trabalhar. Outras atividades organizadas pelo grupo de jovens AIL para o congresso foram os encontros com investigadores seniores e cursos pré- congresso, todos recebidos com grande interesse, e que terão continuidade com o próximo curso intitulado "Introduction to meta-analysis in Ecology" a realizar em Coimbra, em Abril de 2017.

Outra das nossas tarefas coletivas (editor@s autor@s, revisor@s) é a *Limnetica*. A *Limnetica* continua a ser uma prestigiada revista indexada no ISI-Thomson SCI, tendo visto renovada a sua menção de excelência pela Fundação Espanhola para a Ciência e Tecnologia (FECYT). No entanto, continuamos a anelar atrair os melhores artigos para nossa revista, e para isso, é essencial que nós enviemos os nossos artigos de qualidade e que citemos artigos publicados na revista, de forma a ajudar numa melhor classificação, o que, por sua vez, faz a revista mais atrativa para melhores trabalhos.

Quanto às relações com outras entidades, é de salientar que a AIL assinou um protocolo de cooperação com a Fundación Biodiversidad para promover interesses mútuos, incluindo o estabelecimento de contactos entre os nossos associados e a Fundação, de forma a promover o desenvolvimento de projetos de investigação, bem como um possível patrocínio da *Limnetica* pela Fundação. Da mesma forma, temos trabalhado na nossa colaboração com a Asociación Española de Ecología Terrestre (AEET) e com investigadores na área da ecologia marinha, de forma a fortalecer nossos laços científicos e societários, tal como já começámos a fazer com a Sociedade Ibérica de Ictiologia (SIBIC) e o Centro Ibérico de Restauração Fluvial (ICFER), e ao que agradecemos pelos seus prémios em 2016 que galardoaram as atividades da AIL.

Muitas destas atividades têm não só um propósito científico, mas também um desejo de contribuir para a conservação dos nossos ecossistemas e para responder aos desafios sociais relacionados com a nossa ciência. Casos como a iniciativa tomada pelos nossos associados para conseguir a proteção dos habitats de um pequeno anostráceo, *Lindneriella baetica*, ou a adesão da AIL como membro do Pacto Mundial para uma melhor gestão de bacias hidrográficas, são exemplos do nosso compromisso ambiental e social. Gostaríamos ainda destacar que a AIL tem sido reconhecida como uma organização que maximiza a transparência na Plataforma Europeia de Transparência, para a qual contribuirá ainda mais a renovação da nossa página web que estamos a preparar.

Não posso concluir sem continuar a pedir a vossa colaboração para atingir os objetivos da AIL, e também vos dizer não hesitem em pedir o apoio da nossa Associação para as vossas iniciativas para as quais, com certeza, vão encontrar a máxima colaboração possível.

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Toni Camacho, Presidente de la AIL

Notas informativas

Recordamos la página web de la AIL <http://www.limnologia.net>

También la página web de la revista *Limnetica* <http://www.limnetica.net>

El blog de los jóvenes: <http://jiail.blogspot.com/>
Siguenos en Facebook: Grupo Asociacion Iberica Limnologia

Como se ha indicado en repetidas ocasiones, se ruega a todos los socios, que no reciban nuestros comunicados por correo electrónico, faciliten la dirección de la misma con el fin de incluirlas en nuestras bases de datos. También recordad avisar cuando se produce un cambio de domicilio, cuenta bancaria y correo electrónico. Alquilba ya no se publica en papel, tan sólo en PDF. Podeis enviar los nuevos datos a la secretaria bonada@ub.edu o al tesorero juan.soria@uv.es

Por decisión de la Asamblea General de socios celebrada en Tortosa en el pasado Congreso, Limnetica dejará de distribirse en papel a los socios, salvo a quienes lo indiquen expresamente, con un coste adicional de 16 euros anuales. Los interesados en recibir la versión impresa deben comunicarlo al tesorero: juan.soria@uv.es

ACTA DE LA ASAMBLEA DE LA ASOCIACION IBERICA DE LIMNOLOGIA

Tortosa, 5 de julio de 2016, 18:30h
Asisten 65 personas.

Orden del día

- Informe de la presidencia
- Informe de secretaría
- Informe de tesorería y aprobación de cuentas de los ejercicios 2014 y 2015
- Informe de la editora de Limnetica
- Informe de las vocales de “Jóvenes AIL”
- Informe de nuestro representante en la EFFS
- Informe de nuestros representantes para la relación con las sociedades limnológicas latinoamericanas.
- Presentación de candidaturas para la celebración de próximos congresos.
- Ruegos y preguntas

1. Informe de la presidencia

Se presenta el orden del día. Se informa brevemente de que durante este bienio la AIL ha otorgado numeras becas y premios para los Jóvenes-AIL. Asimismo se comenta que se han apoyado varios congresos y cursos, como pueden ser: Wetlands2014, ASLO2015, Congreso Nacional de Humedales, cursos System Ecology, curso UCLM. Respecto al curso de modelización que impartía Sven Jorgensen, se comenta que gracias a los numerosos cursos promovidos por la AIL, el nivel de nuestros Jóvenes-AIL sobre modelización es muy elevado. Toni Camacho insiste que la AIL puede apoyar cursos y congresos que propongan los socios.

Se comenta que en muchas ocasiones se pide el apoyo de la AIL para avalar proyectos o la capacidad de nuestros socios para presentar-se a alguna convocatoria. La AIL no tiene problema en avalar a socios pero se se hará una normalización para tramitar este tipo de apoyos.

La AIL se reunió con la Fundación Biodiversidad para empezar a establecer relaciones. Se incide en que la Fundación puede apoyar como plataforma a diferentes actividades promovidas por los socios (no solo proyectos sino también otras actividades por ejemplo relacionadas con la divulgación). La AIL puede facilitar el contacto con la Fundación. Se anima a los socios en que contacten con la Junta Directiva en caso de que necesiten este contacto.

Se recuerda que la AIL está reconocida como organización que maximiza la transparencia en una plataforma europea.

Respecto a las sesiones especiales en congresos en homenaje a socios AIL, se recuerda que no tienen que impulsarse desde la Junta Directiva sino que los socios también pueden proponerlas a título individual.

Se plantea la intención de establecer un premio a la trayectoria de un investigador AIL tal y como tienen otras sociedades.

Referente a la relación con la Asociación Española de Ecología Terrestre (AEET) y a la potencial Sociedad Ibérica de Ecología se ha invitado a participar en esta asamblea a Paco Lloret (Presidente de la AEET) y a Celia Marrassé (representante de los ecólogos marinos). Toni Camacho recuerda que en Santander se decidió continuar las relaciones con la AEET y los representantes marinos pero que los socios no quieren disolver la AIL. Paco y Celia agradecen a la AIL la invitación y muestran su interés a seguir discutiendo sobre el tema y a promover actividades de colaboración mutua. En este sentido Paco informa de que la primera semana de febrero tendrá lugar en Sevilla el congreso MEDECOS (que coincidirá con el congreso de la AEET) donde se podrían organizar sesiones conjuntas entre los diferentes colectivos. Se mandará información a través de e-Alquibla a todos los socios sobre el envío de resúmenes este mes y sobre la organización de sesiones especiales en septiembre. Por su lado Celia también compartirá toda esta información con los ecólogos marinos y comenta lo positivo que fue el curso Margalef 2014 que contaba con la participación de la AEET y la AIL.

Toni comenta también que se podría hacer un congreso ibérico de Ecología en 2019. Se hará una comisión AEET-AIL-ecólogos marinos y se invita a los socios interesados a participar. Asimismo, Toni informa que se ha hablado con representantes de la Sociedad Ibérica de Ictiología (SIBIC) y del Centro Ibérico de Restauración Fluvial (CIREF) para promover colaboraciones en actividades destinadas a la conservación de los ecosistemas acuáticos. Toni recuerda que el CIREF le dio uno de sus premios a la AIL.

Se recuerda que al actual presidente le quedan 2 años y abre la puerta a futuras candidaturas.

Para terminar se hace un pequeño recuerdo a los socios que han fallecido durante este bienio: Maria Rieradevall (Universidad de Barcelona), Sven Jorgensen (socio honor), Francisco José Vázquez Cea (naturalista, conservacionista, fotógrafo naturalista y pescador), Ruth María Collado (Universidad de La Coruña, especialista en Oligoquetos).

2. Informe de secretaría

Número de socios y gestión

A fecha de 28 de junio de 2016, tenemos un total de 559 socios, de los cuales 191 constan como Jóvenes-AIL y 145 son estudiantes. 27 socios se incorporaron en 2015 y 53 lo hicieron en 2016. Tenemos 8 socios corporativos y 4 socios de honor. La mayor parte de socios son españoles (487), seguido de portugueses (35). El resto son latinoamericanos (13) y de otros países europeos (13) o norteamericanos (5).

Con tal de unificar el listado de socios y cuadrarlo con la base de datos de Jóvenes-AIL, se ha creado un fichero google-drive con los datos básicos de cada socio (nombre, apellidos, residencia, tipo de socio y fecha de alta) al cual tienen acceso el tesorero, la secretaria y los dos miembros de Jóvenes-AIL.

Becas congresos

CONGRESO ASLO 2015

En colaboración con EMASESA, se concedieron 6 becas de 275€ y 10 becas de 140€ para el pago de la inscripción al congreso del ASLO 2015 en Granada. Se presentaron 19 candidatos. Los seleccionados fueron: María Aulló, Joan Pere

Casas, Mireia Fillol, Miguel Cañedo-Argüelles, Elena Hernández, Meritxell Abril, Edurne Estévez, Alexia González, Ibon Aristi, Xavier Benito, Gabriela Onandia, Celia Ruiz, María Morales, Rubén del Campo, Irene Gallego y Francisco José Bullejos.

CURSO R 2015

Se concedieron 8 ayudas de 75€ para el pago de las inscripciones del curso R organizado en la Universidad de Lleida. Los seleccionados fueron: Adrián Ramos, Sergi Compte, Libe Solagaistua, Quim de Gispert, Ana Garcia, Silvia Monroy, Elvira Ramos y Núria Vila.

CONGRESO AIL 2016

Se concedieron 10 ayudas de 160€ para el pago de las inscripciones del congreso de la AIL 2016 en Tortosa. Se presentaron 19 candidatos. Los seleccionados fueron: Javier Soria, Sonia Serra, Carlos Palacín, Carmen Elías, Olatz Pereda, Rubén Rasines, David Cunillera, Laura Barral, Ignasi Arranz y Aitziber Zufiaurre.

CONGRESO SIL 2016

Se concedieron 6 ayudas de 250€ para el pago de las inscripciones del congreso de la SIL 2016 en Torino (Italia). Se presentaron 9 candidatos. Los seleccionados fueron: Anna Camacho, Pablo Almeda, Luís Gómez, Isabel Fernandes y Arunava Pradhan.

CURSO TOLEDO 2016

Se ofrecieron 4 becas para atender al curso “Enfoque relacional y “Political Ecology” para el estudio de conflictos agua-población ante el cambio global en casos de estudio de Castilla-La Mancha” de 50€ cada una. No se presentaron candidatos.

CONGRESO IBEROAMERICANO 2016

El 17 de junio se abrió la convocatoria de becas para ayudar al pago de la inscripción y viaje del 1er Congreso Iberoamericano de Limnología en Valdivia (Chile). Se ofrecen 2 becas que cubrirán las cuotas de inscripción como estudiante más 400€ de gastos de viaje. La convocatoria se cierra el 8 de julio.

Premio tesis doctoral europea EEFS bienio 2013-2014

En 2015 se convocó el premio de la Federación Europea de Asociaciones de Limnología (European Federation for Freshwater Sciences, EEFS) a la mejor tesis en limnología presentada en Europa durante el bienio 2013-2014. Dado que la AIL tiene sus propios premios para tesis y que los congresos de la AIL se alternan con los de la EEFS, se abrió una convocatoria para seleccionar la mejor tesis española y portuguesa del 2014. Las dos tesis seleccionadas en 2014 junto con la mejor española y portuguesa seleccionadas en 2013, se mandaron a la EEFS para competir con las demás tesis europeas presentadas por cada asociación miembro de la EEFS.

La mejor tesis española y portuguesa seleccionada para 2013 fue Paula Arribas (“Evolutionary ecology, biogeography and conservation of water beetles in Mediterranean saline ecosystems” y dirigida por Andrés Millán, Josefa Velasco y Pedro Abellán) y Arunava Pradhan (“Impacts of nanoparticles to microbes and invertebrates: from community responses to cellular targets” y dirigida por Fernanda Cássio, Cláudia Pascoal y Seená Sahadevan).

La convocatoria para seleccionar la mejor tesis española y portuguesa del 2014 recibió 14 candidatos. Las tesis fueron evaluadas de acuerdo a tres criterios independientes: novedad e interés del tema tratado, diseño experimental y metodología, presentación y aspectos formales. Cada candidato fue evaluado por un jurado constituido por 3 miembros: Rafa Marcé, Núria Bonada y Lúcia Guilhermino. Todos los miembros del tribunal constataron el alto nivel de todas las tesis, considerando que las dos mejores (española y portuguesa)

eran la de Xisca Timoner (“Stream biofilm responses to flow intermittency” y dirigida por Sergi Sabater y Vicenç Acuña) y la de Carlos Alexandre (“Ecological impact of streamflow variability in the bio-ecology of freshwater fishes from permanent and temporary Mediterranean river Systems” y dirigida por Pedro Raposo de Almeida y Maria Teresa Ferreira).

Las cuatro tesis seleccionadas del periodo 2013-2014 fueron evaluadas por la EEFS. Ninguno de nuestros candidatos fue seleccionado.

Premio tesis doctoral AIL bienio 2014-2015

En 2016 se convocó el Noveno Premio de Investigación en Limnología que premia a la mejor tesis doctoral en limnología para el bienio 2014-2015. Las dos tesis del 2014 seleccionadas para el premio de la EEFS competieron con las que se presentaron a esta convocatoria. En total se presentaron 10 tesis defendidas en 2015. Las tesis fueron evaluadas siguiendo los mismos criterios que las tesis de la EEFS y, en este caso el jurado estaba constituido por: Rosa Gómez, Verónica Ferreira y Cláudia Pascoal. Después de evaluar todas las tesis del 2015 y de contrastar los resultados con las evaluaciones de las tesis defendidas en 2014, el premio se otorgó a Anna Lupon (Departament d’Ecologia, Universitat de Barcelona) por la tesis “The influence of Mediterranean riparian zones on stream nitrogen dynamics: A catchment approach” dirigida por Susana Bernal y Francesc Sabater. Asimismo, se decidió otorgar un accésit a Rosanna Aguilera por la tesis “Effects of land use and climate variability on the water quality of Mediterranean rivers: Towards a regional vision of global change” realizada en la Universidad de Girona y dirigida por Sergi Sabater y Rafa Marcé.

Proyecto Jóvenes-AIL

En 2016 se ha lanzado la segunda convocatoria de los Proyectos Jóvenes-AIL, dotados con 4500€ para realizar un proyecto de investigación cooperativo entre jóvenes socios de la AIL. En total se han recibido 5 propuestas y la seleccionada según el proceso de evaluación establecido ha sido:

A timely look at effects of agriculture on fluvial dissolved organic matter: the role of hydrology (AGRHYDROM) – Eurne Estévez (Universidad de Cantabria) y Rubén del Campo (Universidad de Murcia)

Asimismo, en 2016 se lanzó la primera convocatoria de proyecto a la EEFS, dotado con 8000€, y con una filosofía muy parecida a la de los proyecto Jóvenes-AIL.

Premio Ramón Margalef 2016

La Generalitat de Catalunya convocó, como cada año, la 12ª edición del Premio Ramon Margalef de Ecología. Este premio pretende reconocer la labor de personas de cualquier parte del mundo que hayan contribuido de manera significativa al avance de la ecología. Des de la AIL se abrió un plazo para que los socios pudieran presentar candidaturas y se presentaron 3: Rosa Maria Miracle, Joan Armengol y David W. Schindler. Después de un periodo de votación, Rosa Maria Miracle fue la seleccionada y la presentada como candidata de la AIL al Premio.

Renovación web AIL

Biel Obrador es el encargado de llevar el tema de la renovación de la web de la AIL. Se ha trabajado sobre una propuesta planteada en abril 2016 y destinada a redefinir la estructura, contenidos y aspecto de la página web para mejorar la difusión y visibilidad de la Asociación y las actividades que promueve. La nueva web tendrá un formato más moderno y dinámico, con una clara apuesta por la presencia en redes sociales (Facebook y Twitter). El desarrollo de la nueva página se ha encargado a un experto en diseño gráfico y multimedia (<http://www.aterkia.com>).

La web tendrá en portada una **sección dinámica de noticias** donde aparecerán anuncios de cursos, actividades, premios y congresos de la AIL, así como noticias relativas a defensas de tesis, convocatorias y cursos y actividades externas pero de interés para los socios. La comunicación de noticias se realizará pues a través la web, con generación automática de un correo a socios y de una entrada en Facebook o Twitter según la relevancia de la noticia. Esto no afectará a aquellas noticias de carácter puramente interno (que serán mandadas exclusivamente por correo como hasta ahora).

También en portada se visualizarán, a medida que aparezcan, los últimos artículos publicados en Limnetica, a la vez que dará más visibilidad a la sección de la revista.

La web mantendrá tres lenguas (castellano, portugués, inglés) en sus secciones estáticas, y una lengua (cualquiera de las tres anteriores) en las noticias más específicas. No habrá una zona intranet con acceso restringido. La gestión futura de la web se realizará por una comisión dentro de la JD, por ahora formada por Biel y por Juan. Actualmente ya se ha definido con el técnico la estructura final de contenidos y se está trabajando en el diseño gráfico.

3. Informe de tesorería y aprobación de cuentas de los ejercicios 2014 y 2015

Juan Soria presenta los ingresos y los gastos para 2014 y para 2015.

INGRESOS 2014	
Saldo inicio año caja + banco	5 552,93 €
Depósitos	76 000,00 €
Venta publicaciones	1 042,63 €
Cuotas cobradas	19 053,14 €
Ayudas	700,00 €
Otros ingresos	- €
Intereses bancarios	810,97 €
TOTAL	103 159,67 €

GASTOS 2014	
Correos y Transportes	2 387,88 €
Papelería	484,47 €
Servidor página web	399,46 €
Comisiones banco	368,87 €
Seguro almacén	354,68 €
Becas AIL	1 381,38 €
Premio AIL	1 200,00 €
Proyecto DOMIPEX	988,53 €
Actividades AIL	2 159,21 €
Limnetica	21 786,25 €
Depósitos	70 000,00 €
Saldo fin año caja + banco	1 648,94 €
TOTAL	103 159,67 €

INGRESOS 2015	
Saldo inicio año caja + banco	1 648,94 €
Depósitos	70 000,00 €
Venta publicaciones	259,58 €
Cuotas cobradas	17 973,86 €
Ayudas	7 400,00 €
Otros ingresos	330,00 €
Intereses bancarios	182,12 €
TOTAL	97 794,50 €

GASTOS 2015	
Correos y Transportes	2 382,03 €
Papelería	309,34 €
Servidor página web	258,16 €
Comisiones banco	112,55 €
Almacén	910,90 €
Becas AIL	2 274,00 €
Premio AIL	- €
Proyecto DOMIPEX	2 009,77 €
Actividades AIL	1 665,69 €
Limnetica	18 874,56 €
Depósitos	60 000,00 €
Saldo fin año caja + banco	8 997,50 €
TOTAL	97 794,50 €

Tras la exposición del informe económico se abre un turno de preguntas.

El informe del tesorero se somete a la aprobación de la asamblea, recibiendo 65 votos a favor, 0 en contra y 0 abstenciones.

3. Informe de la editora de Limnetica

Gestión: económica y otros

Isabel presenta lo que costó Limnetica en 2015 e incide en que el coste que supone Limnetica es una carga para la asociación.

	2015
Secretaría de redacción	~ 6800
Corrección inglés	~ 8000
Impresión	~ 11700
Distribución	~ 2200
Total	~ 28700

Asimismo, se presenta una propuesta que consistiría en mantener los gastos de secretaría de redacción (de los cuales no podemos prescindir) pero modificar el tema de la impresión. Se recuerda que desde enero del 2016 la corrección del inglés ya va a cargo de los autores. Se plantea que todo lo referente a la edición de los pdfs, e-book y gestión del DOI lo lleve el servicio de publicaciones de la Universidad de Barcelona (1000€). También se comenta la propuesta de que Limnetica sea totalmente electrónica a partir de 2017 pero ofreciendo la posibilidad de poder tener una copia digital a cargo de los socios interesados. Se estudiará el tema pero el precio podría ser de unos 30€/año para nacionales y 45€/internacionales. En todo caso, siempre habría que imprimir 10 en digital para el registro y se mantendrían también las copias para los intercambios. En marzo se mandará una encuesta a los socios para ver quien estaría interesado en obtener copias. De seguir con esta propuesta pasaríamos de unos gastos anuales de 28700€ a 8000€.

Se vota la propuesta y se aprueba por unanimidad.

Por otro lado, Isabel comenta que se ha renovado el sello de calidad FECYT/RECYT y ello nos permite tener acceso a una plataforma digital para poder mandar los artículos de Limnetica (Open Journal System). A partir de ahora ya no se mandarían más artículos a Isabel sino que se hará a través de esta plataforma.

Se informa que para el bienio 2014-2015 el mejor artículo publicado por un Joven-AIL en Limnetica ha sido para Laura Jiménez por el artículo:

Jiménez, L.; Romero.Viana, L.; Conde-Porcuna, J.M. & Pérez-Martínez, C. (2015). Sedimentary photosynthetic pigments as indicators of climate and watershed perturbations in an alpine lake in southern Spain. Limnetica 34(2): 439-454.

Evolución de los manuscritos

Se presentan unos resultados que indican de que el número de manuscritos ha aumentado desde 2011. La mayoría son españoles seguidos de brasileños, argentinos y portugueses.

El índice de impacto ha bajado ligeramente en 2015 (0.569) respecto a 2014 (0.707) y ya llevamos varios años bajando desde que Limnetica entró en el JCR en 2011. No obstante, el índice de impacto a 5 años se mantiene (de 1.014 en 2014 a 1.081 en 2015). El número

de citas se mantiene (2013: 504; 2014: 504; 2015: 524), por lo que el descenso en el índice de impacto se atribuye a un mayor número de artículos publicados (de 29 en 2011-2014 a 40 en 2015).

Isabel plantea las opciones de aumentamos el número de citas o publicar menos artículos. Maria Joao Feio comenta que quizás deberíamos ver a ver qué pasa en unos años ya que estos artículos más que se han publicado en 2015 también se citarán. Jordi Catalán sugiere que los números salieran en enero y en julio para que así se pudieran citar más en el año. Se intentará ir por aquí pero al tener que hacer dos volúmenes al año se podría intentar en diciembre sacar un número con 15 artículos y en enero otros con 15 artículos y a partir de allí cada enero y julio. Isabel contactará con los de JRC para ver si se podría seguir esa posibilidad. Por otro lado, Isabel también sugiera hacer más números temáticos y anima a los socios a presentar ideas.

4. Informe Jóvenes-AIL

Núria Catalán informan de su sustitución y Toni Camacho les agradece su compromiso y la labor llevada a cabo durante estos años. Los nuevos representantes de Jóvenes-AIL serán Eurne Estévez (Universidad de Cantabria) e Isabel Fernandes (Universidad du Minho). Se les da la bienvenida.

Se informa de la reunión de género y ciencia. Al final de este acta se puede encontrar el acta de la asamblea de Jóvenes-AIL.

5. Informe de nuestro representante en la EFFF

Sergi Sabater informa que el próximo congreso de la EFFF será en Olomouc (República Checa) los días 2-7 de julio de 2017. Ya hay página web pero de momento solo está la información de los plenarios y de las sesiones regulares. También se informa de los proyectos EFYR-EFFF, unos proyectos parecidos a los de Jóvenes-AIL pero a nivel europeo que intentan fomentar la colaboración entre los estudiantes jóvenes.

6. Informe de nuestro representante para la relación con las sociedades limnológicas iberoamericanas

Arturo Elozegi informa que en el ASLO de Granada se hizo reunión con representantes de las diferentes asociaciones latinoamericanas y de otros países sin asociación. Se acordó que los socios de todas las asociaciones pagarían como socios en todos los congresos de cada asociación. Asimismo, se propuso el primer Congreso Iberoamericano en Limnología que tendrá lugar en Valdivia (Chile) del 1-4 noviembre de 2016. Ya está abierto el plazo de inscripciones. El siguiente congreso podría ser en Brasil.

7. Presentación de candidaturas para la celebración de próximos congresos

Manuel Graça presenta la candidatura de Coimbra 2018 y propone las fechas de 24-29 de junio de 2018. Se vota y se aprueba por unanimidad.

Rosa Gómez presenta la candidatura de Murcia 2020 para hacer un congreso AIL y el segundo Congreso Iberoamericano de Limnología. Se vota y se aprueba por unanimidad.

8. Ruegos y preguntas

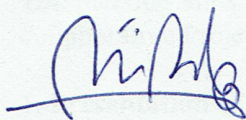
Concha Durán comenta que en breve el Ministerio sacará los pliegos de redes control por cuencas y que se va a valorar muy positivamente la presencia de expertos del tema.

Arturo Elosegui informa que en julio de 2017 se va a celebrar en Bilbao el congreso sobre descomposición y Eduardo Vicente informa que en 2017 se celebrará el Faro el congreso de "ponds". Toni Camacho recuerda que la AIL colaborará en todo lo que los organizadores pidan.

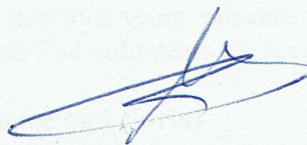
9. Elección de interventores para aprobación del acta

El presidente solicita tres voluntarios para actuar como interventores que aprueben el acta. Son nombrados Eugenio Rico....

Se levanta la sesión a las 20:30h.



Núria Bonada
Secretario de la AIL



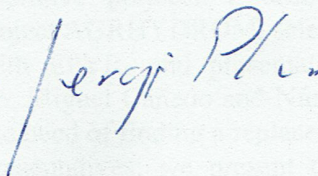
Vº Bueno Toni Camacho
Presidente de la AIL

Intervienen el acta para su aprobación

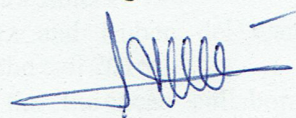
Eugenio Rico



Sergi Pla



Miguel Alonso



Assembly Jóvenes-AIL, Tortosa 2016

Fecha: 5 de julio de 2016, 17:30h

Lugar: Universidad Rovira i Virgili (Tortosa)

Secretaria: Núria Catalán

Summary of the meeting

The meeting aims to sum up the activities of the previous years, presents the winners of the collaborative Project and the aims of the Project and find volunteers for several tasks.

1. Presentation of the following points (by Veronica and Núria)

1. Who are J-AIL and how to find us
2. Why becoming a member (benefits)
3. Balance of the activities:
 - a. Inter-meeting workshops:
 - i. Febrero 2015, Granada “Scientific paper writing”, 32 participants
 - ii. September 2015, Lleida “Statistics with R”, 22 participants
 - b. Pre-meetings workshops:
 - i. Tortosa 2016, “Meta analysis” and “PhD, what’s next?”
 - c. Other activities in the meetings
 - d. Work group gender and science: Manuscript “Women in limnology in the Iberian peninsula” published in Limnetica
 - e. Prize best PhD thesis of J-AIL: Anna Lupon
 - f. Prize best manuscript in Limnetica of a J-AIL: Laura Jimenez
 - g. Call for collaborative projects: Edurne Estevez and Ruben del Campo, presented the project AGRHYDROM, selected in the call 2016.
 - h. Relationship with EFYR, and presentation of the European collaborative project EuroRun. Miguel Cañedo and Núria Cid, the EFYR representatives at EFFS explain the need of finding a replacement for their role.
 - i. Change of representatives: we present the candidates Edurne Estevez and Isabel Fernandez and vote them to be the new representatives of JAIL.
 - j. Presentation of tasks that require volunteers:
 - i. Cross check and maintenance of the list of J-AIL members
 - ii. Blog maintenance
 - iii. Merchandise responsible

2. Activities for the next period:

1. **Gender and science:** meeting on Thursday to talk about developing an itinerant exposition about great Spanish limnology-women. There is also the idea to develop a second study to evaluate the potential impact of gender biases in the main fellowship programs of Spain and Portugal (María Sánchez-Montoya).
2. **Veronica** proposed the next inter-meetings course (2017) to be held in Coimbra, a week extensive course on meta-analysis, to extend the information given in the Tortosa course. People liked the idea.
3. It was suggested the idea of develop a discussion group of “Ethics in science” (Veronica).

4. Also suggested the idea of developing long-term mentorships across career stages within the AIL.

3. Volunteers for the different tasks:

- Andrea Burfeid Castellanos (andrea.burfeid@gmail.com) --> merchandising
- Xavier Benito Granell (xavier.benito.granell@gmail.com) → twitter account and making active the blog, even developing a website.
- Serafina Sgarzi (sgarzi.serena@gmail.com) → merchandising
- Elena Hernández (e.hernandez.delamo@gmail.com) → merchandising
- Meritxell Abril → merchandising (developing new logo, new objects)
- Joan Pere Casas Ruiz (jpcasas@icra.cat) → mailing list
- Andrea Garcia Bravo (andrea.garcia@ebc.uu.se) → mail list or update status or communicate research of JAIL members
- Sonia Herrero (herrero@igb-berlin.de) → keep on building the map of JAIL
- Núria de Castro (nuriadcc@gmail.com) → communicate research of JAIL members in the BLOG
- Jordi-René Mor (jrmor@icra.cat) → communicate research of JAIL members in the Blog
- Tano Gutierrez (tano.gc@gmail.com) → communicate research, build database of funding opportunities in different countries.

Resolución

NOVENO PREMIO DE INVESTIGACIÓN EN LIMNOLOGÍA (mejor tesis doctoral del bienio 2014-2015)

La Asociación Ibérica de Limnología anunció el pasado enero de 2016 la convocatoria del Noveno Premio de Investigación en Limnología para las tesis defendidas durante el bienio 2014-2015. Como sabéis las tesis defendidas en el 2014 ya se evaluaron el año pasado y las mejores se presentaron como candidatas al premio bianual de la EFFS. En esta convocatoria se han evaluado las tesis defendidas en 2015. Del listado final de las puntuaciones de las tesis defendidas en 2014 y 2015 se ha obtenido el ganador de este premio.

En total se han presentado 25 tesis, 14 de las evaluadas fueron defendidas en 2014, 10 en 2015 y una no pudo ser evaluada porque se defendió en 2014 pero se presentó a la convocatoria de 2015. La tesis recibidas han sido (ordenadas por orden alfabético de apellido):

Autor/a	Director(es)	Universidad
AGUILERA, Rosanna	Sergi Sabater & Rafa Marcé	Universidad de Girona
ALEXANDRE, Carlos	Pedro Raposo de Almeida & Maria Teresa Ferreira	Universidad de Évora
ALVES, Ana Sofia	Joao Carlos Marques & Maria José Costa	Universidad de Coimbra
ARISTI, Ibon	Arturo Elosegí & Vicenç Acuña	Universidad del País Vasco
ARROITA, Maite	Arturo Elosegí & Vicenç Acuña	Universidad del País Vasco
BRUNO, Daniel	Josefa Velasco & David Sánchez-Fernández	Universidad de Murcia
FELIPE-LUCIA, María R.	Francisco A. Comín & Javier Escalera	Universidad Pablo de Olavide - IPE CSIC
FLOR-ARNAU, Núria	Jaume Cambra	Universidad de Barcelona
GUARESCHI, Simone	Andrés Millán, Josefa velasco & Pedro Abellán	Universidad de Murcia
GUTIÉRREZ, Cayetano	Josefa Velasco & Andrés Millán	Universidad de Murcia
LANDEIRA, Andrea	Maruxa Álvarez	Universidad de Vigo
LUPON, Anna	Susana Bernal & Francesc Sabater	Universidad de Barcelona
MESTRE, Alexandre	Francesc Mesquita & Juan Salvador Monrós	Universidad de Valencia
MORA-GÓMEZ, Juanita	Anna M. Romaní & Arturo Elosegí	Universidad de Girona
MORALES, María	José Ángel Gálvez & Andrés Cózar	Universidad de Cádiz
ONANDIA, Gabriela	María Rosa Miracle & Eduardo Vicente	Universidad de Valencia
PASTOR, Ada	Francesc Sabater	Universidad de Barcelona
PEIPOCH Marc	Eugènia Martí & Esperança Gacia	CESAB-Universidad de Barcelona
PEÑAS, Francisco	José Barquín & César Álvarez	Universidad de Cantabria
RIBEIRO, Ana-Rita	Maria Elizabeth Tiritan, Carlos MM Afonso & Paula ML Castro	Universidade Católica Portuguesa
RIVERA, Carlos	Jordi Catalan	Universidad de Barcelona - CREAM CSIC
SÁINZ-BARIAIN, Marta	Carmen Zamora-Muñoz	Universidad de Granada
SANPERA, Isis	Isabel Muñoz	Universidad de Barcelona
TIMONER, Xisca	Vicenç Acuña & Sergi Sabater	Universidad de Girona
ÚBEDA, Bárbara	Andrés Cózar & José Ángel Gálvez	Universidad de Cádiz

Las tesis se han evaluado de acuerdo a tres criterios independientes: novedad e interés del tema tratado, diseño experimental y metodología, presentación y

aspectos formales. Cada candidato ha sido evaluado por un jurado constituido por 3 miembros. Nuestro agradecimiento a los miembros del tribunal por el gran trabajo que han hecho. El proceso de selección ha sido muy difícil debido al gran nivel de todas las tesis recibidas, lo que, por otro lado, nos indica el buen estado de salud de la limnología Ibérica. En este sentido, desde la Junta Directiva de la AIL queremos agradecer a todos los participantes por su excelente trabajo y animarles a que sigan su trayectoria investigadora en limnología.

Por cuestiones relacionadas con la protección de datos personales, los concursantes que deseen consultar los resultados completos de su evaluación deberán solicitarlo mediante un mensaje de correo electrónico a la secretaría de la AIL (secretaria@limnologia.net), desde donde se les remitirá dicha documentación.

Después de evaluar todas las tesis, el tribunal ha concluido que **la mejor tesis doctoral en limnología defendida durante el bienio 2014-2015** es:

Anna Lupon (Departament d'Ecologia, Universitat de Barcelona) con el título "The influence of Mediterranean riparian zones on stream nitrogen dynamics: A catchment approach" y dirigida por Susana Bernal y Francesc Sabater.

A Anna, así como a sus directores, ¡muchas felicidades!

Asimismo, la Junta Directiva de la AIL ha decidido otorgar un **accésit a Rosanna Aguilera** por la tesis "Effects of land use and climate variability on the water quality of Mediterranean rivers: Towards a regional vision of global change" realizada en la Universidad de Girona y dirigida por Sergi Sabater y Rafa Marcé. ¡Enhorabuena!

El acto público de entrega del Premio así como la presentación de la tesis ganadora tendrá lugar el **7 de julio de 2016**, durante la celebración del XVIII Congreso de la AIL en Tortosa.

Resolución de la convocatoria para la elección de las mejores tesis ibéricas para optar al premio de la EFFS del periodo 2015-2016

La Federación Europea de Asociaciones de Limnología (European Federation for Freshwater Sciences, EFFS), que aglutina las principales asociaciones europeas de limnología en sentido amplio, lanzó el pasado mes de enero el Premio Europeo a la mejor Tesis Doctoral en Limnología. Dado que los congresos de la AIL se alternan con los de la EFFS, la AIL abrió una convocatoria para seleccionar la mejor tesis española y portuguesa del 2016. Las dos tesis seleccionadas en 2016 junto con la mejor española y portuguesa seleccionadas en 2014, se han mandado a la EFFS para competir con las demás tesis europeas presentadas por cada asociación miembro de la EFFS.

TESIS SELECCIONADAS Y PRESENTADAS EN 2015

Anna Lupon (Universitat de Barcelona) con el título “The influence of Mediterranean riparian zones on stream nitrogen dynamics: A catchment approach” y dirigida por Susana Bernal y Francesc Sabater.

Ana Sofia Alves (Universidade de Coimbra) con el título “Use of benthic meiofauna in evaluating marine ecosystems’ health: how useful can free-living marine nematodes be for ecological quality status (EQS) assessment in transitional waters?” y dirigida por Joao Carlos Marques y Maria José Costa.

TESIS SELECCIONADAS Y PRESENTADAS EN 2016

Se han recibido 12 tesis doctorales defendidas en la Península Ibérica en 2016, cuyos autores e instituciones se detallan en la siguiente tabla (ordenada por orden alfabético de nombre).

Autor/a	Director(es)	Centro
ÁLEX MIRÓ	Marc Ventura	CEAB-CSIC
ANNA FREIXA	Anna Maria Romaní	Universitat de Girona
ANTONIO PICAZO	Antonio Camacho & Eduardo Vicente	Universitat de València
BRUNO CARREIRA	Rui Rebelo & Anssi Laurila	Universidade de Lisboa
CARLA OLMO	Javier Armengol & Raquel Ortells	Universitat de València
FELIX PICAZO	Andrés Millán, José Luis Moreno & David Sánchez	Universidad de Murcia
JUAN ANTONIO VILLASCUSA	Antonio Camacho	Universitat de València
NADIA DARWICHE-CRIADO	Francisco Comín	IPE-CSIC
NOE FERREIRA	Isabel Pardo	Universidade de Vigo
NÚRIA DE CASTRO	Isabel Muñoz	Universitat de Barcelona
PABLO RODRÍGUEZ-LOZANO	Narcís Prat & Maria Rieradevall	Universitat de Barcelona
XAVIER BENITO	Manola Brunet, Rosa Trobajo & Carles Ibáñez	IRTA & Universitat Rovira y Virgili

Las tesis se han evaluado de acuerdo a tres criterios independientes: novedad e interés del tema tratado, diseño experimental y metodología, presentación y aspectos formales. Cada candidato ha sido evaluado por un jurado constituido por 3 miembros (2 españoles y 1 portugués). El proceso de selección ha sido muy difícil debido al gran nivel de todas las tesis recibidas, lo que, por otro lado, nos indica el buen estado de salud de la limnología Ibérica. En este sentido, desde la Junta Directiva de la AIL queremos agradecer a todos los participantes por su excelente trabajo y animarles a que sigan su trayectoria investigadora en limnología. Cada miembro de jurado ha destacado varios puntos fuertes y débiles de cada tesis. Si alguno de los candidatos está interesado en conocerlos, que mande un correo a la secretaría de la AIL (secretaria@limnologia.net).

Después de evaluar todas las tesis, el tribunal ha concluido que las dos mejores tesis (española y portuguesa) defendidas en la Península en 2016 son:

Àlex Miró (CEAB-CSIC) con el título “Fish as local stressors of Pyrenean high mountain lakes: arrival process and impact on amphibians and other organisms.” y dirigida por Marc Ventura.

Bruno Carreira (Universidade de Lisboa) con el título “Warm vegetarians? Heat wave effects on aquatic omnivorous ectotherms” y dirigida por Rui Rebelo y Anssi Laurilla.

A los dos, así como a sus directores, ¡muchas felicidades!

Las tesis de estos dos candidatos junto a las dos que se seleccionen en la próxima convocatoria serán las que competirán para el próximo premio de la AIL que se entregará en el congreso de Coimbra en 2018.

Las cuatro tesis seleccionadas del periodo 2015-2016 serán evaluadas durante las próximas semanas por la EFFF, que informará a los galardonados por lo menos tres meses antes del próximo SEFS en Olomouc.

¡Mucha suerte a todos!

Los quironómidos y el Taj Majal

NARCIS PRAT, Universitat de Barcelona

Pocas veces ocurre que, cuando uno se especializa en un grupo de insectos acuáticos de escasa importancia económica, estos sean objeto de una noticia que ocupa casi una página en un diario de amplia difusión nacional. Es el caso de los quironómidos de la especie *Chironomus calligraphus* que son noticia en la página de La Vanguardia del día 25 de mayo de 2016. Resulta que al Taj Majal le ha salido un nuevo enemigo para su conservación, los quironómidos que emergen del río Yamuna al atardecer. Se posan por millares en el monumento y al parecer lo manchan con sus excrementos. El problema es la contaminación del río Yarmuna que hace que sus aguas tengan una gran cantidad de algas y que se consuma su oxígeno. Las larvas de los *Chironomus*, precisamente, pueden resistir la falta de oxígeno (tienen un intenso color rojo debido a un alto contenido de un derivado de la hemoglobina) y además les gusta comer algas (y la materia orgánica en descomposición), y como nadie depreda los quironómidos, pues emergen a raudales. Los machos son atraídos por la luz y también por elementos destacados del paisaje (en este caso por el color claro del Taj Majal) y allí se dirigen. Su vida es efímera (pocas horas) apenas comen (si comen) y excretar muy poco, su función es encontrar una hembra para que siga poniendo huevos y el ciclo se perpetúe. La contaminación del río se debe a los residuos industriales y municipales sin depurar (el fósforo que pueda provenir de los hornos crematorios de la incineración de cadáveres, que sería responsable de tanto *Chironomus* según la noticia, frente al aportado por otras fuentes no es posiblemente muy relevante).

Este no es un fenómeno nuevo, hace ya muchos años que esta misma especie es una plaga en Florida. Los que poseen una casa al borde de un lago muchas veces no pueden salir de su casa por la cantidad de insectos emergentes y los lagos se tratan con insecticida para prevenir su emergencia. Otras especies además de producir estos efectos indeseables producen efectos alérgicos (por la hemoglobina que contienen) que pueden hacer enfermar parte de la población. En otro caso famoso, hace unos años los vuelos en el aeropuerto de Venecia se veían afectados por las nubes de quironómidos provenientes de la cercana laguna, llena de sus larvas donde se criaban por millones por los excesos de algas que crecían gracias al fósforo vertido por las depuradoras. En Catalunya tenemos también un ejemplo notable. En el lecho del río Besós en Santa Coloma de Gramanet, se crían los *Chironomus riparius* en densidades de centenares de miles de individuos por metro cuadrado. Para su control existe un programa de tratamiento con insecticida de las larvas para evitar que los adultos salgan en masa como hicieron en el pasado. Hace unos años el tomar una cerveza en la terraza de un bar de aquella población era casi una tortura, por los miles de individuos que del río eran atraídos por las luces al atardecer y se posaban sobre los toldos o las luces de la zona cercana al río o invadían los comedores de los pisos cercanos al río que tenían las ventanas abiertas. En los sistemas naturales los quironómidos también emergen por miles, forman unas nubes de machos que en ocasiones se sitúan en los bordes de los caminos, como puede verse en el Delta del Ebro. También son alimento de murciélagos o arañas. Sus larvas son el principal alimento de las criaturas que viven en lagos y ríos. Su proliferación y consideración como peste es nuestra culpa, las soluciones existen, pero como muchas veces la prevención, que sería lo mejor, es más complicada que la cura y al final estamos usando pesticidas para corregir aquello que somos incapaces de resolver en origen.

Para saber más: Failla, A.J. *et al* (2015) *Aquatic invasions* 10 (1): 1-15.

PINTURA Y LIMNOLOGÍA EN LA PENÍNSULA IBÉRICA: una introducción

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Las relaciones entre pintura de paisaje y limnología han sido poco exploradas. Los limnólogos vemos, estudiamos y describimos paisajes acuáticos no sólo mediante la percepción sensorial, sino usando herramientas conceptuales y técnicas, todo lo cual nos produce una visión “científica” del ecosistema acuático. Los pintores, que se acercan al paisaje (acuático o terrestre) desde la mera percepción sensorial, se encuentran más preocupados por la inspiración, la representación, lo sublime artístico (*sensu* Simmel, 2013), los efectos de la luz, el color, la forma e incluso el movimiento. Y de todo esto hay, o puede haber, en los ecosistemas que tanto nos gustan. Otra cosa totalmente distinta es cómo se representen: bien a nuestro modo limnológico, bien al modo de los artistas. Pero, a mi parecer, ambos acercamientos resultan complementarios.

Esta introducción demasiado preliminar al tema de la pintura y el ambiente limnológico se basa en un libro más amplio que estoy redactando sobre el paisaje representado en la pintura del paisaje ibérica, para el cual voy visitando museos de Bellas Artes por toda la piel de toro (Lisboa, Barcelona, Madrid, Bilbao, Cuenca, San Sebastián, Olot, Pamplona, Valencia, Sevilla, Albacete, Almería, Oviedo, Gijón, La Coruña... por ahora). Dispongo ya de mucha iconografía, de la cual aquí os proporcionaré algunas pinceladas (nunca mejor dicho). Las fotos, de calidad obviamente desigual, me las han proporcionado los Museos, los artistas (¡un millón de gracias!), las he hecho yo y/o he sacado alguna de internet: todo vale, Feyerabend. Los cuadros no están reproducidos a escala.

Tradicionalmente, la plasmación de paisajes por los grandes maestros de la pintura ha huido de la representación realista. El fondo de *La Gioconda* es un paisaje; el de *Las Lanzas*, también; pero son más bien mitológicos, inventados más que recreados. El pintor clásico huía del paisaje, lleno de alimañas y enfermedades (de origen acuático a menudo), en vez de acercarse a él. El primer gran artista europeo que representa ambientes acuáticos es el flamenco Joaquim Patinir, el cual vivió a caballo entre los siglos XV y XVI, pero sus cuadros –donde predominan unos azules hermosísimos, pero improbables– recrean el Olimpo acuoso y no ambientes acuáticos reales. En la pintura japonesa hay multitud de representaciones lacustres desde el periodo Muromachi al menos (siglos XIV-XVI), cuando los pintores Sesshu Toyo y Kano Motonobu comienzan a representar ambientes lacustres: su estilización, de una belleza asombrosa, a pesar nuestro nos los aleja de la pintura europea que conocemos. Tras ellos, la temática lacustre se ha convertido en un subgénero, junto con el monte Fuji, de la pintura japonesa.

En nuestro continente, la pintura de paisaje realista comienza en el siglo XVII con el napolitano Salvator Rosa y el lorenés Claude Lorrain. A la Península Ibérica dicha pintura no llegará hasta casi la segunda década del siglo XIX, aunque tengamos el notable precedente del valenciano Mariano Ramón Sancho en los años finales del siglo anterior, cuando representa distintas actividades (lavanderas, pescadores, paseantes) en la orilla del río Anoia (Barcelona).



Mariano Ramón Sancho. *Puente de Martorell*. Obra del siglo XVIII, pero posterior a 1787. Museo de San Telmo, San Sebastián.

Luego, hay dos grandes pintores de pintura de paisaje en el siglo XIX, dedicando algunos esfuerzos a retratar ecosistemas acuáticos continentales. El primero es el barcelonés Ramón Martí Alsina, cuya vida discurre durante gran parte del siglo por su ciudad natal y alrededores y tiene unas admirables composiciones de gran tamaño sobre paisajes fluviales. En muchas de ellas, como la que reproduzco abajo, el artista nos ofrece una perspectiva, ecológicamente muy actual, del valle fluvial, con sus aguas corrientes y estancadas (restos de cuando el río llevaba un caudal mayor), el arbolado ripario (o no), la erosión de los taludes, la pequeñez humana enfrentada al paisaje limnológico...



Ramón Martí Alsina. *La riera d'Argentona*. 1875-1880. Museo Carmen Thyssen. Málaga.

El segundo es Carlos de Haes, artista de origen flamenco que se instala en Madrid a mediados del siglo, y desde su cátedra en la Escuela de Bellas Artes de San Fernando inicia la moderna pintura realista de paisaje

en la Península Ibérica. Con de Haes en Madrid se forman los primeros pintores ibéricos de paisaje (Jaime Morera, Aureliano de Beruete, Nicanor Piñole y muchos más), los cuales después marchan a sus lugares de origen donde perseveran en su arte de paisaje naturalista o impresionista. De Haes resulta un pintor más naturalista que realista y se interesa, sobre todo, por la geología y el arbolado, pero tiene también alguna pintura fluvial en la sierra del Guadarrama, en la desembocadura del Llobregat y en el entorno del monasterio de Piedra (Zaragoza), además de unos preciosos dibujos de la cascada, interrumpida en el momento del dibujo, existente entre las lagunas Redondilla y Lengua (Albacete) y de los Ojos del Guadiana (Ciudad Real). De Haes fue un gran maestro y el origen primordial de nuestra pintura de paisaje. Viajó bastante, lo cual le sirvió –entre muchas otras obras– para pintar las lagunas someras de Abcoude (Utrecht, Holanda).



Carlos de Haes. *Laguna de Piedra*. Alrededor de 1872. Museo del Prado. Madrid.

Martín Alsina fue maestro de numerosos pintores, Joaquín Vayreda entre ellos. El olotí es el principal retratista de los aiguamolls de la Garrotxa a finales del siglo XIX e iniciador de la escuela de paisaje de Olot junto su hermano Marian y con Josep Berga. Son preciosas estampas al óleo donde el espectador puede apreciar la pureza semi-impresionista de la vegetación acuática sumergida (sí, se aprecia en la pintura) y emergente, los clots en medio del bosque, el ganado vacuno que se baña en las aguas estancadas (en ésta) o divagantes (en otras pinturas), los efectos de la luz sobre el agua...



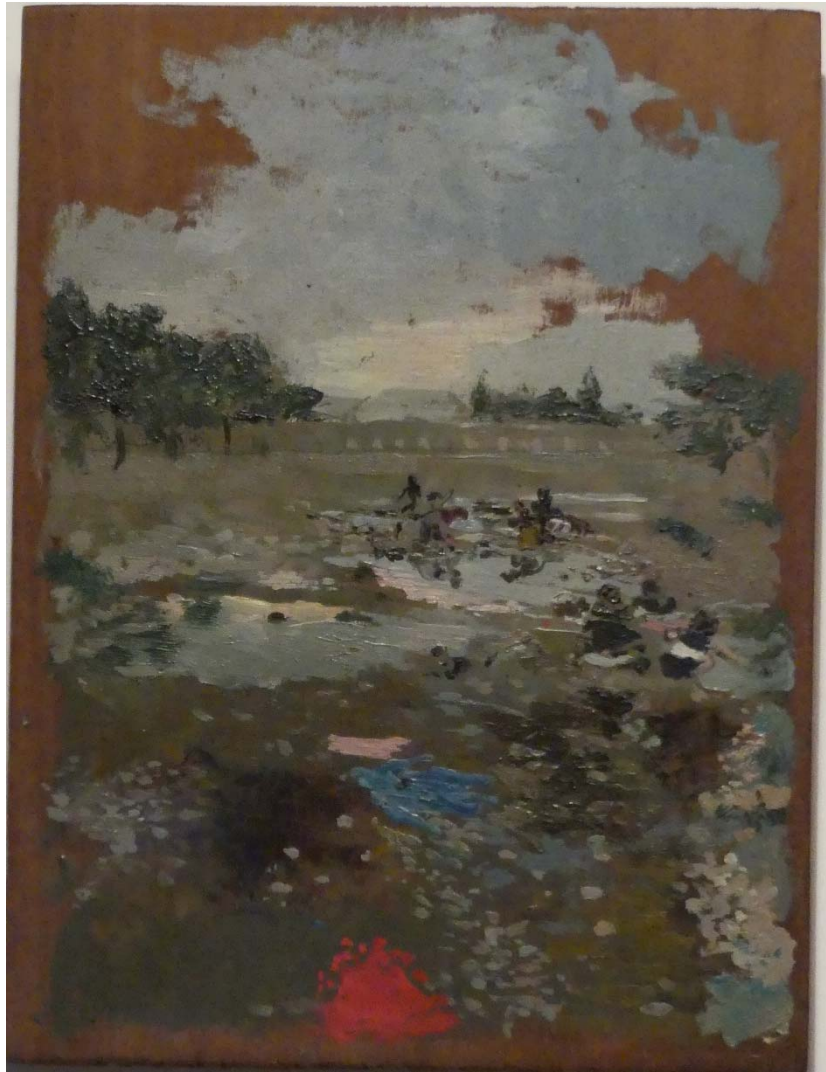
Joaquín Vayreda. *Léstiú*. 1877. Museo de Olot (Girona).

En Madrid, los primeros discípulos de de Haes no se hicieron esperar. Un clásico es Aureliano de Beruete, cuya imagen del río Manzanares, con su cauce trenzado, sus lavanderas y su escaso caudal figura, sin saberlo, en el cerebro de muchos madrileños. Y lo más sorprendente cuando se compara con el actual: el color azul del agua.



Aureliano de Beruete. *El Manzanares (vista de Madrid)*. 1908. Museo Sorolla. Madrid.

El tema de las lavanderas ha dado bastante juego en la pintura. Otro óleo del pintor valenciano que más me gusta, Ignacio Pinazo, nos las muestra desde un ángulo “impresionista”, pero más tirando hacia la abstracción, en un contexto fluvial periurbano, donde los tramos fluviales de aguas lentas y rápidas se confunden con la vegetación (¿algas?), con las mujeres de negro y con la ropa.



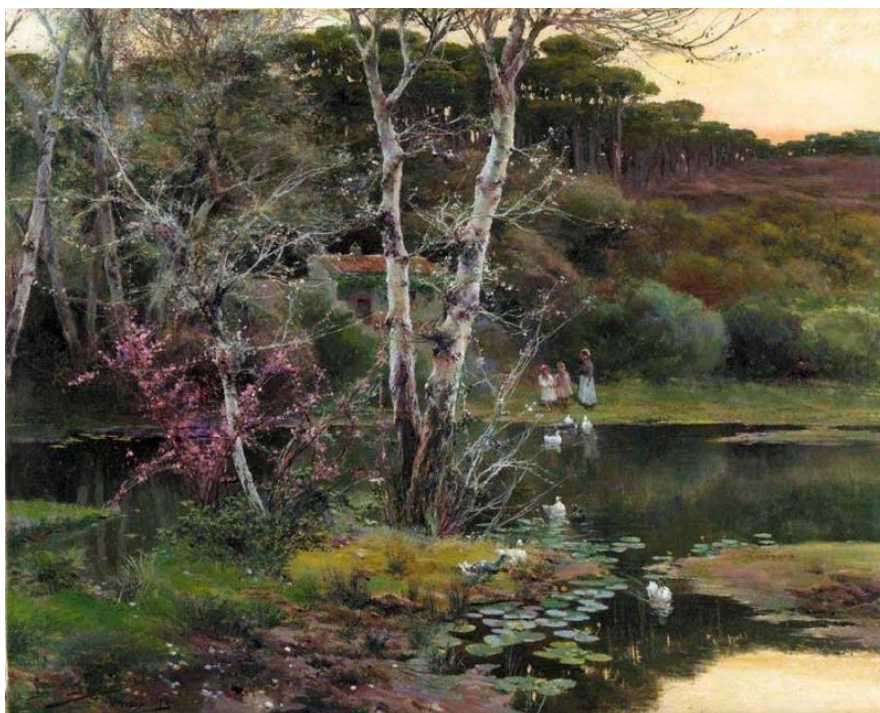
Ignacio Pinazo. *Lavanderas*. 1880-1890. Museo del IVAM, Valencia. El cuadro está obviamente en mal estado.

El mucho más internacionalmente famoso Joaquín Sorolla pinta paisajes a todo gas para abastecer a su clientela mundial. Tiene escenas en la Albufera, por supuesto. En una de ellas muestra una barca típica, varada junto a la vegetación litoral de un canal; delante de la proa, se adivina la vegetación sumergida.



Joaquín Sorolla. *Barca en la Albufera*. 1908. Museo Sorolla. Madrid.

Los pintores de Alcalá de Guadaíra (Sevilla), por su lado, se muestran más interesados por la influencia humana sobre el río y tienden a representar más los numerosos molinos construidos en su vega, sin desdeñar otros aspectos puramente limnológicos. La escuela de Alcalá ha dado lugar hasta la actualidad a varias generaciones sucesivas de pintores, donde destacan José Arpa, Emilio Sánchez Perrier, José Pinelo, José Lafita y bastantes más. Un pintor interesante es el sevillano Manuel García Rodríguez, discípulo de Sánchez Perrier entre otros, y retrata muy bien la margen izquierda del río, con sus álamos blancos, sus nenúfares, sus aves de corral, sus familias, sus orillas en aguas bajas y sus islas fluviales, con el pinar de la Oromana al fondo.



Manuel García Rodríguez. *Cerca del estanque*. 1913. Colección particular.

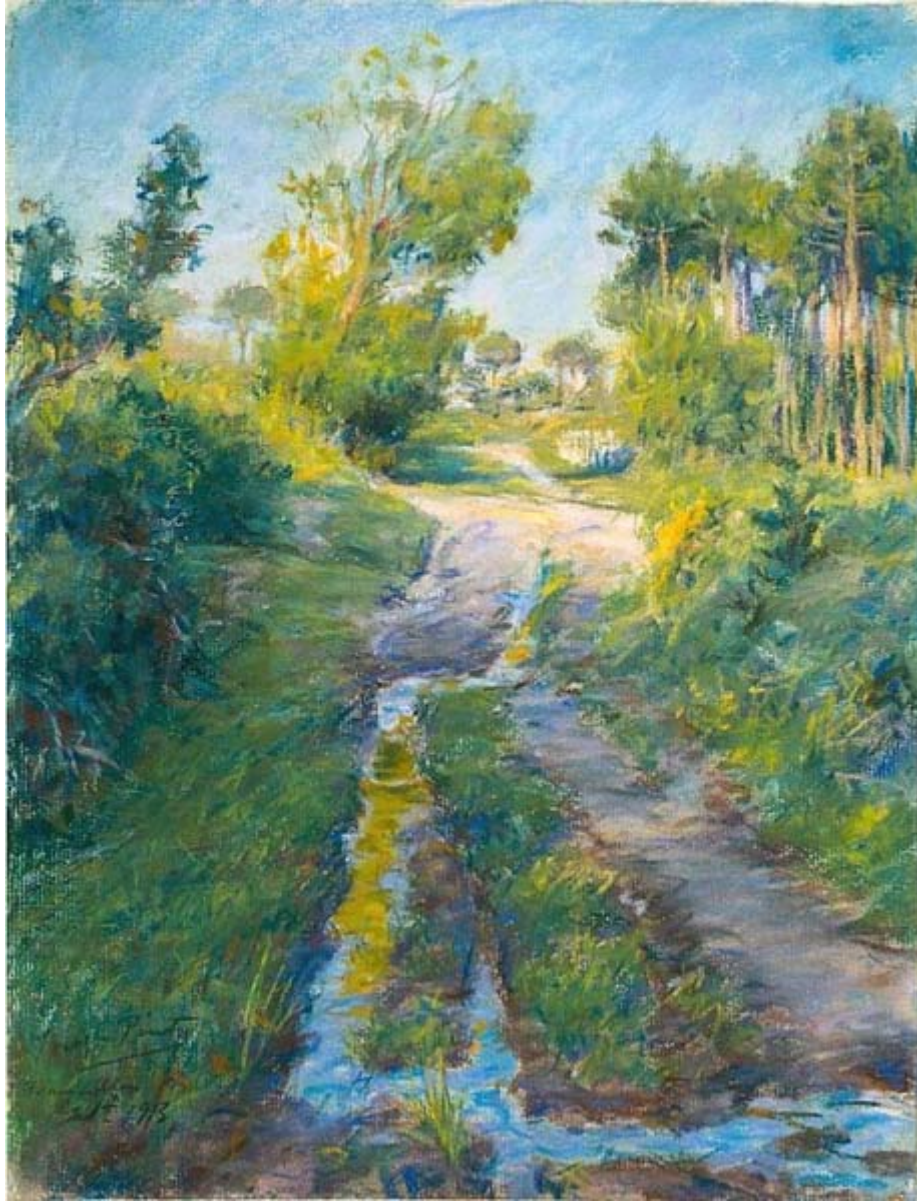
La pintura portuguesa de paisaje se inspira infinitamente más en el medio marino, así que no he encontrado demasiados ejemplos donde el motivo sean las aguas continentales. Entre el naturalismo y el impresionismo tenemos la obra del lisboeta Carlos de Bragança (el rey Carlos I de Portugal, que también fue oceanógrafo, y cayó asesinado en 1908), claramente deudor de la escuela “pleinairista”¹ francesa, cuya representación de una charca en el Alentejo resulta notable por la plasmación del modesto ecosistema acuático rodeado de un paisaje agrario donde no resulta raro imaginarse rebaños yendo a beber. La charca parece una simple depresión en el terreno, que se inunda temporalmente con agua de lluvia.



Carlos de Bragança. *Charneca dos Almos (Alentejo)*. 1898. Museu Nacional de Arte Contemporânea do Chiado. Lisboa.

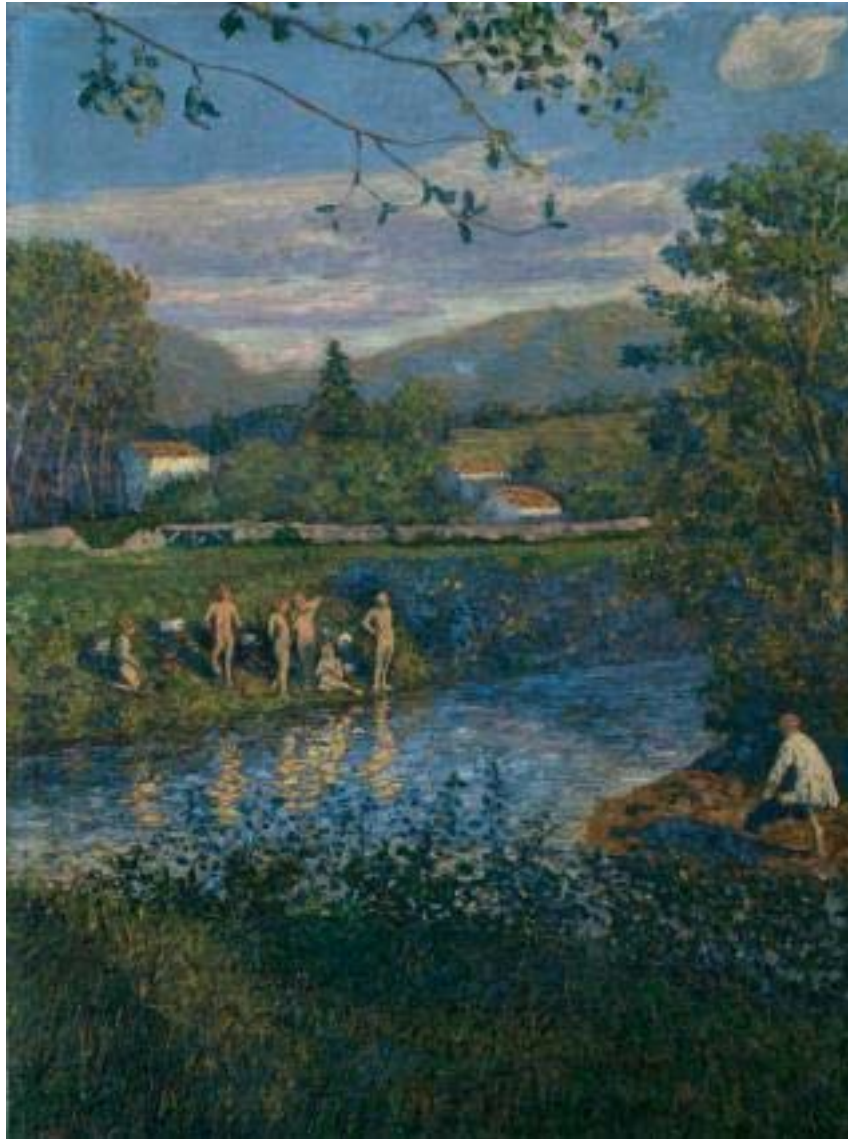
Otra obra portuguesa sorprendente es la del azorense José Júlio de Souza Pinto porque retrata un ambiente limnológico muy efímero y poco conocido: una regata en las rodadas de un camino. Quizá sea mi imaginación, pero yo veo una mancha verdi-amarillenta en ellas que podrían ser algas filamentosas afectadas por una irradiación excesiva; quizá no lo sea o sí, la pintura naturalista que practicaba de Souza trataba de representar la realidad echando toda la carne al asador. Margalef muestreó en las zanjas de las trincheras del ferrocarril, pero ahora no recuerdo si también lo hizo en sitios parecidos al del cuadro. Yo he visto, desde luego, algas y renacuajos en ellos.

¹Galicismo horrible, pero se dice así. Viene del francés *plein air* y alude a los primeros pintores que sacaban el caballete al medio natural y pintaban directamente, prestando una atención especial a los efectos de la luz solar. Lo propugnó la llamada escuela de Barbizon, un grupo de artistas de Fontainebleau (pueblo cercano a París) que pintó en torno a los años 1830-1870. Tuvo mucha influencia en toda Europa.



Jose Júlio de Souza Pinto. *Efeito do sol ao fim da tarde*. 1913. Museu Nacional de Arte Contemporânea do Chiado. Lisboa.

El asturiano Darío de Regoyos, uno de los impresionistas españoles más celebrados, se pasea por el País Vasco y produce varias obras de temática fluvial. La que reproduzco aquí tiene una luz fría, más invernal que estival, y muestra un río donde unos críos se esfuerzan por bañarse. Las aguas son azules oscuro, la vegetación litoral intenta aprovecharse de la luz como malamente puede y uno imagina una flora y una fauna estenotermas bajo del agua.



Darío de Regoyos. *El baño en Rentería*. 1900. Museo de Bellas Artes de Bilbao.

Hay muchos pintores del paisaje vasco, luminosos y bastante más cálidos que Regoyos. Javier Ciga, Gaspar Montes Iturrioz, José Salis son algunos de ellos, muy interesados por representar las aguas del Bidasoa. Sin embargo, ahora quiero traer aquí a una mujer, Menchu Gal, fallecida hace pocos años. En el óleo que os ofrezco abajo, el paisaje fluvial no tiene demasiada presencia, pues la pintora está más interesada por el ambiente pastoril, pero aún así podemos percibir el bosque de ribera antropizado, los chopos, las rocas en el cauce y el agua inusualmente azul del río Bidasoa.



Menchu Gal. *Santesteban (Navarra)*. 1942-1943. Ayuntamiento de Irún. Según me han dicho, cuando pase la crisis quizá construyan un museo en la ciudad. Por ahora, hay que confiar en la buena voluntad de los técnicos municipales, que es mucha, para ver estas obras.

Otra mujer muy importante en la pintura de paisaje ibérica es la sevillana Carmen Laffón, que tiene una vivienda en Sanlúcar, muy cerquita del Coto de Doñana. Su pintura tiene un carácter onírico que casa muy bien con la bruma producida por la pérdida de calor de los ecosistemas acuáticos en otoño y con su evaporación estival. Pero, además, nos ofrece una representación magistral del bosque ribereño y de las nubes verdosas (¿algas? ¿materia coloreada?) que transporta el agua.



Carmen Laffón. *Orilla del coto desde Bonanza*. 2013-2014. Centro Andaluz de Arte Contemporáneo. Sevilla.

Siguiendo con los humedales, cabe citar aquí a Juan D'Opazo, un pintor manchego mucho menos conocido que Antonio López García. Ello no obsta para que tenga algunas obras de gran valía, muy personales, especialmente las dedicadas a Las Tablas de Daimiel. La que enseño aquí refleja el carrizo otoñal y una pequeña tabla de agua, oscurecida por la descomposición de *Phragmites*, en una zona, Flor Ribera, antaño

inundada y muy visitada por los pescadores que vivían en el humedal (véase Alvarez Cobelas & Cirujano, 2015).



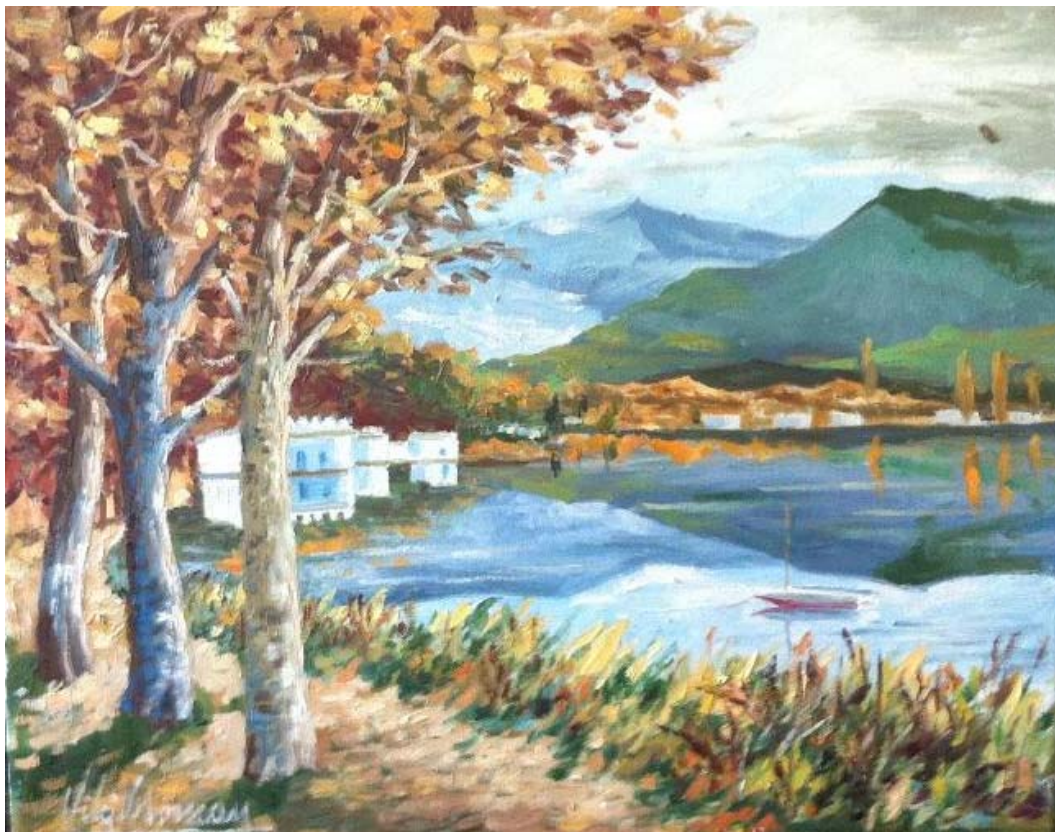
Juan D'Opazo. *Flor de Ribera*. Museo Comarcal de Daimiel, Ciudad Real. Ignoro la fecha de composición de esta obra a pastel.

Y más sobre paisajes estancados: tenemos otra obra de tendencia también onírica, un poco anticuada y mitológica. El coruñés Manuel Abelenda, familiar del dibujante de La Codorniz, retrata una laguna próxima a Redondela. En un ambiente medio brumoso y entre unos extraños ¿eucaliptos? vemos una laguna de fondo de valle a la que se accede por un camino por el que discurre agua. La pintura transmite extrañeza y nos dan ganas de ir a ver si eso es así y qué extraños seres habitan ese lugar espectral.



Manuel Abelenda. *Sinfonía verde en Redondela*. 1947. Museo de Belas Artes da Coruña.

Un ambiente mucho más conocido para todos nosotros es el lago de Banyoles. Joan Vilà, conocido muralista de Vich y director durante muchos años de la escuela de Bellas Artes de Olot, representó sus característicos puestos de pesca, su paseo perimetral y su vegetación emergente en una obra donde le importa más el reflejo montañoso en el agua que cualquier otro efecto de la luz.



Joan Vilà i Moncau. *Lago de Banyoles*. Desconozco la fecha de composición y quién es el propietario.

Y ahora viene lo difícil: la abstracción. Si la ciencia es abstracción más que otra cosa, ¿por qué pasmarnos (y decir que no entendemos) con lo que los artistas llaman “abstracto”? Comienzo por la originalísima obra del alicantino Eusebio Sempere, trufada de abstracción cinética. De él, aquí os traigo una magnífica estilización de un lago somero, endorreico quizá, rodeado de árboles y carrizo en la orilla más cercana al espectador y con una playa arenosa en la más lejana. ¿O son simples reflejos en el agua de algo más alejado del lago?



Eusebio Sempere. *Estanque 2*. 1963. Museo de Arte Abstracto de Cuenca.

Luego, tenemos al coruñés Luis Seoane, el cual pinta una laguna perpendicular a la costa, rodeada de ¿bosque/hierba? y campos, que es de un esquematismo atronador. El espectador, ecólogo o no, puede inventarse todo lo que quieran viéndola.



Luis Seoane. *Paisaxe*. 1966. Museo de Belas Artes da Coruña.

Fernando Zóbel, en fin, se especializa en abstraer la naturaleza usando un enfoque geométrico, a base de cuadraditos y de líneas de fuga. Su obra fluvial que aquí muestro es polimorfa y un poco inquietante. A primera vista parece un río azulado, con vegetación, una roca y mucha bruma. Pero el espectador nunca sabrá si lo que en realidad quiere enseñarnos este pintor español nacido en Manila es la profunda hoz del Júcar a su paso por Cuenca capital, que se vislumbra en la parte inferior derecha del cuadro. O todo a la vez.



Fernando Zóbel. *El Júcar X (la piedra del caballo)*. 1971. Museo de Arte Abstracto de Cuenca.

Ya acabo. Hasta aquí, os he puesto algunos ejemplos de ecosistemas acuáticos continentales vistos por pintores, donde dominan la geomorfología y la vegetación. ¿Y no hay alguno de entes más pequeños, os preguntaréis? No conozco apenas, pero buscaré más. A bote pronto, os termino de rematar con uno de Maruja Mallo, pintora surrealista y clara deudora de Joan Miró, la cual nos propina una versión chundarata de distintos protozoos.



Maruja Mallo. *Protozoarios*. 1981. Museo Nacional Reina Sofía. Madrid.

Resumiendo, y para acabar: la pintura de paisajes ibéricos de aguas continentales tiene una tradición de más de dos siglos, resulta enormemente variada y una gran fuente de placer estético cuando uno quiera descansar la mente del tráfigo limnológico.

CODA

El gran George Evelyn Hutchinson, enorme científico (y limnólogo), se preocupó mucho de las relaciones entre arte y zoología. Visitó en bastantes ocasiones distintos museos de Bellas Artes (Fitzwilliam en el Cambridge inglés, Palazzo Pitti en Florencia, Kunsthistorisches Museum en Viena) para estudiar la pintura medieval de animales, que incluían una lamprea y algo parecido a un lucio. Publicó al menos dos trabajos sobre el tema (Hutchinson, 1974, 1978), además de una especulación original (Hutchinson, 1963) sobre el origen de los museos de Bellas Artes. Don Avelino suponía que habían surgido a partir de las colecciones variopintas que algunos ricos atesoraban a finales de la Edad Media, las cuales incluían objetos biológicos y geológicos más o menos artísticos (plumas, huevos de avestruz, colmillos, guijarros, piedras preciosas, etc.). O sea, que la ciencia de la naturaleza estuvo unida al arte en sus inicios, según el amigo GEH. La pena, digo yo, es que se hayan separado.

Un poco de bibliografía

- Alonso Miura, R. *et al.* 2006. *Paisajes del Guadaíra. Flora, fauna e intervención humana*. Ayuntamiento de Alcalá de Guadaíra. Sevilla.
- Alvarez Cobelas, M. & Cirujano, S. 2015. *Flor Ribera. La gente del río en La Mancha*. Limnolberia nº 3. Grupo de Investigaciones del Agua. Madrid.
- Bosco Díaz-Urmeneta, J. (ed.) 2014. *Carmen Laffón, el paisaje y el lugar*. Centro de Estudios Andaluces. Sevilla.
- Chillón, M.C. 2010. *El pintor Ramón Martí Alsina (1826-1894): Contrastos de la seva vida a partir d'una documentació inèdita, i proposta d'un primer catàleg*. Tesis Doctoral. Dos tomos. Universidad Autónoma. Barcelona.
- Gutiérrez Márquez, A. 2004. *Carlos de Haes en el Museo del Prado*. Catálogo razonado. Museo Nacional del Prado. Ministerio de Cultura. Madrid.
- Hernández, M. 1977. *Fernando Zóbel. El misterio de lo transparente*. Rayuela. Madrid.
- Huici, F. & Pérez de Ayala, J. (eds.) 2010. *Maruja Mallo*. Sociedad de Conmemoraciones Culturales. Madrid.
- Hutchinson, G.E. 1963. The naturalist as an art critic. *Proceedings of the Academy of Natural Sciences of Philadelphia* 115: 99-111.
- Hutchinson, G.E. 1974. Attitudes toward Nature in Medieval England: The Alphonso and Bird Psalters. *Isis* 65: 5-37.
- Hutchinson, G.E. 1978. Zoological iconography in the West after A.D. 1200. *American Scientist* 66. 675-684.
- Milani, R. 2015. *El arte del paisaje*. 2ª edición. Biblioteca Nueva. Madrid.
- Noma, S. *et al.* 2003. *The arts of Japan*. Kondansha International. New York.
- Pérez Rojas, F.J. *et al.* 2005. *Ignacio Pinazo. Los orígenes de la pintura moderna*. Museo IVAM. Valencia.
- Simmel, G. 2013. *Filosofía del paisaje*. Casimiro ediciones. Madrid.
- VV AA, 1998. *Eusebio Sempere. Una antología, 1953-1981*. Instituto de Cultura Juan Gil-Albert. Diputación provincial de Alicante. Alicante.
- VV AA, 2011. *Menchu Gal. La alegría del color*. Fundación Menchu Gal. Madrid.
- VV AA, 2013. *Darío de Regoyos. 1857-1913. La aventura impresionista*. Museo de Bellas Artes. Bilbao.
- VV AA, 2016. *Sorolla, tierra adentro*. Fundación Museo Sorolla. Madrid.
- Zubiaur, F.J. 1986. *La escuela del Bidasoa. Una actitud ante la Naturaleza*. Institución Príncipe de Viana. Gobierno de Navarra. Pamplona.

Trabajos de Investigación

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TÍTULO DEL TRABAJO: On the origin and assembly of communities: Diversity patterns of Trichoptera across a latitudinal gradient in Europe

DIRECTOR: Dr Cesc Múrria, cmurria@ub.edu

CENTRO DE REALIZACIÓN: Grup de recerca FEM (Freshwater Ecology Management), Departament d'Ecologia, Universitat de Barcelona (UB), Barcelona

FECHA DE PRESENTACIÓN: 13-octubre-2015

INTRODUCTION, OBJECTIVES AND HYPOTHESIS

A fundamental question in macroecology is how current and historical environment, species interactions, physiological constraints and evolutionary processes merge to determine community structure and shape the current distribution of taxa. To elucidate the role that these factors have been playing in establishing patterns of regional diversity, three approaches must be integrated at the community level: phylogeny, trait information, and species assemblage at both local and regional scales (WEBB et al., 2002). There is a well-established pattern shared across a wide range of taxa to find high diversity levels in south regions whereas this diversity decreases in northern latitudes (GASTON, 2000). In Europe, current geographical patterns of diversity are intimately associated to cyclic glaciations and ice retreat during the Pleistocene (approximately 2–0.01 Mya ago) that resulted in exchanges and mixing of organisms between northern and southern European regions (HEWITT, 1999). In order to understand the evolutionary processes underlying current European patterns of species diversity, we assessed how species, functional traits and phylogenetic composition of Trichoptera (Insecta) changed among 10 communities within 6 regions located along a latitudinal gradient from Morocco to Sweden. The main hypothesis of the study are summarized in figure 1.

RESULTS

We found a unimodal distribution of α - and γ -diversity being the highest diversity at the Carpathians but also North Iberian Peninsula (Picos de Europa and Cantabria), which is against the main expectation of decrease of diversity as latitude increases. This indicates that, overall, Trichoptera are well-distributed across Europe because the vast majority of genera are found in every region. On the other hand, the partition of β -diversity showed low contribution of the nestedness (10.91%), whereas the β -diversity pattern across latitude is driven by turnover that participates till 89.09%, with little differences along latitude. The phylogenetic tree, which includes more than 80% of all European Trichoptera genera, revealed that phylogenetic relatedness among genera within regions differed from low to high latitudes. The phylogenetic structure of northern communities was clustered (i.e., individuals were phylogenetically closer), whereas southern communities were overdispersed (i.e., individuals were less phylogenetically related). Finally, traits were found phylogenetically conserved indicating strong phylogenetic signal, which means that closer lineages share similar ecological traits and niche preferences.

DISCUSSION

The discovery of high levels of diversity, endemism in South but also central Europe and different phylogenetic community structure across the latitude suggest the existence of cryptic refuges also in temperate regions during glaciations in the Pleistocene. This finding supports Dinodal's hypothesis which predicts that suitable habitat within the periglacial area persisted throughout the cyclic Pleistocene glaciations giving suitable conditions for survival in central Europe (MALICKY, 1983). This result contradicts the theories that locate glacial refuges exclusively in southern areas that are expected to act as centres of speciation and sources of recolonization that originated northern regions (HEWITT, 1999). Herein, the integration of ecology and evolution at the community level explain how Trichoptera lineages have been originally assembled in Europe. Overall the latitudinal pattern of phylogenetic diversity and structure of communities can be explained by historical environmental constraints that together with

phylogenetic niche conservatism are the key factors that promote current diversity distribution of Trichoptera across Europe.

BIBLIOGRAPHY

- GASTON, K. J. (2000). Global patterns in biodiversity. *Nature* 405: 220-227.
- HEWITT, G. M. (1999). Post-glacial re-colonization of European biota. *Biological Journal of the Linnean Society* 68: 87-112.
- MALICKY, H. (1983) Chorological patterns and biome types of European Trichoptera and other freshwater insects. *Archiv für Hydrobiologie* 96: 223–244.
- WEBB, C. O., Ackerly, D. D., McPeck, M. A., & Donoghue, M. J. (2002). Phylogenies and community ecology. *Annual Review of Ecology and Systematics* 33: 475-505.

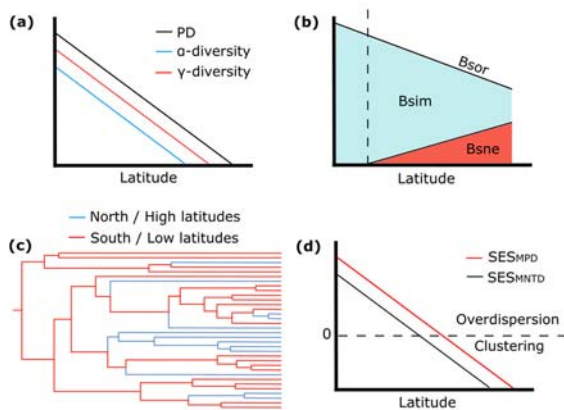


Fig. 1: Scheme of the main hypothesis of the study. (a) The phylogenetic distance (PD), α - and γ -diversities are expected to decrease towards northern latitudes. (b) Total β -diversity (B_{sor}) is also expected to decrease due to species turnover (B_{sim}) in lower latitudes and nestedness (B_{sne}) in the highest latitudes. (c) Only few lineages would have the effective functional traits to colonize and cope harshness in north latitudes, and therefore (d) SES_{MPD} and SES_{MNTD} would have a negative slope in relation to latitude. Values upper 0 indicate overdispersion in southern latitudes whereas values lower 0 show clustering processes in northern regions.

Access link to project: <http://www.ub.edu/fem/index.php/public/treballs-27>

AUTORA: Carla Olmo

TÍTULO DEL TRABAJO: Zooplankton assemblages in a Mediterranean restored area: patterns and processes of colonization and establishment

DIRECTORA: Javier Armengol y Raquel Ortells

CENTRO DE REALIZACIÓN: Dep.Microbiología y Ecología. Fac. CC. Biológicas Universidad de Valencia

FECHA DE PRESENTACIÓN: 27th May 2016

Ponds are systems exceptionally rich in biodiversity terms. They facilitate the connection among different water bodies and provide a great number of ecosystem services such as developing highly relevant ecological scientific studies. Despite their ecological importance, these systems have suffered high anthropogenic pressures that triggered several threats on them. During the 20th century, Mediterranean coastal ponds suffered strong impacts, even disappeared, mainly due to urbanization. In this scenario it has been necessary the development of projects trying to restore and recover the prior ecological functioning of these ponds. Restored ponds have become essential systems to test ecological hypothesis on the patterns and processes of colonization and establishment of aquatic communities. These insights can be essential to determine the priorities and strategies of management and conservation in this kind of systems and over other features related to them.

Albufera Natural Park is a mosaic of different habitats protected by different local, regional, European and international policies (Ramsar, Natura 2000,...). Its surroundings are densely populated and increase the anthropogenic pressure. In addition, fishing, rice cultivation and hunting are allowed in some parts of the area. The Park includes a lake that is separated from the Mediterranean Sea by a moderately urbanized sandbar of 14 km long and one kilometer wide called La Devesa de El Saler. This sand bar is formed by a set of dunes and interdunal depressions that may hold rain water for prolonged periods of time (i. e., interdunal ponds, locally called malladas). There are approximately 40 malladas distributed all along the described area. This typology of ponds was catalogued in the Habitats Directive (92/43/EEC) as “Humid dune slacks (Code 2190)”. These malladas are endorheic, shallow and slightly brackish. Their size is small, with a maximum surface of generally less than one hectare. Most of them are temporary and fishless, although, some were excavated deeper to connect with the phreatic layer. Since these ponds fill up with rain, annual hydrology depend mostly on rainfall. In the Mediterranean region, major rainfall events occur in autumn and spring, while summer is warm and xeric, and all temporary ponds remain dry. According to this, the hydrological year is considered to start in September and finish in August of the next year. However, each hydrological year may include alternating periods of flooding (hydroperiods) and drying. La Devesa de El Saler suffered strong transformations in the past. At 60's, an urban project was approved with the objective of an intensive urbanization of the sand bar. The project involved flattening, which resulted in an almost complete disappearance of the dunes closer to the coastline, together with the malladas which were artificially silted with sand from the dunes. At the late seventies, the urban project was paralysed but not until the 90's did the European, national and regional policies try to recover their natural value via restoration projects. The restoration of the coastal dunes and silted malladas was part of successive large-scale projects (three EU-Life projects in total) that tried to restore La Devesa de El Saler to its prior state. The three projects that included the restoration of malladas were performed in 1998, 2003 and 2007. Restoration works consisted in the removal of external materials and sediments until an impermeable lime layer. During this process, prevalence of the natural bottom sediments (with their correspondent propagule bank) of each basin was not taken into account. Actually, the area of Devesa de El Saler is also a recreational area densely frequented by local people and tourists that indiscriminately cross the malladas mostly in the dry periods. Samples and data for this thesis began to be taken when the last restoration project was finished and the newest malladas were filled with rainwater for the first time (September-October 2007). This natural scenario with ponds of different hydroregime and restoration age was an outstanding opportunity to study the above mentioned patterns and processes of zooplankton communities. We selected 17 malladas: seven restored in 2007 (named Recently restored ponds (R): six temporary and one permanent), four restored in 2003 (named Intermediate ponds (I): three temporary and one permanent) and six restored in 1998 (named Old ponds (O): four temporary and two permanent). We monthly sampled these ponds from October 2007 to May 2011. Each sampling consisted in the measurement of a set of limnological variables in situ (conductivity, pH, temperature, oxygen and depth) and ex situ (ammonium, nitrites, nitrates, soluble reactive phosphorus and chlorophyll a). Other environmental variables such as the

presence of animals (macroinvertebrates, fish, amphibians, waterfowls and mammals) and the vegetation cover (helophytes and submerged macrophytes) were visually checked. In addition, zooplankton samples were taken by filtering 20 L of the water column integrating the possible different microhabitats of the pond. All zooplanktonic organisms from the samples were counted and identified. Finally, additional samples were taken to achieve the specific objectives of each chapter.

The main objective of this thesis was to understand which processes are determinant in the establishment of populations and in the assemblage of communities, always focusing in zooplankton. The structure and specific objectives by chapters are explained below and summarized in Figure 1.

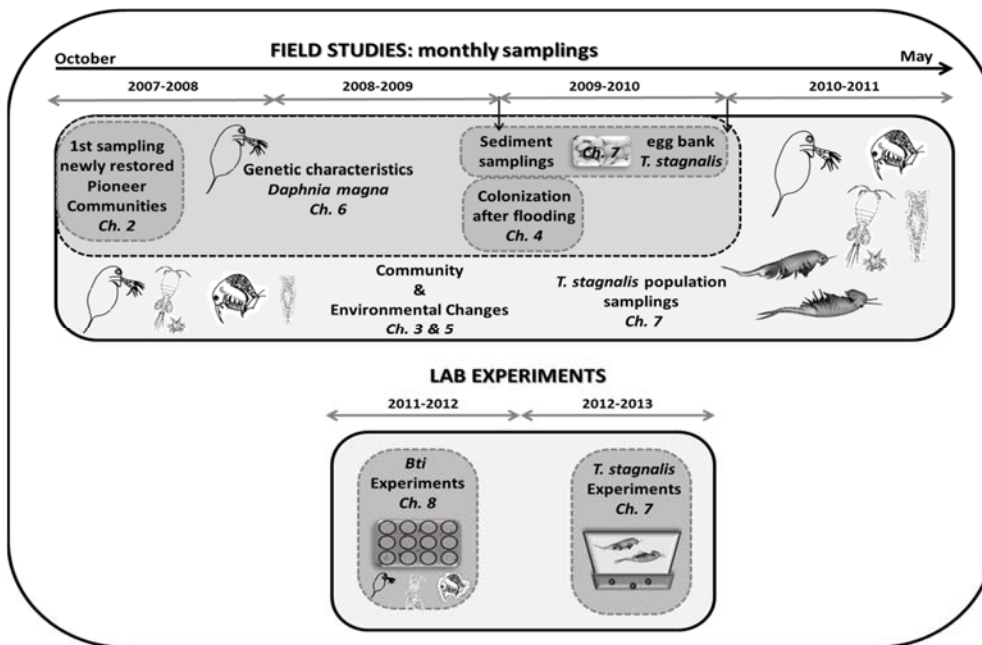


Figure 1. Schematic overview of the temporal organization of the thesis and chapters where the specific topics are included

Chapter 2 provides a detailed description of the study area and pays special attention to six temporary ponds that were restored at the beginning of the thesis (Summer 2007). Pioneer species are those that first colonize a habitat and could have a determinant role in the future assemblage of communities. These pioneer zooplanktonic communities of the recently restored ponds were described by monitoring the first flooding period after restoration (October 2007), and comparing them with the regional species pool described in the area during the hydrological year before restoration (2006-2007). On this first sampling (15 days after flooding), these recently restored ponds had reached 27% of the species previously described. This fact indicates the great dispersive and colonizing abilities of these organisms. The dominant group in richness and abundance was Rotifera. The high number of species and their abundances in some ponds suggests the possibility that a previous egg bank was remaining after restoration works.

Chapter 3 portrays the environmental framework of the study area including the 17 ponds object of this thesis. It describes the main limnological variables and their changes over four years. It also attempts at explaining the most important sources of variation to describe differences among the study ponds and its relationship with restoration age and hydroperiod. Both variables increased heterogeneity among the ponds. In general terms, malladas tended to loose conductivity, pH, oxygen and depth with time (Fig. 2). These differences seemed to be related to age specific processes as salt leaching, natural silting and the increase of vegetation and organic matter decomposition. The knowledge about these local environmental changes could elucidate some aspects about changes in zooplankton communities.

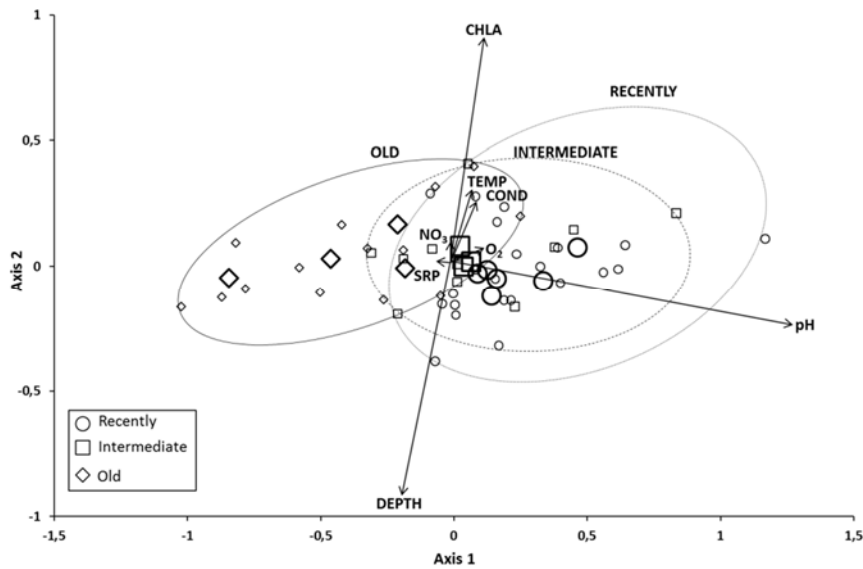


Figure 2. Principal Component Analysis of physico-chemical variables during the study period (2007–2011) in the thirteen temporary ponds (PCA-III). Largest symbols correspond to centroids of each pond (average position of all samplings in a pond) and shortest symbols correspond to average values of each year in each pond. First axis explains 57.3 % and second, 18.4 % of variance. Abbreviations: COND conductivity, TEMP temperature; O₂ oxygen, CHLA chlorophyll *a*, NO₃ nitrates and SRP soluble reactive phosphorus.

The beginning of hydroperiod in temporary ponds is when the re-establishment of communities starts and thus, the moment of higher emergence from the egg bank. **Chapter 4** identifies the differences in community composition during the early stages of community re-establishment after the summer drought (4-week study in September-October 2009) among nine temporary ponds of three different restoration ages. During this detailed study, rotifers and juvenile cyclopids were the dominant organisms. Cumulative richness was not very different between groups of ponds at the end of this month. Nevertheless, some temporal changes and early trends in zooplankton groups were observed which could be related to the restoration age.

Recently restored ponds are quasi-experimental units that allow the study of community succession from its beginning. **Chapter 5** describes the 4-year succession of the zooplankton community in a pond, starting from its restoration and addresses questions related to this process by comparing with two older ponds studied in the same period. All these temporal and spatial data provide interesting information about the environmental changes, their relationships with changes in zooplankton communities and the restoration age of ponds. Restoration promoted high effect in the recently restored pond (R1) as the higher changes (in the environment and in the community) were observed at the first steps of succession (Fig. 3). After this first year, R1 began to converge to the other older ponds in the vicinity which community were more complex.

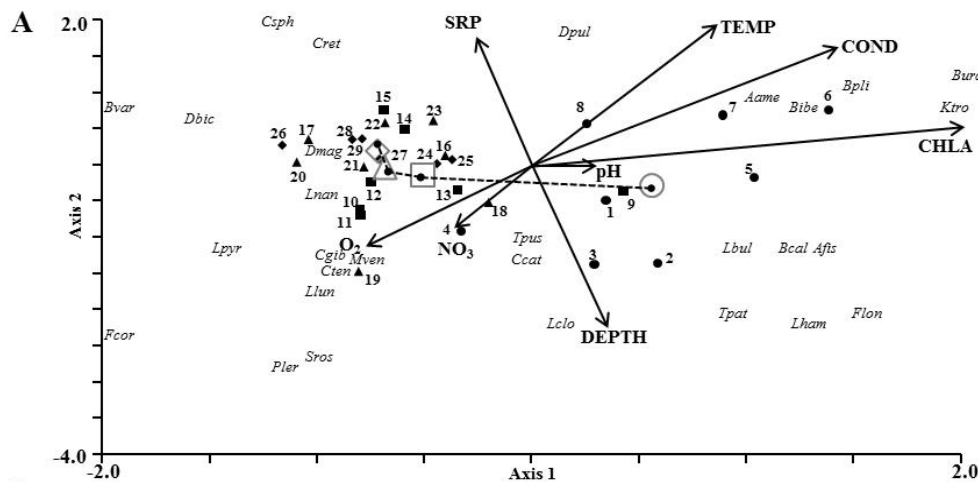


Figure 3. CCA of all samplings of R1 (29 samplings) based on the relative abundance of zooplankton species (abbreviations) and eight environmental variables (arrows). Empty symbols correspond to the centroids (averages of sample ordination coordinates) of each hydrological year. Circles, squares, triangles and diamonds correspond to first, second, third and fourth year, respectively. The dotted line joining centroids indicates their trajectory through time. The species shown are those distinctive of each hydrological year. For the sake of clarity, only those species with densities higher than 0.1 Ind L⁻¹ and those with scores higher than 1 in both axes were included in the graph. Abbreviations: COND, conductivity; TEMP, temperature; O₂, oxygen concentration; CHLA, chlorophyll *a*; NO₃, nitrates; SRP, soluble reactive phosphorus. The percentages of variance explained for each axis: Axis 1 (32.2%), Axis 2 (21.6%).

Colonization process can also be studied with model organisms from a population genetics perspective. **Chapter 6** genetically quantifies the colonization and establishment of one species in two newly created ponds during their first three years after restoration. The model organism used was the cladoceran *Daphnia magna* as it offers the possibility to track genetic changes during the colonization process due to clonal proliferation during the first hydroperiod before sexual reproduction disrupts clonal composition at the end of the growth phase. With this study, Monopolization Hypothesis was demonstrated for the first time in the field. This result highlights the importance of dispersal, founder effects and natural selection of zooplankton populations.

During the colonization process, the species arriving to a new habitat should be tolerant to the local abiotic and biotic factors. In addition, they should find feeding resources and, in the case of strictly sexual species, a mate to reproduce and establish with success. **Chapter 7** combines field observations and laboratory experiments to evaluate the ecological requirements of the fairy shrimp *Tanymastix stagnalis*. Active populations of this species are exclusively present in one old pond in our study area. The study reveals that conductivity is the main factor determining this habitat exclusiveness as it limited the hatching and survival of the species (Fig. 4). The high conductivity of nearby recently restored ponds makes them unsuitable to *T. stagnalis*. Due to its imminent local extinction, we provide suggestions for species conservation at a local and wider scale.

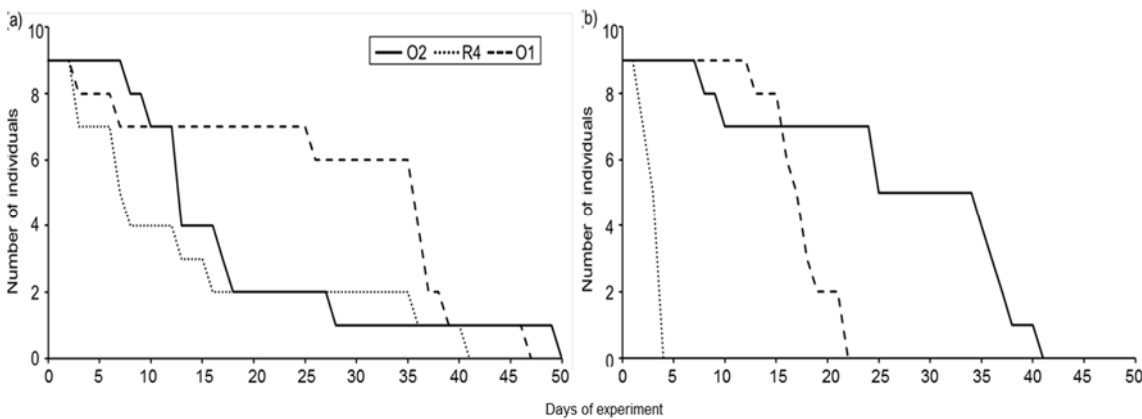


Figure 4. Survival curves (totals for all replicates) of *T. stagnalis* cultured in sediment from the three ponds (O2, R4 and O1) collected on a) 2009 and b) 2010 (see “Methods”)

Historically, our study area was artificially dried avoiding mosquito populations which were malaria vectors. Currently, a natural biocide, *Bacillus thuringiensis var. israelensis* (*Bti*), is widely used to mosquito control as it is considered environmentally safe. Some species of mosquito larvae shared habitat and feeding resources with zooplankton species. **Chapter 8** evaluates the use of this biocide over non-targeted zooplanktonic microcrustaceans collected from natural populations through laboratory experiments. In total, 294 bioassays (6 concentrations x 5 species {2 of them with two developmental stages} x 7 replicates) were performed. A total of 1890 individuals were tested. The selected species are common in our study area and therefore, the possible effects on these populations could have important consequences at the community level. Despite the high variability of responses among and within species, we observed the increase of mortality with increasing concentration and time. Nevertheless, we cannot attribute any significant toxic effect over these non-target species, at least at those operational doses used in the field.

From all of the above, we suggest a series of measurements for future restoration projects: 1) the propagule bank should not be rejected, as the maintenance of the prior propagule bank can fasten the return to the original habitat, 2) we believe that stepwise restoration resulting in ponds of different age is a good method to increase the biodiversity in the area and to produce a healthy metapopulation via dispersal, 3) we propose some easy conservation measures for *T. stagnalis* which include a cyst bank storage or/and adult translocations to nearby ponds with studied suitable conditions, 4) we strongly recommend following the operational conditions of *Bti* use which are known to be harmless to zooplankton communities, 5) the possibility of a new restoration could be considered in the described ponds and others in the area that remain silted.

In all cases, future restoration and management should promote a wide range of wetland types, maintaining the temporal water regime and, therefore, the large biodiversity associated with temporary ponds in the coastal Mediterranean basin.

AUTOR: Alexandre Miró Pastó

TÍTULO DEL TRABAJO: Fish as local stressors of Pyrenean high mountain lakes: arrival process and impact on amphibians and other organisms

DIRECTOR: Marc Ventura Oller

CENTRO DE REALIZACIÓN: Centre d'Estudis Avançats de Blanes (CEAB-CSIC).

FECHA DE PRESENTACIÓN: 8 de enero de 2016

Pyrenean high mountain lakes are naturally fishless due to natural barriers that have prevented the natural colonisation of fish species from lower streams. However, there have been numerous trout introductions to such ecosystems, both in historical and recent periods. Differing from other high mountain regions, some high mountain lakes of the Pyrenees were exploited traditionally for trout cultivation. This activity started at least centuries ago and lasted until 1950s, affecting approximately 25% of the lakes. Since 1950, and similar to other high mountain regions, a wave of modern introductions with exotic species has affected among 35% and 85% of the lakes depending on the valley. In recent decades, minnows have also been introduced, being present in 2000 in 27% of Pyrenean high mountain lakes, as a result of recreational fishing with live-bait.

The first part of the thesis was intended to provide an objective description of the fish introduction process in the Pyrenees. For that purpose we collected data on trout and minnow occurrence from 520 high mountain lakes >0.5 ha of the southern Pyrenees and quantified, by generalized additive models, which particular factors either environmental or anthropogenic, best explained their present distribution and as a result their lake conservation status.

The distribution of *Salmo trutta* in the southern slope of the Pyrenees was best explained by both, anthropogenic factors and lake characteristics, while only anthropogenic factors linked to recreational fishing were associated with the distribution of the exotic trout *Salvelinus fontinalis* and *Oncorhynchus mykiss*. For the case of minnow occurrence, previous presence of trout in the lake was the most explanative variable, confirming its association with recreational fishing using them as live-bait.

Trout and minnow introductions can cause large ecological problems and ecosystem alterations in high mountain lakes and ponds, since both trout and minnows occupy the top of a lake's food chain. In the second part of the thesis, we sampled 1736 Pyrenean high mountain lakes and ponds at different levels of intensity and investigated the effects of introduced fish on indicator faunal groups such as amphibians and conspicuous macroinvertebrates in the littoral, and crustaceans from the plankton. We also studied if there was a trophic cascade from fish to the littoral epilithic community of these ecosystems.

Our results showed that fish presence was linked with the disappearance of most amphibian species and of most conspicuous macroinvertebrates. Minnows also showed sizeable impact on the pelagic habitat reducing the abundance of some herbivorous species of zooplankton that appeared to be unaffected by trout. In the case of amphibian species, we found that, although introduced fish had a high local impact, western-eastern patterns of some environmental variables are the main drivers of amphibian species distribution at Pyrenean range scale. In addition, we confirmed the presence of a littoral trophic cascade that define most of the characteristics of the littoral epilithon of Pyrenean high mountain lakes and ponds, through fish predation of tadpoles and hence, by a drastic reduction of grazing activity.

AUTORA: Ana Sofia Alves

TÍTULO DEL TRABAJO: Use of benthic meiofauna in evaluating marine ecosystems' health: How useful can free-living marine nematodes be for Ecological Quality Status (EQS) assessment in transitional waters?

DIRECTORES: Professor João Carlos Marques and Professor Maria José Costa

CENTRO DE REALIZACIÓN:

FECHA DE PRESENTACIÓN: 3-marzo-2015

Estuarine meiofauna communities have been only recently considered to be good indicators of ecological quality, exhibiting several advantages over macrofauna, such as their small size, high abundance, rapid generation times and absence of a planktonic phase. In estuaries we must account not only for a great natural variability along the estuarine gradient (e.g. sediment type and dynamics, oxygen availability, temperature, flow speed) but also for the existence of anthropogenic pressures (e.g. high local population density, presence of harbours, dredging activities). In the scope of the growing awareness of the threat human activities represent to aquatic ecosystems, there has been a development in environmental policies, mainly focused on the ecological quality assessment.

The present work was focused on the meiobenthic communities of the Mondego estuary (Portugal), a South-Western European transitional system that suffered intense anthropogenic pressure over the last decades, with known overall decline in its environmental quality. The system's evolution and condition has been followed in the scope of both research projects and monitoring programs, with special emphasis on water quality, hydraulics, sediment dynamic and biological communities.

The investigation developed in this thesis had as main objective to understand the role of meiobenthic and free-living nematode communities in temperate estuarine systems, and to evaluate their potential role as ecological quality indicators, expanding our knowledge on their distribution constraints, ecological and functional characterization while identifying critical features that could be used in an accurate classification of transitional systems. A group of studies was undertaken to respond to the following specific objectives:

1. To analyze if nematode and macrofauna assemblages provide similar ecological assessment information;
2. To assess the spatial and temporal distribution of meiobenthic and, more specifically, free-living nematodes in estuarine systems;
3. To investigate the use of taxonomic classification and functional traits of nematodes regarding the detection of the main factors related to communities distribution patterns;
4. To assess the ability of intertidal meiofauna and nematode communities to be indicators of a system's recovery.

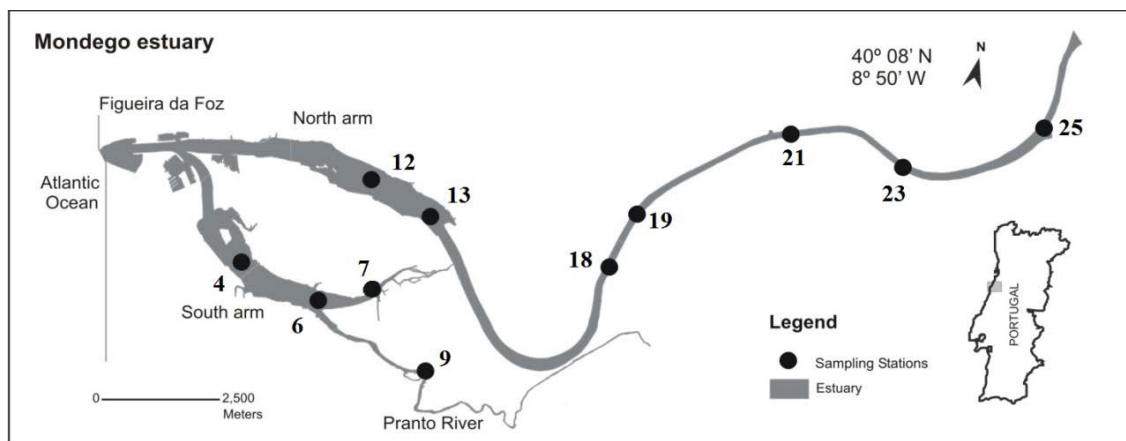


Figure 1. Mondego estuary (Portugal). Station locations represented by the black circles. Estuarine areas: Euhaline (station 4), Polyhaline South arm (stations 6, 7 and 9), Polyhaline North arm (stations 12 and 13), Mesohaline (stations 18 and 19) and Oligohaline (stations 21, 23 and 25).

The Mondego estuary (Portugal) (**Fig. 1**) was addressed as case study. This estuary is located on the Atlantic coast of Portugal (40°08'N, 8°50'W), and it is a polyhaline system influenced by a warm-temperate climate. It is 21 km long (based on the extent of tidal influence) with an area of about 8.6 km² and, in its terminal part (at a distance of 7 km from the sea) it divides into two arms, northern and southern, separated by an alluvial island (Murraceira island), which rejoin near the estuary's mouth. The two arms have very different hydrological characteristics and, in May 2006, the communication between both arms was re-established in order to improve the water quality in the terminal part of the estuary by reducing the residence time in the southern arm. It supports not only the Figueira da Foz harbour (regular dredging is carried out to ensure shipping conditions) but numerous industries, receiving agricultural run-off from rice and corn fields in the Lower River valley.

Along the several works presented in the thesis, the meiofauna and nematode communities were sampled along sampling stations following the division of the estuary based on water and sediment variables, covering five different areas, with natural variability: Euhaline (station 4), Polyhaline South arm (stations 6, 7 and 9), Polyhaline North arm (stations 12 and 13), Mesohaline (stations 18 and 19) and Oligohaline (stations 21, 23 and 25) (**Fig. 1**). Along with the biological sampling, environmental variables were collected and later related with the biological patterns encountered.

The results of the abiotic variables showed that along the estuary, salinity and nutrient concentrations showed opposite trends, with higher salinity values and lower nutrient concentrations downstream and lower salinity values and higher nutrient concentrations upstream. A decrease in grain size was also observed from Oligohaline area towards the mouth of the estuary (**Fig. 2**).

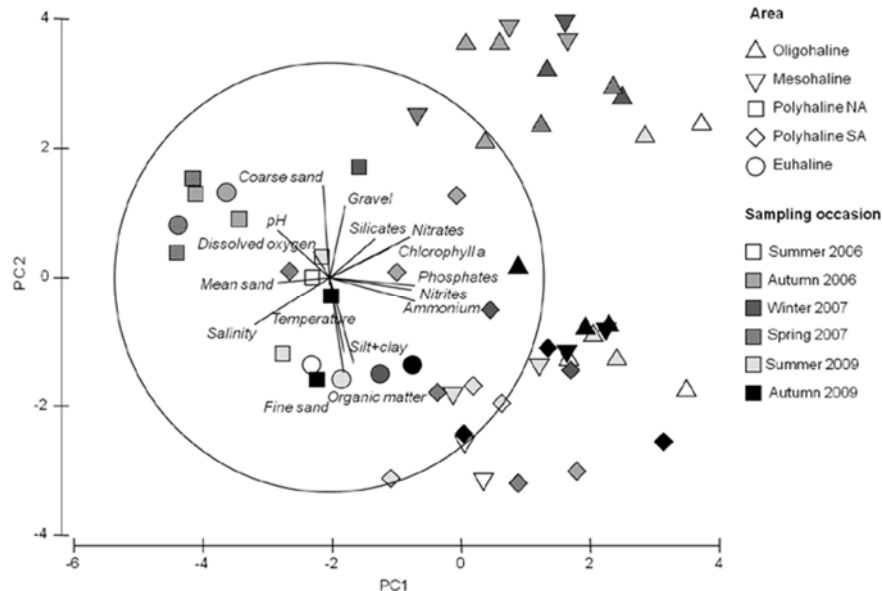


Figure 2. Principal component analysis (PCA) plot based on the environmental variables measured in each “area” (Oligohaline, Mesohaline, Polyhaline North Arm, Polyhaline South Arm and Euhaline) and “sampling occasion” (Summer 06, Autumn 06, Winter 07, Spring 07, Summer 09 and Autumn 09). PC1= 29.0%, PC2=23.8%.

The analysis of the subtidal meiobenthic communities at a major taxa level allowed the determination of their composition, which was similar to what is found in other European estuaries. Meiobenthic communities are mainly composed by nematodes, polychaetes and copepods, and their distribution pattern shows a gradient that is closely linked with the estuarine gradient. By increasing the taxonomic resolution, with the investigation of nematode genera distribution it became clearer that nematodes are the ones that best mirror the estuarine gradient, with different communities characterizing different predefined sections of the estuary. In fact, when comparing the “pictures” of the estuary provided by the analysis of the macrofauna and nematodes communities, a clearer pattern of separation of the areas arose regarding the nematode communities, confirming the separation of the estuarine areas based on an environmental characterization. Although the comparative approach regarding macrofauna and nematode communities was only performed on a short temporal range (one season), it allowed highlighting that the diverse life histories of these communities integrate differently the environmental constraints, being recommended that both groups should be used in pollution monitoring groups, since they may integrate different aspects of the system, revealing complementary aspects of the factors structuring the benthic ecosystem.

The application of the maturity and trophic diversity indices to the nematodes communities allowed the identification of some knowledge gaps regarding their useful application. Nevertheless, the application of the referred indices enabled the recognition that different areas of the estuary present different constraints to the structure of the communities and, when assessing their ecological status, different functional aspects must be taken in consideration. Moreover, based on the functional structure of the communities, it was possible to further recognize that this estuarine division is not only based on environmental characteristics but also on ecological ones, reinforcing the utility of functional analysis.

The detailed analysis of biological traits presented by nematodes allowed, on one hand, to reinforce the knowledge on their distribution patterns along the estuarine gradient, understanding the effect of the most structuring variables and, on the other hand, enabled to determine that different insights on the system were highlighted by single and multi-trait analysis. Single traits analysis was, in fact, especially competent in disentangling the effects of abiotic estuarine variability, reinforcing their potential role as indicators of different environmental conditions. Nevertheless, there is never an overlap of the information, demonstrating that the inclusion of diverse aspects of the functioning of the system allows a more realistic image of the systems to be obtained. Furthermore, it was also illustrated that information regarding biological traits is scarce for nematodes and even the basis of the Maturity Index and Index of Trophic Diversity rely on information that may not be the most accurate.

The analysis of the intertidal meiofauna and nematodes of the South arm of the Mondego showed a different pattern from the one presented along the estuary. By taking a small-scale approach, focusing only on the polyhaline stretch, temporal differences were observed, differently from the larger scale (whole estuary) previously presented. The effects of extreme climatic events were verified and, although unpredictable, droughts and floods are known to influence meiobenthos and nematode communities, causing salinity alterations and sediment disruption.

The described distribution patterns and related factors allowed to not only detect trends in meiobenthic distribution but to highlight factors that must be concerned in environmental assessments. From a management perspective, it is first needed to know the distribution trends of the communities and their structuring factors to correctly analyze the effects of anthropogenic impacts. In fact, if physicochemical conditions are altered, these will have impacts on the structure of the communities, which, in turn, may affect higher trophic levels, which should be considered when applying well structured assessment actions. The complementarity between taxonomic and functional approaches allowed for a better knowledge of the system, which may have future implication in assessing different areas of the estuary known to present discrete communities.

AUTORA: Anna Freixa Casals

TÍTULO DEL TRABAJO: FUNCTION AND STRUCTURE OF RIVER SEDIMENT BIOFILMS AND THEIR ROLE IN DISSOLVED ORGANIC MATTER UTILIZATION

DIRECTORA: Anna M. Romaní Cornet

CENTRO DE REALIZACIÓN: Universitat de Girona. Institut Ecologia Aquàtica

FECHA DE PRESENTACIÓN: 18/02/2016

Access thesis: <http://www.tdx.cat/handle/10803/363921> Contact: annafreixa7@gmail.com

Microbial communities in sediments play a key role in the degradation of organic matter in river ecosystems. These communities are directly influenced by environmental variables that fluctuate through time and space. In addition, in Mediterranean streams, object of study of this thesis, environmental variability is enhanced by the impact of human activities and further affected by global climate change. The main objectives of this thesis were to study the changes in the biofilm structure and dissolved organic matter utilization in river sediments at different spatial and temporal scales and, to detect main environmental drivers that modify these microbial communities.

To meet these objectives, two field studies and two laboratory experiments were performed (Fig. 1). The first field study was performed in the Llobregat river, where the changes in the utilization of organic carbon compounds from mid to lower reaches in river sediments were analysed, using the Biolog EcoPlates technique. Second, an intense longitudinal sampling of sediments and water in the Tordera river were performed at two different hydrological periods, in order to study differences in bacterial community composition and microbial organic matter utilization. Moreover, this thesis also includes two laboratory

experiments. The first experiment was performed using an infiltration sediment tank in order to study microbial organic matter utilization in sediment depth and at different oxygen concentrations. In the second experiment, artificial streams were used to study the warming effect and alteration of diel temperature pattern in carbon metabolism and biofilm composition. Finally, the Biolog EcoPlates technique was extensively reviewed in the first chapter of the thesis.

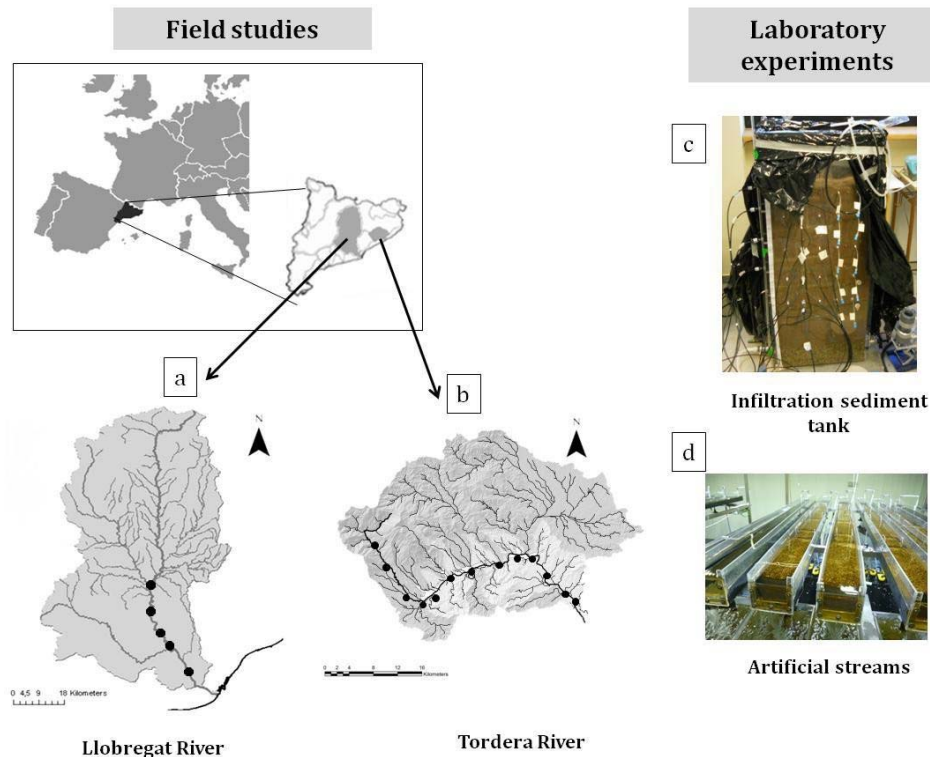


Fig.1. Field (a, b) and laboratory experiments (c, d) performed in the thesis.

Results from this thesis suggested that **Biolog EcoPlates** are a practical and useful approach to study the spatial and temporal differences in carbon substrate utilization and functional diversity of fresh environmental sediment samples. In this way, results suggested that preserving frozen samples is not recommended, because significant biases can be observed such as a reduction of the overall functional diversity and richness of the microbial community inoculated in the plates.

Related to **spatial variability** in sediment biofilm microbial functioning and structure, our results demonstrated that the terrestrial inputs of organic matter in headwaters dictated the longitudinal pattern of organic matter utilization along the Tordera river. In headwaters, the potential degradation of cellulose and hemicellulose dominated and this was linked to higher input of allochthonous material from riparian forest, whereas accumulation and degradation of more recalcitrant compounds became relevant downstream. Otherwise, in another chapter of this thesis in the Llobregat river, results showed that an increase in water pollution downstream could be responsible for changes in structure and functioning of biofilm communities. In this river, the biofilm located downstream, in the most polluted sampling sites, was less structured (with lower content of extracellular polysaccharides) and was characterized by being able to degrade more complex carbon compounds such as polymers, when compared to upstream sites. On the other hand, in a smaller spatial scale, from the laboratory experiment using a sediment infiltration tank, evident vertical gradient were observed in microbial organic matter utilization between surface and depth sediments (50 cm) linked with the depletion of dissolved oxygen in depth. In this experiment, microbial communities in surface sediments were capable of using a wider range of organic substrates in contrast to deeper sediments where microbial organic matter degradation was clearly affected by the anoxic conditions.

In relation to **temporal variability**, the study in the Tordera river showed that seasonality (especially due to different hydrological conditions) modified river sediment functioning and bacterial composition. During the drought period, the disconnection of the river continuum stimulated the formation of microhabitats where gamma and delta-Proteobacteria dominated and microbial community was potentially able to degrade more

diverse organic compounds particularly in relation to nitrogen. In contrast, during base flow, higher use of carbon organic compounds and abundance of alpha-Proteobacteria were observed. On the other hand, in the laboratory experiment using artificial streams where sediment carbon metabolism was studied in a shorter temporal scale, a clear diel pattern was observed for β -Glucosidase activity peaking at night linked with dissolved organic carbon reduction. This result highlights the importance to taking into account the exact sampling hour when measuring microbial activities, especially those linked to the use of labile and easy to decompose compounds. Moreover, from this experiment and in relation to **climate change**, results pointed out that warming river temperature and especially at night-time, may have large consequences in carbon metabolism, enhancing heterotrophic activities and clearly modifying the river food web structure.

The findings of this thesis showed a large temporal and spatial variability of microbial dissolved organic matter utilization in Mediterranean river sediments which are modified mainly by temperature, oxygen and dissolved organic matter quality (Fig. 2). Finally, it is also observed that warming and pollution might also significantly affect the sediment biofilm activity and structure. Thus, river sediments, which play a key role for ecosystem functioning and carbon cycle, appear to be very vulnerable to global climate change.

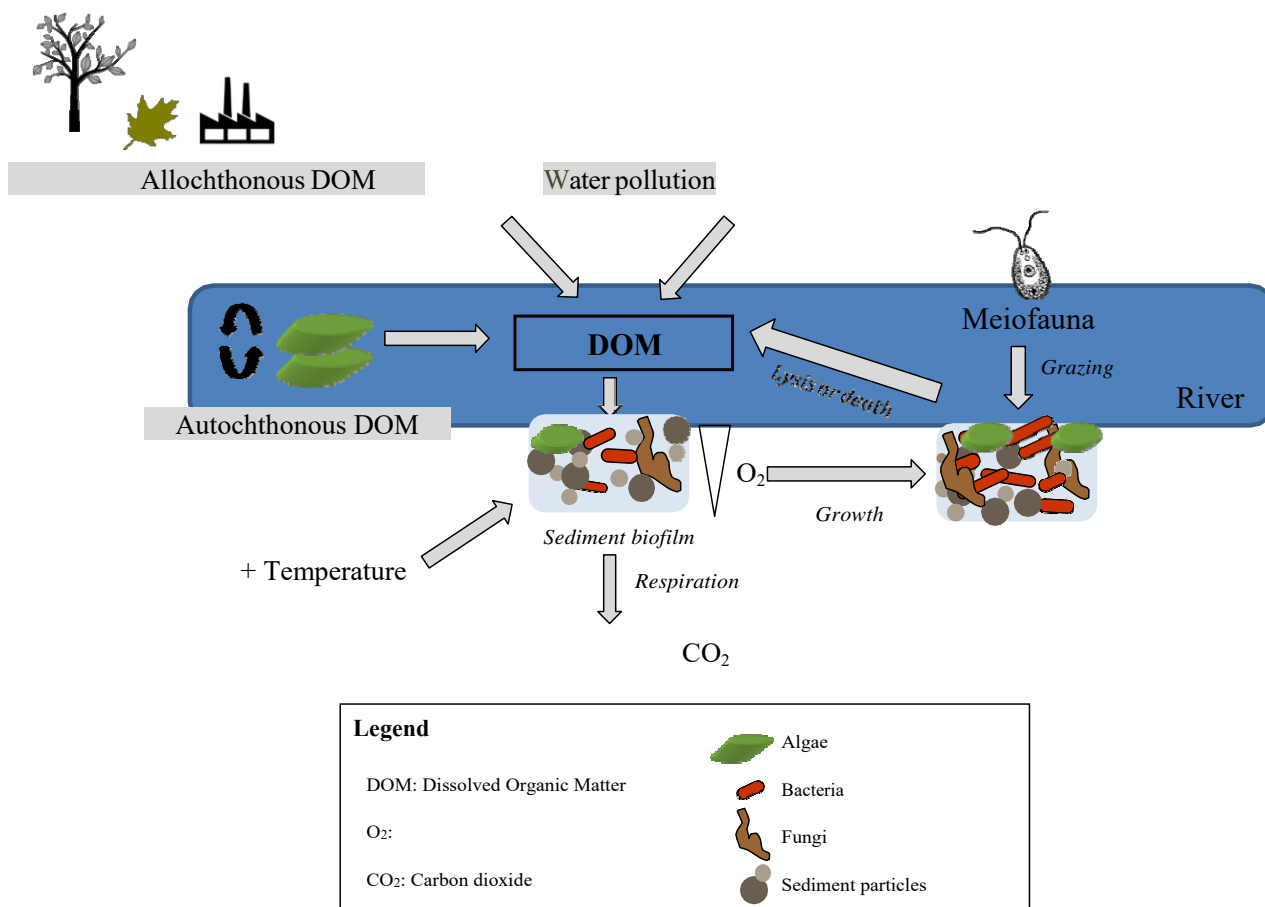


Fig. 2. Inputs and processing of DOM by sediment biofilms in rivers.

AUTORA: Anna Lupon

TÍTULO DEL TRABAJO: THE INFLUENCE OF MEDITERRANEAN RIPARIAN ZONES ON STREAM NITROGEN DYNAMICS. A CATCHMENT APPROACH

DIRECTORA:

CENTRO DE REALIZACIÓN: Universitat de Barcelona

FECHA DE PRESENTACIÓN:

During last decade, anthropogenic activities have doubled the available nitrogen (N) in catchments, leading to several environmental problems such as eutrophication, toxicity or reduced biodiversity (Schlesinger 2009). Riparian areas, those ecosystems lying at the border of stream channels, are recognized to be natural filters

of N because they can substantially diminish the delivery of this essential nutrient from terrestrial to aquatic ecosystems (Vidon et al. 2010). However, quantifying the ecological role of riparian areas within catchments has been challenging for ecologists, mainly because stream water chemistry integrates biogeochemical processes co-occurring within upland, riparian and fluvial ecosystems. The present dissertation aims to contribute to fill this gap of knowledge by exploring the influence of Mediterranean riparian zones on regulating both stream hydrology and N dynamics. To this end, we combined different empirical and modelling approaches in order to examine in detail some of the processes and mechanisms by which Mediterranean riparian zones can shape catchment N exports. Our monitoring strategies included different catchment pools (i.e., soils, groundwater and stream water) and temporal scales (ranging from sub-daily to annual), which ultimately enabled the analysis of the riparian system within the upland-riparian-stream context.

The findings obtained from plot experiments show that riparian soils acted as hot spots of soil microbial N supply within catchments because they exhibited greater net N mineralization (NNM) and net nitrification (NN) rates compared to surrounding oak and beech soils (1.3 vs. $0.1-0.4$ $\text{mg N kg}^{-1} \text{d}^{-1}$). In addition, results from a mechanistic model show a distinct climatic sensitivity of microbial processes between upland and riparian soils. Microbial processes in upland soils were extremely sensitive to water availability, while both temperature and precipitation shaped soil N dynamics in the permanent moist riparian soils. Therefore, all soils exhibited pulses of NNM and NN following spring rewetting events (> 20 mm), though summer temperatures ($> 16^\circ\text{C}$) only stimulate microbial activity in the riparian site. Such riparian pulses coincided with disproportional increases in stream nitrate (NO_3^-) loads ($R^2 = 0.75$), which contrast with the small influence of upland NN rates on N exports ($R^2 < 0.5$). These results highlight that Mediterranean riparian soils are not only hot spots of microbial N supply, but also important sources of N to adjacent aquatic ecosystems. However, the role of riparian zones on whole catchment N budgets and exports can vary widely among biomes (Figure 1). In arid regions, water scarcity may limit microbial activity and N transport in both riparian and upland systems, suggesting a minor contribution of riparian zones on catchment N production and losses (Harms and Grimm 2010). In the other extreme of the climatic gradient (i.e. temperate systems), waterlogged riparian soils may contribute to N removal via denitrification, thus being upland soils the major drivers of catchments N exports (Vidon et al. 2010). Together, these findings point out that the soil N cycle strongly relies on microclimatic conditions; and that Mediterranean riparian zones may have the largest impact on the overall catchment N cycling compared to other riparian areas across the globe.

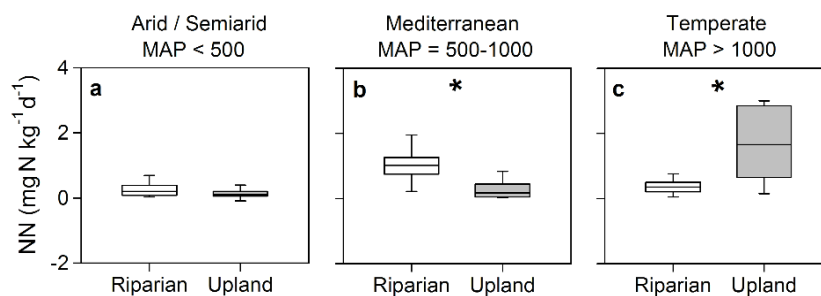


Figure 1 Comparison of mean daily net nitrification rates (NN) between riparian and upland systems in (a) arid/semi-arid, (b) Mediterranean, and (c) temperate regions. Asterisks indicate significant differences between riparian and upland NN rates (Wilcoxon rank sum test, $p < 0.01$). The number of cases (n) for riparian and upland systems was: 10 and 10, 10 and 12, and 11 and 13 for arid/semi-arid, Mediterranean, and temperate regions, respectively. Studies were classified according to its mean annual precipitation (MAP). References and characterization of the study sites are in Appendix B of the thesis. Net nitrification rates measured at Font del Regàs sites (MAP = 900 mm) match perfectly with data reported for other Mediterranean riparian and upland sites.

In addition, findings obtained from catchment-scale studies show that Mediterranean riparian zones can exert a strong control on stream hydrology despite being a small component of annual water budgets. In the studied catchment, riparian evapotranspiration (ET) contributed only 4.5% to the total annual catchment water depletion, but influenced the temporal pattern of stream discharge, riparian groundwater elevation and riparian-stream water exchange across daily and seasonal scales ($R^2 = 0.6-0.8$) (Figure 2a and 2b). Moreover, the influence of riparian ET on stream hydrology increased from headwaters to the valley bottom, where

stream hydrological retention was prominent during the vegetative period (60% of the time). These findings concur with the results from the PERSiST model (Futter et al. 2013), which reveal that the riparian compartment was required for successfully simulate stream hydrology at the valley bottom of this Mediterranean catchment. At the end, our results showed the close hydrological link between riparian and stream ecosystems, and highlight that riparian ET could be essential to predict stream discharge and essential nutrient exports in those regions experiencing some water limitation.

Although there was a strong hydrological linkage between riparian and stream ecosystems, the results obtained in this dissertation showed a limited capacity of Mediterranean riparian zones to reduce stream N concentrations at the catchment scale. During the dormant season, we did not find any evidence of N removal in the riparian zone based on the small differences in N concentration between headwater and valley groundwater (Figure 2c and 2d). Furthermore, during the vegetative period, in-stream NO_3^- release and ammonium (NH_4^+) uptake predominated at the valley bottom and led to increments in stream NO_3^- concentration. These results suggest that in-stream nitrification occurred simultaneously with stream hydrological retention, overwhelming any potential N retention by biota at the stream-riparian interface (Figure 2c and 2d). However, riparian groundwater NH_4^+ inputs did not suffice to sustain the observed increments in stream NO_3^- concentration, which suggest that stream nitrifiers were feeding on an additional N source. We proposed that low discharges, well oxygenated hyporheic zones and relatively warm conditions favored the mineralization and nitrification of the large stocks of riparian leaf litter at the valley bottom of Font del Regàs stream. Therefore, Mediterranean riparian zones may not only deliver DIN to streams via surface and groundwater flow paths, but also may be important sources of organic N via litterfall, which can be transformed to NO_3^- by in-stream biota when environmental conditions are suitable. The presence of N_2 -fixing species such as the invasive *Robinea pseudoacacia* could enhance stream N cycling by providing N-rich leaf litter, and thus, natural or human induced changes in riparian species composition could have a strong impact on stream nutrient dynamics.

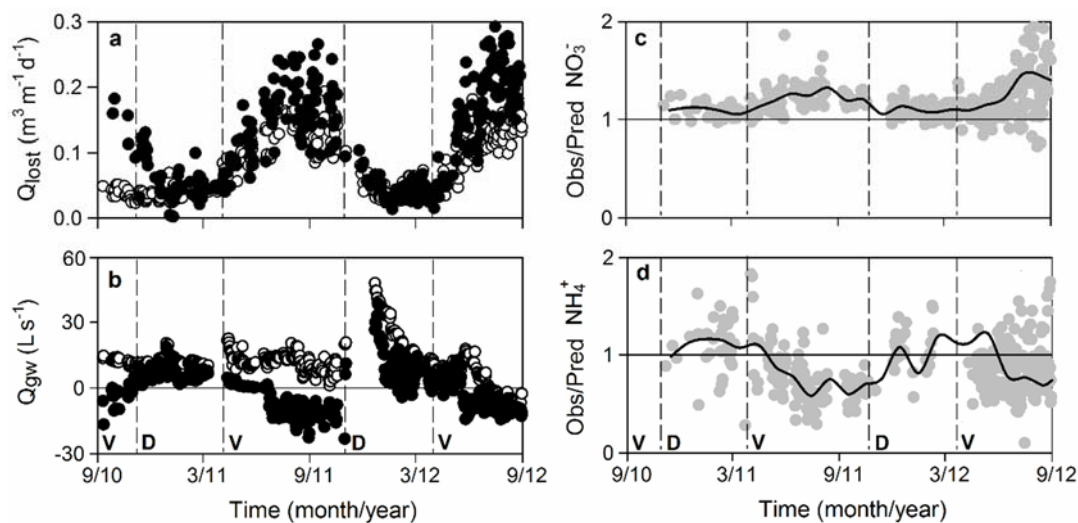


Figure 2 Temporal pattern of (a) diel cycles in stream discharge (Q_{lost}), (b) daily net riparian groundwater inputs (Q_{gw}) and the ratio between observed stream solute concentration at the valley bottom and those predicted from hydrological mixing for (c) nitrate and (d) ammonium during the period 2010-2012. In panels (a) and (b), white and black circles are values for the headwater and valley reaches, respectively. In panel (a), Q_{lost} is used as a proxy of riparian evapotranspiration ($R^2 > 0.95$). In panel (b), Q_{gw} indicates the net flux of water between riparian groundwater and stream. The $Q_{gw} = 0$ line is shown as a reference; $Q_{gw} > 0$ and < 0 indicate when the stream reach was net gaining and net losing water, respectively. In panels (c) and (d), Obs:Pred ratio indicates the capacity of stream (during the vegetative period) and riparian zone (during the dormant period) to shape stream N concentrations. Solid lines are the running median (half-window of 7 days). The Obs:Pred = 1 line is indicated as a reference; Obs:Pred > 1 and Obs:pred < 1 indicate stream N release and stream N uptake, respectively. V: vegetative period, D: dormant period.

At finer temporal scales, there were no diel variations in stream NH_4^+ concentrations over the whole study period, while marked diel variations in stream NO_3^- concentrations occurred in spring. Such diel NO_3^- fluctuations were not associated with diel variations in riparian ET, stream discharge, riparian groundwater level, or riparian solute concentration, suggesting little influence of terrestrial (and riparian) processes on

diel stream N dynamics (Figure 3). Conversely, day-night variations were strongly related to daily light inputs ($R^2 = 0.74$) and they showed an excellent fit with day-night NO_3^- variations predicted from gross primary production (GPP) ($R^2 = 0.85$). These results suggest that, when high light inputs favored GPP prior to riparian canopy closure, in-stream photoautotrophic activity can drive diel NO_3^- variations in heterotrophic headwater streams comparable to those reported for high productivity rivers (e.g. Heffernan and Cohen 2010) (Figure 3). However, and as it occurred for summer nitrification, the influence of GPP on stream N dynamics increased exponentially along the stream continuum. At the valley bottom, in-stream photoautotrophic activity drop midday stream NO_3^- concentration by 13% and reduced catchment spring NO_3^- exports by 10%. In contrast, no diel NO_3^- variations occurred at the up- stream site likely because water temperature was colder (10 vs. 12 °C) and light availability was lower (4 vs. 9 $\text{mol m}^{-2} \text{d}^{-1}$). Our study clearly shows that the activity of photoautotrophs can substantially change over time and along the stream continuum in response to key environmental drivers such as light and temperature, and further, that its capacity to regulate diel and seasonal N fluxes can be important even in low productivity streams.

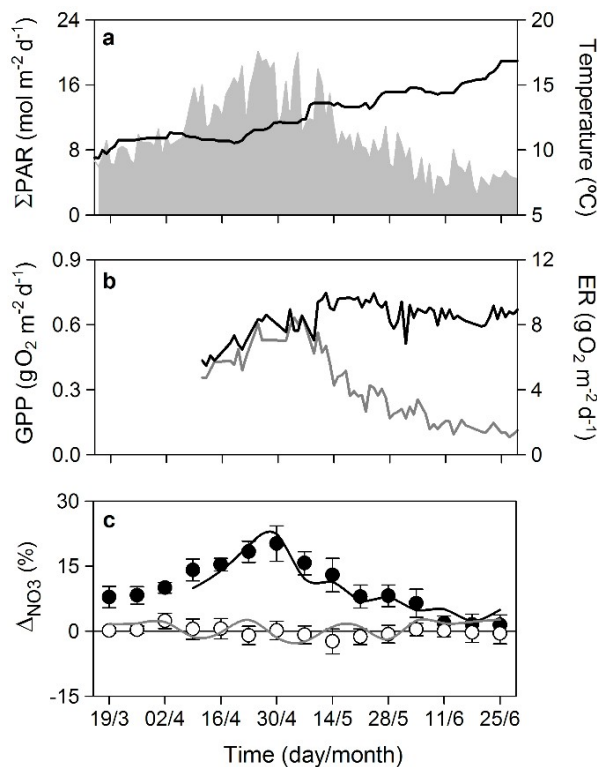


Figure 3 Temporal pattern of (a) environmental conditions, (b) stream metabolism and (c) the relative difference between midnight and noon concentrations for nitrate during spring 2012 at the valley bottom of the catchment. In panel (a), different colors showed data for daily photosynthetically active radiation (ΣPAR) (grey shadow) and mean daily stream water temperature (black line). In panel (b), different colors showed data for GPP (black) and ER (grey). In panel (c), different colors showed data for stream water (black circles) and riparian groundwater (white circles). Solid lines represent the predicted day-night variations in stream nitrate concentration calculated from GPP rates (black line) and from hydrological mixing with groundwater (grey line).

Finally, mass balance calculations at the whole-reach scale showed weak or nil correlations between riparian groundwater and stream N concentrations ($\rho = 0-0.4$), suggesting that the high in-stream bioreactivity could screen the potential buffer capacity of riparian zones. However, the stream net N uptake (FSW) was highly variable over time and space (Figure 4). For NH_4^+ , the occurrence of $\text{FSW} > 0$ (gross uptake > release) was high, while for NO_3^- , the occurrence of $\text{FSW} < 0$ (gross uptake < release) increased along the stream continuum (Figure 4). At whole-reach scale, in-stream net uptake reduced stream NH_4^+ flux up to 90%, while the stream acted mostly as a source of NO_3^- . Nonetheless, our mass balance approach revealed that both in-stream processes and riparian groundwater inputs contributed to longitudinal changes in stream N concentrations, and thus, both sources of variation were necessary to understand stream water chemistry along the catchment.

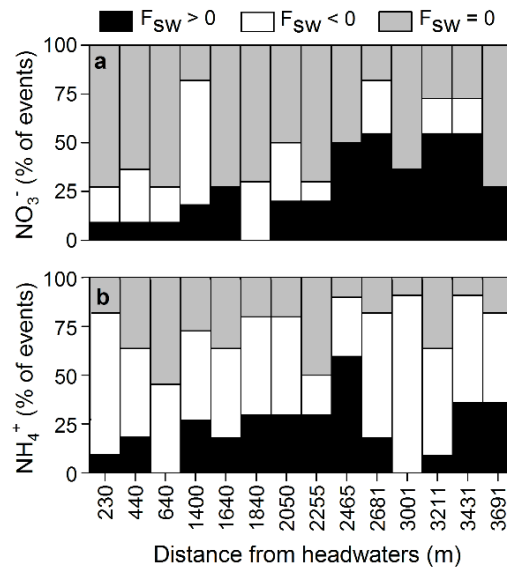


Figure 4 Frequency of dates for which $F_{sw} < 0$ (gross uptake < release), $F_{sw} > 0$ (gross uptake > release), and $F_{sw} \sim 0$ (gross uptake ~ release) for (a) nitrate and (b) ammonium for the 14 contiguous segments along the Font del Regàs reach from August 2010 to December 2011 ($n = 11$). The frequency is expressed as number of events in relative terms. The figure shows the extraordinary potential of in-stream processes to regulate stream N fluxes in this Mediterranean catchment, yet the stream net N uptake may be highly variable over time and space.

Overall, findings gathered in the present dissertation question the well-established idea that riparian zones are efficient N buffers (e.g. Vidon et al. 2010), at least for Mediterranean regions. However, longitudinal patterns of the structural or functional traits of riparian zones can influence in-stream N cycling, thus affecting catchment N exports from headwaters to the valley bottom. Therefore, results from this dissertation stress the importance of studying a particular biogeochemical processes or systems within a broader context in order to get a more complete picture of their ecological role at relevant spatial and temporal scales. Based on what we have learned, we suggest that future catchment research should take into account, as much as possible, the links between upland, riparian, and in-stream biogeochemical cycles to be able to quantify their potential role as regulators of water, nutrients, sediments, and pollutants within landscapes.

References

- Futter, M.N., M.A. Erlandsson, D. Butterfield, P.G. Whitehead, S.K. Oni and A.J. Wade. 2013. PERSiST: the precipitation, evapotranspiration and runoff simulator for solute transport. *Hydrol. Earth Syst. Sci.* 10:8635–8681.
- Harms, T.K. and N.B. Grimm. 2010. Influence of hydrologic regime on resource availability in a semi-arid stream- riparian corridor. *Ecohydrology* 3:349-359.
- Heffernan, J.B. and M.J. Cohen. 2010. Direct and indirect coupling of primary production and diel nitrate dynamics in a subtropical spring-fed river. *Limnol. Oceanogr.* 55:677-688.
- Schlesinger W.H. 2009. On the fate of anthropogenic nitrogen. *PNAS* 106:203-208.
- Vidon, P., C.J. Burns, T.P. Duval, N. Gurwick, S. Inamdar, R. Lowrance, J. Okay, D. Scott and S. Sebestyen. 2010. Hot spots and hot moments in riparian zones: potential for improved water quality. *JAWRA* 46:278-298.

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TÍTULO DEL TRABAJO: Ecología del picoplancton en una laguna cárstica estratificada.

DIRECTOR: Antonio Camacho González y Eduardo Vicente Pedrós

CENTRO DE REALIZACIÓN: Instituto Cavanilles de Biodiversidad y Biología Evolutiva y Dep. de Microbiología y Ecología. Universitat de València.

FECHA DE PRESENTACIÓN: 2015

URL: <http://roderic.uv.es/handle/10550/49879>

Relevance of picocyanobacteria in aquatic ecosystems is nowadays a well-documented fact, both in terms of its absolute abundance and the relative biomass with respect to the other planktonic organisms present in these ecosystems. Pico-cyanobacteria are also the main primary producers in most aquatic ecosystems, being the base of the trophic network in some of these ecosystems, with a very important impact on their biogeochemical cycles. In the present work, abundance and biomass dynamics, both in the vertical profile and in its evolution along the limnological cycle, of the populations of picoplankton, and in particular of picocyanobacteria (Pcy) in lake La Cruz, have been

studied. There are many factors that can influence the abundance and dynamics of picocyanobacteria, physical and chemical factors, such as the location and morphology of the cuvette, its thermal regime and stratification patterns, the distribution of light in the vertical profile, the availability of essential inorganic nutrient and biotic factors such as interaction with other primary producers or predation.

Meromictic Lake La Cruz is located in the mountainous area near Cuenca (1032 m.a.s.l.) at the bottom of a sinking doline, circular in shape (116 m of diameter and about 10.000 m² of surface area). The lake shows a strong summer thermal stratification with vertical gradients of light, oxygen, and nutrients, among others. These stratification patterns allow a great diversity of microenvironments where different populations of microorganisms can develop with a great variety of metabolisms, both photosynthetic, chemolithotroph, and heterotrophs. The strong seasonal thermocline and its meromictic character make it possible to form two stability maxima (measured as Brunt Väissälä frequency), one permanent in the pycnocline at 16 m depth and another at the thermocline of variable depth as the stratification develop, allowing very stable micro-stratification of planktonic microbial populations, but also limits the diffusion of matter and energy in the vertical profile, such as the diffusion of nutrients from the monimolimnion.

Lake La Cruz shows different morphotypes of picocyanobacteria with a small bacillary type as dominant along the limnological cycle. The average abundance values in the vertical profile are of the order of magnitude of 10⁶, with maximum abundance values in the deep chlorophyll maximum (DCM), around 14 x 10⁶ cells ml⁻¹. These values are high even for these types of ecosystems, which generally present abundance ranges between 10³ and 10⁵ cells ml⁻¹. Maximum values of integrated abundance of Pcy in the water column are observed in spring, concretely in May. During this period Pcy are homogeneously distributed in the epilimnion and the metalimnion, however, with the development of stratification and as a consequence of nutrient depletion, predation pressure and changes in light availability and quality, population of Pcy are concentrated forming a DCM around the oxycline. With a well-established deep chlorophyll maximum, in middle of the summer Lake La Cruz shows a tumultuous calcium precipitation (whiting), which causes a very important loss of microbial biomass in the vertical profile, mainly Pcy potentially acting as relevant nucleation factor in the formation of calcite crystals. From September, a very important increase of Pcy biomass is noted in the deep chlorophyll maximum, between 10 and 12 m of depth, that does not affect significantly the integrated Pcy values observed in the lake.

Lake La Cruz can be a good model system to study methodological aspects related to the spatial distribution in the vertical profile of the different populations of photosynthetic organisms. In relation to the analysis of the different photosynthetic pigments present, it has been verified the adequacy of some of the most used spectrophotometric equations in the literature in systems stratified with complex mixtures of pigments. Regarding the quantification of photosynthetic populations of microorganisms, the feasibility of the use of flow cytometry for the identification and counting of the most important photosynthetic organisms of the lake has been studied, showing that, with adequate calibration, it is possible to make these determinations by flow cytometry even with size differences of several orders of magnitude.

Lake La Cruz shows different microbial populations coexisting with different metabolisms associated to inorganic carbon fixation, both by photosynthesis (oxygenic and anoxygenic) and by chemolithotrophy. In terms of biomass, Pcy dominate the water column of the lake in spring and summer, whereas, the eukaryotic nanophytoplankton dominates at the end of the stratification period. During the mixing period both groups have a very similar biomass. Biomass of picoeukaryotes and photosynthetic bacteria is relatively much smaller than that observed for Pcy and nanophytoplankton. Integrated biomass of all primary producers increases as the stratification develops, as is the case with NPB ("Non Photosynthetic Bacteria") biomass, which is coupled to the primary production. The vertical mix in winter produces a very significant gap in this coupling, mainly due to the mineralization of the remains of the high biomass of nanophytoplankton from autumn, which, together with the mixing process, produces a greater availability of nutrients due to the mineralization process that continues during the winter period, allowing the rapid spring development of Pcy.

The integrated annual production in the water column of Lake La Cruz along the limnological cycle of 2006 was 183.6 g C m⁻² year⁻¹ in the range observed for mesotrophic lakes. Most of this production is due to light-dependent processes (92.4%), particularly oxygenic photosynthesis (89.7%) and anoxygenic photosynthesis (2.7%), while dark chemolithotrophy accounts for 7.6% of the total inorganic carbon assimilation. The main responsible for oxygen photosynthesis are Pcy and nanophytoplankton in well-oxygenated waters and in the oxycline. Anoxygenic photosynthesis is carried out by sulfur bacteria, mainly purple sulfur bacteria, *Lamprocystis purpurea*, and green sulfur bacteria, *Chlorobium chlatratiforme*, which develop mainly in the monimolimnion, and during the stratification period in the hypolimnion, where the population of *Lamprocystis* is located below the DCM and the *Chlorobium* layer under *Lamprocystis*.

The rate of oxygenic photosynthesis in epilimnion and mixolimnion remains relatively stable at around 5 mg C m⁻³ h⁻¹. The maximum values of oxygenic photosynthesis (40 mg C m⁻³ h⁻¹) were observed during the stratification period in autumn, at around 0.1% PAR, and correlated with the development of the deep chlorophyll maximum, formed mainly by Pcy. The maximum values of anoxygenic photosynthesis were located at the oxic-anoxic interface and in the upper hypolimnion, coinciding with a greater availability of light in the anoxic layers. Inorganic carbon assimilation by chemolithotrophy was relatively important in the Lake La Cruz, mainly at the end of the stratification period and during the mixing period, where dark inorganic carbon assimilation in hypolimnion and monimolimnion shows rates comparable to the photosynthetic rates observed in epilimnion and metalimnion. Net dominance of prokaryotic fraction in the processes related to inorganic carbon assimilation is observed in Lake La Cruz, mainly by oxygen photosynthesis performed by picocyanobacteria, responsible for more than 80% of the inorganic carbon assimilation at a global level. At the end of the stratification period, the assimilation of inorganic carbon by chemolithotrophy becomes a significant source of organic carbon for the lake. In contrast, anoxygenic photosynthesis contributes very little to the inorganic carbon fixation, mainly due to the limitation of the habitat to be developed and the low concentrations of sulphide present in Lake La Cruz.

In situ Bioassays show that during the period of maximum stratification and stability, and at the time when the biomass of Pcy is more important, predation control by protozoa (nanoflagellates and metazooplankton) of Pcy populations, mainly in DCM, can be highly relevant, but nevertheless Pcy maintains abundance values an order of magnitude higher than expected for similar aquatic systems. Soluble phosphorus and its dynamics are also a key factor in understanding Pcy dynamics and dominance. Some populations present a rate of uptake and accumulation of this nutrient, in the form of pyrophosphate, so high that the concentrations in the lake are always limiting for the rest of microorganisms. This strategy allows Pcy to have available phosphorus, providing a significant advantage over the other photosynthetic groups, allowing to maintain very high Pcy abundances with respect to similar aquatic ecosystems.

Listado de publicaciones derivadas de la tesis:

Camacho, A., Picazo, A., Miracle, M. R., & Vicente, E. (2003). Spatial distribution and temporal dynamics of picocyanobacteria in a meromictic karstic lake. *Algological Studies*, 109(1), 171-184.

Picazo, A., Rochera, C., Vicente, E., Miracle, M. R., & Camacho, A. (2013). Spectrophotometric methods for the determination of photosynthetic pigments in stratified lakes: a critical analysis based on comparisons with HPLC determinations in a model lake. *Limnetica*, 32(1), 139-158.

AUTOR: Bruno Carreira

TÍTULO DEL TRABAJO: Warm vegetarians? Heat wave effects on aquatic omnivorous ectotherms

DIRECTORES: Rui Miguel Borges Sampaio e Rebelo e Anssi Laurila

CENTRO DE REALIZACIÓN: Faculdade de Ciências da Universidade de Lisboa

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Climate change unfolded many ecological questions that gained relevance under the current climatic projections and the unprecedented biodiversity loss worldwide. Among these topics, the influence of temperature on nutrient acquisition by ectothermic organisms is attracting a great deal of interest and became the focus of several studies in the forefront of climate change biology. Indeed, a better understanding of temperature and nutrient interactions across ecological organization levels was recently identified as critical to develop realistic predictions about the ecological responses to global change.

Experimental evidence showed that various components of ectotherm metabolism may scale differently with temperature and that these imbalanced temperature effects may favor the assimilation of plant diets (carbohydrate-rich) at higher temperatures. By promoting a greater increase in feeding and gut passage rates than in assimilation rates at the intestine wall, higher temperatures may hamper the assimilation of slow digestion nutrients such as proteins, and favor the assimilation of smaller and structurally less complex nutrients, thereby increasing the relative assimilation efficiency of carbohydrates. Alternatively, some studies suggest that increasing the consumption of plant diets (carbohydrate-rich) at higher temperatures may be adaptive, as these that fast energy sources should compensate for the lower assimilation efficiency and help ectotherms to better cope with the greater energetic demands. Furthermore, temperature's stronger effect on catabolism than on anabolism promotes a greater increase in respiration than in growth, which may

increase the demand for carbon over nitrogen and motivate ectotherms to feed selectively and increase the consumption of plant diets at higher temperatures. Whether through a passive effect upon nutrient assimilation or an active modulation of feeding preferences, temperature may play an important role in nutrient acquisition by omnivorous ectotherms, promoting carnivory at lower temperatures and herbivory at higher temperatures. And, in fact, recent studies have shown the preference for plant diets to increase at higher temperatures in some invertebrates.

Freshwater habitats are especially vulnerable to climate change, as their communities are mainly composed of ectotherm species, whose metabolism is highly influenced by temperature. As such, the relevance of the relationship between ectotherm diet and temperature is clear, since climate changes projections indicate a trend for global warming and a greater importance of extreme climatic events. Although neglected until recently, these discrete climatic events may pose a serious threat to the stability of freshwater communities, as organisms may be unable to display an immediate and effective response. For instance, global climatic models project more frequent, more intense and longer lasting heat waves, especially in the areas of the globe currently more afflicted by these climatic anomalies, such as the basin of the Mediterranean.

The main goal of this thesis was to study heat waves effects on nutrient acquisition by aquatic omnivorous ectotherms. Specifically, the objectives were to determine if: 1) performance on the animal diets decreased at higher temperatures; 2) performance on the plant diets increased at higher temperatures; 3) higher temperatures induced assimilation shifts; 4) assimilation shifts were adaptive; 5) assimilation shifts resulted from altered feeding preferences.

In a multi-taxa approach, I selected species representative of the most important taxonomic groups commonly found in Mediterranean temporary ponds: larvae of three anuran species breeding along seasonal climatic gradient (*Discoglossus galganoi*, *Hyla arborea* and *Hyla meridionalis*), a gastropod (*Radix balthica*) and an invasive decapod (*Procambarus clarkii*). Individuals were fed animal, plant or mixed diets and exposed to temperature treatments simulating the current short heat waves afflicting the southwest of Portugal, or to long heat waves, which are expected to become more frequent in the future. Treatment responses were recorded in terms of survival and life history traits, as well as behavioral changes in the anurans. Additionally, the proportion of animal and plant material assimilated by the individuals feeding on the mixed diet was estimated with stable isotopes. As quantification of consumption is hard in species of small body size, especially in aquatic species, the analysis of stable isotope ratios ($^{13}\text{C}/^{12}\text{C}$, $^{15}\text{N}/^{14}\text{N}$) allowed reliable and time-integrated estimates of their diets.

In chapter 2, I addressed the role of temperature on nutrient acquisition in vertebrates and demonstrated a gradient in the specialization of anuran feeding preferences matching a gradient in the minimum temperature the species experience in nature – greater carnivory by the species breeding in colder temperatures and greater herbivory by the species breeding at higher temperatures (Fig. 1). I also showed that the quality of diets changes with temperature, with a decreased performance on animal diets and an increased performance on plant diets at higher temperatures. Furthermore, heat waves induced assimilation shifts which, despite not uniform across species, always increased the assimilation of plant material (Fig. 1). Although adaptive in one of the species and potentially adaptive in another, the higher assimilation of plant material at higher temperatures was maladaptive in the most carnivorous species.

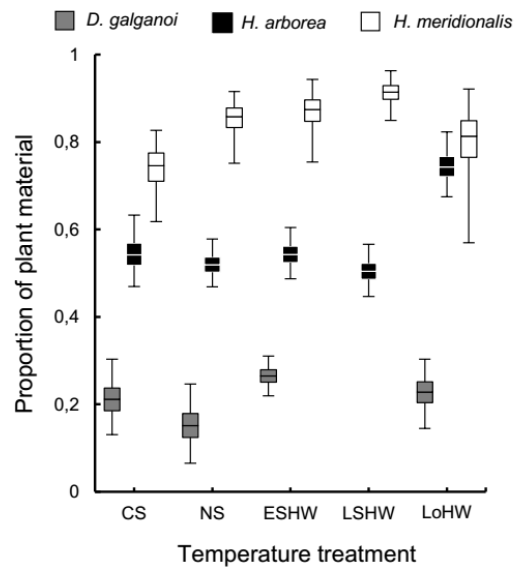


Figure 1. Proportion of plant material assimilated by the mixed diet tadpoles of each species in the temperature treatments: Cold Spring (CS), Normal Spring (NS), Early Spring Heat Wave (ESHW), Late Spring Heat Wave (LSHW) and Long Heat Wave (LoHW). Boxes show the median and the 25th – 75th percentiles; whiskers indicate the 2.5th – 97.5th percentiles.

In chapter 3, I investigated behavioral changes in the larvae of the three anuran species and demonstrated that the temperature-induced change in the quality of diets was met by changes in the activity levels of tadpoles, which regulated activity according to level of stress experienced in the diet-temperature combinations. Indeed, using growth as a measure of stress, the results suggest that the variation in tadpole activity levels follows the general shape of a performance curve as a function of stress. The curve may be divided in four regions that correspond to four quadrants in a growth vs. activity biplot (Fig. 2). Starting at the bottom left and proceeding clockwise, the quadrants define four general regions of the performance curve: 1) absence of stress on the left tail allowing tadpoles to attain high growth (Fig. 2, G^+A^-); 2) low to intermediate stress on the center left, allowing tadpoles to maintain high growth through increased activity (Fig. 2; G^+A^+); 3) intermediate to high stress on the center right, preventing tadpoles from maintaining high growth despite the high activity (Fig. 2; G^-A^+); 4) severe stress in the right tail, causing a strong reduction in the activity of the debilitated tadpoles (Fig. 2, G^-A^-).

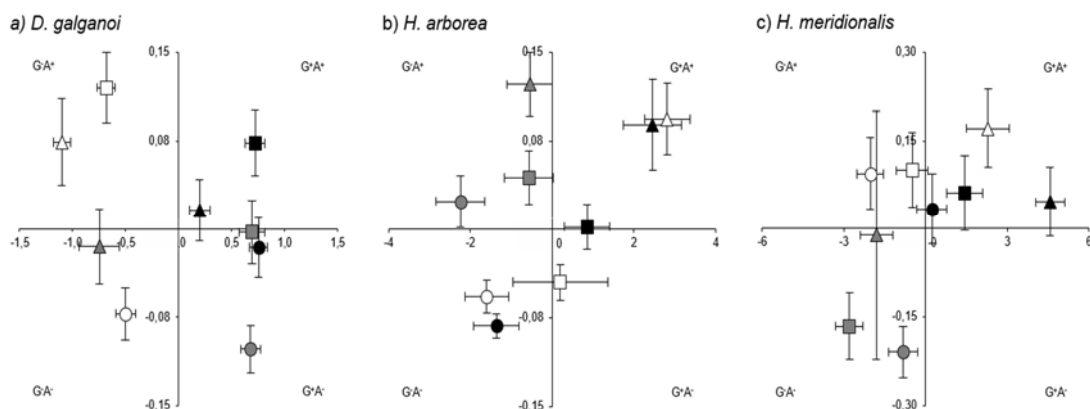


Figure 2. Difference between treatment mean and the overall mean for the proportion of active tadpoles (y-axis) in function of the respective growth rates (x-axis) in a) *D. galganoi*, b) *H. arborea* and c) *H. meridionalis*. Diet treatments are color coded: animal diet in gray, mixed diet in black and plant diet in white; temperature treatments are shape coded: Cold Spring in circles, Normal Spring in squares and Long Heat Wave in triangles. Bars represent standard deviation.

In chapter 4, I studied the effects of heat waves on an invasive alien species, the red swamp crayfish, and showed that the assimilation of plant material increased in the heat waves, but mostly in juveniles (Fig

3). Such a response allowed juvenile crayfish to maintain high growth rates in the long heat wave, suggesting the greater assimilation of plant material at higher temperatures to be adaptive. Surprisingly, despite approximating the climatic conditions of this subtropical species to those in its native distribution range, heat waves had a negative effect on both juveniles and adults of this alien invader. However, the greater assimilation of plant material in the heat waves by the juvenile crayfish indicates this species overall herbivory may increase at higher temperatures, potentially aggravating the impact on aquatic vegetation and economic damage to rice crops.

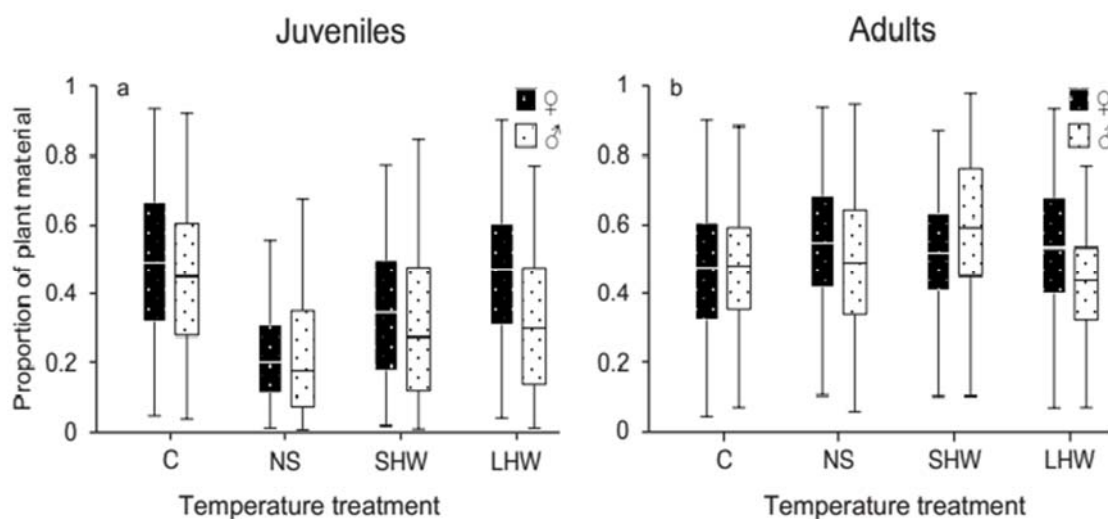


Figure 3. The effect of the temperature treatments: Cold (C), Normal Spring (NS), Short Heat Wave (SHW), and Long Heat Wave (LHW) on the assimilation of plant material by *Procamburus clarkii*. Proportion of plant material assimilated by male and female (a) juveniles and (b) adults fed on the mixed diet; the boxes show the median and the 25th – 75th percentiles and the whiskers indicate the 2.5th – 97.5th percentiles.

In chapter 5, I investigated the potential mechanisms underlying the assimilation shifts by the gastropod induced by the heat waves. Increasing the assimilation of plant material in the long heat wave allowed the snails on the mixed diet to attain higher growth rates without compromising egg production, suggesting this responsive to be adaptive. More importantly, the disproportional increase in the assimilation of plant material when subjected to a short heat wave points to an effect stronger than a simple linear increase of plant nutrient assimilation with temperature, suggesting snails regulated diet and increased herbivory (Fig. 4).

Changes in survival and life-history traits support that the quality of diets changed with temperature, and that performance on the animal diets decreased at higher temperatures, while performance on plant diets increased. Despite the variation in the type of heat wave and in the magnitude of the shift, generally heat waves increased the assimilation of plant material, which was adaptive in almost all species. Although consumption was not measured, the results regarding the proportion of plant material assimilated suggest that, in some cases, the greater assimilation of plant material in the heat waves may reflect changes in the feeding preferences of the study species, which increased herbivory at higher temperatures.

Overall, the repeatability of the results in species from three different Phyla strongly suggests that temperature has an important role in modulating nutrient acquisition - an underlying generalized temperature effect on ectothermic organisms unknown until very recently. The greater assimilation of plant material, or even the greater herbivory, may help omnivorous ectotherms to cope with higher energetic demands imposed by higher temperatures. However, a generalized decrease in the trophic level of these organisms may trigger changes in the functioning and structure of freshwater communities and food webs. Even if the trends shown in this thesis only partly describe the influence of temperature on nutrient acquisition, the awareness of these temperature effects provides additional support for the metabolic theory of ecology and contributes to a better understanding and reassessment of the ecological effects of the ongoing climate change.

AUTOR: Félix Picazo Mota.

TÍTULO DEL TRABAJO: Diversity patterns in freshwater ecosystems: new insights using water beetles at different spatial scales

DIRECTORES: Andrés Millán Sánchez, José Luis Moreno Alcaraz y David Sánchez Fernández

CENTRO DE REALIZACIÓN: Universidad de Murcia

FECHA DE PRESENTACIÓN: 21 de enero de 2016

Link al pdf de la tesis: <http://hdl.handle.net/10201/47850>

The main goal of this thesis is to increase the existing knowledge about diversity patterns displayed by biological communities in freshwater ecosystems, the understanding on the main factors underlying them and their performance at different spatial scales, especially focusing on the particularities derived from the lotic-lentic divide. For that purpose, different approaches (taxonomic, functional and ecological), at different spatial scales (from local assemblages of Iberian southeast to whole inventories of different biogeographic regions in the Western Palaearctic), and using beetles as surrogates of aquatic biodiversity, have been tackled, so that, all this information can be finally useful to be implemented in future nature conservation policies. Chapters 1 and 2 deal with the contribution of standing water bodies to regional diversity of water beetles, both for the whole set of localities and for each of the habitat types established. The former is focused exclusively on the local assemblage composition, whereas the latter also tackles the way in which they are structured. Both chapters confirm the importance that these systems have not only for lentic specialist but also for a wide spectrum of facultative species. The role of natural pools in terms of total richness and endorheic lagoons close to saline habitats in terms on endemic richness is highlighted as well. Chapter 2 shows that conductivity is the most explanatory variable for differences in assemblage composition, whereas the degree of anthropogenic impact is the main responsible for the nestedness pattern detected. When fresh and saline water bodies were analyzed independently the two mentioned variables played different roles both in the assemblage composition and structure. The degree of anthropogenic stress was again the most explanatory variable for the nestedness pattern showed by the fresh water sites, whereas for saline sites was conductivity. Chapter 3 includes a functional approach and demonstrates that the species richness of the different water beetle families is significantly related to their biological and ecological trait diversities. However, there were families which displayed higher or lower biological trait diversity than expected in relation to their taxonomic diversity. These results point to the predominance of habitat filtering processes in headwater streams whereas biotic factors, such as interspecific competition, would be more relevant in a priori less stressed habitats as some lentic systems are. As a result of the detailed taxonomic study of the water beetle assemblages carried out in the previous chapters, in chapter 4 a new species for science is described: *Stictionectes abellani*. Such information is completed with the estimation of the potential distribution and the environmental preferences of the 3 Iberian endemic species of the genus. Finally, chapter 5 evidences, in a wider spatial scale, the existence of contrasting latitudinal patterns of alpha and gamma diversity for lotic and lentic specialist, as well as the decrease of beta diversity as latitude increases for both groups of species. Such findings prove the key role that dispersal ability, framed in the Pleistocene climate changes, plays in shaping the diversity patterns observed in the Western Palaearctic.

AUTOR: Carlos A. Rivera-Rondón

TÍTULO DEL TRABAJO: Diatom-based reconstruction of Late Glacial and Early Holocene environment in the Pyrenees

DIRECTOR: Jordi Catalan Aguilà

CENTRO DE REALIZACIÓN: Universitat de Barcelona

FECHA DE PRESENTACIÓN:

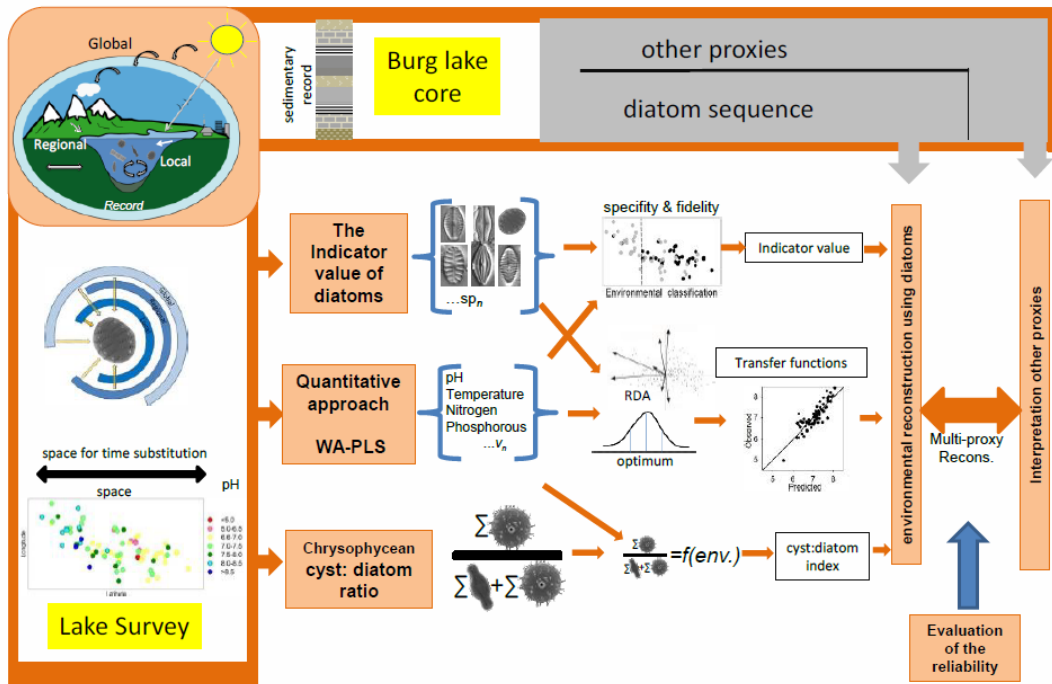
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Introduction. Lakes are ecosystems exposed to the combined influence of climate and catchment processes. Lakes collect and archive evidence of this forcing in their sediments through of a complex interaction with internal processes. Deciphering and extracting information from the sediments is a challenging task because, in addition to the inter-dependence between the forcing agents, the lake ontogeny affects the way in which the system responds to them. The sediment record includes an amalgam of inorganic and organic materials and some recognisable remains of organisms. The latter can be extremely informative about the conditions in which they grew. Among the sub-fossil material, diatoms occupy a prominent position. The remains can be identified to the species level, due to the siliceous composition of their valves. This fact, added to the rich community that at any instant exists in the lake, make diatoms an excellent proxy for environmental reconstructions. The regional variability of diatom distributions is usually explained by pH or acid neutralising capacity (ANC) gradients in alpine and temperate areas. However, there is a large

remaining unexplained variability, which is related to other environmental factors, and could also be used in environmental reconstructions. Some researchers question the feasibility of independent reconstructions of several variables from a single diatom record; they argue that the high temporal autocorrelation of the local assemblages might obscure secondary influences. The main objective of this thesis was to explore the diatom potential for past multivariate environmental reconstructions, with an application to the Late Glacial and Early Holocene sedimentary sequence of Burg Lake (Pyrenees). The specific objectives of the thesis were: 1. To study the diatom flora of the mountain lakes of the Pyrenees, 2. To explore the environmental factors that, besides pH, explains the diatom distribution in the lakes of the Pyrenees, including in-lake proximal factors as well as general descriptors of catchment characteristics, 3. To demonstrate that it is possible to reconstruct different independent variables from a unique diatom dataset, 4. To apply the indicator species and the transfer functions developed to the diatoms of the sedimentary sequence of Burg Lake covering Late Glacial and Early Holocene, and 5. To analyse the reconstructed variables regarding in-lake processes and their eventual link with climate and catchment processes.

Methods. The study of the diatom species distribution and ecology was based on a survey of 83 lakes of the Pyrenees. Lakes were distributed across wide environmental gradients determined by bedrock type, altitudinal range and lake morphology. They were selected to have a stratified representation of the environmental variability and cover the geographical extreme. Variables describing the physical environment such as temperature, ice cover duration, light environment and habitat substrate were considered. Water samples for chemical analyses were collected at the outflow of each lake. Two types of diatom samples were collected at each lake simultaneously with the water chemistry survey: top sediment and epilithon. Top samples were gathered in the deepest part of each lake using a gravity corer. Epilithon samples were collected by brushing stones in the shoreline area. The relationship between diatom assemblages and environmental variables was analysed through different complementary approaches: indicator species, species ecological optima and tolerance, and species diversity patterns. The survey lakes were classified according to their chemical characteristics. The lake classification was carried out using environmental groups and threshold values affecting algal distribution in freshwater ecosystems. The occurrence of indicator species for these groups was assessed using the indicator value index. Redundancy analyses were applied to examine the species-environment relationship and determine which variables were candidates for reconstruction. Transfer functions were developed using weighted averaging - partial least squares models and bootstrapping as cross-validation method. To obtain some further insight into the meaning of the chrysophycean cyst-diatom ratio (CD index) in mountain lakes, the ratio was estimated counting the cysts during the diatom counting. The environmental significance of the CD index was explored by multivariate analysis. The CD index in the lakes of the Pyrenees is more sensitive to lake depth than to other factors such as nutrients (i.e., TP) and chemical composition (Ca²⁺, Mg²⁺, pH). Accordingly to this, the ratio may be used to study past water level variability.

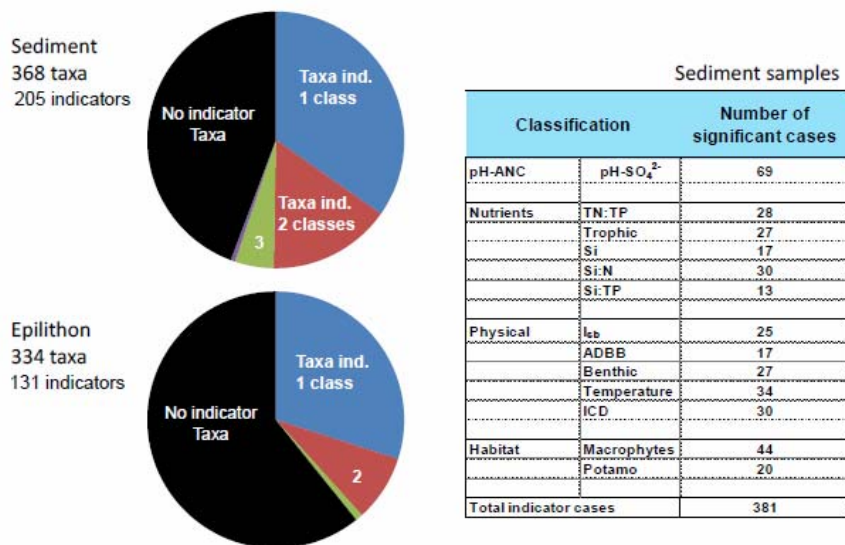
Drilling of the Burg Lake sediments was carried out using a Rolatec RL 48-L drill machine with 10 cm in diameter. The record (1441 cm) was sliced every centimetre. In this study, the section from 1330 cm to 642 cm was analysed (every centimetre). Fifteen samples of the sequence were dated using the radiocarbon method. In addition to the study of diatoms, some complementary measurements were made for a better interpretation of the record: diatom preservation, Chrysophycean cyst abundance, loss on ignition, specific density of sediment, composition of dominant minerals (X-ray diffraction), elemental composition (X-Ray Fluorescence) and subfossil photosynthetic pigments (UPLC). The temporal changes in the diatom assemblages of Burg record were studied using diatom diversity, assemblage zonation, the rate of change, and principal component analysis. The transfer functions developed were applied to the diatom sequence of Burg Lake. The reliability of the reconstructions was evaluated from three complementary perspectives: indicative species, statistical reliability, and functional sense.



Schematic representation of the methodology followed for this study.

Results and discussion. Lakes showed a high diversity being distinguished 549 diatom taxa, with a relatively high proportion of them that has not been properly described yet. The Burg Lake sequence had 77% (57) taxa present in the regional study, which indicates a good effective number of species for environmental reconstruction. The Pyrenean lakes were characterised by a large number of statistically significant indicator species of water chemistry, nutrients, physical, and habitat conditions. From 368 taxa found in the training-set, 205 were indicators of some environmental classification, being recorded 381 significant IndVal values. The most outstanding result is the low number of indicator species shared by lake classifications made with different criteria analysed.

The variables suitable for developing transfer functions were selected using different approaches that included the significant explanation of species variation and the ecological meaning of these variables. Transfer functions for pH and ANC showed the best performance using the sediment dataset. Bootstrapping for pH and ANC showed a small reduction in the explanation of the models and a slight increase of RMSE. Model for summer surface water temperature (SSWT), TP and IZmax showed a remarkable reduction in r2 and an increase in the RMSE after bootstrapping. However, the data distribution and residuals of the models suggest a high reliability of reconstructions. According to the transfer function performance, the sediment dataset appears more suitable for environmental reconstructions using the sedimentary diatom records of the Pyrenees.

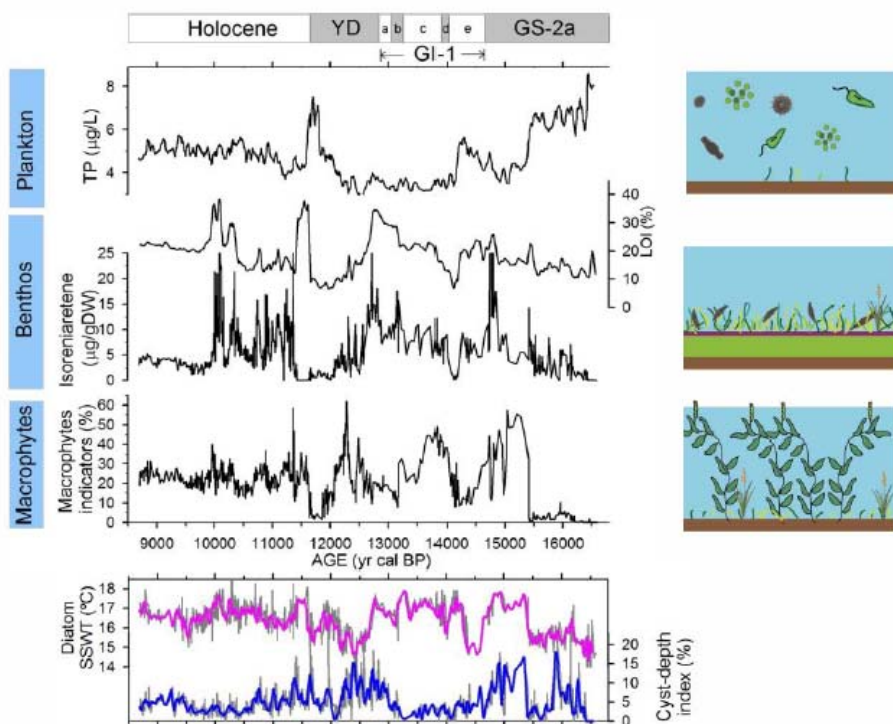


Summary of the indicator analyses. The number of significant indicator species for each classification is shown. Isb: Irradiance at the bottom, ADDB: Active diatom biofilm at the bottom, ICD: Ice cover duration. Potamo is the presence of potamid macrophytes.

The analysis of the Burg sedimentary sequence showed a high reliability of the quantitative reconstructions. TP is one of the variables reconstructed that could be highly conditioned by other variables such as ANC and SSWT. In Burg

Lake, reconstructed TP shows a different temporal pattern than ANC. In fact, the training-set data shows a positive correlation between TP and ANC, while the reconstructed values are negatively correlated. Therefore, it cannot be argued that the training-set dependency is translated into the environmental reconstructions through the transfer functions applied. The relationship between reconstructed TP and ANC change at different periods, being most of the time non-significant. This pattern was also observed between other reconstructed variables.

The Burg Lake underwent a reduction in the maximum depth achievable. This dramatic change in depth was probably responsible for the long-term trend of different proxies such as LOI, pH, and, partially, TP. The trend may reflect the progressive conversion of the system to a wetland; a shallow seepage lake switched progressively to the current fen state. The decline in depth is not independent of other geomorphological changes in their lake surroundings. The smoothing of the watershed slopes and decrease in the energy of the water flows is illustrated by the changes in the elemental ratios between elements linked to minerals of relatively large particle size and elements associated with fine particles that indicate a progressive decline in the size of the particles that reach the lake. The Burg Lake record shows contrasting TP distributions for the two periods, during the Holocene the values are about 50% higher, and the whole range of TP values scarcely overlap between the two periods. This ontogenic change is also evidenced by the increased LOI, pH and S/Fe ratio in the sediments. Everything points to a shallower lake with a higher biological activity per unit of surface during the Holocene period considered respect the climatically similar period of the Late Glacial, when the lake was deeper. The first scenario of high TP concentration (up to ~15300 yr cal BP) was probably related to high external P loadings from a catchment with high amounts of exposed fresh rock and till debris as glaciers were shrinking and soil and weathered patina on rocks were scarcely developed. The catchment ontogeny and lake ontogeny are necessarily correlated, but whereas the catchment development produces a control of nutrients exported to the lake, the lake ecosystem development towards a wetland causes a progressive increase in the lake trophic state, probably due to shorter distances for internal nutrient recycling. Despite there are periods in which TP and LOI follow the same general trend, in general, they are not highly coupled. LOI show more concordance with indicators of benthic productivity (i.e., pigments and benthic proxies), which in this kind of lake may probably be more relevant. The lake conditions during late GS-2a and GI-1 exemplify the most important of the benthic compartment. Around 15400 yr cal BP, the lake undergoes a change in the main source of production, extending throughout the GI-1. The high values of macrophyte indicators and pigments of cyanobacteria and anoxic photosynthetic bacteria (Isoreniaretene) indicate the development of a complex biofilm in the bottom of the lake surrounded by macrophytes. In this type of environment, there is a strong control of redox conditions of the sediment and nutrients recycling. Anoxic conditions mobilise P but they hardly can diffuse into the water column as the photosynthetic microbial mat cap uptake it. As the microbial mat growth upwards, organic matter can accumulate in the anoxic conditions below the microbial biofilm. On the other hand, while during the late GS-2a macrophytes and pigments of benthic indicators start to increase synchronically; during the GI-1, they have a decoupled trend. This fact suggests that the benthic component and macrophytes alternate the control of lake productivity while phytoplankton depends more on external loads.



Sequence of proxies related with plankton productivity (reconstructed TP), Benthos productivity (LOI, Isoreniaretene pigments), and macrophytes presence (macrophytes indicators). Reconstructed values of temperature (Diatom SSWT) and depth are also shown (Cyst-depth index).

The analysis of the diatom sequence shows that the main climatic events and periods recorded in the Greenland record. Temperature and water level showed a high variability during the first lake centuries with excursions from the lowest to relatively high values. At ~15400 yr cal BP, diatom-SSWT increased suddenly and coincided with a rise in the water level, LOI and the abundance of indicators of macrophyte presence as well as a significant change in the diatom assemblage. These facts suggest a tipping point in the lake ecosystem, related with warmer summers and a reduction of the cool winter season and a positive water balance in the catchment, or, at least, a high melting of remaining glaciers. After the first warming, diatom-SSWT maintained high values until 15000 yr cal BP, and the lake water column depth kept high values. During GI-1 diatom-SSWT follows the general trend of Greenland records. However, the chronology of the transition from GS-2a to GI-1 differs slightly. Despite the reconstructed SSWT follows the general climatic patterns of GI-1, the warmest periods were more similar between them in Burg than the ones recorded in Greenland. The diatom-SSWT showed two differentiated parts in the YD than contrasts with a more homogenous Greenland record. Indicators of catchment erosion, vegetation cover and LOI indicated that the cold conditions of YD in Burg Lake clearly extended until 11700 yr cal BP as in Greenland, but the whole period differentiated into a colder oscillation (centred around 12300 yr cal BP) and a warmer phase (centred around 12000 yr cal BP). The latter phase may refer exclusively to warm conditions during summers as in it is shown mainly by SSTW and less by other proxies. This diatom-SSTW pattern in Burg Lake is closer to patterns in the Atlantic and Western Mediterranean Seas and the Iberian Peninsula than to Central European and Greenland palaeoclimatic patterns. The end of YD was marked by a reduction in SSWT followed by a rapid increase. The Holocene started with a sudden increase in the diatom-SSWT that extended until 11400 yr cal BP. After this, diatom-SSWT dropped rapidly (~11150 yr cal BP) maintaining low values until 10950 yr cal BP. At the beginning of the Holocene, the depth of the lake was relatively high, but then it became highly variable and underwent a progressive reduction.

Remarks and Conclusions. 1. The Pyrenean lakes contain remarkable diatom diversity. 2. Many diatom species has indicative value for chemical, nutrient, physical and habitat classifications of the Pyrenean lakes. 3. The strength of this indicator character is that species are statistically significant for a reduced number of the lake classification across the different environmental gradients. 4. Diatom assemblages from top sediments contain more information for environmental reconstruction than epilithic assemblages. 5. Using sediment diatom sequences, pH, ANC, TP, irradiance at the lake-bottom, and SSWT can be reconstructed quantitatively in the Pyrenean lakes. 6. The reliability of independent reconstructions of these variables is based on the fact that a sufficient quantity of species responds to each variable and the others contribute neutrally. 7. The ratio between chrysophycean stomatocysts and diatoms can be used for the reconstruction of lake level fluctuations in the past for lakes of similar characteristics. 8. Diatom-based reconstructions allow inferring fluctuations on chemical and physical water variables during Late Glacial and Early Holocene that are hardly recorded by any other proxy. 9. The lake ontogenic changes over extended periods of time may modify the response to similar climatic forcing. 10. In relatively shallow mountain lakes (such as Burg Lake); the entire lake basin becomes a productive biofilm making benthic signals predominant in the sedimentary sequence. 11. The main climatic oscillations recorded in the Greenland ice records during Late Glacial and Early Holocene are also reflected in Burg Lake sedimentary sequence through the diatom-based reconstruction of the SSWT, the indicator species analysis and the CD index. 12. The temporal trend of SSWT in Burg Lake and lake depth oscillations were not coupled throughout the Late Glacial and Early Holocene. This was probably due to the seepage character of the lake and changing contribution to the water budget of glaciers and snowfields during this period. 13. The Greenland Interstadial in the Pyrenees was characterised by warm summers and short winters. A reduction in the influence of Northern colder air masses and the progressive weakening of winters caused warmer conditions than in the Early Holocene. 14. Two climatic phases were identified during the Younger Dryas in the Pyrenees: a first period with cold conditions and high water level, followed by a second period gradually warmer and drier.

AUTORA: Gabriela Onandia Bienco

TÍTULO DEL TRABAJO: Carbon cycling and biogeochemical modelling of a hypertrophic shallow lake: la Albufera de Valencia

DIRECTORA: María Rosa Miracle

CENTRO DE REALIZACIÓN: Instituto Cavanilles de Biodiversidad y Biología Evolutiva, Universidad de Valencia

FECHA DE PRESENTACIÓN: 18 de mayo de 2015

Shallow lakes are one of the most abundant lake type at the global scale and frequently support multiple economical and recreational activities. Over the last decades, a rising number of shallow lakes have undergone a cultural eutrophication process that often resulted in a transition from a “clear state”, characterized by high water transparency and submerged macrophyte abundance, to a “turbid state”, characterized by low water transparency, phytoplankton dominance and low submerged macrophyte abundance. La Albufera de Valencia, a shallow lagoon that shifted to turbid state in the beginning of the

1970s, exemplifies this transition. Despite the implementation of different restoration measures since the 1990s, la Albufera de Valencia currently remains a hypertrophic lake in a turbid state. However, “clear water events”, with chlorophyll-*a* concentrations below 5 µg L⁻¹, take place at the end of winter in a recurrent manner (Miracle and Sahuquillo, 2002; Romo *et al.*, 2005). These events are not analogous to the clear-water alternative stable states typically experienced by shallow lakes (Scheffer *et al.*, 1993), inasmuch as they are short and do not entail macrophyte reappearance. Similarly, they differ in terms of timing and causes from the clear-water phases that characteristically occur in shallow eutrophic lakes. Whereas in most shallow eutrophic lakes clear-water phases typically take place in spring and are triggered by zooplankton grazing, in la Albufera de Valencia, “clear-water events” are primarily driven by i) the hydrological management of the lagoon, which leads to the lagoon “flushing” when the rice paddies located in the surrounding watershed are drained and the drainage water flows through the lagoon into the adjacent Mediterranean Sea, ii) the mild water temperatures that facilitate the net growth of Cladocera; and iii) a decrease in fish predation on zooplankton, due to the annual maximum catch rates by local fishermen during the period (Romo *et al.*, 2005).

Previous studies in the lagoon have portrayed these “clear-water events” as periods of increased water transparency, reduced phytoplankton biomass encompassing a decline in the proportion of cyanobacteria and increased *Daphnia magna* abundance (Sahuquillo *et al.*, 2007). However, to date, the influence of these events on phytoplankton primary production, heterotrophic bacterial production and their coupling, as well as on the carbon transfer from phytoplankton and heterotrophic bacteria to zooplankton remains unstudied. The first part of this doctoral thesis focuses on the study of these aspects, which are essential to improve the knowledge on the carbon dynamics and ultimately the ecological functioning of shallow hypertrophic lakes. Further, information regarding these lakes is scarce, especially for those located in warm-temperate, subtropical and tropical regions (Jeppesen *et al.*, 2003).

Understanding the ecological functioning of shallow eutrophic lakes requires the synthesis of a large amount of information and the use of quantitative tools that enable a simultaneous analysis of various ecological interactions. In this context, ecological models represent valuable instruments to identify the biogeochemical and physical processes underlying eutrophication processes and to design effective management plans capable of meeting environmental and socio-economic demands (Usaquén *et al.*, 2012). The second part of this doctoral thesis is aimed to develop a biogeochemical model able to reproduce the interactions determining plankton dynamics and that can be prospectively applied as a management tool to improve the trophic state of la Albufera de Valencia.

Firstly, within Chapter 1, we investigated seasonal variations in bacterial secondary production (BP) with a specific focus on how closely these variations are related to the changes in water turbidity experienced by the lagoon. BP was estimated *in situ* by measuring ³H-leucine and ³H-thymidine incorporation rates (LIR and TIR). Moreover, we assessed the effect of measuring LIR and TIR under conditions of exposure to *in situ* photosynthetic active radiation (PAR) *versus* under the commonly used dark conditions. In addition, we studied diel variations in BP and explored the upper limit of BP in hypertrophic systems.

Our study indicates that BP remains relatively constant across seasons. Nevertheless, BP declines in late winter under conditions of high water flow through the lagoon and concomitant minimum chlorophyll-*a* values. With regard to the light/dark LIR and TIR estimations, the light:dark ratio of LIR and TIR is close to 1 but tends to be >1 when dissolved organic carbon (DOC) concentrations were lower, namely in winter. These results suggest that light effects are partly modulated by DOC concentrations and support the use of either light or light/dark combined incubations for the estimation of BP. We found that LIR and TIR showed an evident diel pattern under hypertrophic conditions. This pattern involves an increasing trend throughout the night followed by a sharp decrease at dawn (Fig. 1). DOC showed the opposite diel pattern and was negatively correlated to BP, suggesting that as BP increases, DOC is depleted from the water column. Despite our DBP (daily areal bacterial production) estimations are considerably high (186-390 mg C m⁻² d⁻¹), they do not exceed previously values obtained in hypertrophic lakes.

The present work represents the first BP estimation in the lagoon and adds to the scarce data available on diel and seasonal dynamics in hypertrophic lakes. From a methodological point of view, our results concerning light *vs* dark incubations provide relevant information for the design of future studies concerning the estimation of BP in aquatic ecosystems.

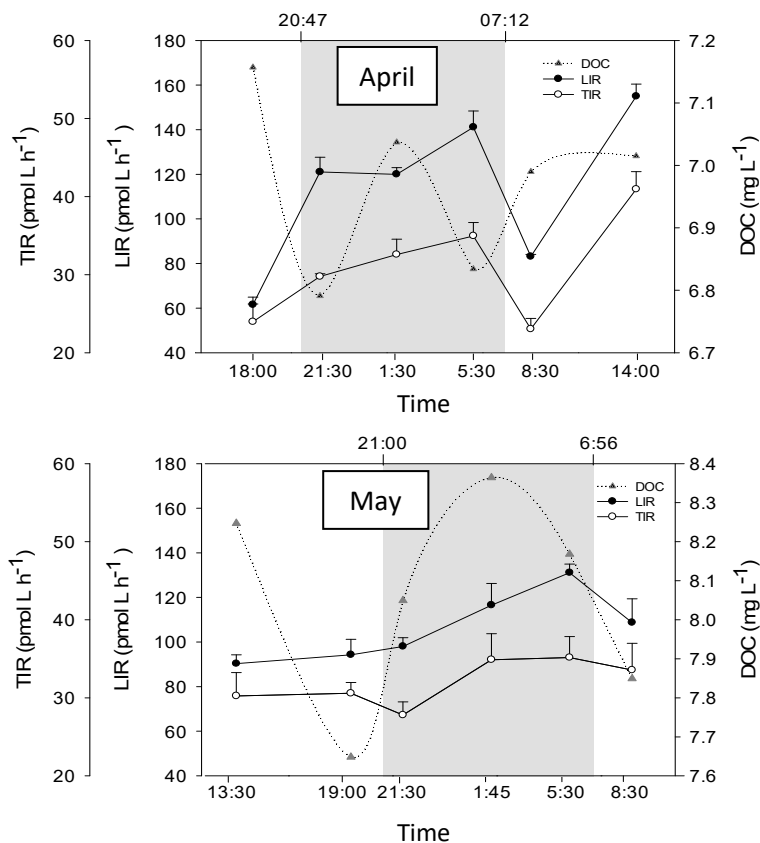


Figure 1. Diel changes in incorporation rates of ^3H -leucine (LIR), ^3H -thymidine incorporation rates (TIR) and dissolved organic carbon (DOC) during 2 diel cycles. Error bars represent standard deviations. Local times for sunrise and sunset are also indicated on the top axis.

Similar to Chapter 1, within Chapter 2 we investigated seasonal variations in particulate primary production (PP) in relation to the changes in water turbidity experienced by the lagoon. Based on the BP results from Chapter 1, we assessed whether PP and BP are coupled at the seasonal scale and therefore respond similarly to the mentioned water turbidity changes. In addition, we studied diel variations in PP and compared our data to results from shallow hypertrophic lakes. PP was measured *in situ* following the ^{14}C uptake method.

PP changes significantly across seasons. The maximum was reached in spring, associated to low water renewal rates and high chlorophyll-*a* levels. The minimum occurs in winter, coinciding with maximum water transparency and high water renewal rates. In summer, PP shows only moderate values most likely as a consequence of dissolved inorganic nitrogen (DIN) limitation. This hypothesis is supported but a marked decline in DIN concentration and the relevant contribution of heterocystous cyanobacteria to phytoplankton biomass in this season.

The DBP/DPP (daily areal particulate primary production) ratio is always > 1 . Thus, phytoplankton provides most of the particulate organic carbon available for higher trophic levels in la Albufera de Valencia throughout the annual cycle.

The important changes in PP contrast with the slight variations experienced by BP in the lagoon (Fig. 2). Despite there is a common PP and PB decrease in late winter followed by a joint increase in spring, our results indicate that PP and PB are not coupled at the annual scale. The high DOC availability might explain our results. Indeed, the extracellular dissolved organic carbon released by phytoplankton is sufficient to meet bacterial carbon demand in the experimental dates explored. The latter results suggest that allochthonous carbon sources play a minor role in sustaining BP in the lagoon.

We found that PP displays noticeable diurnal variations defined by the solar radiation curve, showing a noon maximum in all experimental dates. The DPP values measured in the lagoon ($0.9 - 12.2 \text{ g C m}^{-2} \text{ d}^{-1}$) are extremely high and surpass most values described in hypertrophic lakes to date.

Our work assessed for the first time the link between seasonal changes in water turbidity and PP in la Albufera de Valencia. Likewise, this work provides novel data on the interaction between PP and BP as well as they relative contribution to particulate carbon production.

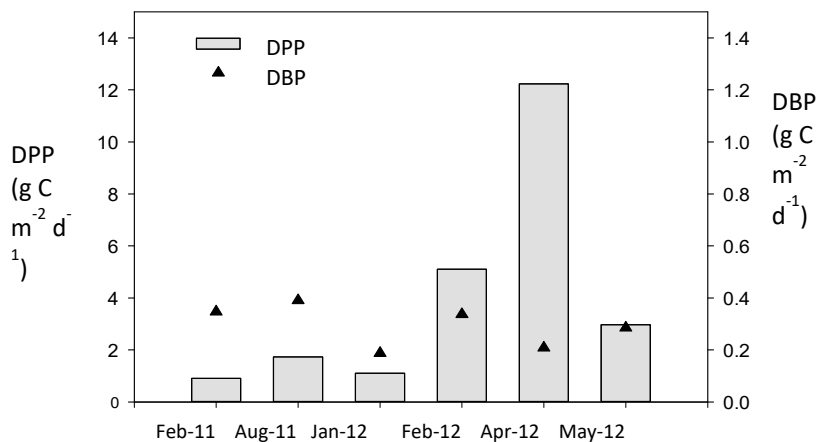


Fig. 2. Daily areal primary production (DPP) along with daily areal bacterial production (DBP) on each experimental date.

Within Chapter 3 we characterized the grazing habits of the lagoon natural zooplankton community during two seasonal periods: (1) end of winter/onset of spring, after a period of increased water flow through the lagoon that reduces phytoplankton density and cyanobacterial dominance and (2) mid-spring, after the spring phytoplankton bloom and under conditions of cyanobacterial dominance. Likewise, we studied the contribution of different algal and bacterioplankton size fractions to zooplankton feeding. Multiple parameters related to grazing zooplankton habits (*i.e.* clearance rates, CRs) were measured by labelling natural seston with ¹⁴C-bicarbonate and ³H-thymidine/leucine.

During the end of winter/onset of spring, *Daphnia magna* is the dominant species in the natural zooplankton community. *Daphnia magna* shows very low CRs for phytoplankton and bacteria (Fig. 3), probably as a result of the high abundance of filamentous cyanobacteria in the lagoon. *Daphnia magna* CRs are very similar for phytoplankton and bacteria (Fig. 3), which verifies the unselective feeding of *Daphnia*. The fact that bacteria provide around 40 % of the planktonic carbon ingested by *Daphnia magna* and this carbon is assimilated with the same efficiency as that provided by phytoplankton, suggests that the microbial loop and the classic grazer trophic web are strongly coupled at the onset of spring in the lagoon. Therefore, the microbial loop seems to contribute relevantly to energy transfer to higher trophic levels (fish) in this period.

In mid-spring, *Bosmina longirostris* dominates the natural zooplankton community. *Bosmina longirostris* shows low CRs for phytoplankton and bacteria (Fig. 3), probably because the food concentrations surpassed the incipient limiting level. We found that *Bosmina longirostris* shows a selective feeding behavior. More specifically, CRs are higher for 1-15 μm algae than for < 1 μm bacteria (Fig. 3). Most of the planktonic carbon ingested by *Bosmina longirostris* is provided by algae sized 3-15 μm. Similarly, when considering the total mid-spring zooplankton community, phytoplankton contributes 90 % of the planktonic carbon ingested. The latter results suggest that the energy transferred to zooplankton via bacteria during the spring phytoplankton bloom (when cyanobacteria dominate) constitutes a smaller fraction than during periods of lower phytoplankton density. Lastly, during the two studied periods, the zooplankton consumed a small proportion of PP and BP, adding evidence to the hypothesis of reduced top-down control in hypertrophic lakes.

Our work makes a contribution to the scarce data concerning zooplankton grazing on natural phytoplankton and bacterioplankton communities and improves the knowledge on carbon transfer between the lower components of the food web in Albufera de Valencia.

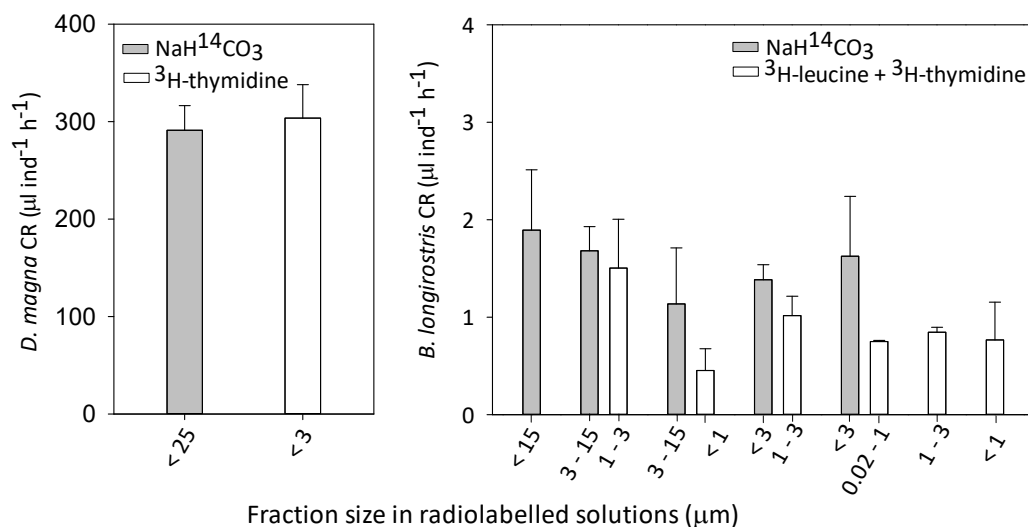


Fig. 3. Mean clearance rates (CR, $\mu\text{L ind}^{-1} \text{h}^{-1}$) of *Daphnia magna* and *Bosmina longirostris* in March 2011 and May 2012 for the different size fractions of labeled organisms. Error bars indicate the standard deviation.

Finally, within Chapter 4, we developed a biogeochemical model targeting the reproduction of the ecological processes that determine phytoplankton dynamics in the lagoon. The model simulates two elemental cycles (nitrogen and phosphorus), two phytoplankton groups (cyanobacteria and non-cyanobacteria), and heterotrophic bacteria. We assessed the ability of the model to predict the observed plankton dynamics and accounted for the uncertainty associated with the external forcing factors. In order to detect the most influential parameters on chlorophyll-*a* predictions, we performed a sensitivity analysis. Next, the model was utilized to explore the phytoplankton response to potential restoration actions, which comprised the simultaneous modification of external nutrient loadings and flushing rates.

The developed biogeochemical model successfully simulates a number of water quality variables in the ecosystem (*i.e.* total chlorophyll-*a*, nitrate, ammonia, total nitrogen and total phosphorus). The sensitivity analyses identified the parameters related to phytoplankton growth and settling rates as the most influential parameters on chlorophyll-*a* predictions. As a result of the scenario analysis, nutrient external loadings were identified as the main factors determining the phytoplankton dynamics at the annual scale (Fig. 4). Therefore, their control should be the main target of local management plans. Interestingly, the scenario analysis results concerning the February-March period pointed to a dilution of cyanobacteria mass associated to high flushing rates (Fig. 4), which suggest that that the hydrological manipulation of the lagoon might additionally serve as an efficient management tool for its restoration. As a final point, during our model exercise we identified the inclusion of the zooplankton and macrophyte role as critical future model augmentations.

The developed model allows exploring the biogeochemical and trophic connections underlying the eutrophication processes in the lagoon and represents a first approximation to the development of an effective managerial tool to improve the trophic status of la Albufera de Valencia.

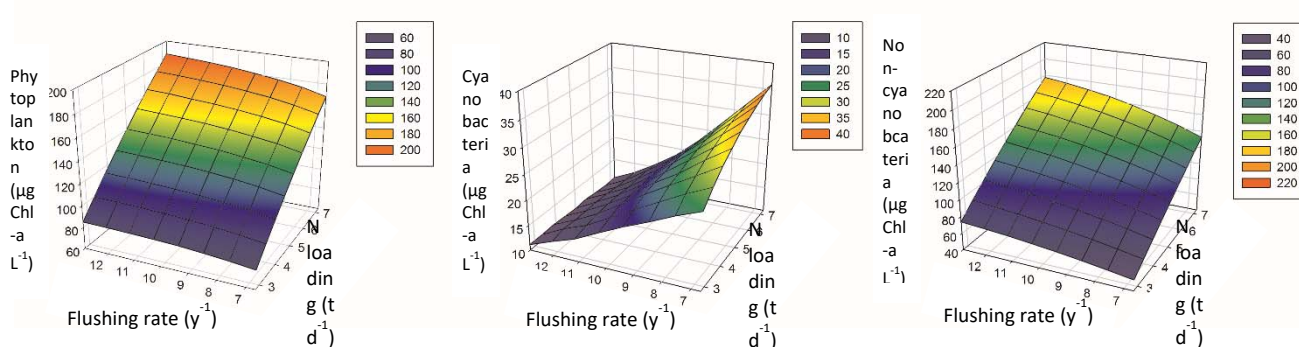


Fig. 4. Model predictions for mean February-March total chlorophyll a (left panel), cyanobacteria (central panel) and non-cyanobacteria (right panel) concentrations under a wide range of loading and flushing conditions. The nutrient loading variations correspond to flow-weighted mean concentrations from 4.4 to 11.3 mg TN L⁻¹ and 130 to 340 µg TP L⁻¹, respectively.

References

- Jeppesen, E., Søndergaard, M., Jensen, J.P., Lauridsen, T.L., 2003. Recovery from eutrophication. In: Kumagai, M., Vincent, W.F. (Eds.), *Freshwater Management. Global versus Local Perspectives*. Springer-Verlag, New York, pp. 1–16.
- Miracle, M.R., Sahuquillo, M., 2002. Changes of life-history traits and size in *Daphnia magna* during a clear-water phase in a hypertrophic lagoon (Albufera of Valencia, Spain). *Verh. Int. Ver. Limnol.* 28, 1203–1208.
- Romo, S., Villena, M.J., Sahuquillo, M., Soria, J.M., Gimenez, M., Alfonso, T., Vicente, E., Miracle, M.R., 2005. Response of a shallow Mediterranean lake to nutrient diversion: does it follow similar patterns as in northern shallow lakes? *Freshw. Biol.* 50, 1706–1717.
- Sahuquillo, M., Melão, M., Miracle, M., 2007. Low filtering rates of *Daphnia magna* in a hypertrophic lake: laboratory and in situ experiments using synthetic microspheres. *Hydrobiologia* 594, 141–152.
- Scheffer, M., Hosper, S.H., Meijer, M.L., Moss, B., Jeppesen, E., 1993. Alternative equilibria in shallow lakes. *Trends Ecol. Evol.* 8, 275–279.
- Usaquén Perilla, O.L., Gómez, A.G., Gómez, A.G., Díaz, C.Á., Cortezón, J.A.R., 2012. Methodology to assess sustainable management of water resources in coastal lagoons with agricultural uses: An application to the Albufera lagoon of Valencia (Eastern Spain). *Ecol. Indic.* 13, 129–143.

AUTOR: Ibon Aristi

TÍTULO DEL TRABAJO: Effects of global change on the functioning of the Mediterranean rivers

DIRECTORES: Arturo Elosegı y Vıcenç Acuña

CENTRO DE REALIZACIÓN: Universidad del País Vasco (UPV/EHU).

FECHA DE PRESENTACIÓN: Julio 2015.

Human population and per capita use of resources have been rising dramatically in the last centuries, resulting in environmental change of global proportions and affecting every ecosystem on earth. As a result of this global environmental change, large effects are expected in river ecosystem functioning, which is the base of many ecosystem services essential for humans. Streams and rivers are among the most affected ecosystems, especially those in highly populated areas with a shortage of water availability, such as the Mediterranean region, where they are subject to multiple pressures including flow regulation, water abstraction, pollution, changes in channel form, modification of riparian areas, and invasive exotic species. These pressures can be seen as stressors as they result from human activity, exceed the range of normal variation of rivers, and adversely affect individual taxa, community composition or ecosystem functioning. Ecosystems are influenced simultaneously by multiple stressors, and Mediterranean rivers are a paradigmatic example. Unfortunately, their complex interactions make the joint consequences of multiple stressors unpredictable on the basis of knowledge of single effects. Besides, strong

seasonal variability in flow makes Mediterranean rivers especially vulnerable to pollution and water extraction during the dry seasons. Incidentally, river ecosystems have multiple functions, which can be measured with a varied array of techniques, change at different spatial and temporal scales, and respond to environmental stressors in specific manners. In this work, we mostly worked with decomposition of organic matter and river metabolism, commonly measured ecosystem functions which are integrative measures of river ecosystem functioning, and respond to human activities at different scales. Therewithal, this PhD dissertation explored the effects of global change on the functioning of Mediterranean river ecosystems, which are severely impacted by these human activities, including a combination of field and laboratory studies.

In our first work, we were concerned about how Mediterranean rivers in the Iberian Peninsula are being increasingly affected by human activities threatening their ecological status, although we missed a clear picture of how do these multiple stressors affect river ecosystem functioning. It is thus that we addressed this question by measuring a key ecosystem process, namely breakdown of organic matter, at 66 sites distributed across Mediterranean Spain. We performed breakdown experiments by measuring the mass lost by wood sticks for 54 to 106 days. Additionally, we gathered data on physicochemical, biological and geomorphological characteristics of study sites. Study sites spanned a broad range of environmental characteristics and breakdown rates varied fiftyfold across sites. No clear geographic patterns were found between or within basins. 90th quantile regressions performed to link breakdown rates with environmental characteristics included the following

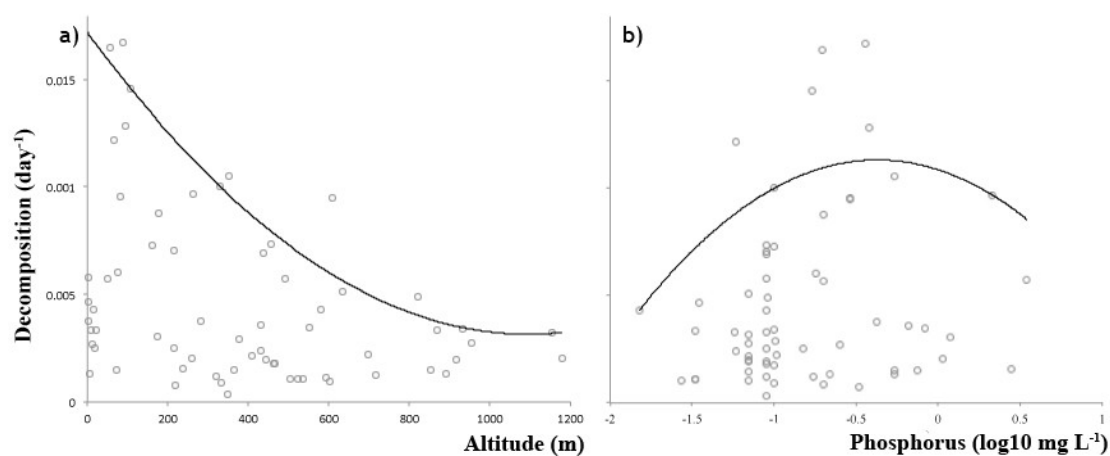


Figure 1. Relationships between (a) altitude and (b) phosphorus concentration for Iberian rivers breakdown rates (circles) and for 90th quantile regression models (lines).

7 variables in the model, in decreasing order of importance: altitude, water content in phosphorus, catchment area, toxicity, invertebrate based biotic index, riparian buffer width, and diatom-based quality index. Breakdown rate was systematically low in high-altitude rivers with few human impacts, but showed a high variability in areas affected by human activity (*Figure 1a*). Besides, breakdown rates variability increased with phosphorus concentration, although up to a level where the variability declined (*Figure 1b*). This increase in variability is the result of the influence of multiple stressors acting simultaneously, as some of these can promote whereas others slow down the breakdown of organic matter. Therefore, stick breakdown gives information on the intensity of a key ecosystem process, which would otherwise be very difficult to predict based on environmental variables.

In the second work, we faced another great impact in the Mediterranean rivers, the flow regulation. Flow regime is far from natural in most rivers, as dams modify the quantity, timing and variability of water discharge. Mediterranean rivers are strongly affected by flow regulation. In particular, the Iberian Peninsula hosts one fifth of all European reservoirs, and has the largest number of dams per inhabitant and per land area in the world. Within this background, organic matter accrual and metabolism were measured in reaches upstream and downstream from large reservoirs in three tributaries of the Ebro River (NE Iberian Peninsula) during three sampling campaigns. Dams reduced downstream hydrological variability, dampened floods and increased the duration of inter-flood periods (*Figure 2a* and *b*). Benthic organic matter increased two-fold and chlorophyll-a eight-fold (*Figure 2c*). Gross primary production increased by 59% on average, whereas ecosystem respiration increased by 75% (*Figure 2d*). In general, flow regulation intensified the capacity of downstream river reaches to store and process materials and energy, therefore increasing the amount of organic carbon processed and altering the whole flux of materials and energy along the river continuum.

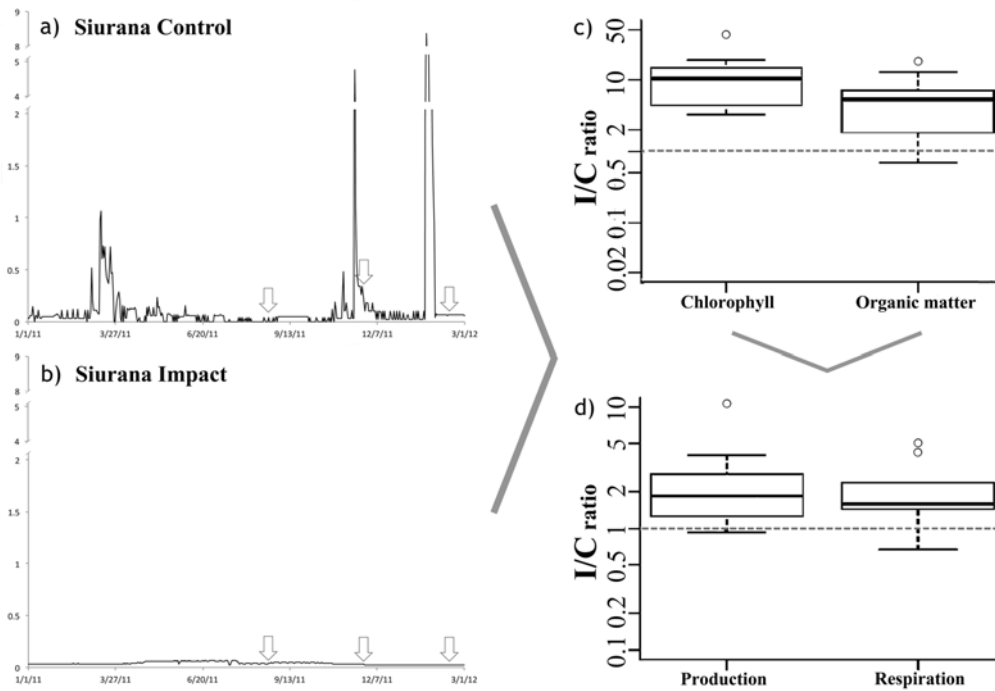


Figure 2. Hydrographs of the Siurana River (as example) at the (a) control and (b) impact sites, and its effects on (c) organic matter accumulation and (d) metabolism (as Impact/Control ratios).

In addition to flow regulation, many stressors increasingly impair Mediterranean rivers, where strong droughts increase the effects of pollution. Pollution can reach rivers from both point and diffuse sources, and often appear in complex mixtures whose joint effects can have contrasting effects. The effluents of wastewater treatment plants (WWTP) are clear examples of complex mixtures of pollutants reaching river ecosystems, as they include nutrients, organic matter, metals, pesticides, and other contaminants such as emerging pollutants, and are another common impact on river ecosystems, especially in conurbations. Nutrients can subsidize autotrophic and heterotrophic organisms, while toxic pollutants can act as stressors, depending, for instance, on their concentration and interactions in the environment. Hence it is difficult to predict the overall effect of WWTP effluents on river ecosystem functioning. We assessed the effects of WWTP effluents on river biofilms and ecosystem metabolism in one river segment upstream from a WWTP and three segments downstream from the WWTP and following a pollution gradient (Figure 3a). The photosynthetic capacity and enzymatic activity of biofilms showed no change, with the exception of leucine-aminopeptidase, which followed the pollution gradient most likely driven by changes in organic matter availability. The effluent produced mixed effects on ecosystem-scale metabolism (Figure 3b). It promoted respiration (subsidy effect), probably as a consequence of enhanced availability of organic matter. On the other hand, and despite enhanced nutrient concentrations, photosynthesis- irradiance relationships showed that the effluent partly decoupled primary production from light availability (Figure 3c), thus suggesting a stress effect (Figure 3d) which also triggered defense mechanisms at biofilm scale such as the non-photochemical quenching (Figure 3e). Overall, WWTP effluents can alter the balance between autotrophic and heterotrophic processes and produce spatial discontinuities in ecosystem functioning along rivers as a consequence of the mixed contribution of stressors and subsidizers.

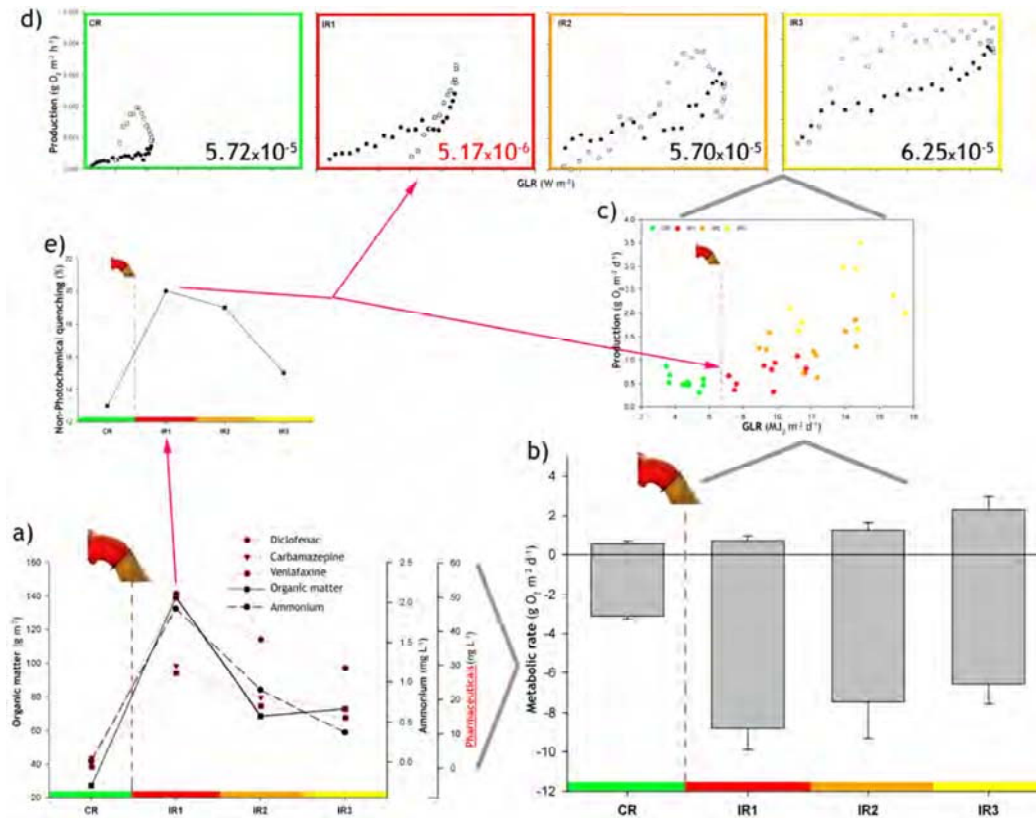


Figure 3. Effects of WWTPs induced pollution gradient (CR, Control upstream the effluent, and IR1 to IR3 Impacts downstream) on contaminants (a), total metabolism (b), Production-Irradiance relationships (c - daily averages; d - day curves with slopes), and Non-Photochemical Quenching (e).

Due to this last work, new questions emerged because when multiple anthropogenic stressors occur in mixtures, these contaminants can have either antagonistic, neutral or synergistic effects; but little is known on their joint effects. Hence we assessed the interaction effects of a mixture of assimilable and toxic contaminants on stream biofilms in a manipulative experiment using artificial streams, and following a factorial design with three nutrient levels (low, medium or high) and either presence or absence of a mixture of emerging contaminants (ciprofloxacin, erythromycin, diclofenac, methylparaben, and sulfamethoxazole). We measured biofilm biomass, basal fluorescence, gross primary production and community respiration. Our initial hypotheses were that biofilm biomass and activity would: (i) increase with medium nutrient concentrations (subsidy effect), but decrease with high nutrient concentrations (stress effect); (ii) decrease with emerging contaminants, with the minimum decrease at medium nutrient concentrations (antagonistic interaction between nutrients subsidy and stress by emerging contaminants) and the maximum decrease at high nutrient concentrations (synergistic interaction between nutrients and emerging contaminants stress). All the measured variables responded linearly to the available nutrients, with no toxic effect at high nutrient concentrations (Figure 4). Emerging contaminants only caused weak toxic effects in some of the measured variables, and only after 3-4 weeks of exposure (Figure 4b-d). Therefore, only antagonistic interactions were observed between nutrients and emerging contaminants, as medium and high nutrient concentrations partly compensated the harmful effects of emerging contaminants during the first weeks of the experiment. Our results show that contaminants with a subsidy effect can alleviate the effects of toxic contaminants, and that long-term experiments are required to detect stress effects of emerging contaminants at environmentally relevant concentrations.

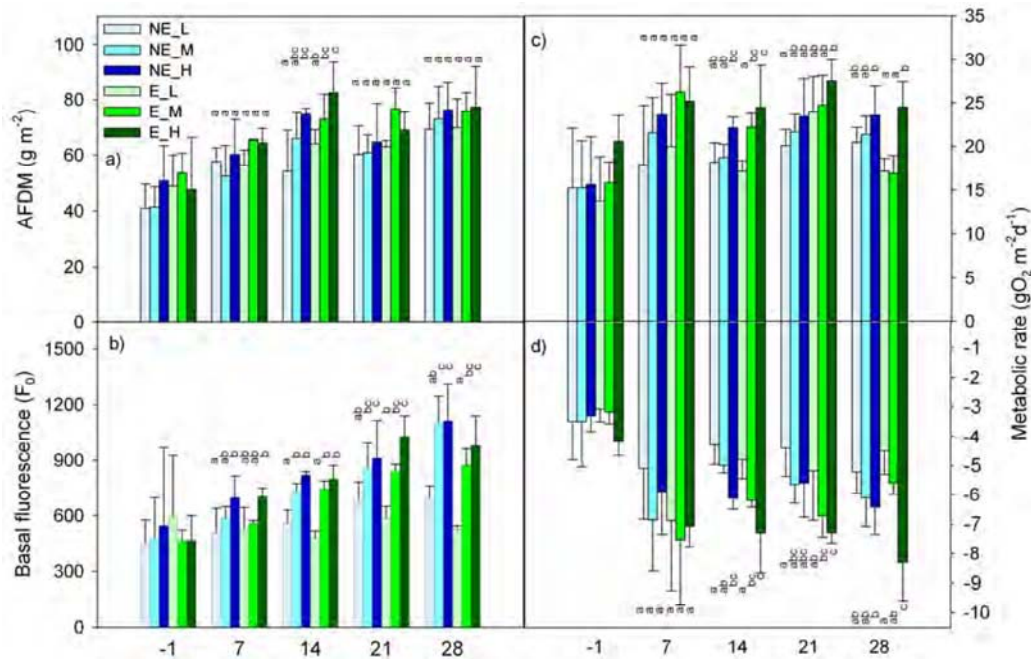


Figure 4. Changes in biofilm variables, expressed as the means (\pm SD) of the values per treatment and per time of (a) ash free dry mass (AFDM), (b) basal fluorescence (F_0), (c) gross primary production (GPP), and (d) community respiration (CR). Note that, NE stands for treatment with no emerging contaminants and E for treatment with emerging contaminants; and that L stands for treatment with low, M for treatment with medium and, H for treatment with high nutrient concentrations. Post-hoc Tukey test results for each day of the experiment after treatment implantation are shown in letters.

Overall, our results provide evidence of the important ecological effects of global change on Mediterranean rivers, and suggest important consequences for the society, in terms of ecosystem services. The knowledge regarding the combined effects of stressors is increasing, but we are still far from completely understanding the myriads of combinations affecting simultaneously freshwater ecosystems. The effects of stressors will likely affect increasingly longer river sections. Therefore, it is urgent to take action to protect and restore Mediterranean rivers, as they are the most vulnerable to environmental damage.

AUTOR: Iñigo Moreno Ocio

TÍTULO DEL TRABAJO: Bioacumulación de Hg y Cu en la cuenca minera del Nalón (Asturias, España): Evaluación en cuatro taxones bentónicos indicadores mediante la condición de referencia.

DIRECTORAS: Dra. Maite Martínez-Madrid & Dra. Pilar Rodríguez

CENTRO DE REALIZACIÓN: Departamento de Zoología y Biología Celular Animal, Universidad del País Vasco

FECHA DE PRESENTACIÓN: 7 de septiembre de 2016

Se han evaluado las concentraciones de Cu y Hg en sedimento y en tejido de macroinvertebrados representantes de cuatro grupos tróficos (Ephemeroptera: fitófago, Hydropsychidae: colector-filtrador, Microdrili: colector-recogedor y Rhyacophilidae: depredador) en 13 localidades-test y 14 localidades-referencia de diferentes tipologías fluviales en la cuenca minera del Nalón. El análisis del sedimento deparó unas concentraciones de Hg superiores al TEC en todas las localidades-test y superiores al PEC en el 62% de los casos; el TEC fue superado en el 50% de las localidades-test para el Cu. La concentración de metales en biota fue significativamente diferente entre las localidades-referencia y las localidades-test afectadas por las minas de Cu y Hg y se superaron los valores de los CTL en algunas de las localidades-test. Se ha demostrado la existencia de diferencias en la bioacumulación en los distintos grupos funcionales mientras que la tipología fluvial no influye en la bioacumulación. Los niveles-base calculados como el percentil 90 de cada metal para cada taxón han resultado efectivos a la hora de evaluar las localidades-test frente a la condición de referencia y han sido validados con la bibliografía existente.

AUTORA: Isabel Reyes Bárbara

TÍTULO DEL TRABAJO: Estudio de las microalgas de la Cuenca del Guadalquivir. Efecto del tipo de sustrato y ecorregionalización.

DIRECTORA: Julia Toja Santillana y María adela Casco.

CENTRO DE REALIZACIÓN: Dep. Biología Vegetal y Ecología. Universidad de Sevilla.

FECHA DE PRESENTACIÓN: 22 enero 2016

URL: <https://idus.us.es/xmlui/handle/11441/38645>

INTRODUCCIÓN

La cuenca del Guadalquivir se compone de una red de ríos y arroyos con 57527 km² de superficie. Básicamente existen 3 grandes unidades hidrogeomorfológicas: Sierra Morena, Montañas Béticas y el Valle del Guadalquivir (Figura 1). Además se observan diferencias espaciales marcadas por la geomorfología de cada zona y diversas perturbaciones.

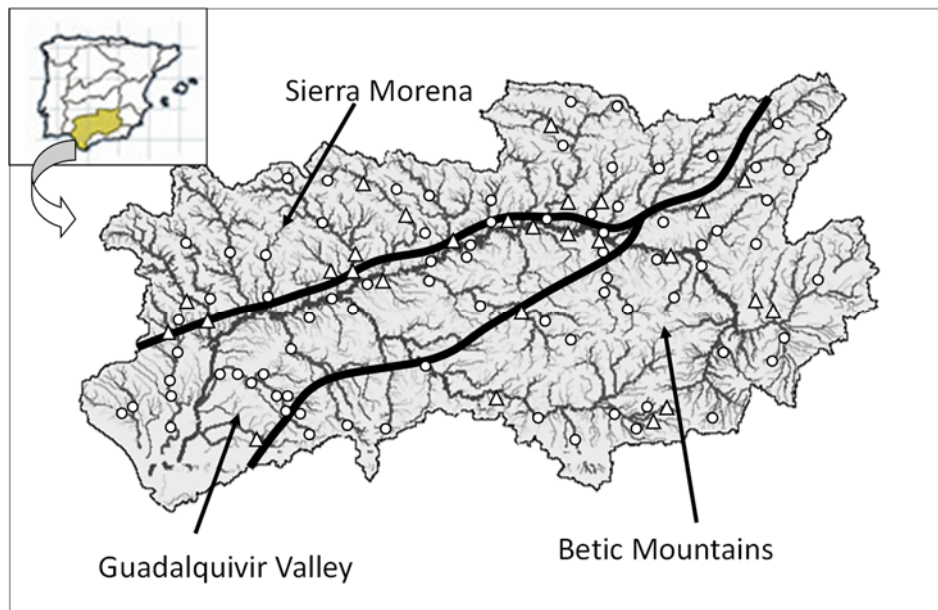


Figura 1 Tramos muestreados en la cuenca del Guadalquivir y delimitación de las 3 grandes unidades hidrogeológica.

Las microalgas bentónicas tienen un gran valor como bioindicadores, ya que responden con relativa rapidez a los cambios en la calidad del agua, la heterogeneidad espacial, las variaciones estacionales y las características hidrogeomorfológicas. Asimismo, la diversidad de sustratos colonizables (naturales y artificiales), es una variable más para evaluar el estado ecológico de los ríos.

OBJETIVOS

1. Realizar el estudio del grado de conservación de los ríos, en función de la hidrogeomorfología y del estado trófico de sus tramos. Conocer la flora bentónica de la cuenca del Guadalquivir. Identificar taxones cosmopolitas y exclusivos.
2. Evaluar el efecto del sustrato sobre la composición y abundancia del perifiton.
3. Realizar una ecorregionalización en función de las algas bentónicas.
4. Comparar la idoneidad del uso de los resultados cualitativos frente a los cuantitativos.
5. Relacionar las variables ambientales con la composición de las taxocenosis.

METODOLOGÍA DE MUESTREO

Se muestrearon 109 tramos de río en toda la cuenca del Guadalquivir (95 de la red ICA + 14 puntos controles). En todos se tomó una muestra multihabitat (Figura 1), se midieron las variables físico-químicas *in situ*, y se valoró la calidad del hábitat.

En 30 de esos tramos se evaluó el efecto de la heterogeneidad de los sustratos, incluyendo sustratos artificiales.



Figura 2 Esquema del muestreo multihábitat.

Tanto los datos cualitativos (presencia, frecuencia, composición específica) de las muestras multihábitat de los 109 tramos como los cuantitativos (abundancia, diversidad, biovolumen, concentración de clorofila a) de los 30 tramos, se relacionaron con variables indicadoras de la calidad del agua y de la hidrogeomorfología.

RESULTADOS

La cuenca del Guadalquivir muestra una alta riqueza taxonómica de algas fitobentónicas (143 cianobacterias, 2, rodofitas, 3 dinofíceas, 38 euglenofitas, 1 criptofita, 4 crisofíceas, 427 diatomeas y 167 clorofitas).

Achnantheidium minutissimum, *Amphora pediculus* y *Gomphonema parvulum* son los taxones más frecuentes ($\geq 70\%$). Sólo 24 taxones presentan una frecuencia de aparición mayor del 40%. El 71% de los taxones identificados tienen una frecuencia de aparición menor del 5%.

Cada una de las 3 grandes unidades geomorfológicas registra un gran número de taxones exclusivos: 189 en Sierra Morena; 129 en las Montañas Béticas y 34 en el Valle del Guadalquivir.

Los tramos muy perturbados por contaminación orgánica, independientemente de su situación geográfica, tienen una taxocenosis de algas similar entre sí (*Navicula veneta*, *G. parvulum*, *Nitzschia frustulum* y *Tryblionella hungarica*), ya que la contaminación enmascara el efecto de los demás factores.

La composición de las taxocenosis desarrolladas sobre distintos sustratos de un mismo tramo suelen ser similares. Sólo se encontró especificidad respecto al sustrato en algunas cianobacterias: *Homoeothrix margalefii* y *Homoeothrix juliana*, exclusivas de roca. Muchas clorofitas adnatas, aunque colonizan todos los sustratos, tienen cierta preferencia por los macrófitos.

Pero, comparando el desarrollo del perifiton (densidad, concentración de clorofila a y biovolumen), hay diferencias significativas entre sustrato lítico y vegetal, siendo mayor en la roca (Figura 3). No hay diferencias entre los sustratos líticos naturales y artificiales.

Figura 3 Resultados de los análisis ANOVA para la diferenciación de sustratos tanto en densidad como biovolumen y concentración de clorofila a.

Variable	Sustratos comparados	F	p
Densidad (cel/cm²)	Roca/Vegetal	4,494	0,04
	Roca/Artificial	0,146	6,89
Concentración de clorofila a (µg/cm²)	Roca/Vegetal	6,41	0,016
	Roca/Artificial	2,699	1,39
Biovolumen (mm³/cm²)	Roca/Vegetal	4,643	0,08
	Roca/Artificial	0,114	7,37

El análisis a partir de los datos de presencia- ausencia de los taxones muestra que existen 4 grupos (Figura 4) significativamente diferentes según el test ANOSIM (Figura 6). Tres de ellos coinciden con las tres grandes unidades geológicas de la cuenca y un cuarto engloba los tramos muy contaminados. Analizando cada grupo por separado, el factor discriminante es la su cuenca (Figura 5).

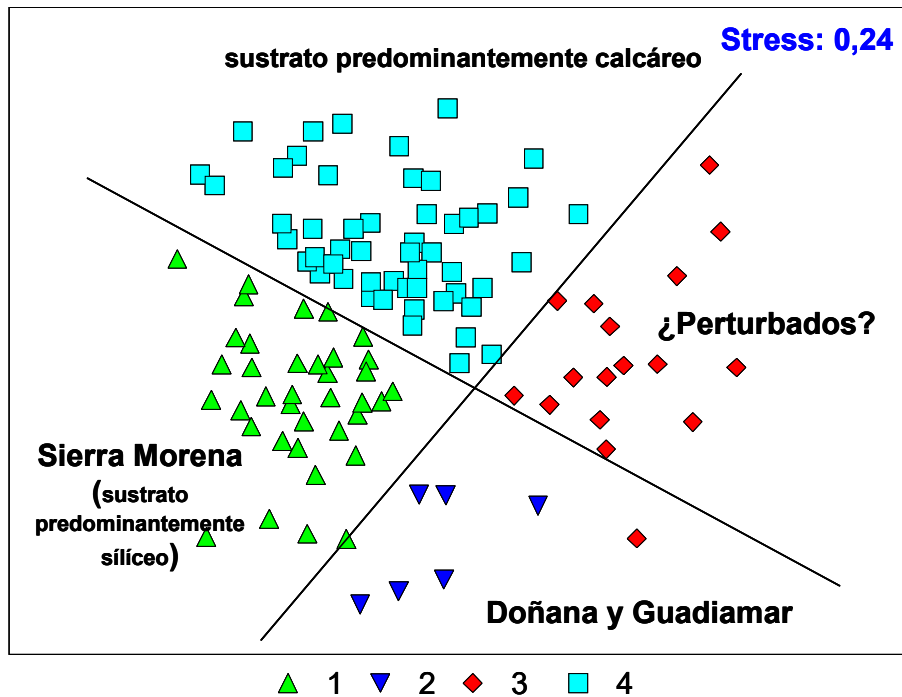


Figura 4: Ordenación de los 109 tramos estudiados según un análisis MDS realizado con datos de presencia-ausencia en las muestras multihábitat (1: Sierra Morena; 2: Doñana y Bajo Guadalquivir, 3: Tramos contaminados independientemente de su situación geográfica y 4: tramos predominantemente calcáreos).

La composición considerando exclusivamente Oscillatoriales (segundo grupo dominante en el perifiton) muestra la misma clasificación por subcuencas que la taxocenosis completa, aunque con menor robustez ($R=0,270$, $p=0,001$). Comparando la discriminación por subcuencas en cada ecorregión se observa una robustez similar al perifiton completo (Figura 5).

Figura 5: Tests ANOSIM realizados con el total de taxones y sólo las Oscillatoriales para cada ecorregión, considerando la subcuenca como factor discriminante.

		Factor discriminante Perifiton completo		Sólo Oscillatoriales	
Estadísticos ANOSIM		R	p	R	p
Ecorregión 1	Subcuenca	0,679	0,001	0,202	0,001
Ecorregión 2	Subcuenca	0,602	0,001	0,612	0,001
Ecorregión 3	Subcuenca	0,425	0,001	0,442	0,001
Ecorregión 4	Subcuenca	0,214	0,002	0,221	0,003

Figura 6: Comparación de los diferentes sistemas de clasificación para dos tipos de muestreo (cualitativo multihábitat y muestreo cuantitativo)

Tipo de Muestreo		Cualitativos	Cuantitativos
Nº tramos		109	30
Riqueza acumulada		841	366
Clasificación Ecorregiones	ANOSIM ($R, p>0,001$)	0.613	0.313
Clasificación Subcuencas	ANOSIM ($R, p>0,001$)	0.459	0.542

También el análisis con datos cuantitativos, muestra a la subcuenca como el factor discriminante (Figura 6).

En la cuenca del Guadalquivir, los regímenes fluviales, la composición del sustrato y la carga de nutrientes son las variables más influyentes. Esto coincide con otros estudios (ABOAL *et al.*, 1996). En las relación de los taxones con los factores del medio, en el grupo 1 del CCA los taxones más discriminantes son *Leptolyngbya foveolarum*, presente en rocas y gravas y *Phormidium numidicum*, taxón subaerofítico (KOMAREK & ANAGNOSTIDIS, 2004). También *Navicula cryptotenella* es representativa de este grupo y, según LEIRA & SABATER (2005), es un taxón que está igualmente influenciado por condiciones físico-químicas y por la altitud. Por tanto este grupo está claramente diferenciado por las variables hidromorfológicas.

El segundo grupo están discriminado por *Nitzschia fonticola*, asociada a la altitud (LEIRA & SABATER 2005), *Phormidium nigrum* y *Phormidium uncinatum* propias de aguas estancadas o con bajo flujo e incluso en condiciones anóxicas (DOODS, 2006) y, por último, *Pseudoanabaena limnetica*, taxón ticoplanctónico y con alta tolerancia a la contaminación (KOMAREK & ANAGNOSTIDIS, 2004).

Los taxones discriminantes del grupo 3 son *Homoeothrix margalefii* y *Lyngbya martensiana* adaptadas a cualquier tipo de flujo y distintos sustratos (KOMAREK & ANAGNOSTIDIS, 2004). También son importantes taxones propios de aguas corrientes como *Nitzschia dissipata* var. *dissipata* (BERES *et al.*, 2014) y otros muy tolerantes a la contaminación como *Nitzschia palea* (STENGER-KOVACS *et al.*, 2013).

En conclusión en esta Tesis se aportan datos sobre la alta biodiversidad de algas de la Cuenca del Guadalquivir, su distribución geográfica, su especificidad o no por el sustrato y su presencia respecto a contaminantes. Se analiza la relación con características ambientales diferentes de la contaminación y, por primera vez, se utilizan las algas bentónicas en la ecorregionalización.

BIBLIOGRAFÍA

- ABOAL, M., M.A. PUIG & G. SOLER. (1996). Diatom assemblages in some Mediterranean temporary streams in southeastern Spain. *Arch. für Hydrobiologie* 136 (4): 509-527.
- ACS, E., BORSODI, A. K., MAKK, J., MOLNÁR, P., MÓZES, A., RUSZNYÁK, A., RESCONE, M.N. & KISS, K. T. (2003). Algological and bacteriological investigations on reed periphyton in Lake Velencei, Hungary. *Hydrobiologia*, 506 (1-3), 549-557.
- BARBOUR, M. T., GERRITSEN, J., SNYDER, B. D., & STRIBLING, J. B. (1999). *Rapid bioassessment protocols for use in wadeable streams and rivers*. Periphyton, Benthic Macroinvertebrates, and Fish (2nd edn). US Environmental Protection Agency, Office of Water, Washington, DC EPA.
- BERES, V., TÖRÖK, P., KÓKAI, Z., KRASZNAI, E. T., TÓTHMÉRÉSZ, B., & BÁCSI, I. (2014). Ecological diatom guilds are useful but not sensitive enough as indicators of extremely changing water regimes. *Hydrobiologia*, 738(1), 191-204.
- CHARLES, D. F., ACKER, F. W., HART, D. D., REIMER, C. W., & COTTER, P. B. (2006). Large-scale regional variation in diatom-water chemistry relationships: rivers of the eastern United States. *Hydrobiologia*, 561(1), 27-57.
- COCHERO, J., LICURSI, M., & GOMEZ, N. (2015). Changes in the epipellic diatom assemblage in nutrient rich streams due to the variations of simultaneous stressors. *Limnologia*, 51, 15-23.
- KOMAREK, J. & K. ANAGNOSTIDIS, (2004). *Cyanoprokaryota. 2 Oscillatoriales. Süßwasserflora von Mitteleuropa Band 19 (2). Gustav Fischer Verlag, 750 pp***
- LEIRA, M., & SABATER, S. (2005). Diatom assemblages distribution in catalan rivers, NE Spain, in relation to chemical and physiographical factors. *Water Research*, 39(1), 73-82.
- MARÍN MURCIA, J. P., & ABOAL SANJURJO, M. (2005). Aportaciones a la flora de diatomeas de Euskadi. *Algas*, 33, 25-32.
- MARTÍN, G., TOJA, J., SALA, S. E., DE LOS REYES FERNÁNDEZ, M., REYES, I., & CASCO, M. A. (2010). Application of diatom biotic indices in the Guadalquivir River Basin, a Mediterranean basin. Which one is the most appropriated?. *Environmental monitoring and assessment*, 170(1-4), 519-534.
- POTAPOVA, M. G., & CHARLES, D. F. (2002). Benthic diatoms in USA rivers: distributions along spatial and environmental gradients. *Journal of Biogeography*, 29(2), 167-187.
- POTAPOVA, M., & CHARLES, D. F. (2003). Distribution of benthic diatoms in US rivers in relation to conductivity and ionic composition. *Freshwater Biology*, 48(8), 1311-1328.
- ROS, M. D., MARÍN-MURCIA, J. P., & ABOAL, M. (2009). Biodiversity of diatom assemblages in a Mediterranean semiarid stream: implications for conservation. *Marine and Freshwater Research*, 60(1), 14-24.
- STENGER-KOVÁCS, C., LENGYEL, E., CROSSETTI, L. O., ÜVEGES, V., & PADISÁK, J. (2013). Diatom ecological guilds as indicators of temporally changing stressors and disturbances in the small Torna-stream, Hungary. *Ecological Indicators*, 24, 138-147.
- TORNÉS, E. (2009). *Distributional patterns of diatom communities in Mediterranean rivers*, PhD Thesis. University of Girona, Spain. 154 pp.

TOWNSEND, S. A., & GELL, P. A. (2005). The role of substrate type on benthic diatom assemblages in the Daly and Roper Rivers of the Australian wet/dry tropics. *Hydrobiologia*, 548 (1), 101-115.

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TÍTULO DEL TRABAJO: Rasgos fisiológicos y biológicos que definen el nicho ecológico en Corixidae (Hemiptera): respuestas al cambio climático e invasiones biológicas

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En este estudio se exploran aspectos claves de la variación de nicho ecológico tanto a nivel intra-específico como a nivel inter-específico, empleando los corixidos (Hemiptera) como organismos modelo. Esta familia de chinches acuáticos es una de las más extendidas y bien adaptadas a una gran variedad de cuerpos de agua en todo el mundo. Los corixidos están presentes habitualmente en todo tipo de medios leníticos, temporales o permanentes, desde aguas dulces a salinas. Son igualmente clave en la red trófica de los ecosistemas que habitan, al tratarse de uno de los grupos más abundantes y que mayor biomasa aporta. Como consecuencia de su distribución mundial y su importancia para los ecosistemas, la ecología y biología de esta familia de insectos ha sido ampliamente estudiada. Este aspecto, junto al carácter ubiquista de muchas especies, su pequeño tamaño y su abundancia, hacen a esta familia ideal para estudiar la variación inter e intra-específica de los rasgos fisiológicos y de historia de vida que definen el nicho ecológico. Además, esta familia presenta la única especie invasora de insecto acuático establecida en Europa, *Trichocorixa verticalis verticalis* (Fieber, 1851), originaria de Norteamérica y actualmente extendida en Sudáfrica, Nueva Caledonia, Marruecos, España y Portugal. Esta especie ofrece una excelente oportunidad para estudiar qué rasgos pueden favorecer el éxito en el establecimiento y dispersión de especies exóticas y sus interacciones con especies nativas, lo cual puede resultar de gran ayuda para predecir los impactos que las invasiones biológicas pueden generar sobre las comunidades acuáticas.

El principal objetivo de esta tesis ha sido abordar los rasgos fisiológicos y biológicos clave que caracterizan el nicho ecológico de especies relacionadas de corixidos: especies nativas del género *Sigara* y la especie exótica *Trichocorixa verticalis verticalis*, el único hemíptero acuático reconocido como invasor en Europa. El estudio del nicho ecológico de estas especies ha permitido explicar sus distribuciones, coocurrencia y respuestas frente a las presiones ambientales. Los resultados obtenidos suponen una aportación significativa sobre los impactos del cambio climático y las invasiones biológicas a nivel de población, especie y comunidad.

En el **capítulo 1** se estudió el papel que juega la salinidad y química del agua en la ocupación de hábitat de tres especies de corixidos que muestran una clara diferencia en la preferencia de hábitat: *Sigara nigrolineata nigrolineata* (Fieber, 1848) de medios dulces, *Sigara scripta* (Rambur, 1840) presente en aguas hiposalinas y *Sigara selecta* (Fieber, 1848), especie que ocupa aguas meso e hipersalinas. Específicamente, los objetivos han sido determinar, para cada una de las especies, el nicho realizado con relación a la salinidad y composición iónica del agua a partir de datos de campo, para comparar con el nicho fundamental definido en condiciones de laboratorio para los tres estadios de vida de las especies (huevo, ninfa y adulto). Los resultados mostraron una fuerte concordancia entre ambos nichos, realizado y fundamental. Los estadios de vida más tempranos de las especies (huevos y ninfas) mostraron una menor tolerancia a la salinidad que los adultos. No se encontraron limitaciones fisiológicas en laboratorio con relación a condiciones de agua dulce y baja salinidad para la especie salina *S. selecta*, por lo que otros factores, probablemente relacionados con interacciones bióticas, pueden estar jugando un papel importante en la distribución de esta especie.

En el **capítulo 2** se estudiaron posibles diferencias en rasgos metabólicos (consumo de oxígeno – MO_2) y reproductivos (producción de huevos y volumen de los mismos) entre dos poblaciones de *Sigara selecta*, una situada en el centro de su área de distribución (sureste de España) y otra situada en el margen o borde norte (sureste de Inglaterra). Asimismo, se estudió la plasticidad de esas características a cambios ambientales, interpretando las implicaciones que podría tener en las respuestas de ambas poblaciones frente al cambio global. La población del margen mostró una mayor plasticidad fenotípica en cuanto al metabolismo y la fecundidad que la población del centro. La mayor plasticidad de la población del margen facilitaría su expansión hacia el norte con el calentamiento climático. Por el contrario, la población del centro, más resistente, puede ser capaz de compensar la variabilidad ambiental actual con cambios menores en metabolismo y fecundidad. Sin embargo, esta población podría ser más propensa a la extinción si los cambios de temperatura y salinidad excedieran sus límites de tolerancia en el futuro.

En el **capítulo 3** se estudiaron varios rasgos fisiológicos, de historia de vida y morfológicos que, a priori, pueden hacer de la especie invasora *T. v. verticalis* un mejor competidor respecto a varias especies nativas del género *Sigara*, pudiendo explicar su distribución y expansión recientes en el suroeste de España. En concreto, se comparan dichos rasgos con tres especies de *Sigara* con las que convive en el área de invasión a lo largo de un gradiente de salinidad: *Sigara lateralis*, *S. scripta* y *S. selecta*. Para estimar la habilidad para tolerar factores ambientales se midió la tolerancia a la salinidad (de huevos, ninfas y adultos) y tolerancia térmica. Como indicadores de la capacidad de reclutamiento de nuevos individuos se estudió la tasa reproductiva (estimada como la producción de huevos por día) y el tiempo y porcentaje de eclosión. Asimismo, con relación a la capacidad de dispersión y expansión, se estimó la capacidad de vuelo mediante el cálculo del ratio de aspecto alar y la carga alar. Los resultados mostraron que adultos y ninfas de *S. selecta* presentan la mayor tolerancia a la salinidad, sin embargo, *T. v. verticalis* mostró la mayor tolerancia para la fase de huevo. Asimismo, *T. v. verticalis* mostró la mayor tolerancia a altas temperaturas, aunque su tolerancia al frío fue menor que la de las especies nativas. *T. v. verticalis* se caracterizó por tener el mayor valor de ratio de aspecto alar, lo que indica que la especie presenta alas alargadas y estrechas, relacionadas con un vuelo activo y enérgico. *T. v. verticalis* también presentó una mayor tasa reproductiva que las especies de *Sigara*, sobre todo en condiciones mesosalinas. En resumen, el éxito en el establecimiento y dispersión de la especie exótica *T. v. verticalis* podría deberse principalmente a su alta capacidad reproductora, importante resistencia a la salinidad y temperatura, especialmente de los huevos, y a una mayor capacidad de dispersión por vuelo.

Finalmente, en el **capítulo 4** se estudió el impacto de la especie invasora *T. v. verticalis* sobre los patrones de coocurrencia de las tres especies nativas de *Sigara* con las que puede coexistir a lo largo de un gradiente de salinidad, así como los mecanismos que determinan dicha coocurrencia (*filtro de hábitat* o *diferenciación de nicho*). Para ello se describieron los nichos de especialización de hábitat y funcional de las especies (mediante un Análisis de Coordinadas Principales - PCoA) y su solapamiento (porcentaje de solapamiento) a partir de rasgos fisiológicos (tolerancia a la salinidad) y biológicos definidos y categorizados mediante experimentos de laboratorio y fuentes bibliográficas. Para determinar si la presencia de *T. v. verticalis* modifica los patrones de distribución y coocurrencia de las especies nativas se realizó un análisis de coocurrencia empleando datos de campo de la distribución de las especies tanto en el área invadida cercana (sur de la península ibérica y norte de Marruecos) como no invadida (SE España). Finalmente, mediante el empleo de modelos nulos identificamos el mecanismo de asociación de especies (*filtro de hábitat* o *diferenciación de nicho*) que estaba jugando un papel significativo en la distribución y coocurrencia de las especies, tanto en el área invadida como en la no ocupada. Los resultados revelaron que la presencia de *T. v. verticalis* modifica los patrones de distribución y coocurrencia de las especies nativas a lo largo del gradiente de salinidad. En el área no invadida, el filtro de hábitat parece determinar la segregación de las especies nativas (mostrando un patrón de coocurrencia negativo entre ellas). En este escenario, debido al alto solapamiento en el nicho funcional las especies se segregan en función de su tolerancia fisiológica a lo largo del gradiente de salinidad. Por otro lado, la diferenciación de nicho parece configurar la coexistencia entre la especie invasora y las especies nativas *S. selecta* y *S. scripta* en el área de invasión. Una posible explicación puede ser la baja similitud funcional de *T. v. verticalis* con las especies nativas, fundamentalmente en su nicho trófico, de manera que el reparto de recursos permitiría la coexistencia de las especies.

Publicaciones derivadas de la tesis

CARBONELL, J.A., MILLÁN, A. & VELASCO, J. (2012). Concordance between realised and fundamental niches in three Iberian *Sigara* species (Hemiptera: Corixidae) along a gradient of salinity and anionic composition. *Freshwater Biology*, 57, 2580–2590.

CARBONELL, J.A., BILTON, D., CALOSI, P., MILLÁN, A., STEWART, A. & VELASCO, J. (accepted). Metabolic and reproductive plasticity of core and marginal populations of the eurythermic saline water bug *Sigara selecta* (Hemiptera: Corixidae) in a climatic change context. *Journal of Insect Physiology*. DOI: 10.1016/j.jinsphys.2016.11.015

CARBONELL, J.A., MILLÁN, A., GREEN, A.J., CÉSPEDES, V., COCCIA, C. & VELASCO, J. (2016). What traits underpin the successful establishment and spread of the invasive water bug *Trichocorixa verticalis verticalis*? *Hydrobiologia*, 768, 273–286.

CARBONELL, J.A., VELASCO, J., MILLÁN, A., GREEN, A.J., COCCIA, C., GUARESCHI, S. & GUTIÉRREZ-CÁNOVAS, C. (under second review). Biological invasion modifies the co-occurrence patterns of insects along a stress gradient. *Functional Ecology*.

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TÍTULO DEL TRABAJO: Valoración de la influencia de diferentes factores ecológicos a una escala espacial y temporal sobre la comunidad de macrófitos en una laguna mediterránea

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Las lagunas someras mediterráneas están sometidas a procesos de deterioro debido a alteraciones ambientales como la eutrofización, los cambios en los usos del suelo de su cuenca de drenaje y la acción del cambio climático (FELD *et al.*, 2016). Además, estos ecosistemas son especialmente importantes en términos ecológicos y de conservación, pues aunque solo representen el 1% de la superficie terrestre, casi el 10% de las especies conocidas habitan en ellos (LOH & WACKERNAGEL, 2004) y la velocidad de extinción de su biota se encuentra más acelerada que en el caso de ecosistemas terrestres y marinos (DUDGEON *et al.*, 2006). Los macrófitos tienen una importancia capital en el funcionamiento y dinámica de los ecosistemas (MCKEE *et al.*, 2003). Además, la estructura y composición de sus comunidades son dos buenos parámetros indicadores de alteraciones ambientales y del cambio climático (LAURIDSEN *et al.*, 2015).

El estudio se realizó en la laguna Sentiz (42° 33' 22'' N y 5° 12' 26'' O), localizada a 940 m de altitud en el municipio leonés de Valdepolo, incluido en el norte de la Comarca Esla-Campos, que se configura como una extensa planicie endorreica (Figura 1).

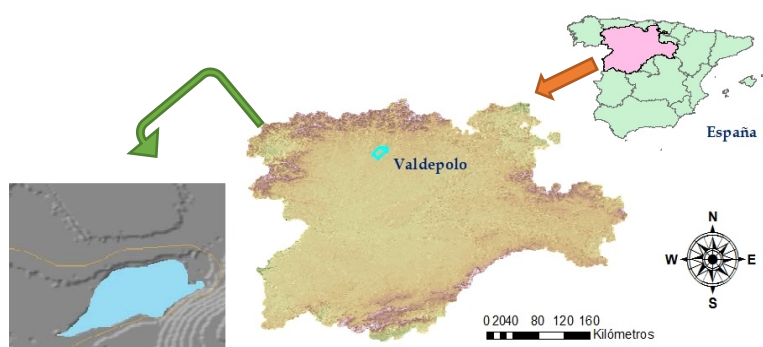


Figura 1. Situación geográfica de la laguna Sentiz y del municipio de Valdepolo sobre un mapa hipsométrico

El primer objetivo de la investigación fue estudiar la influencia relativa de algunos factores ecológicos sobre las comunidades de macrófitos en una laguna somera mediterránea, a lo largo de una escala espacial y temporal, considerando la climatología como factor global, los usos del suelo como factor regional o de cuenca y el hábitat y la hidroquímica como un factor local. Asimismo, se analizó la composición y la dinámica del material sedimentado, en época estival e invernal, con el fin de averiguar el riesgo de colmatación de la laguna y sus posibles influencias sobre la sucesión ecológica de las comunidades de macrófitos. Por último, este estudio pretendió averiguar qué factores ambientales son los responsables de los cambios acelerados que han experimentado la vegetación acuática y la condición trófica de la laguna a lo largo de los últimos años, y contribuir, de esta manera, al conocimiento de los agentes responsables de la dinámica de las comunidades macrofíticas en lagunas someras mediterráneas.

La influencia de diferentes tipos de variables ambientales sobre las comunidades de los sistemas leníticos ha sido registrada por numerosos autores (DEL POZO *et al.*, 2011; MEIER *et al.*, 2015). En la laguna Sentiz se observó una interacción diferencial entre los distintos tipos biológicos de vegetación y los factores ambientales a lo largo de un gradiente espacial (Figura 2), siendo las variables hidroquímicas las que definieron las variaciones de la vegetación sumergida; mientras que las de hábitat, usos del suelo y clima lo hicieron en el caso de los macrófitos de hojas flotantes, grandes helófitos y pequeños helófitos, respectivamente. Resultados similares fueron registrados por DEL POZO *et al.* (2011) en un conjunto de lagunas esteparias de Castilla y León.

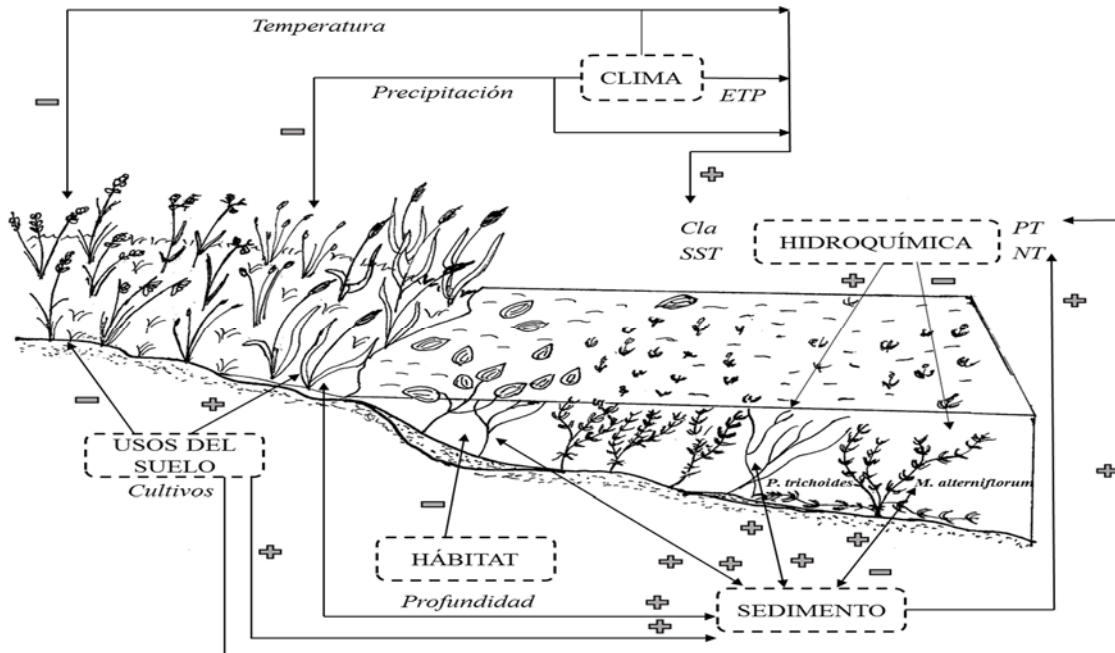


Figura 2. Principales interacciones entre factores ambientales, vegetación y material sedimentado. Nótese que los signos + representan una interacción directa o positiva y los signos - una interacción inversa o negativa.

El estudio realizado reveló, así mismo, un alto grado de interrelación entre las variables ambientales, corroborando las observaciones de FELD *et al.* (2016). Esta interacción entre factores explicó la mayor parte de los cambios acaecidos durante la sucesión ecológica de los macrófitos en lagunas esteparias, tal y como describieron ÁLVAREZ-COBELAS & CIRUJANO (2007) para la vegetación emergente de Las Tablas de Daimiel. Sin embargo, este trabajo amplía el modelo a un mayor número de biotipos de vegetación acuática (sumergidos y hojas flotantes) y emergente.

Los cambios en los usos del suelo registrados en los últimos 35 años y, en particular, la expansión de las actividades agrícolas, que se han producido además en un escenario de cambio climático (aumento de temperatura e intensificación del periodo de aridez), han provocado cambios morfológicos y un incremento de la mineralización y de la condición trófica de la laguna. Las variables asociadas al aumento de la condición trófica (SST y Clorofila "a") han mostrado ser las mejores predictoras de los cambios en la estructura de las comunidades macrófiticas, tal y como han reflejado otros estudios previos (DEL POZO *et al.*, 2011; KISSON *et al.*, 2013). La importancia relativa de estas variables de perturbación sobre la estructura de las comunidades vegetales acuáticas de lagunas someras mediterráneas puede deberse al pequeño tamaño de estos ecosistemas someros, y al alto grado de interacción entre la laguna y la cuenca de drenaje (SZYPER & GOLDYDYN, 2002).

Simultáneamente al aumento del estado trófico del sistema, se constata un cambio en la composición de la comunidad macrófitica, que ha supuesto un incremento de la superficie cubierta por vegetación emergente e hidrófitos de hojas flotantes, estando propiciado y favorecido por un proceso *feedback* de colmatación de la laguna. Asimismo, es evidente una expansión de especies que se encuentran beneficiadas por un proceso de eutrofización progresiva, como *Ceratophyllum demersum* y *Potamogeton trichoides*, en detrimento de especies menos tolerantes como *Myriophyllum alterniflorum* (Figura 3).

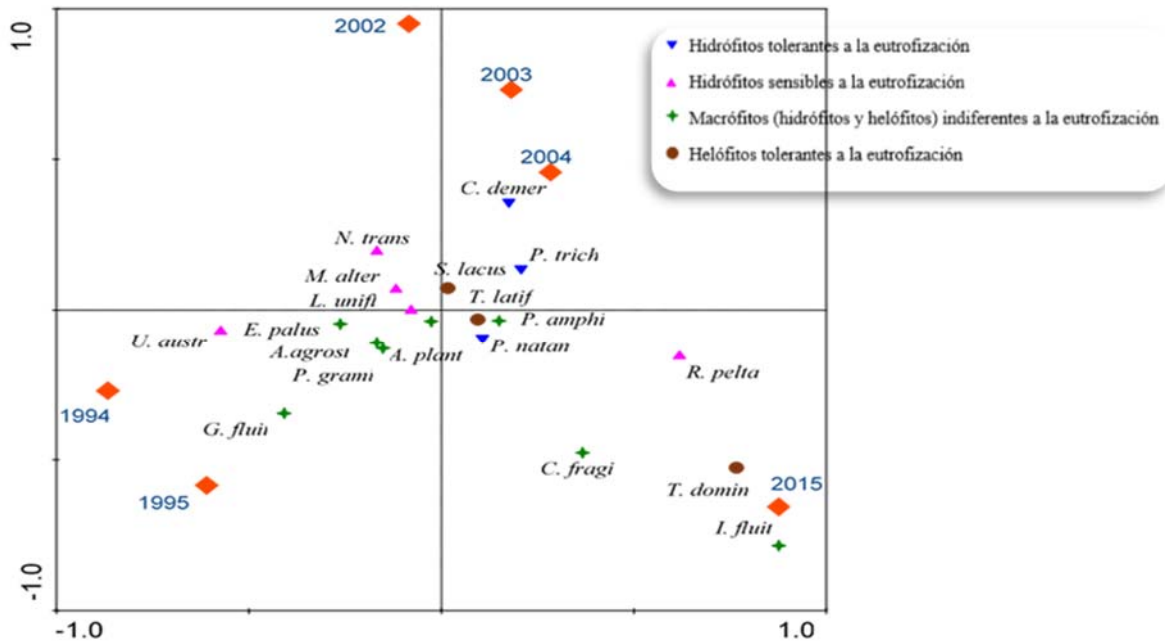


Figura 3. Análisis Factorial de Correspondencias (AFC) realizado con los datos taxonómicos de los macrófitos. Se muestra la ordenación de las muestras en función de los años de seguimiento. La clasificación de las especies según su sensibilidad a la eutrofización se ha realizado a partir del trabajo de Penning *et al.* (2008). Abreviaturas utilizadas en el gráfico: *U. austr*: *Utricularia australis*; *G. fluit*: *Glyceria fluitans*; *E. palus*: *Eleocharis palustris*; *A. agrost*: *Antinoria agrostidea*; *P. gram*: *Potamogeton gramineus*; *L. unifl*: *Litorea uniflora*; *A. plant*: *Alisma plantago-aquatica*; *M. alter*: *Myriophyllum alterniflorum*; *N. trans*: *Nitella translucens*; *S. lacus*: *Scirpus lacustris*; *T. latif*: *Typha latifolia*; *P. natan*: *Potamogeton natans*; *P. amph*: *Polygonum amphibium*; *P. trich*: *Potamogeton trichoides*; *C. demer*: *Ceratophyllum demersum*; *R. pelta*: *Ranunculus peltatus*; *C. fragi*: *Chara fragilis*; *T. domin*: *Typha domingensis*; *I. fluit*: *Isolepis fluitans*.

El cambio climático afecta a la composición y dinámica del sedimento, pues la alteración de las precipitaciones y los procesos hidrológicos, entre ellos la escorrentía superficial, puede llegar a incrementar en un 32% la tasa global de sedimentación en lagos, así como una mayor liberación de nutrientes retenidos en el sedimento (CARPENTER & LODGE, 1986). Además, el ascenso de las temperaturas se encuentra asociado con un mayor aporte de sedimentos, al incrementarse la producción primaria de la vegetación acuática y de los ecosistemas terrestres aledaños (SCHIEFER *et al.*, 2013). Si bien los procesos de sedimentación en la laguna aumentaron en invierno, se puede concluir que la comunidad de macrófitos resultó determinante de la proporción orgánica sedimentada y que además afectó a la concentración de nutrientes disueltos en el agua, particularmente en las zonas dominadas por vegetación sumergida. Queda patente un modelo espacio-temporal en el proceso de sedimentación asociado al desarrollo estacional de los macrófitos.

No obstante, es previsible que el aumento del aporte alóctono de material sedimentario derivado de la expansión de los cultivos y la eliminación de la barrera protectora de vegetación higrófila en el entorno de la laguna, unido al incremento en detrito vegetal autóctono, generado por la expansión en las orillas de la vegetación de hojas flotantes, de los helófitos y de los densos lechos de *P. trichoides* y *C. demersum* en las zonas centrales del medio palustre, puedan llegar a producir una fuerte colmatación de la laguna a largo plazo, estimulando la sucesión ecológica hacia comunidades dominadas por vegetación emergente y de hojas flotantes (Figura 2), más tolerantes a las altas concentraciones de material orgánico en el sedimento (CARPENTER & LODGE, 1986).

Por todo lo visto anteriormente, y en virtud del artículo 11 de la Directiva 2000/60/CE, se destacan las siguientes propuestas de gestión y conservación, de forma que se reviertan o anulen, en su defecto, los potenciales efectos negativos de las actividades humanas sobre la laguna Sentiz y se incremente la resiliencia natural de este ecosistema: planificación y ordenación integral de las explotaciones agrícolas, reducción de la presión ganadera sobre la vegetación de las orillas y seguimiento temporal de las variables hidroquímicas y de hábitat, así como de la evolución de los parámetros estructurales y de la composición de la comunidad macrofítica.

REFERENCIAS

- ÁLVAREZ-COBELAS, M. & CIRUJANO, S. (2007). Multilevel responses of emergent vegetation to environmental factors in a semiarid floodplain. *Aquatic Botany*, 87, 49-60.
- CARPENTER, S.R. & LODGE, D.M. (1986). Effects of submersed macrophytes on ecosystem processes. *Aquatic Botany*, 26, 341-370.
- DEL POZO, R., FERNÁNDEZ-ALÁEZ, C. & FERNÁNDEZ-ALÁEZ, M. (2011). The relative importance of natural and anthropogenic effects on community composition of aquatic macrophytes in Mediterranean ponds. *Marine and Freshwater Research*, 62, 101-109.
- DUDGEON, D., ARTHINGTON, A.H., GESSNER, M.O., KAWABATA, Z.I., KNOWLER, D.J., LÉVÊQUE, C., NAIMAN, R.J., PRIEUR-RICHARD, A.H., SOTO, D., STIASSNY, M.L.J. & SULLIVAN, C.A. (2006). Freshwater biodiversity: importance, threats, status and conservation challenges. *Biological Reviews*, 81, 163-182.
- FELD, C.K., BIRK, S., EME, D., GERISCH, M., HERING, D., KERNAN, M., MAILEHT, K., MISCHKE, U., OTT, I., PLETTERBAUER, F., POIKANE, S., SALGADO, J., SAYER, C.D., VAN WICHELEN, J. & MALARD, F. (2016). Disentangling the effects of land use and geo-climatic factors on diversity in European freshwater ecosystems. *Ecological Indicators*, 60, 71-83.
- KISSOON, L.T.T., JACOB, D.L., HANSON, M.A., HERWIG, B.R., BOWE, S.E. & OTTE, M.L. (2013). Macrophytes in shallow lakes: Relationships with water, sediment and watershed characteristics. *Aquatic Botany*, 109, 39-48.
- LAURIDSEN, T.L., JEPPESEN, E., DECLERCK, S.A.J., DE MEESTER, L., CONDE-PORCUNA, J.M., ROMMENS, W. & BRUCET, S. (2015). The importance of environmental variables for submerged macrophyte community assemblage and coverage in shallow lakes: differences between northern and southern Europe. *Hydrobiologia*, 744, 49-61.
- LOH, J. & WACKERNAGEL, M., 2004. Informe planeta vivo. WWF, Gland.
- MCKEE, D., ATKINSON, D., COLLINGS, S.E., EATON, J.W., GILL, A.B., HARVEY, I., HATTON, K., HEYES, T., WILSON, D. & MOSS, B. (2003). Response of freshwater microcosm communities to nutrients, fish, and elevated temperature during winter and summer. *Limnology and Oceanography*, 48, 707-722.
- MEIER, S., LUOTO, M. & SOININEN, J. (2015). The effects of local, buffer zone and geographical variables on lake plankton metacommunities. *Hydrobiologia*, 743, 175-188.
- SCHIEFER, E., PETTICREW, E.L., IMMELL, R., HASSAN, M.A. & SONDEREGGER, D.L. (2013). Land use and climate change impacts on lake sedimentation rates in western Canada. *Anthropocene*, 3, 61-71.
- SZYPER, H. & GOLDDYN, R. (2002). Role of catchment area in the transport of nutrients to lakes in the Wielkopolska National Park in Poland. *Lakes and Reservoirs: Research and Management*, 7, 25-33.
- Unión Europea (2000) Directiva 2000/60/CE del Parlamento Europeo y del Consejo, de 23 de octubre de 2000, por la que se establece el marco comunitario de actuación en el ámbito de la política de aguas. In: Diario Oficial, 22 de diciembre de 2000, núm. L 327, p. 0001.

AUTOR: Juan Antonio Villaescusa Vinader

TÍTULO DEL TRABAJO: FUNCTIONAL AND TAXONOMIC DIVERSITY IN MARITIME ANTARCTIC LAKES

DIRECTOR: Antonio Camacho González

CENTRO DE REALIZACIÓN: Fac. Ciencias Biológicas. Univ. Valencia

FECHA DE PRESENTACIÓN: 14 enero 2015

Byers Peninsula (Livingston Island, Antarctica) is one of the largest ice-free areas in the maritime Antarctica (Figure 1), displaying an important number of ice-free water bodies during the austral summer. These features, as well as its status as Antarctic Special Protected Area (ASP), featured Byers as a reference site for Limnological studies in maritime Antarctica. This thesis deals with the study of the lakes located in Byers Peninsula, focusing our attention in Lake Limnopolar, used as a model lake for limnological studies during the last two decades.

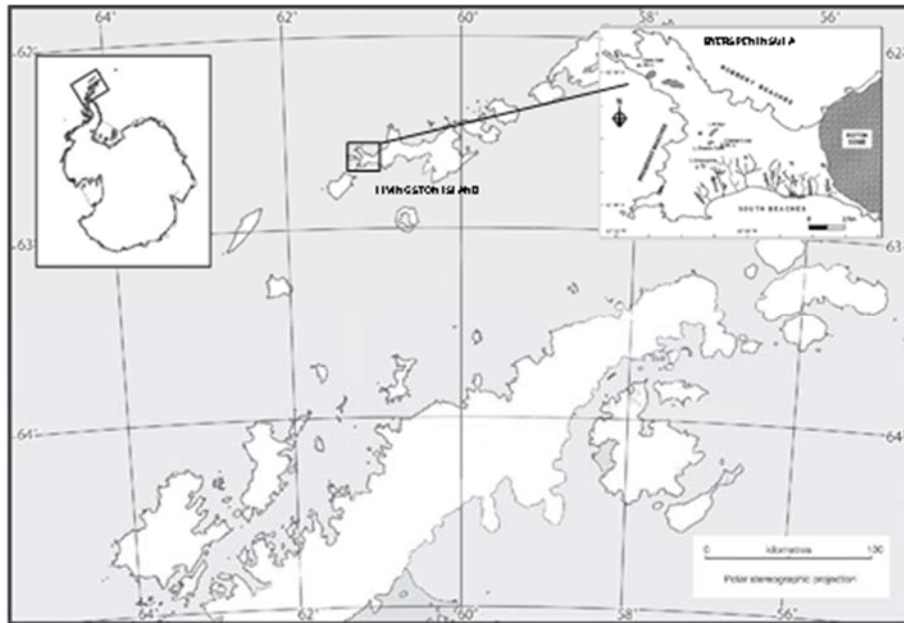


Figure 1. Byers Peninsula, Livingston Island, South Shetland Islands, location map

Primarily, our studies were focused on the environmental heterogeneity of the lakes and ponds of Byers Peninsula, showing a contrasting trophic status among these lakes, which was strongly determined by the external inputs of nutrients and the internal removal processes from the lake sediment. This environmental heterogeneity was also reflected in the composition of bacterial community, with lakes displaying higher trophic status showing the lower bacterioplankton diversity. Additionally, the study of the consumption of different carbon sources by bacterioplankton, evidenced differences among the studied lakes in their consumption profiles, that can be related to the origin of the organic matter and the relation of each lake with their catchment, flora and fauna. Our results revealed a pattern by which lakes with the highest trophic status also showed the highest diverse physiological activity, contrarily to the diversity of bacterial taxa that dropped as trophic status increased.

Continuous meteorological monitoring in the area and the study of Lake Limnopolar from 2001 to 2009 has revealed a high variability of meteorological features in this area of maritime Antarctica, with summers with different average temperatures that directly affect the ice melt and the length of the productive period. Accordingly, the bacterioplankton community of Lake Limnopolar shows changing dynamics between different summers. This feature could be directly related to the availability of organic carbon and the length of the productive period. The physiological studies on Lake Limnopolar also evidenced this changing pattern, showing a statistically significant correlation between bacterioplankton abundance and the concentration of the different dissolved organic carbon compounds. Also, the bacterial community from in Lake Limnopolar shows a differential vertical distribution (Figure 2) even though a physical and chemical vertical gradient did not appear. The analysis of the bacterial sequences retrieved from the lake revealed that the origin, composition and abundance of the organic matter are directly affecting the bacterial composition in the lake and the appearance of this “biological stratification”.

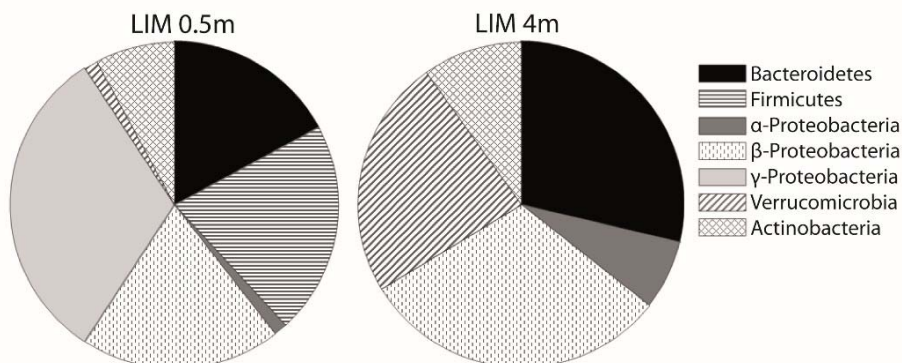


Figure 2. Differences in the phylum (or Class) assignment among bacterial composition between lake surface (0.5 m) and lake bottom (4 m) in Lake Limnopolar-

Phytoplankton and bacterioplankton production rates in Lake Limnopolar display a clear uncoupling (Figure 3). Allochthonous contributions of organic carbon from microbial mats, along with autochthonous contributions of organic carbon from benthic mosses, subsidize the planktonic bacterial production in Lake Limnopolar. Manipulative in-situ experiments performed in Lake Limnopolar have demonstrated the response of the planktonic community to fertilization processes and the strong relationship of phytoplankton growth and inorganic carbon fixation with light

(including photoinhibition when excessive) and nutrient availability. Bacterioplankton, however, seems to be less responsive to glucose enrichment treatments, which can be related to the existence of specialist bacterial species. On the other hand, the study of the epibiosis on crustacean zooplankton in Lake Limnopolar has demonstrated the existence of a nutritional strategy of the algal epibionts, mainly composed by diatoms and euglenophytes, in response to extreme oligotrophic conditions. In this situation, epibiosis acts as efficient strategy when nutrient availability is low.

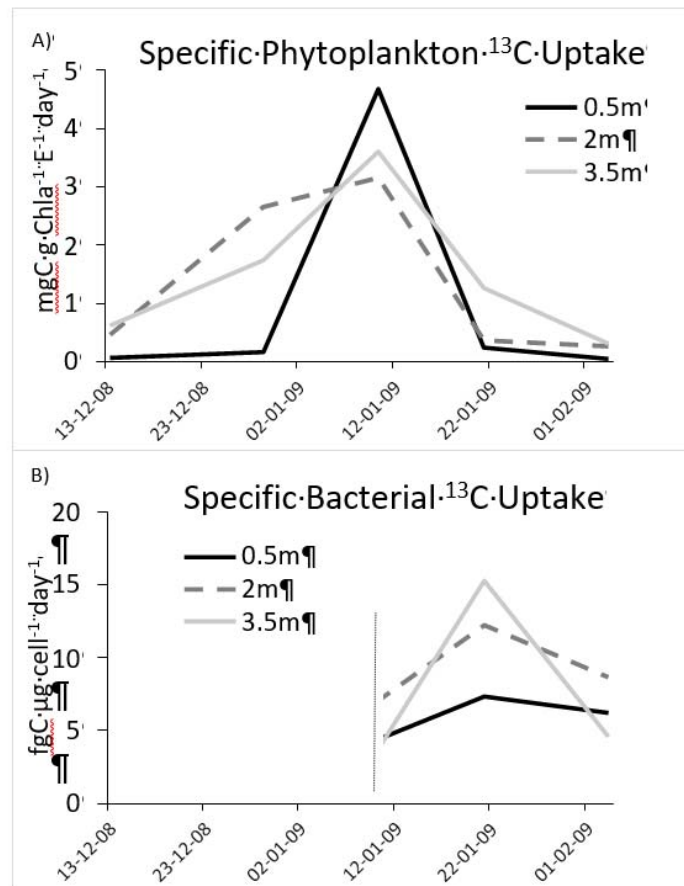


Figure 3. Values of specific ¹³C uptake: A) phytoplankton ¹³C uptake; B) bacterial ¹³C uptake. Data of bacterial ¹³C uptake before 10-1-09 were not available (these samples were lost during transportation).

To summarize the obtained results and monitor Lake Limnopolar dynamics, an ecological model was developed. Our model clearly shows the control exerted by the temperature on the bacterioplankton dynamics and the availability of carbon sources, mainly dissolved organic carbon (DOC). However, the use and interpretation of the developed model should be taken with care due to the high interannual meteorological heterogeneity in Byers Peninsula.

AUTORA: Maite Arroita Azkarate

TÍTULO DEL TRABAJO: Effects of water abstraction on stream ecosystem functioning

DIRECTOR: Arturo Elosegui Irurtia

CENTRO DE REALIZACIÓN: Programa de Doctorado “Biodiversidad, Funcionamiento y Gestión de Ecosistemas” de la Universidad del País Vasco

FECHA DE PRESENTACIÓN: 14 diciembre 2015

Water abstraction is a prevalent impact in streams and rivers worldwide, and it is likely to intensify in the near future as a result of the escalating demand for irrigation, hydropower, and drinking water. Reduced discharge derived from water abstraction decreases the availability of in-stream habitats, can degrade water quality and affects fluvial communities. There is less information on the effects of water abstraction on stream ecosystem functioning, although impacts are likely since all hydraulics, channel morphology and biodiversity are tightly linked to ecosystem processes. This dissertation explored the effects of water abstraction on stream ecosystem functioning, combining observational and manipulative, field and laboratory experiments.

We first assessed the impact of water abstraction on the storage and breakdown of coarse particulate organic matter by comparing these variables in reaches upstream and downstream from five low dams in mountain streams, and

repeating the experiment in winter and in spring. Water abstraction did not affect water quality, but significantly reduced the width and depth of the wetted channel in both experiments. It also reduced the storage and breakdown of organic matter, although differences were limited to winter (Fig. 1). The number of shredders colonizing litter bags was also significantly lower in downstream reaches. These results point to an important effect of water abstraction on the storage and breakdown of organic matter in streams at least in some periods, which could impact the energetic basis of stream ecosystems.

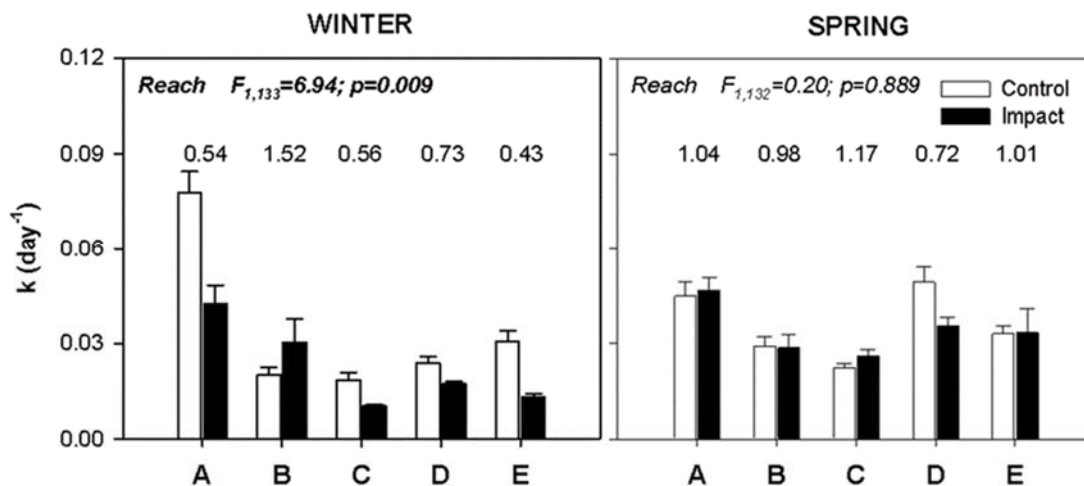


Figure 1. Breakdown rates (day⁻¹) of alder leaves in Control and Impact reaches of the five streams in winter (left) and in spring (right). Error bars show standard errors. Results from two-way (Stream x Reach) ANCOVA and Impact/Control ratios are also shown.

Because the previous study was limited to surface organic matter breakdown and aquatic organisms have been shown to seek refuge in the hyporheos when streamchannel dries out, we also analyzed the relative contribution of the hyporheic breakdown when the surface of the wetted channel is reduced and organic matter gets stranded in emerged sediments. We measured microbial and total breakdown rates of organic matter both on the surface and in the subsurface of the permanently wet channel and the parafluvial areas. Microbial and total breakdown were significantly lower in the surface of parafluvial areas (Fig. 2). In contrast, breakdown rates in all buried litter bags were very similar to the ones in the surface of the wet channel, showing that subsurface layers sustain breakdown activity even when the surface of benthos has dried out, a common feature of reaches impacted by abstraction. Breakdown in these layers would depend on the effect of water abstraction on subsurface hydrology, on climatic conditions and on the vertical connectivity of the stream.

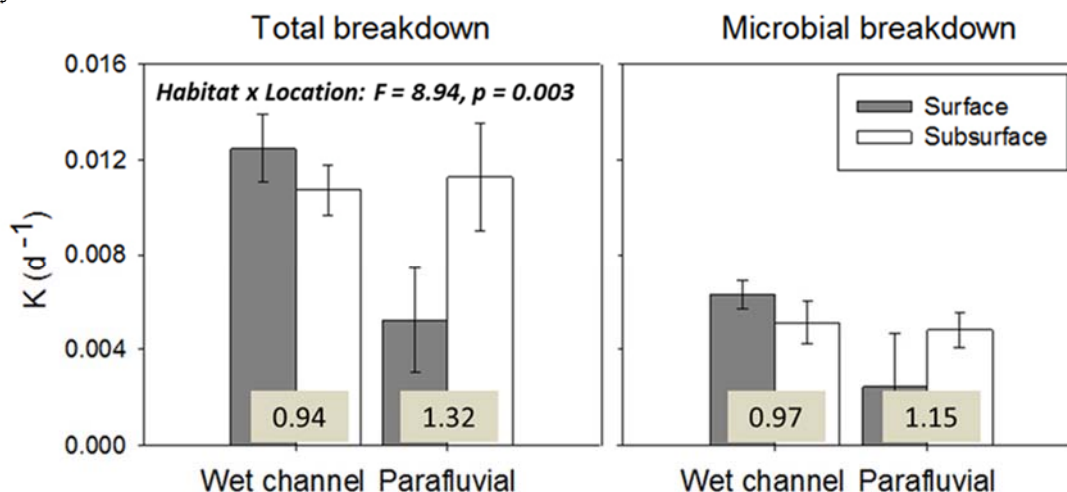


Figure 2. Total and microbial breakdown rates for alder leaves depending on the location (Wet channel and Parafluvial areas) for the surface and subsurface. Error bars show standard errors. Results for the Habitat x Location interaction and Subsurface/Surface ratios are also shown.

Additionally, water abstraction can alter not only the frequency and severity of drying events, but also their timing, which could affect aquatic communities and processes showing marked temporal dynamics. Therefore, we studied how the degree of drought-related stress affects fungal activity and microbial decomposition, and whether the impacts depend on the timing of stress. In microcosms we recreated areas with flowing water, stagnant water and dry beds. Combining these conditions and their sequence, we created 9 treatments (10 with the control) that differed in the stress

level (low, medium, high) and the timing of peak stress (early, middle, late) and measured fungal biomass, sporulation, microbial respiration and decomposition of alder disks. The effects of drought-related stress levels were not consistent among response variables (Table 1), which probably reflects that we recreated a small stress range. However, the effects of disturbances were systematically more detrimental in early stages of the decomposition process, and resulted in a lower fungal biomass and activity, and reduced litter decomposition. These results suggest that the effects of stress on breakdown-associated variables depend not only on the intensity and duration of stress, but also on its timing, early stress exerting greater impact than late stress on breakdown.

Table 1. Statistical results for the effect of low (L), medium (M) and high (H) stress levels and early (1), middle (2) and late (3) timings of peak stress. Post hoc Tukey HSD tests were only performed when the two-way ANOVA (Stress level x Timing) yielded significant differences. Letters are ordered from highest (a) to lowest values.

VARIABLE	WEEK	STRESS LEVEL			TIMING OF PEAK STRESS		
		F	p	Tukey HSD	F	p	Tukey HSD
Ergosterol ($\mu\text{g gDM}^{-1}$) (non-transformed)	6	3.44	0.042	H ^a L ^{ab} M ^b	0.84	0.441	
	8	9.35	< 0.001	H ^a L ^b M ^b	8.10	0.001	3 ^a 2 ^b 1 ^b
	10	1.88	0.166		6.33	0.004	3 ^a 2 ^b 1 ^b
Sporulation (log-transformed)	6	5.41	0.012	H ^a M ^{ab} L ^b	9.11	0.001	3 ^a 2 ^a 1 ^b
	8	17.13	< 0.0001	M ^a L ^b H ^b	5.02	0.016	2 ^a 3 ^{ab} 1 ^b
	10	-	-	-	-	-	-
Cumulative sporulation (non-transformed)	6	4.17	0.105		1.66	0.299	
	8	4.82	0.086		4.15	0.106	
	10	-	-	-	-	-	-
Respiration (non-transformed)	6	3.31	0.047	M ^a H ^{ab} L ^b	4.30	0.020	3 ^a 2 ^{ab} 1 ^b
	8	0.20	0.823		2.85	0.069	
	10	1.04	0.363		0.31	0.733	
Cumulative respiration (non-transformed)	6	2.51	0.197		4.72	0.088	
	8	1.48	0.330		6.17	0.060	
	10	0.48	0.649		7.00	0.049	3 ^a 2 ^{ab} 1 ^b
Remaining mass (non-transformed)	6	3.73	0.033	L ^a M ^{ab} H ^b	2.58	0.088	
	8	23.68	< 0.0001	M ^a L ^b H ^c	3.02	0.060	
	10	5.55	0.007	L ^a M ^a H ^b	3.84	0.030	2 ^a 3 ^{ab} 1 ^b

Finally, we experimentally abstracted water from a headwater mountain stream by putting in operation a long-unused diversion scheme and followed a Before- After/Control-Impact design in order to assess the effects of abstraction on biofilm biomass and activity, nutrient retention, and retention and breakdown of organic matter. Moreover, results were analyzed at the patch (i.e. per square meter) and the reach (i.e. per lineal meter) scales to determine which is the most meaningful way to measure the impact of water abstraction. At the patch scale abstraction reduced the biomass and the exoenzyme activity of biofilm, and the uptake of nutrients. At the reach scale all variables except benthic chlorophyll-a and leaf retention were significantly reduced by abstraction, as a consequence of the reduced surface of the wetted channel (Table 2). Our results suggest that water abstraction has strong impacts on stream ecosystem functioning, being mainly associated to decreased wetted perimeter, which is a universal consequence of water abstraction.

Table 2. The effect size and the interaction between period and reach (BA:CI) obtained from linear mixed-effects model for all the variables at the patch and the reach scales. *p* values were obtained by means of likelihood ratio tests.

Variable	Patch scale			Reach scale		
	Effect size (%)	$F_{\text{BA:CI}}$	<i>p</i>	Effect size (%)	$F_{\text{BA:CI}}$	<i>p</i>
Discharge	---	---	---	35.34	302.75	<0.0001
Wetted width	---	---	---	46.81	138.44	<0.0001
Water depth	---	---	---	58.68	5.98	0.011
Water velocity	---	---	---	43.94	31.08	<0.001
Biofilm biomass	52.99	5.18	0.023	25.57	26.09	<0.0001
Chlorophyll <i>a</i>	85.67	0.01	n.s.	42.20	2.57	n.s.
Alkaline phosphatase	47.25	7.71	0.006	24.01	21.13	<0.0001
B-Glucosidase	101.56	0.38	n.s.	45.17	7.31	0.007
Ammonium uptake	7.82	3.91	0.051	4.11	6.30	0.021
Phosphate uptake	40.41	4.51	0.023	22.72	6.73	0.007
Gross Primary Productivity	84.20	0.02	n.s.	25.91	32.04	<0.001
Biofilm respiration	44.26	0.82	n.s.	13.77	9.40	0.022
Leaf retention	432.78	3.11	n.s.	140.26	0.58	n.s.
Litter breakdown Macroinv.	107.88	2.05	n.s.	88.72	3.18	0.039
Microinv.	83.24	0.79	n.s.	66.83	3.45	0.030

Despite some spatial and temporal constraints, overall, this dissertation showed diversion schemes in the Basque Country to reduce the rates of diverse key processes of stream ecosystem functioning, which could have significant effects beyond the studied reaches. The decrease in organic matter breakdown, together with the decrease in biofilm biomass due to water abstraction could reduce the energy transfer to higher trophic levels, ultimately affecting stream productivity and altering the trophic structure of river ecosystems. Moreover, retention of nutrients is the basis of the self-purification capacity of streams and rivers, one of the most important services provided by these ecosystems. As water abstraction becomes more prevalent, these services will fade, with detrimental effects not only for the integrity of freshwater ecosystems, but also for the societal welfare. Therefore, our results cast doubt on the adequacy of the environmental flows, at least in our region, and reveal the urgent need of further investigation to address all the open questions, and develop and improve water abstraction practices that will effectively integrate human and ecosystem water needs in a timely and comprehensive manner.

AUTORA: María R. Felipe-Lucia

TÍTULO DEL TRABAJO: Analysis of ecological and social interactions along the flow of ecosystem services. Suggestions for the management of the River Piedra floodplain.

CENTRO DE REALIZACIÓN: Universidad Pablo de Olavide

FECHA DE PRESENTACIÓN: 30 abril 2015

The assessment of ecosystem services (the direct and indirect benefits humans receive from ecosystems) has become a common and useful tool in ecosystems management, due to its direct connection to the various dimensions of human well-being. Ecosystem services can be assessed from an ecological, economic, or social approach. The ecological approach focuses on measuring ecological functions or ecosystem properties; the economic approach estimates the use and non-use values of ecosystems in monetary terms; and the social approach is based on the values society attributes to each ecosystem service (Figure 1).

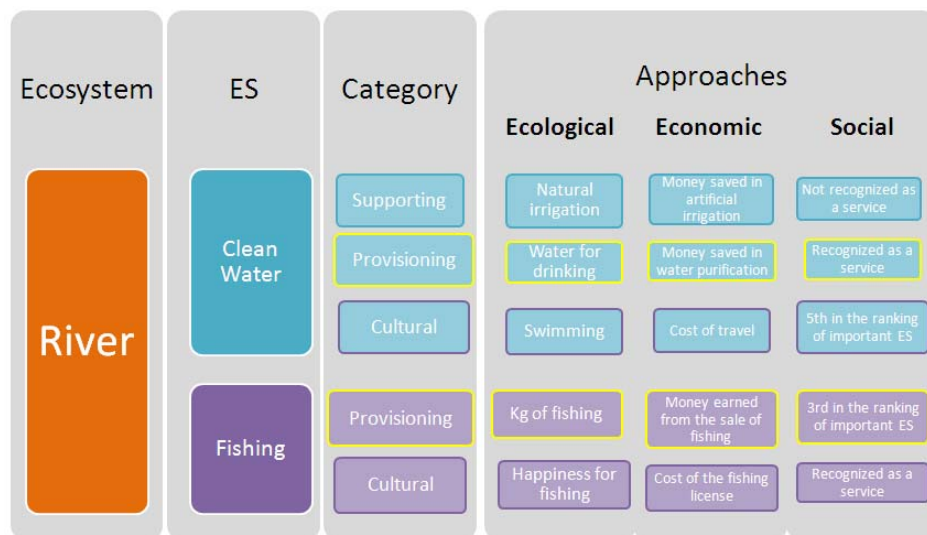


Figure 1. Example of approaches that can be applied to evaluate two ecosystem services (ES) provided by riverine ecosystems. Although each service is often ascribed to a unique category (second column, blue box for supporting and purple box for cultural), it can actually be evaluated by more than one category (third column, blue frame for supporting, yellow frame for provisioning, and purple frame for cultural). Furthermore, each category can be evaluated from the ecological, economic, or social approach, using different indicators. The assessment of all three approaches is strongly recommended for a complete valuation of ecosystem services.

Most studies assessing ecosystem services use the economic approach; whereas the ecological and social approaches have received less attention and their methods are still ill-defined. This PhD thesis contributes to understanding the relationships between the ecological and the social aspects that influence the flow of ecosystem services through the River Piedra floodplain case study (River Ebro basin, NE Spain). In addition, this thesis provide meaningful support to applying the analyses of such interactions to ecosystems management. Floodplains are usually a land use mosaic of riparian forests, meadows, agricultural, urban, and industrial areas. Understanding how floodplains can be sustainably managed is especially important given that floodplains are one of the most endangered habitats and biodiversity hotspot, while they are mostly used for agricultural production and are still the second highest worldwide attraction for housing developers. Thus, including the assessment of floodplain ecosystem services in land and environmental policies is key to reaching a balanced supply of ecosystem services in the long term.

Regarding the ecological valuation of ecosystem services in floodplains, this PhD thesis deepens on the value supplied by each land use type identified in the River Piedra floodplain (Figure 2). For this, we assessed ecosystem services supply and estimated plant diversity associated to each land use type. In addition, we estimated ecosystem services supply at three spatial scales: patch, municipality, and landscape (the whole floodplain) using field and public data. Data were analysed using general and mixed lineal models, multi-comparative tests, and correlation analyses.

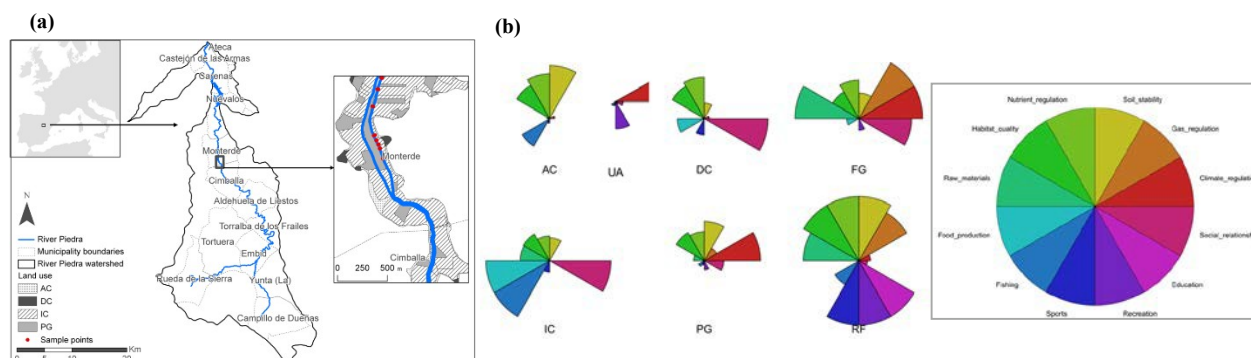


Fig. 2. a) Location of the study area in Spain (left inset). Piedra River watershed and municipalities traversed by the Piedra River (center) and detail of the river floodplain spatial distribution showing some land-use types and sample points (right inset). b) Ecosystem services supply of the River Piedra floodplain under single-land use alternatives. Pie size represents the relative value. (AC = abandoned crops; DC = dry cereal crops; FG = fruit groves; IC = irrigated cereal crops; PG = poplar groves; RF = riparian forest; UA = urban areas).

On the one hand, we identified ecosystem services associated to each land use type and the effect of the land use type in ecosystem services-biodiversity interactions. For instance, natural and semi-natural habitats supplied more number of ecosystem services and hosted greater diversity than cultivated land use types. In addition, most plant diversity indexes were positively correlated to habitat provision and environmental education, but negatively correlated to food provision (Table 1). On the other hand, we identified synergies and trade-offs between ecosystem services across land use types and spatial scales. We found that the spatial scale at which measurements were taken affected the composition of services. For instance, at patch scale, riparian forest supplied the most services of any land use type, but dry cereal croplands provided the most services across the municipality and landscape because of their large area. Additionally, we propose a classification of ecosystem services interactions that incorporates societal values (as drivers of management decisions) along with biophysical factors as likely causes of ecosystem services trade-offs.

Table 1. Correlation analyses between selected ecosystem services and plant diversity indexes (n = 165; ·P < 0.1; *P < 0.05; **P < 0.01; *P < 0.001).** Strong correlations ($|0.7| > r > |0.5|$) are marked in bold, and very strong correlations ($r > |0.7|$) are marked within a box. Plant diversity indexes: SR, Species richness; SA, Species abundance; TSD, True species diversity; GR, Growth-forms richness; GA, Growth-forms abundance; TGD, True growth-forms diversity.

		Plant diversity					
		SR	SA	TSD	GR	GA	TGD
Ecosystem services	Gas regulation	-0.06	0.20*	0.19*	0.53***	0.20*	0.68***
	Soil formation	-0.01	0.28***	0.37***	0.29***	0.28***	0.38***
	Nutrient regulation	0.15 ·	0.40***	0.35***	0.24**	0.40***	0.35***
	Habitat provision	0.14 ·	0.80***	0.70***	0.50***	0.80***	0.76***
	Food provision	-0.26***	-0.56***	-0.46***	-0.22**	-0.56***	-0.19*
	Raw materials	-0.18*	0.09	0.07	0.34***	0.09	0.57***
	Education	-0.02	0.59***	0.50***	0.54***	0.59***	0.83***
	Recreation	0.02	0.66***	0.55***	0.47***	0.65***	0.77***

Regarding the social valuation of ecosystem services, we reviewed current trends in literature on spatial-temporal scales, type of participants, and methodology used. We found that most studies are addressed at the municipality or supra-local scale, local residents are included just in a third of the valuations, and the methods most commonly used are both ecosystem services identification and ranking. Based on the agreements which emerged from this review, we proposed a set of guidelines that should be explicit in such assessments to enable comparisons across studies. In addition, we illustrated the proposed framework through the social valuation of ecosystem services in the River Piedra floodplain.

Next, we explored both ecological and social interactions that mediate ecosystem services flow to human well-being. On the ecological side, we identified that regulating and supporting services were key to maintaining the ecosystem services flow to stakeholders using a structural equation model. On the social side, we identified power asymmetries between stakeholders that mediate access and management to ecosystem services. These analyses revealed that the ability of stakeholders to manage supporting and regulating services determine power relationships among them (Figure3).

This PhD thesis concludes with a comparative analysis of ecosystem services supply in the River Piedra floodplain across five alternative management scenarios. Scenarios were based on the combination of a land use intensity gradient and a riparian forest restoration gradient. We found that the scenario fostering riparian forest enhancement and no intensive agricultural use supplied a more balanced set of ecosystem services (Figure 4).

This PhD thesis contributes to provide tools for integrating the assessment of ecosystem services in environmental and land management policies. In doing so, we aim to foster the assessment of ecosystem services from multiple approaches, promote multifunctional landscapes that provide a balanced set of ecosystem services, include public participation in decision-making, and achieve a more equal access to ecosystem services.

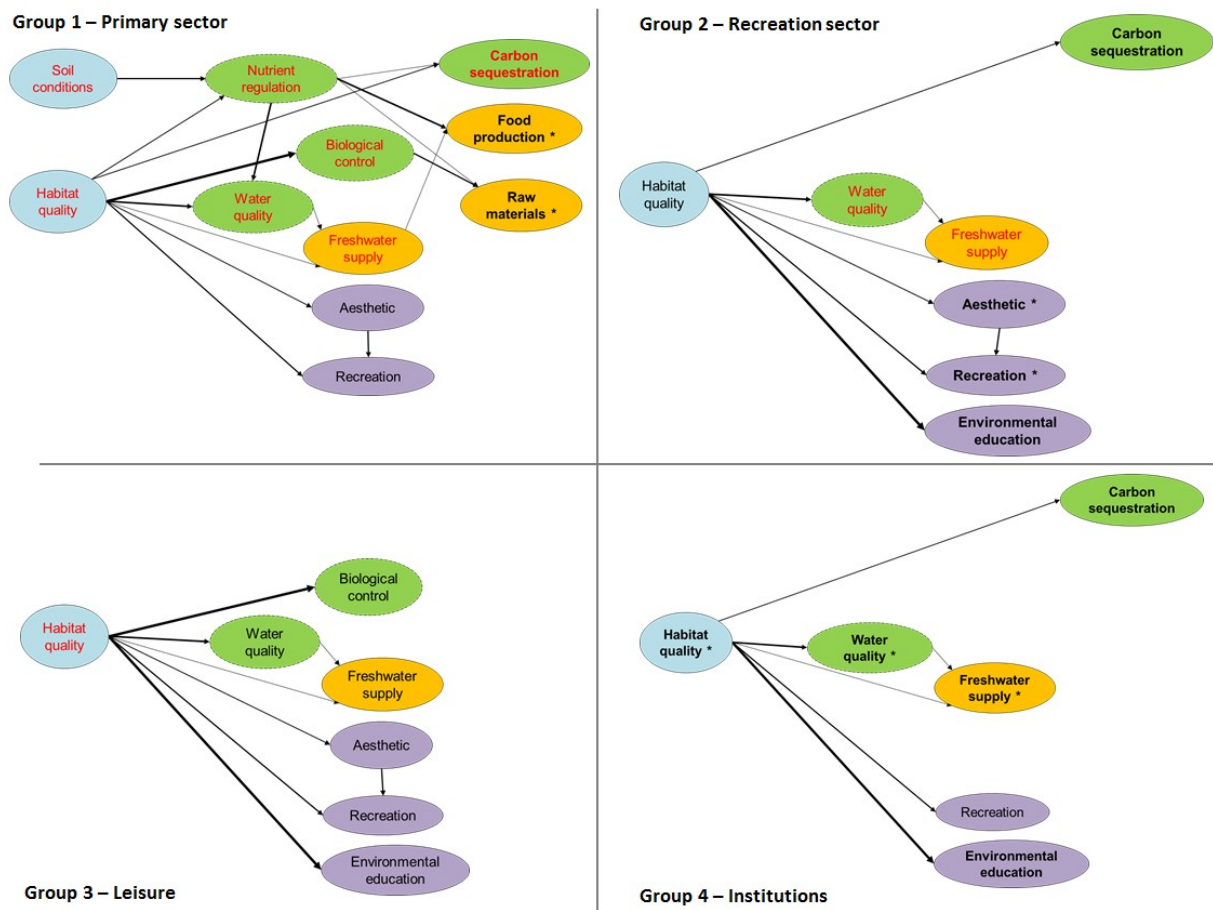


Figure 3. Ecosystem services related to each stakeholder group. Arrow thickness represents the percentage of the contribution to each service. Colours indicate the type of ecosystem services (green=regulating, gold=provisioning, purple=cultural) and supporting ecological properties (blue). Intermediate regulating services are dashed and final services are solid. Impaired ecosystem services are in red, ecosystem services managed or co-produced are in bold, and they are marked with an asterisk (*) when managed by a single group. Note that habitat quality and carbon sequestration were only indirectly used by groups 1, 2 and 3, and that all ecosystem services linked to group 4 (excluding environmental education) were used indirectly.

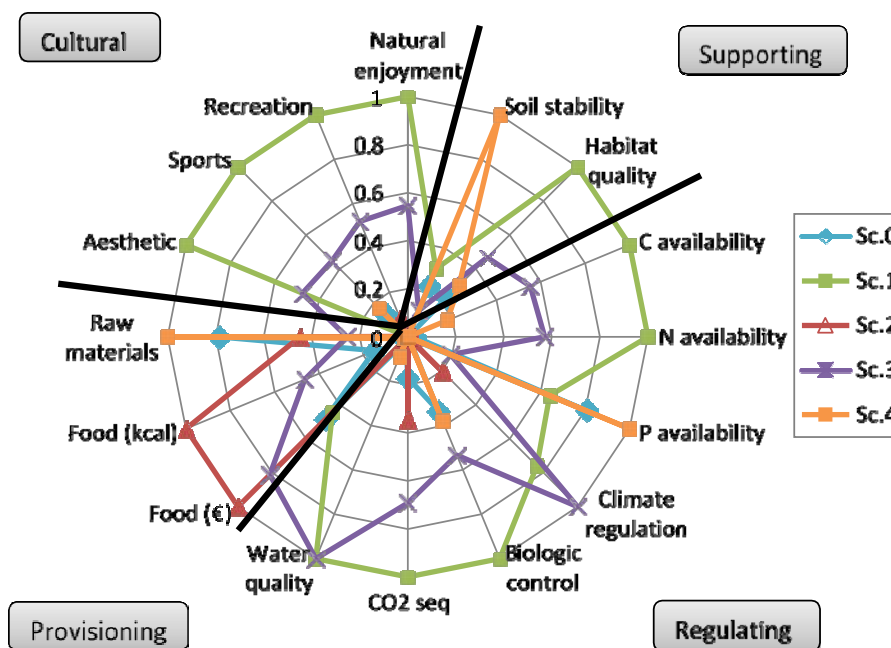


Figure 4. Radial plot where axes represent the relative contribution of ecosystem services and coloured lines the values for each scenario. Blue line, *Business as usual* (Scenario 0); green line, *Conservation and Restoration* (Scenario 1); red line, *Intensive agriculture* (Scenario 2); purple line, *Conservation and Production* (Scenario 3); orange line, *Rural abandonment* (Scenario 4). Dashed lines indicate different ecosystem services categories (clock-wise: supporting, regulating, provisioning and cultural services).

AUTORA: María Morales Pineda

TÍTULO DEL TRABAJO: Intercambios de CO₂ atmósfera-agua y sedimentación biogénica en embalses mediterráneos estratificados con distinto estado trófico

DIRECTORA:

CENTRO DE REALIZACIÓN:

FECHA DE PRESENTACIÓN:

We are now aware that inland waters play an important role in the global C cycle by emitting and burying C. However, streams, lakes and reservoirs are generally overlooked in bottom-up approached C budgets. Inland water bodies are important components of global carbon cycling despite occupying a small fraction of the Earth's surface (Battin et al. 2009). The increasing recognition of the role of lakes and reservoirs as conduits of CO₂ to the atmosphere has prompted global analyses of *p*CO₂ dynamics in the surface waters of these ecosystems (e.g. Tranvik et al. 2009). Approximately 90 % of lentic freshwater systems are supersaturated with CO₂, playing a crucial role in the carbon emissions to the atmosphere (Raymond et al. 2013). On the other hand, the downward flux of the particulate organic carbon present in lentic ecosystems, especially in water reservoirs, can reach the sediment (Dang et al. 2010) and contribute to the build-up of the carbon sink (Dean and Gorham 1998). Overall, the balance between the air-water flux of CO₂ and the permanent sedimentation of organic carbon determines the sink or source character of a given water body (Hanson et al. 2004). This integral approach has been undertaken in recent carbon budget studies (Tranvik et al. 2009), but wider empirical support across ecosystem types, trophic status or climatic zones is required to better understand the worldwide behaviour of lentic water bodies.

The low abundance of natural water bodies in Mediterranean area makes the study of the more abundant reservoirs essential (Nasseli-Flores 2003). However, reservoirs emissions are still poorly known, partly because they greatly vary between regions and reservoir types (Barros et al. 2011). While most of the research dealing with freshwater systems has traditionally been focused on lakes and hydroelectric reservoirs (Roland et al. 2010), there is an increasing interest in studying water-supply, agricultural and irrigation reservoirs, usually showing higher carbon emissions (Downing et al. 2008) and downward C fluxes (Cole et al. 2007).

In the present PhD Thesis, we analyzed the main processes involved in the carbon processing of Mediterranean reservoirs, a gap in the current knowledge of the global carbon cycling. The role of processes as sedimentation, air-water CO₂ fluxes, community metabolism or hydrology on the net carbon dynamics cycle were analyzed in two reservoirs with different trophic status. To achieve this goal, we simultaneously studied two reservoirs during the period of stratification. The studied reservoirs, Bornos and Guadalquivir (Cadiz, Spain), are under the influence of an oceanic Mediterranean climate. As the reservoirs differ from the trophic status, they are particularly suitable for comparing the main processes controlling the carbon dynamics. The stratification period was chosen in order to minimize the influence of the vertical mixing on the organic carbon production in the photic zone and the carbon export to deep layers through sedimentation. The measurements were carried out with high frequency over the whole stratification period in order to unravel the weight of the different controlling processes on time scales from hours to months. During the summer of 2009 and 2010, we monitored Guadalquivir and Bornos reservoirs, to estimate, among others, C gross sedimentation and CO₂ emissions with high sampling frequency.

The studied reservoirs show different trophic status (Romero-Martínez et al. 2013), which allowed the analysis of the carbon cycling from different carbon-productivity perspectives. Moreover, we took advantage from the inter-annual differences in rainfall, which led to significant changes in trophic status of the reservoirs. The timing of the organic and inorganic nutrients inputs to the ecosystem from the watershed largely depend on the rainfall variability. During our study period, an exceptional rain event during winter 2009 to 2010 led to the increase in the water column depth in Guadalquivir and the washed out of Bornos reservoir during beginning of 2010, increasing the renovation rate. Those hydrological alterations changed the trophic status of Bornos from meso-eutrophic to mesotrophic, causing a reduction in chlorophyll a and total phosphorus concentrations and increasing the photic depth after the winter.

Guadalcaacín shifted from oligo-mesotrophy to mesotrophy, likely due to the fertilization effect of the new flooded area.

Gross sedimentation of particulate organic carbon (S_{POC}) was measured from sediment traps sampled with biweekly periodicity. This sampling revealed a predominantly inorganic matrix in the settling material, reflecting the dominating role of inorganic allochthonous material input. Both reservoirs showed relatively high percentages of remineralization (14 to 53 % d^{-1}), although gross sedimentation was an important removing particulate organic carbon (POC) to deep layers. We estimated that from 8.4 to 13 % d^{-1} were transferred to the hypolimnion during the stratified period. Periods of high inflow and water renewal usually result in the export of higher quantities of DOC due to the shorter time for degradation and CO_2 release (Tranvik et al. 2009). In our study, the export ratio (settling rate/production) decreased as trophic status increased, as other authors previously reported (Baines et al. 1994). Consequently, water incomings played a major role in the regulation of POC fluxes. Water inputs significantly controlled S_{POC} by supplying new material or diluting particulate pool in the water body.

Environmental forcing factors (e.g. solar irradiance, wind and temperature) drive the $p\text{CO}_2$ dynamics in surface waters through their control on physical, chemical and biological processes at different time scales. High-frequency measurements at hourly resolution of surface partial pressure of CO_2 ($p\text{CO}_2$) were simultaneously carried out in both reservoirs, Bornos and Guadalcaacín. We used temporal series statistics and modeling to link the timing of the environmental forcing factors with their relative importance over the CO_2 dynamics. Temporal scales of variability for the $p\text{CO}_2$ in surface waters were examined through the temporal decomposition of 5-month time series. The results evidenced that $p\text{CO}_2$ had significant variability at daily, biweekly and seasonal scales. Each of these scales explained one third of the total $p\text{CO}_2$ variation registered. A major environmental factor driving phytoplankton activity at daily scale is solar radiation; accordingly, a negative correlation was found between radiation and $p\text{CO}_2$ at daily time scales. The wind- induced mixing events strongly operated at biweekly scale, becoming the main environmental factor controlling the $p\text{CO}_2$ dynamics at this scale. Water temperature was closely related to the seasonal variability. This result highlighted the importance of taken into consideration the small scales of time variability in the analyses of the carbon fluxes. Moreover, although $p\text{CO}_2$ is not a direct measure of the CO_2 flux from the waterbodies, it is the most important factor influencing these emissions (Sobek et al. 2005). Given the strong influence of the seasonal trend of temperature on $p\text{CO}_2$ (Morales-Pineda et al. 2014), our results suggest that the predicted rise in temperature (IPPC 2007) may have a relevant impact on $p\text{CO}_2$ and, consequently, on CO_2 emissions. In order to demonstrate the importance of considering the different scales of variability in the assessment of CO_2 fluxes within stratified water bodies, a sensitivity test was performed by varying the sampling frequency.

This thesis included a first general carbon budget of two Mediterranean reservoirs with different trophic status in stratification period (Morales-Pineda et al. 2015). CO_2 fluxes to atmosphere in Guadalcaacín were in the range of global means reported by St Louis et al. (2000). CO_2 emissions in Bornos were similar to fluxes reported for tropical and subtropical waterbodies, which are in the higher upper limit of CO_2 global emissions (Wang et al. 2011). Consequently, our measurements showed that both reservoirs were oversaturated, emitting CO_2 to atmosphere during the stratification period despite the summer period is generally being associated with the seasonal maximum of phytoplankton biomass (Cole et al. 1994), and presumably the highest CO_2 consumption. According to the worldwide study of Tranvik et al. (2009) about carbon cycling and climate, the highest CO_2 emissions (F_{CO_2}) were found in Amazonian and Boreal lakes. On the other hand, highest burial POC sedimentations rates (S_{POC}) were found in temperate regions. Both Mediterranean systems studied here were in the middle range of CO_2 emissions according to latitude situations, but were clearly significant systems of POC burial as percentage of carbon input. In terms of carbon processed into the freshwater system, our study points to the warm-temperate latitude reservoirs were turned into significant hotspots for C emission to the atmosphere at global scale (Figure 1). During the study period, we estimated that the studied reservoirs emitted more than double the amount of the C laterally exported from the catchment. This suggests that Mediterranean reservoirs can be especially active freshwater systems and should then be accounted in global analyses. Moreover, a significant positive relationship was found between F_{CO_2} and S_{POC} , differently from other previous studies, suggesting a new way of regulation of F_{CO_2} by external inputs. Interestingly, S_{POC} and the estimations of POC burial were higher than F_{CO_2} , classifying the studied reservoirs as net carbon sink

systems. In addition, a recent study from worldwide reservoirs (Barros et al. 2011) explored the global significance of CO₂ and CH₄ emissions from hydroelectric reservoirs, using published data from reservoirs situated between 68N and 25S. It showed a clear gap in latitudes between 23 to 37 grades. We believe that this thesis contributes to fill this gap with original data.

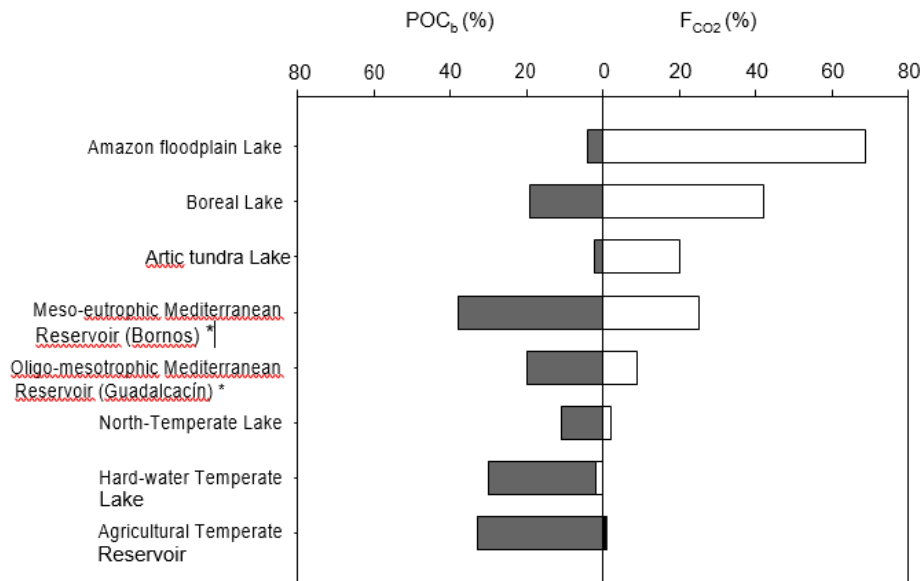


Figure 1. CO₂ fluxes to atmosphere (F_{CO2}) and POC burial rates (POC_b) expressed as percentage of the total carbon input (%) for lentic waters of different climatic regions (Tranvik et al. 2009) and for the study reservoirs (*). The ecosystem types on the Y-axis are organized in decreasing order in relation to the balance between F_{CO2} and POC_b (known as C_v). Thus, the Amazon floodplain Lake has the largest positive value of C_v.

We depicted a conceptual diagram in order to stress out the processes and main forcing factors controlling the CO₂ dynamics along the temporal scale (Morales-Pineda et al. 2014, Figure 2). Gross sedimentation, together with the air-water fluxes were deeply study here. Biological processes driven by irradiance or light could cause diel changes in the respiration/production balance (del Giorgio and Peters 1994), affecting at shorter time scales both processes: CO₂ degassing and gross sedimentation. Through temperature variation along the seasonal periods (Hanson et al. 2006), the metabolism rates changes and becomes important at longer time scales as it reduce biological processes in winter and leads mixing periods during spring and autumn. At longer scales, metabolic rates and gas solubility which changes along the seasons, are forcing by temperature. At week or month scale, the material flux fuels biological processes by the nutrient entrainment; or in the gross sedimentation process simply by entrance of allochthonous matter available to be sedimented or remineralized (Weyhenmeyer 1996). Over gross sedimentation process, turbulence and resuspension (Gálvez and Niell 1992) as physical factors may be important processes determined also by the particle size, shape or density of the particles sensitive to be sedimented. Calcite precipitation could shift mainly seasonally and influenced by changes in the phytoplankton production along the year. Variability in gross sedimentation and air-water fluxes of CO₂ is usually a reflect of the ecosystem metabolism, but our results and analysis showed that other factors had important effects across a range of time scales from days to seasons. The forcing factors could be characteristics from each time scale but also act differently or in different amplitude temporally.

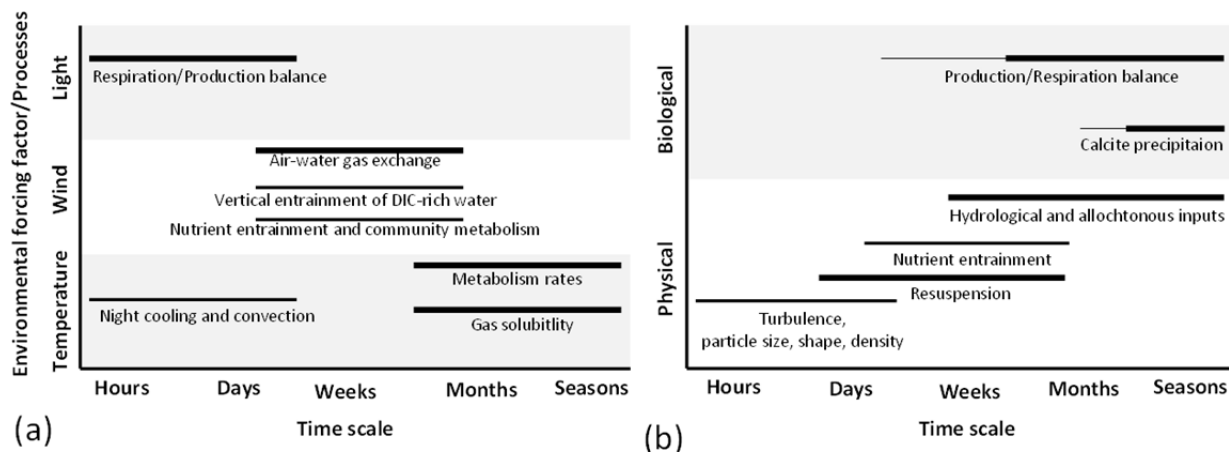


Figure 2. Conceptual diagram of the main processes acting on the surface $p\text{CO}_2$ (a), modified from Morales-Pineda et al. 2014 and in the gross sedimentation dynamics (b) of the reservoirs studied in relation to the time scale. Line width represents the importance of the process.

In this PhD Thesis, we tried to account for multiple temporal scales of analysis, from diel cycles, biweekly carbon sedimentation or seasonal metabolic dynamics. We integrated information of carbon flows from original data to place our systems in a seasonal carbon budget, and combined these results with estimates of different carbon budgets worldwide. The wavelet analysis allowed identifying the main forcing factors and processes controlling the CO_2 dynamics. We truly believe that integrating such diversity of sources of information results in a better understanding of the functioning of the studied system.

References:

- Barros et al. (2011) doi 10.1038/NGO1211
 Battin et al. 2009. Nat Geosci 2:598
 Cole et al. (1994) Science 265:1568
 Cole et al. (2007) Limnol Oceanogr 45(8):1718
 Dang et al. (2010) Sci Total Environ 408:4654
 Dean & Gorham (1998) Geology 26:535
 del Giorgio and Peters (1994) Limnol Oceanogr 39(4):772
 Gálvez and Niell (1992) Hydrobiologia 235/236:133
 Hanson et al. (2004) Glob Change Biol 10:1285
 IPCC (2007) Cambridge University Press. 996 pp
 Morales-Pineda et al. (2015) doi 10.1007/s00027-015-0423-6
 Morales-Pineda et al. (2014) doi 10.1002/2013JG002317
 Nasseli-Flores (2003) Hydrobiologia 506-509:13
 Roland et al. (2010) doi 10.1007/s00027-010-0140-0.
 Romero-Martínez et al. (2013) Aq Ecosys Heal Mng 16(2):183
 Sobek et al. (2005) Global Biochem Cy 19:GB2003
 St Louis et al. (2000) Bioscience 50:766
 Stabel (1896) Limnol Oceanogr 31(5):1081
 Tranvik et al. (2009) Limnol Oceanogr 54(6, part2):2298
 Wang et al. (2011) Atmos Environ 45:3827
 Weyhenmeyer (1996) Can J Fish Aq Sc 53:1254

AUTORA: Nadia Darwiche Criado

TÍTULO DEL TRABAJO: SPATIOTEMPORAL ASSESSMENT OF WATER QUALITY IN AN AGRICULTURAL MEDITERRANEAN CATCHMENT AND IMPROVEMENT PROPOSAL BY WETLANDS RESTORATION.

DIRECTORA: Francisco Comín

CENTRO DE REALIZACIÓN: Instituto Pirenaico de Ecología (IPE-CSIC)

INTRODUCTION

In recent years studies about the ecological impact of land uses have been conducted (Bis et al., 2000; Riva-Murray et al., 2002; Woodcock et al., 2006). Agriculture is considered the main source of nitrogen compounds in European aquatic environments (Grizzetti et al., 2005). Creation and restoration of wetlands combines the water

quality improvement, the environment and biodiversity protection, and has been proposed as a strategy to achieve the sustainable development of agriculture, due to the wetlands capacity to mitigate the impact of diffuse pollution sources (Mitsch et al., 2001, Zedler, 2003).

The main goal of this PhD Thesis was to study the pollutant patterns (especially nitrates, NO_3^-) at the Flumen River basin (Huesca, Spain), under different spatial and seasonal circumstances, and under punctual flood events. Moreover, we wanted to understand the restored wetlands performance for establishing a model which allows optimizing its effectiveness under different criteria. In addition to the involvement of the stakeholders in this project, the obtained results are descriptive, novel, and applicable in other study areas with other problems and characteristics.

RESULTS

Using classification techniques such as hierarchical cluster analysis (CA) and partial triadic analysis (PTA), we evaluated the water pollution sources and the seasonal influence of human activities on water composition. Our results suggested that a strong connection linked both factors. CA showed the spatial relationship between water chemistry and adjacent land uses. PTA associated the analyzed

variables to their source (Fig. 1). Electrical conductivity (EC), Cl^- , SO_4^{2-} - S, Na^+ and Mg^{2+} were related to agricultural sources, whereas NH_4^+ - N, PT and PO_4^{3-} - P were associated with contaminated urban areas. NO_3^- -N concentration was associated with urban land use. Differences were also found in the water composition according to the irrigation intensity during the irrigation season.

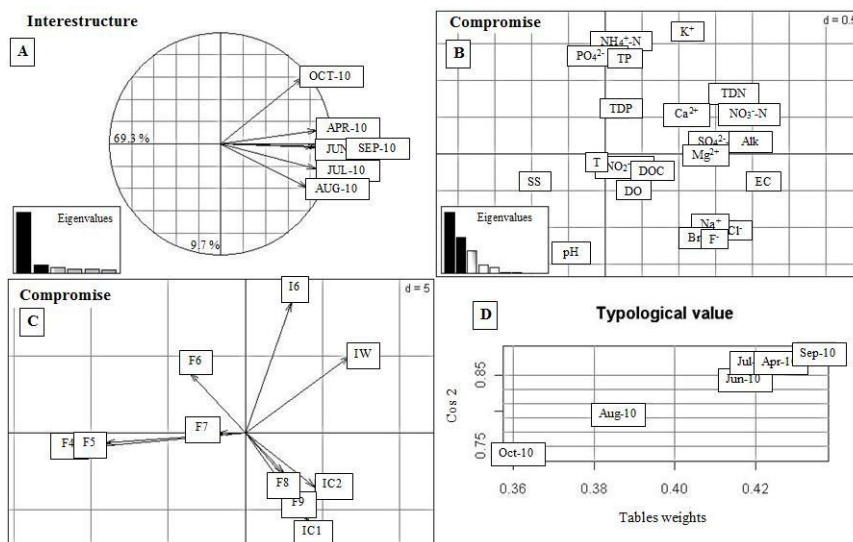


Fig 1. PTA results. A) Inter-structure analysis, differences between the sampling dates regarding to the water composition B) C) Compromise analysis, distribution of the analyzed variables and their relationship with the sampling stations. D) Influence of each table (sampling date) in the Compromise construction.

For the next chapter, we used multivariate techniques (CA and Pearson Correlation Matrix) to establish the relationship between the water discharge and the NO_3^- behavior, as well as to identify agricultural and hydrometeorological parameters influencing its different mobilization trends. The relationship between the changes in NO_3^- (ΔC) concentration and the overall dynamic of each hysteresis loop (ΔR) was also analyzed in order to describe the NO_3^- trend as a water discharge function (Fig. 2). A general dilution pattern of the NO_3^- concentration was observed regarding to the increase in water flow caused by irrigation return flows. While the fertilization activities increased the NO_3^- concentration, the beginning of the irrigation season contributed to its dilution. However, in case of the NO_3^- load, the maximum values occurred during the high flow periods in the irrigation season, suggesting the influence of irrigation return flows on the NO_3^- load.

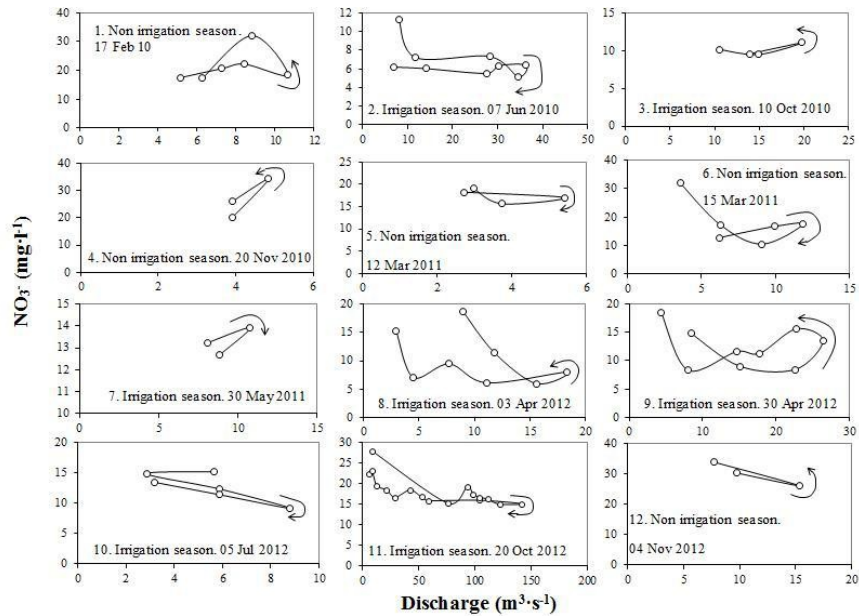


Fig 2. Hysteresis patterns in the Flumen River during the study period.

For the next chapter of the PhD thesis, 11 in-stream wetlands and 5 off-stream wetlands were restored in the southern part of the Flumen river basin, with the objective of evaluating their effectiveness in removing NO_3^- , and assessing the factors influencing its performance (Fig. 3). During 2011-2014, samples were taken at different times of the year for studying the influence of agricultural activities during the two years following the completion of the restoration works. NO_3^- loading rate (NLR) was a key parameter for the removing prediction in "off-stream" wetlands. However, in-stream wetlands showed higher NO_3^- loads and lower correlations with their removal rates. The patterns followed by the first-order constant (k) for NO_3^- removal were different for in-stream and off-stream wetlands, and during the irrigation season and the non-irrigation period. During the irrigation seasons, k increase was observed regarding to the NLR increase ($p < 0.05$); during the non-irrigation seasons, the NO_3^- outflow concentration was negatively correlated ($p < 0.01$) with k for in-stream wetlands. However, only the hydraulic loading rate (HLR) and NLR were significantly correlated ($p < 0.01$) with k during the irrigation season. The results showed a high efficiency of the restored wetlands because, after three years of restoration, 75% showed NO_3^- reduction.

Finally, and due to the importance of integrating environmental, biophysical and socioeconomic factors in wetland restoration projects, a comparison of two multi-criteria approaches (a suitability model and a greedy algorithm) was conducted. With the main objective of removing NO_3^- , the suitability model was applied taking into account the "terrain slope", "proximity to the watercourses" and "soil permeability". The greedy algorithm was carried out based on the "availability of public land" and "costs of restoration works". Both the suitability model and the algorithm provided essential information for siting a wetland and demonstrated the effectiveness of both approaches. The suitability model described the priority sub-basins for wetlands restoration from biophysical criteria, and the greedy algorithm indicated the availability of public lands or the cost of the restoration works (Table 1).

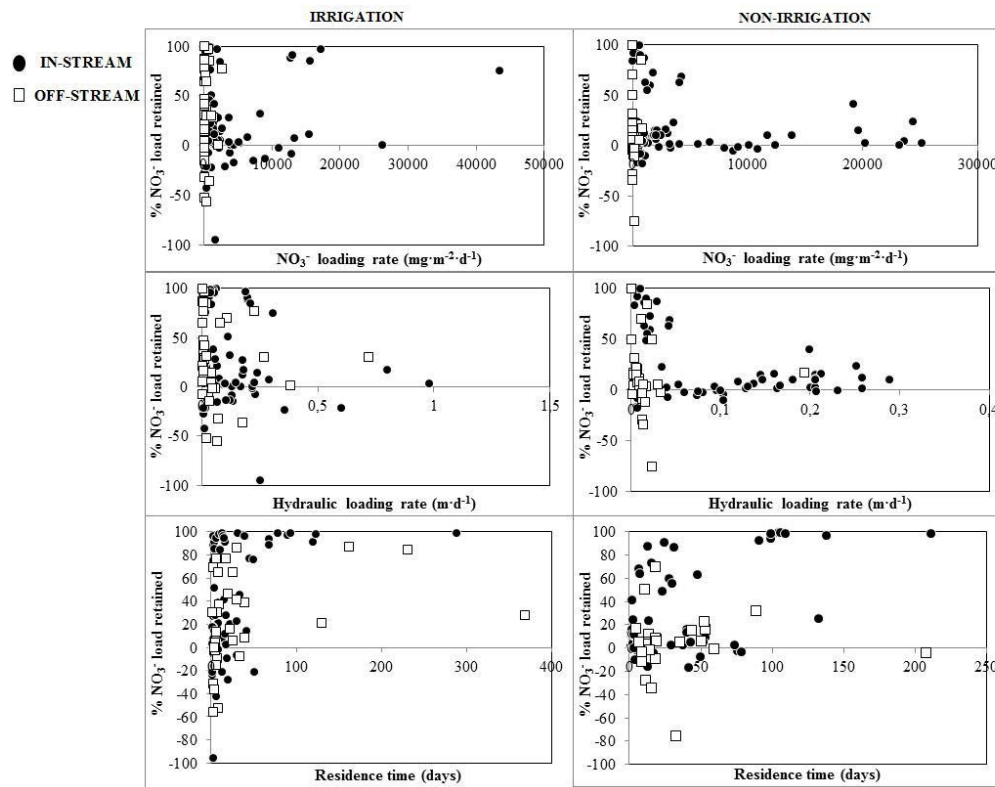


Fig 3. Relationship between NO_3^- load retained and NO_3^- load, hydraulic loading rate and residence time.

	Suitability Model	Greedy Algorithm
Values assigned to sites	Numerical value assignment	Relative order of sites
Resolution/differentiation between sites	High resolution and each site is differentiated	Relative differentiation, where two sites may have the same order of preference.
Ease to use	Not simple, requiring scientific- technical	Easier to use if sub-basin nitrate export data are available
Data requirements	Requires data that may not be readily available, potentially requiring field work	Requires data that may not be readily available and may require administrative work to obtain socio-economic data
Work effort	Tedious, but can be developed by specialized team or technicians	Tedious and requires compliance from stakeholders
Practical results	Good technical results, but may be difficult to put into practice	Relatively good results, and easy to put into practice

Table 1. Differences and attributes of each applied method.

DISCUSSION

After a first approximation to the Flumen River basin state in terms of water quality through the CA results, PTA was used to evaluate the spatial and seasonal variability of water quality in the urban and agricultural areas of the watershed. The PTA results showed that this method is an efficient tool for the three-input tables analysis, facilitating their joint interpretation and the definition of the relationships between the analyzed elements. Like Mendes et al. (2010), we indicated that its effectiveness can be limited by the essential requirement to have the same number of rows and columns in each table. That is, the number of sampling stations, the sampling dates and the analyzed parameters must be the same to perform this analysis. However, due to our adequate sampling planning and to our clear objectives, the PTA execution allowed us to relate the analyzed variables to the urban and agricultural areas, as well as to evaluate the seasonal variability of the water quality during study period.

Although the PTA results showed that NO_3^- -N was associated with an urban origin, due to the punctual character of this source (Huesca WWTP), and the data provided by similar works indicating its importance as a pollutant variable in the study area (Martin-Queller et al., 2010, Comín et al., 2014), we wanted to study the mechanisms and processes influencing the NO_3^- transport to the river. Hysteresis analyzes, the interpretation of the relationship between the pollutant concentration (C) and the water flow (Q) during a flood event, the resultant loop, its slope, direction and width, show the solutes

behavior patterns in relation to hydrogeochemistry and the characteristics of each basin (Bond, 1979). However, in the Mediterranean basins the water discharge only explains a small fraction of the solutes patterns variability (Bernal et al., 2002; 2004). As in Butturini et al. (2006), a clear relationship between the rotational patterns of the studied hysteresis and the specific hydrological characteristics of the study area was not found because even during flood events, the influence of the runoff from irrigated lands characterized the NO_3^- trends-. Therefore, although the flood typology study and its antecedent conditions are fundamental to describe the NO_3^- concentration variability, in semi-arid basins with intensive irrigation, the hydrological information is not enough to find satisfactory answers to the NO_3^- transport and the factors regulating it.

Regarding to the developed model for assessing the efficiency of the restored wetlands and the factors regulating their performance, the results showed that k only showed significant correlations with those parameters related to the NO_3^- load for in-stream wetlands (NLR and NO_3^- concentration). This fact was similar for off-stream wetlands (NLR, HLR) during the irrigation season when the loads are higher. High NO_3^- inputs from agricultural activities and excessive water discharge as a result of irrigated return flows were limiting factors for the wetlands effectiveness. Therefore, we think that although there were other factors (temperature and dissolved oxygen in our case) affecting denitrification, the high NO_3^- load inputs influence was greater and could alter this process. From this point of view, decreasing the NO_3^- pollution of surface waters can be efficiently achieved through the wetlands restoration, but should be accompanied by the improvement of good agricultural practices for decreasing the nitrogen amounts used as fertilizer, and the irrigation volumes.

Finally, the choice of methods for the optimal wetlands siting must be based on the objectives of each project. In this case, since we were looking for a priority sub-basin order for wetlands restoration, we considered that suitability formula was adequate for this aim. However, for practical purposes, the greedy algorithm provided information which can be used in the calculation of the project budget.

The NO_3^- pollution at Flumen River basin has to be approached from the double perspective of improving the agricultural practices management, and restoring wetlands and riparian zones. Combining both approaches a reduction of up to 90% of total NO_3^- discharge could be possible.

CONCLUSIONS

The results of this PhD. thesis revealed that "the land uses seasonality and the meteorological factors influence the pollutant dynamics", and that "the wetlands restoration is a useful tool for removing NO_3^- , and is also compatible with the socio-economic requirements".

REFERENCES

- BERNAL, S., BUTTURINI, A., & SABATER, F. (2002). Variability of DOC and nitrate responses to storms in a small Mediterranean forested catchment. *Hydrological and Earth System Sciences*, 6, 1031–1041.
- BERNAL, S., BUTTURINI, A., RIERA, J.L., VÁZQUEZ, E., SABATER, & F. (2004). Calibration of the INCA model in a Mediterranean forested catchment: the effect of hydrological inter-annual variability in intermittent streams. *Hydrological and Earth System Sciences*, 8(4), 729–741.
- BIS, B., ZDANOWICZ, A., ZALEWSKI, & M. (2000). Effects of catchment properties on hydrochemistry, habitat complexity and invertebrate community structure in a lowland river. *Hydrobiologia*, 422(423), 369-387.
- BOND, H.W. (1979). Nutrient concentration patterns in a stream draining a montane ecosystem in Utah. *Ecology*, 60, 1184–1196.
- BUTTURINI, A., GALLART, F., LATRON, J., VÁZQUEZ, E., SABATER, & F. (2006). Cross-site comparison of variability of DOC and nitrate c–q hysteresis during the autumn–winter period in three Mediterranean headwater streams: a synthetic approach. *Biogeochemistry*, 77, 327-49.
- COMÍN, F.A., SORANDO, R., DARWICHE-CRIADO, N., GARCÍA, M., MASIP, & A. (2014) A protocol to prioritize wetland restoration and creation for water quality improvement in agricultural watersheds. *Ecological Engineering*, 66, 10-18.
- GRIZZETTI, B., BOURAOU, F., & DE MARSILY, G. (2005). Modelling nitrogen pressure in river basins: A comparison between a statistical approach and the physically-based SWAT model. *Physics and Chemistry of the Earth, Parts A/B/C*, 30, 508-517.
- MARTÍN-QUELLER, E., MORENO-MATEOS, D., PEDROCCHI, C., CERVANTES, J., & MARTÍNEZ, G.

- (2010). Impacts of intensive agricultural irrigation and livestock farming on a semi-arid Mediterranean catchment. *Environmental Monitoring and Assessment*, 167, 423-435.
- MENDES, S., FERNÁNDEZ-GÓMEZ, M.J., PEREIRA, M.J., MIRANDA-ACEITEIRO, U., & GALINDO-VILLARDÓN, M.P. (2010). The efficiency of the Partial Triadic Analysis method: an ecological application. *Biometrical Letters*, 47, 83-106.
- MITSCH, W.J., DAY, J.W., GILLIAM, J.W., GROFFMAN, P.M., HEY, D.L., RANDALL, G.W., & WANG, N. (2001). Reducing nitrogen loading to the Gulf of Mexico from the Mississippi River Basin: Strategies to counter a persistent ecological problem. *Bioscience*, 51, 373-388.
- RIVA-MURRAY, K., BODE, R.W., PHILLIPS, P.J., & WALL, G.L. (2002). Impact source determination with biomonitoring data in New York State: Concordance with environmental data. *Northeastern Naturalist*, 9, 127-162.
- WOODCOCK, T., MIHUC, T., ROMANOWICZ, E., & ALLEN, E. (2006). Land-use effects on catchment- and patch-scale habitat and macroinvertebrate responses in the adirondack uplands. *American Fisheries Society Symposium*, 48, 395-411.
- ZEDLER, J.B. (2003). Wetlands at your service: reducing impacts of agriculture at the watershed scale. *Frontiers in Ecology and Environment*, 1, 65-72.

AUTORA: Núria De Castro-Català

TÍTULO DEL TRABAJO: Invertebrate community responses to pollutants in Mediterranean basins: insights from ecotoxicological approaches

DIRECTORA: Isabel Muñoz Gracia

CENTRO DE REALIZACIÓN: Departamento de Ecología. Universidad de Barcelona – Universitat de

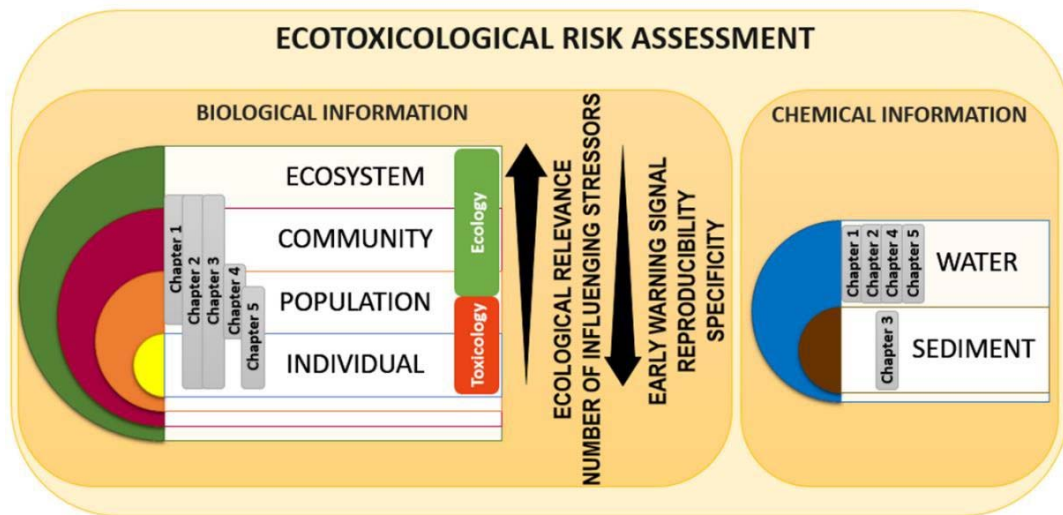
FECHA DE PRESENTACIÓN: 5 de febrero de 2016

Aquatic systems are under pressure from multiple stressors that affect the structure, the functioning, and the health of species, communities and ecosystems. One of the main human pressures affecting the Earth's ecosystems is chemical pollution. Large-scale chemical production has led to the release of these compounds from agricultural, industrial, and municipal waste, into riverine, transitional, and marine waters. These pollutants can cause harmful effects on aquatic species and communities, in turn causing severe negative impacts on the structure and functioning of ecosystems, and the goods and services they provide. Chemical pollution is not only one of the most important threats to aquatic systems, it is also a complex threat due to the diversity of compounds present in these systems (pesticides, pharmaceutical active compounds, perfluorinated compounds, polycyclic aromatic hydrocarbons, heavy metals, etc.), and the dynamics and interaction of these compounds with physical (water, sediment) and biological (amphibian, fish, invertebrate, algae) compartments. Furthermore, aquatic pollution is of special concern in Mediterranean basins, which suffer high flow variability and receive significant contaminant inputs from diffuse and point sources. Future scenarios predict that these basins will be increasingly affected by both the scarcity of water, enhanced by climate change, and high pollution.

Apart from well-known pollutants, called priority substances, many studies have revealed the widespread occurrence of low level concentrations of different micropollutants, also known as emerging contaminants (ECs), and awareness is growing with regard to the importance of mixtures of several contaminants, priority and emerging, as found in the more polluted water bodies of Europe.

The thesis focuses in the study of the effects of water and sediment pollution on the biota at different levels of organization, from the individual level to the community level, including emerging and priority substances. Our main target was the invertebrate community and the thesis comprises the analysis of the community responses working directly in the field, but also in the laboratory, to test the specific effects of water and sediment pollutants, as well as doing *in situ* experiments. Specifically, we employed these different tools: ecological methods (Chapter 3, 4 and 5), biomarkers of field-exposed organisms (Chapter 4 and 6), or *in vitro* and *in vivo* bioassays (Chapter 4, 5, 6 and 7) (Fig. 1).

A)



B)

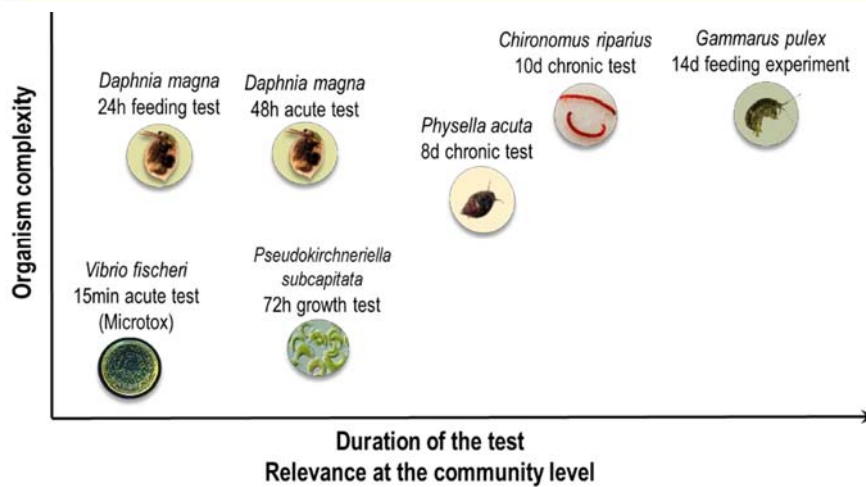


Figure 1. A) Schematic overview of the thesis. B) Examples of some of the ecotoxicity tests employed in the thesis ordered according to the organism complexity and the ecological relevance.

By combining the described tools, the thesis provides evidence of the effects of chemical stressors on invertebrate communities in four threatened Mediterranean rivers of the Iberian Peninsula: the Ebro, the Llobregat, the Júcar and the Guadalquivir (Fig. 2).

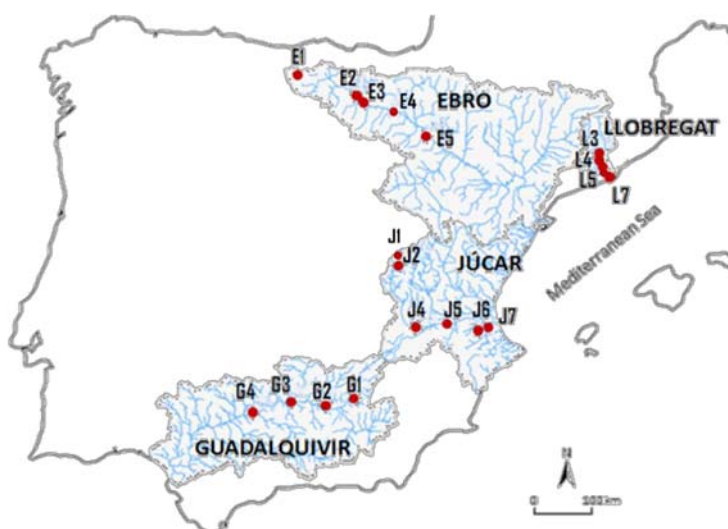


Figure 2. Study sites in the Ebro, the Llobregat, the Júcar, and the Guadalquivir rivers.

Chapter 3: Analysis of monitoring programs and their suitability for ecotoxicological risk assessment in four Spanish basins

The main objective was to identify those chemicals most likely responsible of the environmental toxicological risk in the four SCARCE basins and to investigate the relationships between toxicological risk and biological status. The toxicological risk was evaluated through historical monitoring data compiled by different water authorities and applying the TU concept. Biological data compiled by water authorities was compared with TU results obtained. These analyses allow to evaluate whether a potential risk (measured as TU) accurately reflects the risk to the community or, alternatively, whether new criteria should be developed to improve the risk assessment.

Chapter 4: Invertebrate community responses to emerging water pollutants in Iberian river basins

We aimed to identify the relationships between the presence and the concentration of common, priority and emerging pollutants (Pesticides, PhACs, EDCs and PFCs) in water and changes in the invertebrate community. The study was developed in the four Mediterranean basins of the SCARCE project and the sampling was performed in the autumn period of two consecutive years (2010 and 2011). Structural (species composition and density) and functional variables were analysed to determine which of the pollutants would greatly influence invertebrate responses. Two functional biomarkers were studied: the antioxidant enzymatic activity (catalase) of the trichopteran *Hydropsyche exocellata*, and the inhibition of the feeding activity in the cladoceran *Daphnia magna*. Our hypothesis was that the structural (community) and functional (biomarkers) descriptors would change reflecting the pollution gradient. We expected a decrease in invertebrate community richness due to the absence of pollution-sensitive species in sites with higher levels and diversity of pollutants.

Chapter 5: Ecotoxicity of sediments in rivers: Invertebrate community, toxicity bioassays and the toxic unit approach as complementary assessment tools

Three main objectives were addressed in this chapter: (i) the study the sediment pollution of the SCARCE rivers and the determination of their associated toxicity using the TUs approach (iii) the study of the composition and density changes of the benthic invertebrate community and their relationships with the sediment quality and (iii) the implementation of a battery of toxicity bioassays with organisms of different organization levels to complement the ecotoxicological risk assessment. The toxicity tests used covered different trophic levels, from primary producers (*Pseudokirchneriella subcapitata*) to consumers (*Chironomus riparius*). We hypothesized that the invertebrate community changes would be related with pollutants accumulated in the sediment, and that the battery of bioassays would respond in a similar way, in relation to sediment pollution. We also thought that the different species would respond differently to the pollutants depending of the mode of action and the exposure time.

Chapter 6: Is reproduction of the snail *Physella acuta* affected by endocrine disrupting compounds? An in situ bioassay in three Iberian basins

The main aim of this chapter was to study lethal (survival) and sublethal (reproduction and development) effects in the freshwater gastropod *Physella acuta* in three of the rivers where EDCs have been detected using an in situ bioassay. In order to detect which compounds could be contributing in a greater extent to the effects, the endpoints (number of clutches, eggs and hatching) were contrasted with EDC concentrations in river water and their estrogenic equivalent quotients (EEQs). We hypothesized that the reproduction and the development of the snails would be affected by the presence of EDCs and their estrogenicity. That is, those compounds with higher potential estrogenic activity would modify the reproductive and developmental responses, causing trans- generational effects.

Chapter 7: Direct and indirect effects of the antidepressant fluoxetine and the fungicide prochloraz in a leaf litter feeding experiment with *Gammarus pulex*

We aimed to detect direct and indirect effects of two pollutants widely detected in European rivers, the fungicide prochloraz and the antidepressant fluoxetine, in a feeding experiment with the freshwater amphipod *Gammarus pulex*. Concretely, we wanted to study the bottom-up effects of prochloraz on the amphipod through leaf litter conditioning (*Alnus glutinosa*), and the top-down effects of fluoxetine through water exposure. Our hypothesis was that both compounds would exert effects through different pathways in relation to their mode of action. We hypothesised that fluoxetine would directly affect the amphipods behavior and prochloraz would alter the microbial conditioning of the leaves and thus would indirectly (low quality of the food) affect the amphipod consumption.

As a general summary of the results of the thesis, ecotoxicological effects were detected at the community level, but also at the population and individual levels. It was found that contaminants in water, and also contaminants accumulated in surficial sediments affect community structure (richness and abundance). It was also seen that some contaminants (Endocrine Disrupting Compounds), may affect the reproductive capacity (number of eggs) and the development and growth of some species, such as the freshwater snail *Physella acuta*, or the dipteran *Chironomus riparius* in its larval stage. Other contaminants (heavy metals) affected the growth and the survival of species, such as the bacteria *Vibrio fischeri* or the green algae *Pseudokirchneriella subcapitata*. Some pesticides (e.g., fungicides) affected the feeding activity of species such as *Daphnia magna* or *Gammarus pulex*, and also the activity of antioxidative enzymes (catalase) of the trichopteran *Hydropsyche exocellata*. In addition, sublethal behavioral effects of two emerging compounds (prochloraz and fluoxetine) were detected at very low concentrations.

In the discussion of the thesis, a weight of evidence approach was applied in order to integrate all the results, to determine the ecotoxicological status of the studied sites, and to identify the main drivers of toxicity in the four Mediterranean basins. The general picture obtained showed that priority and emerging pollutants represent a serious toxicity risk for invertebrates in these basins, and that the main specific drivers of this risk are pesticides, alkylphenols, and metals.

Research based on field studies and laboratory toxicity tests, combining experimental assays with natural community studies, is essential to understand the effects of stressors at different scales and to prevent future degradation of aquatic ecosystems. This thesis integrated observational and experimental approaches of different environmental disciplines (environmental chemistry, ecotoxicology and ecology) to elucidate the effects of pollution. The combination of experimental tests to study natural communities can help to understand the effects of disturbances at different scales and prevent the degradation of aquatic ecosystems and improve its management.

AUTORA: Noé Ferreira Rodríguez

TÍTULO DEL TRABAJO: INVASIVE ECOLOGY OF *Corbicula fluminea* (Müller, 1774)

DIRECTORA: Isabel Pardo Gamundi

CENTRO DE REALIZACIÓN: Universidad de Vigo

FECHA DE PRESENTACIÓN: 12 diciembre 2016

Between the worst invasive species in Europe, the Asian clam *Corbicula fluminea* (Müller, 1774) represents an important threat to aquatic environments. The species started its worldwide dispersion at the beginning of the twentieth century associated with human activities such as global trade, fishing bait, recreational activities and so on. In addition to the native range in Asia, at current the species is present in North and South America, North Africa and Europe. In Europe, *C. fluminea* was first record as invasive exotic species in 1980. Since then, the species has greatly expanded its distribution range being present in almost all European river basins, from Iberia in the southwest to Ireland and UK in the North and to Bulgaria and Romania in the East.

Given this wide distribution range, in the first part of this thesis we aim to 1) actualize the distribution of *C. fluminea* in Galicia and draw an ecosystem approach to biological invasions in freshwaters from the region and to *C. fluminea* invasion in particular. To achieve these objectives we designed a survey campaign covering sixteen river systems and one pond system (total of 65 sampled localities) in Galicia. Additionally, field data were complemented with a series of interviews and a revision of scientific and grey literature. As a result of our field research we actualized *C. fluminea* distribution in Galicia. Nowadays, *C. fluminea* is present in three river basins (Miño-Sil, Ulla and Mero). Additionally, grey literature signaled its presence at Lagoa de Antela and Pontiña river. Our data indicated a mean upstream spread of 3.6 km yr⁻¹. Regarding spread vectors of *C. fluminea* in Galicia, the ecosystem approach revealed that the area occupied by the species may be related with loss of native biodiversity, economy and implementation of legislative instruments regarding invasive species. These results are of value to address introductory pathways and dispersal vectors of invasive species in the region. An example is the involvement of different stakeholders (e.g. fishermen) in order to early identify the presence of new invasive species.

In general, the variation of environmental factors in brackish and freshwaters determines its natural biodiversity and constitutes important environmental barriers for invasive species establishment. In this regard, estuaries act as filters transferring exotic species between marine and freshwater ecosystems due to the salinity gradient. Once in freshwaters, calcium is a key physiological compound for invertebrates. It is required for shell formation, muscle contraction, mediates gene expression, and allows counteracting acidosis during stress periods, among other functions. In the second part of this doctoral thesis, we aimed to obtain a complete characterization of the River Miño estuary (invaded since late 80's), focused upon the study of the environmental factors of relevance for the distribution of *C. fluminea* in the area. According to these results we tested the capacity of *C. fluminea* to cope with osmotic stress conditions previously to invade new freshwater habitats through estuaries. Secondly, we aimed to decipher whether the environmental calcium concentration might hamper *C. fluminea* invasiveness in the upstream colonization process

from the estuary. To achieve these objectives we designed two sampling campaigns. Firstly, a quantitative survey campaign completed at 47 sites along the 15 km in the River Miño estuary where the species was known to occur. Secondly, environmental factors and *C. fluminea* populations were studied at twelve rivers and two lagoons (total of 22 sites) located in the Northwestern Iberian Peninsula, between the Ulla River (Galician, Spain) and the Mira River (Central Portugal).

Additionally, laboratory experiments were performed to assess the ability of *C. fluminea* to cope with estuarine osmotic stress conditions and to grow under different environmental calcium concentrations. Further, we used a multidisciplinary and integrative approach in order to decipher whether the environmental calcium concentration might hamper *C. fluminea* invasiveness. In this regard, field surveys were complemented with *in situ* Ca²⁺ content assessment in soft tissues and molecular biology analyses as well as growth laboratory experiments.

At local scale (River Miño estuary), density and biomass were positively related to coarse sediments and to sedimentary organic matter that can be taken as a food supplement. The study of size frequency distributions indicated that individuals of size 20 mm dominated the River Miño estuarine population, with at least two annual cohorts. Smaller individuals preferred coarse sediments in combination with high organic matter contents, allowing us to identify the estuary recruitment areas. Downstream, osmotic stress exposure compromised the establishment and survival of *C. fluminea*. Under osmotic stress exposure, great mortality rates were reached after 19 days. The species tolerance range, measured by individual maintained activity, was at salinity-20 when exposed to winter temperatures, while when animals were exposed to summer ones its tolerance was reduced to salinity lower than 15. Results revealed that *C. fluminea* shows a great physiological flexibility to cope with salinity variations in estuaries. In summer, the temperature increases the metabolic rate making the species more vulnerable to osmotic stress exposure. Upstream, calcium may determine invasiveness of ecosystems. A Principal Component Analysis of different environmental factors at 22 sampling stations within *C. fluminea* distribution area identified environmental Ca²⁺ concentration as one of the variables that majorly explains variations among sampling station. Calcium content in animal's body from two representative rivers was dependent on the environmental calcium concentration of freshwater basins; the lower the concentration, the lower the body's content. Expression of stress- and calcium homeostasis-related genes was higher in *C. fluminea* from low calcium concentration environments than in those from calcium rich freshwater basins. Finally, under experimental conditions, low water calcium concentrations decreased *C. fluminea*'s growth.

Our results identify important ecological features of *C. fluminea* and provide valuable information to improve exotic invasive species management in the region. Firstly, the identification of environmental factors controlling *C. fluminea* distribution and recruitment areas in the River Miño estuary aims to be the basis for management plans designed to prevent and control the species in Atlantic estuaries, at a time that allowed us the design of experimental assays to validate the observations resulting from this study. Our experiments designed to assess *C. fluminea* resistance to osmotic stress may be of valuable concern to prevent new invasions through ship ballast waters ensuring complete mortality if individuals are retained for >26 days or at higher temperatures. In addition, for the first time, present data suggests environmental calcium concentration as a determinant factor of invasive success of *C. fluminea* in freshwater environments; and provides new clues for freshwater basins management allowing the identification of areas with great invasion risk. Following, if invasive species are able to cope with environmental barriers and establish self-sustaining populations may cause environmental harm, economic harm and impact to human health. Environmental harm involves negative impacts over native fauna related to already damaged populations. Conversely, invasion of successional mature and undisturbed communities usually requires that the alien taxon overcomes a different category of barriers that increases ecological resistance of the environment.

The global decline of freshwater mussels is related with a great variety of threats, including the introduction of invasive species. In this regard, *C. fluminea* may compete with freshwater bivalves for space and/or food resources. In addition, the negative impact on native freshwater mussels is also likely to occur through other mechanisms, such as possible ingestion of unionid sperm, glochidia or newly metamorphosed juveniles by *C. fluminea*, massive mortalities which result in unionid mortality by ammonia toxicity, and bioturbation activities and organic matter enrichment due to production of faeces and pseudofaeces, which may alter sediment biochemistry and impair the survival of unionids. But, in a general context, the worldwide decline of freshwater biodiversity (including freshwater mussels) is attributed to global change. Global warming, eutrophication or invasive species introduction are some components of the ongoing global change. Namely, global warming influences species migration and distribution, abundance and population dynamics, and functional variation in aquatic and terrestrial organisms. In this regard, most studies to date conclude that climate changes increase the distribution range and will promote the establishment of the most invasive aquatic invertebrates in new areas. Given this global change context, the third part of this thesis aim to determine if *C. fluminea* interacts negatively with native freshwater mussels (i.e. *Unio delphinus*), potentially competing for food resources and/or space. In addition, we aim to determine if the successful biological traits of *C. fluminea* may enhance its competitive ability compared to native mussels in a global change context (increased temperatures and/or nutrient enrichment).

Concerning the negative impact of *C. fluminea* over native freshwater mussels, we perform field and laboratory experiments. Namely, inter-specific assays using the invasive species *C. fluminea* and the native species *U. delphinus* comprised two different approaches: i) a field experiment to determine possible negative effects on growth and physiological condition of *U. delphinus* under different *C. fluminea* density and ii) a laboratory experiment to assess possible alteration on the activity pattern of *U. delphinus* in sympatry with *C. fluminea*. In a global change context, we experimentally simulated the effect of increasing temperatures during summer heatwaves to assess strengths and weaknesses of *U. delphinus* in coexistence with *C. fluminea*. We measured several physiological parameters (clearance rate, oxygen consumption and absorption efficiency) and the energetic balance to determine the potential effects of increasing temperatures on mussel physiological activity. In addition, the effect of *C. fluminea* presence was evaluated by measuring *U. delphinus* faeces production, as a response variable to food consumption. Faeces production was measured under fixed evacuation times, and under three temperatures and three trophic conditions, using phytoplankton concentrations as a proxy for trophic condition.

Our results showed that *U. delphinus* exhibited lower growth, lower physiological condition and greater locomotor activity at higher *C. fluminea* density, which may suggest that this unionid is negatively affected by *C. fluminea* and may be displaced to less favorable habitats. In a global change context, *U. delphinus* responded to high temperatures with higher respiration rates, showing an increase in energy expenditure. *U. delphinus* faeces production, a proxy for food consumption, varied significantly with each factor analyzed (temperature, food availability and *C. fluminea* presence) and there was an interactive effect between these factors; increasing with temperature and trophic condition, and declining in the presence of the invasive clam. Results showed that heatwaves will negatively influence the physiology of native mussels and suggest that *C. fluminea* will advantageously outcompete *U. delphinus* in warmer and highly productive freshwater environments.

Although we were not able to establish the main mechanisms responsible for these results our experiments identified important clues for native freshwater mussel conservation. Possibilities may include competition for food resources, competition for space which may result in mussel displacements and/or changes in microhabitat features, as a result of bioturbation and production of faeces and pseudofaeces by *C. fluminea*. Given that results, in a global change context, we confirm that warming is likely to worsen the scenario when invasive species are present. *C. fluminea* can negatively affect unionids by a more efficient food uptake in warmer and nutrient enriched freshwaters, limiting food availability at time that native mussels depend on food quantity to compensate for the metabolic demand from increasing temperatures. Hence, the early identification of areas that are threatened by invasive species is crucial for planning effective control measures or conservation actions (e.g. mussel translocation from highly invaded areas). Those might be based on the relative impact of each factor and considering the possible 'interactive effects' as driving forces of native species decline.

Besides, biological invasions can yield substantial benefits for native biodiversity. There is a large literature on the rapid adaptation of native species to an introduced species. Interactions among native and exotic fauna involve facilitative interactions, cascading effects across trophic levels, community re-structuration or evolutionary changes. In the fourth part of this thesis we aim to assess if native aquatic bird population trend (i.e. *Haematopus ostralegus*) was related to global change drivers, namely temperature and *C. fluminea* introduction. In addition, we aim to examine the facilitation process on native and exotic terrapin species by the invasive clam *C. fluminea* in Iberian inland waters. Finally, we aim to determine if two invasive bivalves, the Asian clam *C. fluminea* and the Eurasian zebra mussel *Dreissena polymorpha* (Pallas 1771), could be potential food items for *Acipenser sturio* Linnaeus, 1758 and assess the potential of sturgeons as biological control of invasive bivalves.

To investigate how global change affects oystercatcher population, winter temperature data in the Rive Miño, average Autumn temperature data from the North Sea, North Atlantic Oscillation and Asian clam invasion as a potential 'perturbation factor' were included in an Auto-Regressive Integrated Moving Average model (ARIMA) to analyze the average number of wintering oystercatchers for a 30-years period (1985 – 2014). Regarding the possibility of future facilitation processes among terrapin species, we compare the predation rate and size selection with native and alien freshwater turtles. We run multiple experimental trials to estimate turtles predation rates on *C. fluminea* using native and exotic terrapins established in the Iberian Peninsula. Finally, a pilot study was designed to determine if the invasive bivalves, *C. fluminea* and *D. polymorpha*, could be potential food items for *A. sturio* and to describe sturgeon predator – bivalve prey relationship in order to determine the potential of sturgeon's reintroduction plans as biological control in invaded ecosystems.

Facilitative interactions analysis has shown an adaptation of native waterbird species to *C. fluminea* invasion. Results showed that wintering waterbirds declined since the mid-1980s. In contrast, oystercatchers doubled its wintering effectiveness within the study area. The ARIMA model showed that relative abundance is partially dependent of *C. fluminea* density in the River Miño estuary. Additionally, warming at the study area and in North Sea had a significantly relation with oystercatcher population. Regarding terrapin diet, our results evidenced great similarities between native and exotic emidid species. Meanwhile there were different feeding capabilities among terrapins. In general, the ability to feed upon *C. fluminea* was correlated with terrapin's mouth kinematics and differed greatly between native and exotic species. In this regard, the opportunistic behavior of exotic species contrasts with the

adaptive pattern of native species. Finally, the pilot study designed to explore the potential of juvenile European Atlantic sturgeon to feed upon *C. fluminea* and *D. polymorpha* shown that, the potential to control both invasive species may be restricted to initial invasion stages.

In this final part of the thesis we discuss facilitative interaction with native and exotic species. As shown, results presented in this work indicate that at the study site, the Eurasian oystercatcher population increased its wintering effectiveness in response to *C. fluminea* invasion. The species provide a novel exploitable food resource that may favor both, oystercatcher's movements from adjacent coastal areas to the inner estuary and the establishment of a resident population. Hence, control measures applied to long term invasions must be carefully analyzed since invasion has created a dependent native community. In other side, *C. fluminea* may facilitate the establishment of new exotic terrapin species (e.g. *Graptemys pseudogeographica*, *Sternotherus odoratus*) in Europe, and promote the spreading expansion of the Slider turtle *Trachemys scripta*. Additionally, our results suggest that *A. sturio* reintroduction programs may be limited but of value in prevent the establishment of high invasive bivalve densities during early invasion stages.

AUTOR: Pablo Rodríguez Lozano

TÍTULO DEL TRABAJO: Fire legacies in Mediterranean streams: the key roles of the riparian canopy and the top predators on food webs

DIRECTORES: Dr. Narcís Prat & Dr. Maria Rieradevall

CENTRO DE REALIZACIÓN: University of Barcelona

FECHA DE PRESENTACIÓN: 29 enero 2016

Wildfires are expected to increase in frequency and intensity because of climate change and changes in land use and management. Fire may act as prime driver of change in the physical, chemical, and biological characteristics of streams, its cascading effects on these ecosystems being highly complex (see Figure 1). In last decades, the research on fire effects on aquatic systems has grown, but it has been mainly conducted in the short- and mid-term (<5 years). Therefore, longer time frames are needed to assess fire effects on freshwater ecosystems. For instance, fire impacts on riparian and upland forests can be long-lived and wildfires often extirpate fish populations from streams, which may not recover due to barriers within the river network. Regarding fish extirpations, it is worth noting that freshwater fish are one of the most threatened fauna worldwide, especially the small-bodied species. In this context, the overarching goal of this PhD thesis was to investigate the long-term effects of a wildfire in Mediterranean streams. Specifically, this PhD thesis covered the indirect effects of two fire legacies: (1) the riparian canopy reduction and (2) the local extinction of the top predator in these streams, the endangered small-bodied fish *Barbus meridionalis*. This PhD thesis was structured in four independent but interconnected chapters.

AUTORA: Rosana Aguilera Becker

TÍTULO DEL TRABAJO: Effects of land use and climate variability on the water quality of Mediterranean rivers: Towards a regional vision of global change

DIRECTORA: Rafael Marcé y Sergi Sabater

CENTRO DE REALIZACIÓN: Institut Català de la Recerca de l'Aigua (ICRA) - Girona

FECHA DE PRESENTACIÓN: 10 marzo 2015

In spite of the growing awareness of global change effects on freshwater ecosystems, studies concerning the effects of environmental change on river water-quality patterns remain scarce. The Mediterranean region is particularly vulnerable, as it undergoes a myriad of alterations that compromises the sustainability of freshwater resources and further impairs water quality. The two main objectives of the present thesis were: (1) To describe nutrient source apportionment and biogeochemical processes involving nutrients in impaired rivers by leaning towards a more integrative approach of biological and hydrological factors acting on in-stream retention at the basin scale. (2) To characterize the spatio-temporal variability of nitrate and phosphate concentration in a large Mediterranean basin and attribute the potential drivers behind the underlying patterns in the context of global change, while tackling the most commonly encountered challenges in time-series analysis.

In-stream nutrient processes and source apportionment at the basin scale

In order to describe the effective nutrient retention capabilities at river basin scale, a better understanding of the factors influencing lumped concepts and variables (such as nutrient spiraling metrics at larger scales) is needed. The

models developed to simulate nutrient transport and retention at the basin scale usually rely on reaction-rate expressions to describe nutrient retention in terrestrial and aquatic ecosystems, most of them assuming first-order kinetics (i.e., nutrient uptake rates linearly increase with nutrient concentration). However, it has recently been argued that the concentration of nutrients in streams regulates the uptake rate and that the efficiency of such process rates relative to increasing concentration eventually declines (Efficiency Loss (EL) concept).

The formulation for stream nutrient retention in the hybrid statistical and process-based SPARROW model for the Llobregat River basin (NE Spain) was modified in this thesis to include a wider range of nutrient uptake dynamics (including first-order kinetics and EL). The decreasing values of the uptake velocity (v_f), the downward velocity at which nutrients are removed from the water column, along the concentration gradient confirmed a loss in uptake efficiency in streams of all sizes in the Llobregat basin. However, the slopes were much steeper than those corresponding to the relationship described by the bibliographical data and the EL concept (Fig. 1). Thus, nutrient retention capacity decreased with increasing nutrient concentration, particularly in the Llobregat nitrate model. Overall, increased exported nutrient load and decreased in-stream nutrient removal coincided in a downstream direction, probably due to the significant chemical and geomorphological changes found in the lower part of the Llobregat basin.

The assumption that nutrient retention is at least a two dimensional problem (i.e., considering both roles of hydrology and biological activity on nutrient retention), implies that different approaches to estimate the uptake velocity v_f would yield distinct dynamics for nutrient retention, especially when considering larger scales (i.e., other than the reach scale). By applying a constant v_f , the nutrient retention fraction would be exclusively dependent on the hydrological conditions of the streams under evaluation, and only situations of low hydraulic load (i.e., the ratio between water residence time and water depth; most probably in small headwater streams) will support high retention capacity. However, if v_f is dependent on nutrient concentration, higher hydraulic loads maintain higher nutrient retention as we move from an EL model to the dynamics found in this thesis for the Llobregat basin. One consequence of this is that the use of hydrological-driven formulations of nutrient retention might contribute to a biased view of the relative role of headwater streams on nutrient retention at large scales, completely disregarding the nutrient retention potential in larger streams and rivers.

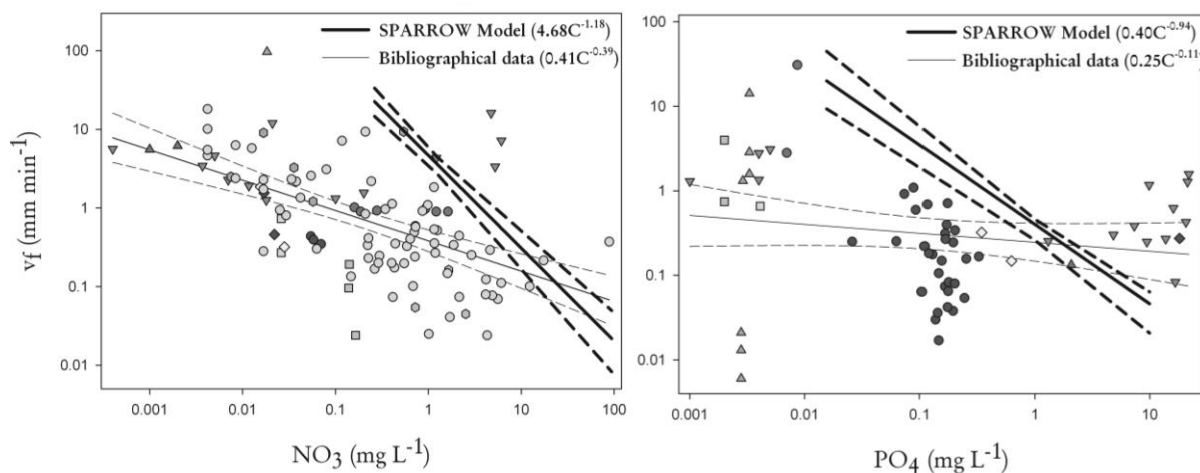


Figure 1: Relationship between uptake velocity (v_f) and nutrient concentration in literature studies (different symbols) and estimated in SPARROW for the Llobregat River Basin. (left, nitrates, right, phosphates). The power laws for literature data and the SPARROW results along with 95% confidence intervals are included.

In terms of nutrient source apportionment in the Llobregat basin, diffuse sources accounted for the major part of nitrate load arriving to rivers (natural land, 42% and cultivated land, 33%). Point sources accounted for the greatest portion (48%) of the total average phosphate load generated in the basin. Natural sources of the two nutrients predominated in the upper part of the Llobregat basin, whereas agricultural activities were more relevant in its middle section. Point sources were large contributors of nutrient loads, especially phosphates, in the lower part of the basin (Fig. 2). Furthermore, point source pollution was greater under dry hydrological conditions for both nitrate and phosphate models.

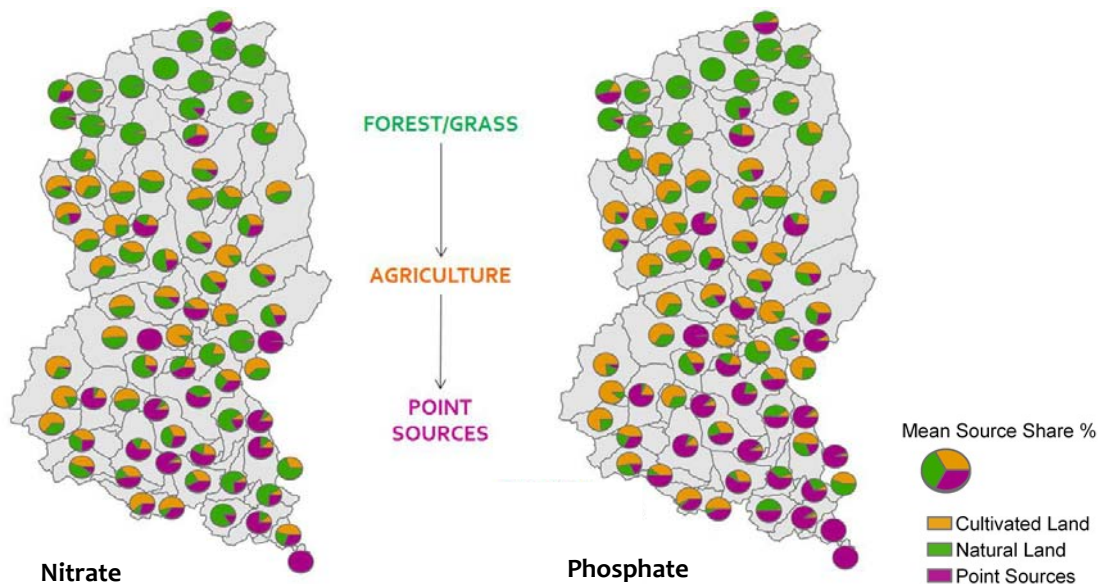
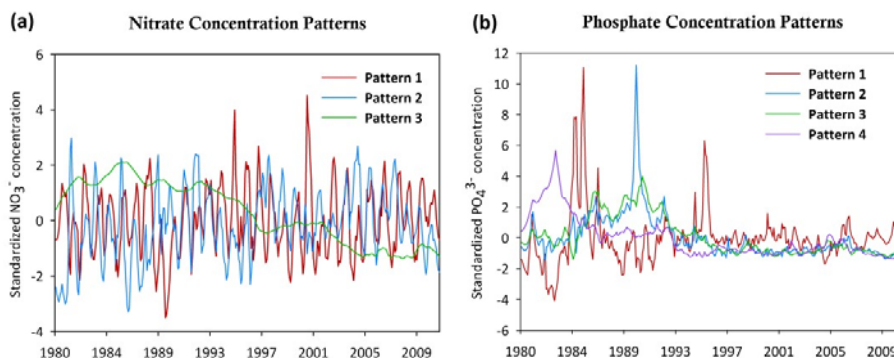


Figure 2: Mean percentage of the three main nutrient sources for the 79 sub-basins comprising the SPARROW models for the Llobregat basin. The nutrient source apportionment pattern broadly agreed with the land use distribution in basin, where natural land predominates in the upper part, moving to more agriculture-dominated in the mid-part and lastly becoming highly urbanized in the lower part.

Regional river water quality signatures

The assessment of global change impacts on freshwater resources, which frequently relies on scantily available data (i.e., limited availability of continuous and long-term observations), is further complicated by the complex interaction of processes at multiple temporal and spatial scales. Nitrate and phosphate common patterns (Fig. 3a-b) were extracted from a set of 50 time-series (1980-2011; monthly nutrient concentration data from local water agency dataset) scattered across the Ebro River Basin (Spain) by means of dynamic factor analysis (DFA). DFA provided the methodological framework to extract patterns in time-series with missing observations. Patterns are modeled as random walks and are thus allowed to be stochastic. The resulting patterns were related to factor loadings (e.g., Fig. 3c), which indicate the weight or relevance that each pattern has in a given time-series. Since time-series are linked to a network of monitoring points and thus related to a specific site/region in the basin, the spatial dimension was also considered in the present analysis by using the magnitude and sign of the factor loadings associated with each extracted pattern. These patterns were further characterized using complementary methods such as frequency and trend analyses for the temporal dimension, together with regression and cluster analysis of spatially distributed data.



(c) Factor Loadings

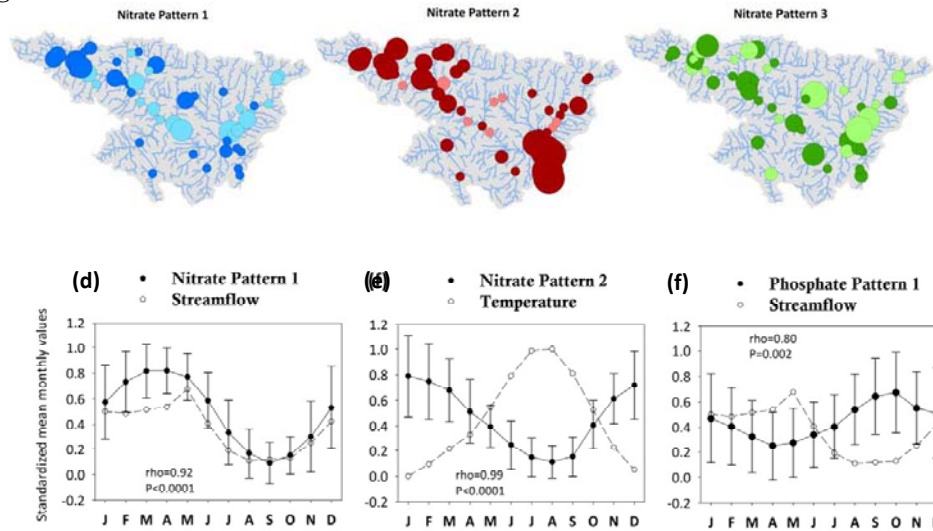


Figure 3: *Top*: DFA resulting patterns for nitrate (a) and phosphate (b) concentration. *Center*: (c) Factor loadings associated to nitrate patterns. Dark circles indicate positive factor loadings and light-colored circles represent negative factor loadings. The size of the circles represents the magnitude of the factor loading at each point (time-series). *Bottom*: Seasonal variation for nitrate Pattern 1 and streamflow (d), nitrate Pattern 2 and Temperature (e), and phosphate Pattern 1 and streamflow (f). Points depict monthly averages for the entire 30-year period. For temperature and streamflow, the average is for all time-series available. Standard deviations as error bars included only for the nutrient patterns to enhance readability.

The three common nitrate concentration patterns extracted from the set of 50 time-series within the 30-year study period described a large proportion of the observed variability at the basin scale. Conversely, the resulting four common concentration patterns in the phosphate analysis did not fully describe the behavior of all monitoring points included in the analysis.

In the case of nitrate, the analyses in this thesis identified the presence of irrigated agriculture and its corresponding fertilization management practices (synthetic fertilizers or manure), the presence of industrial activities in the basin, and damming as the main global change factors in the Ebro basin. Other climatic processes linked to streamflow variability were also identified (Table 1), but the impact of climate changes on these processes is uncertain and could not be disentangled in this study. These factors shape a complex dynamics including temporal trends, and interannual and seasonal cycles, with either strong or vanishing relationships with streamflow, and links with phenological processes in terrestrial ecosystems and reservoirs. Interestingly, the impact of identified factors on this rich dynamics was not homogenous across the basin, but clustered in 4 regions not entirely coherent from a geographic perspective.

Table 1: Characterization of nutrient common patterns and their relation with streamflow in the Ebro basin. Relationships between these variables were assessed with the maximal information coefficient (MIC) method.

Nutrient	Trend (Kendall tau)	Significant oscillations	Significant MIC relationships	Other relationships with streamflow
Nitrate				
Pattern 1	ns	1 and 34	34	Strong seasonal coherence (Fig. 1d)
Pattern 2	ns	1 and 12	12	Nothing to remark
Pattern 3	-0.53**	3.5	22	Trend NOT related to streamflow Coincident and significant streamflow oscillation at 3.2
Phosphate				
Pattern 1	ns	1 and 2	2	Moderate seasonal coherence (Fig. 1f)
Pattern 2	-	ns	4	Trend NOT related to streamflow
Pattern 3	ns	1.6 and 25	25	Coincident and significant streamflow oscillations at 1.5
Pattern 4	-0.08*	ns	10	Trend NOT related to streamflow

The seasonality of nitrate patterns was either driven by hydrological or phenological processes, depending on the geographical location of the monitoring point. The frequencies of the cycles identified in nitrate concentration patterns were further potentially linked to climatic oscillations, such as the El Niño Southern Oscillation (ENSO) and the North Atlantic Oscillation (NAO). Because the hydrology of inland waters is intimately linked to precipitation, the influence of climatic oscillations on river discharge would be expected. Physical responses to climatic oscillations might result in secondary chemical responses, due for instance to changes in river inflow or in mixing or upwelling processes.

In contrast, phosphate concentration showed a more idiosyncratic behavior. The only relevant global change mechanism acting at large scales is the presence of industrial activities and the application of synthetic fertilizers. Decreasing phosphate trends observed across space and time coincided with changes in land-use management practices in Ebro basin such as the implementation and the improvement of sewage water treatment facilities (a shared characteristic with river basins across Europe) and the reduction of phosphate content in the composition of fertilizers. The explanatory power of the models results was low in the case of phosphate concentration dynamics, meaning that most variability was accounted by factors not considered in this work. Although these factors may include some relevant regional drivers, the contrasting results from the nitrate analysis imply that the ultimate reason of the lower performance of the phosphate models is the absence of the more local factors, such as the different timing of implementation of wastewater treatment technologies. Overall, these results emphasize the synergistic interaction between land use and climate changes that shape both temporal and spatial patterns in water quality as a consequence of local and global anthropogenic activities (Fig. 4).

(a) Nitrate

(b) Phosphate

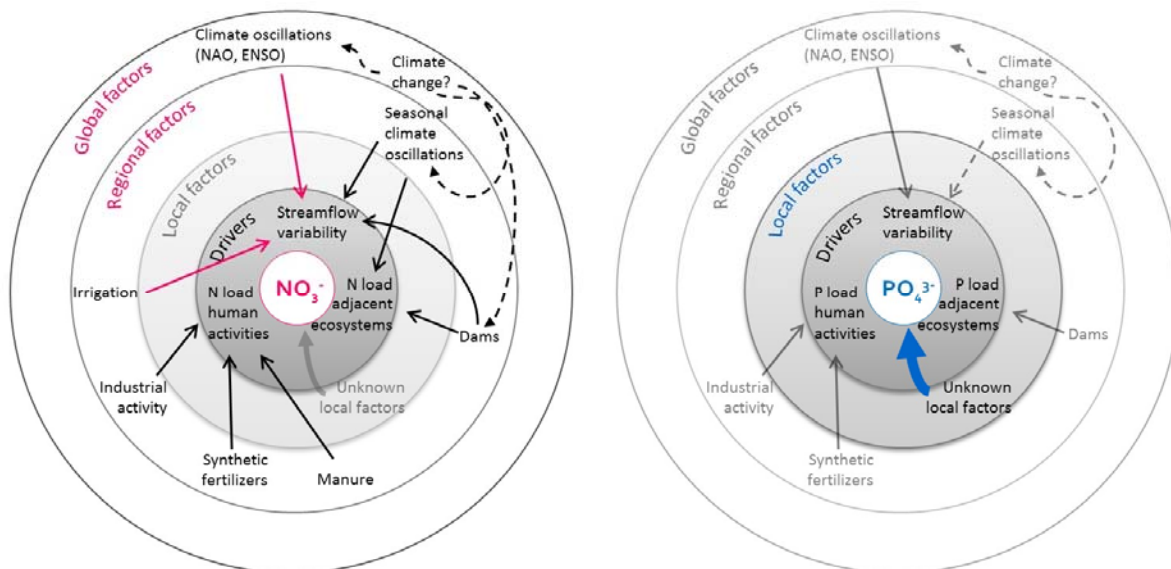


Figure 4: Global change factors acting at different scales contribute to shape the variability of nitrate and phosphate concentration in the Ebro basin. The impact of global change on nitrate dynamics was found to be a multifaceted process including regional and global factors (a), whereas impacts on phosphate rely mainly on local factors (b).

The proposed collection of methodological steps was successful in providing a complete characterization of patterns and drivers of water quality signatures. This procedure might be also applicable to river basins other than Mediterranean basins, since it is able to deal with the most commonly encountered problems in the assessment of global change effects on freshwater ecosystems, such as the lack of continuous and long-term data and the ability to deal with different temporal and spatial scales at which changes and responses occur. The work in this thesis was driven by the question of how global environmental change affects the concentration of nutrients in Mediterranean rivers at basin and regional scales. By means of a modeling effort using data collected by water agencies, this work has contributed to the knowledge of the relevant factors that drive nutrient dynamics in Mediterranean rivers, and how these change in time and space. Furthermore, it has clearly shown the potential modeling and time-series analysis offer to river scientists and managers.

7) **Publicaciones:**

Aguilera, R., Livingstone, D. M., Marcé, R., Jennings, E., Piera, J., Adrian, R. (2016). Using dynamic factor analysis to show how sampling resolution and data gaps affect the recognition of patterns in limnological time series. *Inland Waters*, 6 (3): 284-294.

Aguilera, R., Sabater, S., Marcé, R. (2016). A methodological framework for characterizing the spatiotemporal variability of river water-quality patterns using dynamic factor analysis. *Journal of Environmental Informatics*, doi:10.3808/jei.201600333.

Aguilera, R., Marcé, R., Sabater, S. (2015). Detection and attribution of global change effects on river nutrient dynamics in a large Mediterranean basin. *Biogeosciences* 12: 4085–4098.

Aguilera, R., Marcé, R., Sabater, S. (2013). Modeling nutrient retention at the watershed scale: does small stream research apply to the whole river network? *Journal of Geophysical Research-Biogeosciences*, 118: 1-13.

Aguilera, R., Marcé, R., Sabater, S. (2012). Linking in-stream nutrient flux to land use and inter-annual hydrological variability at the watershed scale. *Science of the Total Environment*, 440: 72-81.

Aguilera, R., Sabater, S., Marcé, R. (2012). In-Stream Nutrient Flux and Retention in Relation to Land Use in the Llobregat River Basin. In: *The Llobregat: The Story of a Polluted Mediterranean River*, S. Sabater et al. (eds), *The Handbook of Environmental Chemistry*, 21: 69-92.

AUTORA: Simone Guareschi

TÍTULO DEL TRABAJO: Retos para la conservación de los macroinvertebrados acuáticos y sus hábitats en la península ibérica

DIRECTORES: Andrés Millán, Josefa Velasco, Pedro Abellán

CENTRO DE REALIZACIÓN: Facultad de Biología, Universidad de Murcia

FECHA DE PRESENTACIÓN: 29 enero 2015

This thesis addresses different challenges related to the conservation of freshwater biodiversity in the Iberian Peninsula using aquatic macroinvertebrates as a model system. This information will contribute to a better understanding of the determinants that affect and threaten aquatic macroinvertebrate biodiversity and, aims to provide insights for use in nature conservation policies.

The thesis is structured in four chapters, corresponding to four scientific articles:

Chapter 1. Guareschi S., Gutierrez-Canovas C., Picaza F., Sanchez-Fernandez D., Abellan P., Velasco J., Millan A. (2012). Aquatic macroinvertebrate biodiversity: patterns and surrogates in mountainous Spanish national parks.

Chapter 2. Guareschi S., Abellan P., Laini A., Green A.J., Sanchez-Zapata J.A., Velasco J., Millan A. (2015). Cross-taxon congruence in wetlands: assessing the role of waterbirds as surrogates of macroinvertebrate biodiversity in Mediterranean Ramsar sites.

Chapter 3. Guareschi S., Bilton D., Velasco J., Millan A., Abellan P. How well do protected area networks support taxonomic and functional diversity in non-target taxa? The case of Iberian freshwaters.

Chapter 4. Guareschi S., Coccia C., Sanchez-Fernandez D., Carbonell J.A., Velasco J., Boyero L., Green A.J., Millan A. (2013). How far could the alien boatman *Trichocorixa verticalis verticalis* spread? Worldwide estimation of its current and future potential distribution.

Chapters 1 and 2 focus on the assessment of potential biodiversity surrogates in aquatic ecosystems, while Chapter 3 is dedicated on the effectiveness of protected areas networks in representing freshwater diversity. In Chapter 4, starting from new records of an alien aquatic insect detected in the Iberian Peninsula, global potential distribution maps for this species are produced since the prevention of biological invasions is the most cost-effective way to avoid problems related with nature conservation.

Chapter 1 reveals that mountainous national parks in Spain contain a large percentage of the overall Iberian biodiversity with respect to aquatic macroinvertebrates at family level. Coleoptera family richness displays the highest correlation with the other taxonomic groups and remaining richness values and may be used as a macroinvertebrate biodiversity surrogate in well preserved mountainous areas. Such a taxonomic indicator could be complemented by the use of Odonata family richness in case of standing waters (Fig. 1).

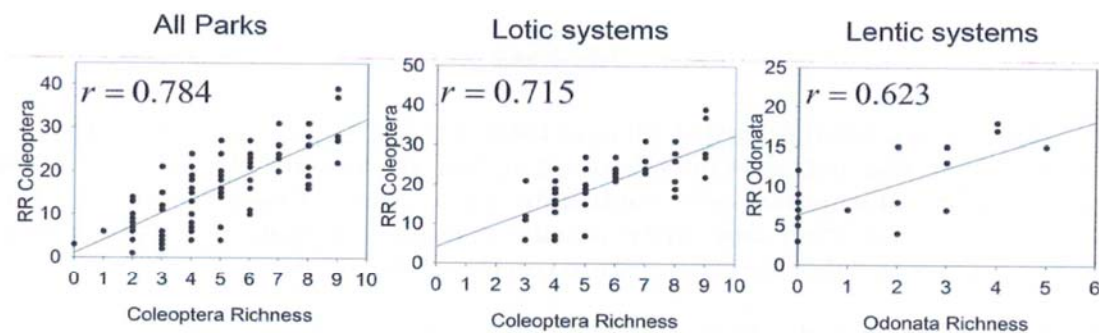


Fig. 1. Relationship between proposed richness surrogates and the remaining richness (RR), i.e., overall richness minus that of the studied group. Spearman correlation values were applied both globally ($p < 0.001$) and separately for lotic ($p < 0.001$) and lentic sites ($p < 0.01$).

Chapter 2 assesses the performance of a charismatic group (waterbirds) as surrogate of macroinvertebrates biodiversity in wetlands. The results show limited concordance between the community composition of waterbirds and macroinvertebrates, and negligible or negative correlations between the metrics of their taxonomic richness (Fig. 2). Contrasting responses to environmental gradients were detected and waterbirds can therefore be considered poor indicators of aquatic biodiversity in these ecosystems.

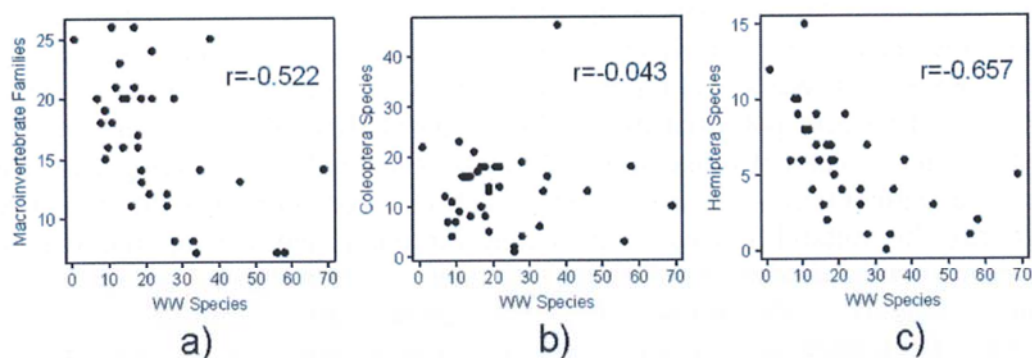


Fig. 2. Scatter plots showing the relationships between the richness of the aquatic invertebrate groups (macroinvertebrate families, Coleoptera species, Hemiptera species) and Winter waterbird species (WW) showing Spearman correlation values. (a) $p < 0.01$; (b) not significant; (c) $p < 0.001$.

Chapter 3 provides the first attempt at assessing the effectiveness of protected areas in representing alpha, beta and gamma components of taxonomic and functional macroinvertebrate diversity at different spatial scales (Iberian Peninsula and 100 km radius windows). The main findings highlight the contrasting performance of reserve systems in the maintenance of taxonomic and functional freshwater diversity (see Table 1), and point to a bias in environmental representation within protected area networks. Importantly, this mismatch means that caution should be exercised when using any one diversity component as a surrogate for others, and emphasizes the importance of adopting an integrative approach to biodiversity conservation in aquatic ecosystems.

Table 1. Representation of taxonomic (n° of species) and functional γ diversity in protected area networks at Iberian scale (protected) and comparison with the values expected from 1,000 random draws of an equal number of grid cells (random, mean value \pm SD). RNAs= National protected area network, N2000= Natura2000 network.

	Protected	Random	<i>p</i> -value
Taxonomic diversity			
RNAs	419	404.2 \pm 8.4	0.04
N2000	458	442.7 \pm 5.9	0.002
Functional diversity			
RNAs	0.283	0.283 \pm 0.002	0.692
N2000	0.284	0.283 \pm 0.001	0.131

The last chapter focuses on *Trichocorixa verticalis verticalis* (Corixidae, Hemiptera, Fig. 3), one of the few exclusively aquatic insects that can be considered as an alien species, and for which large populations have been newly recorded in numerous Ramsar wetlands in Andalusia (south-west Spain). The predictive maps obtained of current potential distribution suggest that this corixid may expand well beyond its current range and find inhabitable conditions in temperate areas across a wide range of latitudes (Fig. 4). When considering a future climatic scenario, the suitability area showed only limited changes compared with the current potential distribution. The results allow the detection of potential contact zones among currently colonized areas and potential areas of invasion, as well as zones with a high level of suitability overlapping areas recognized as global biodiversity hotspots.

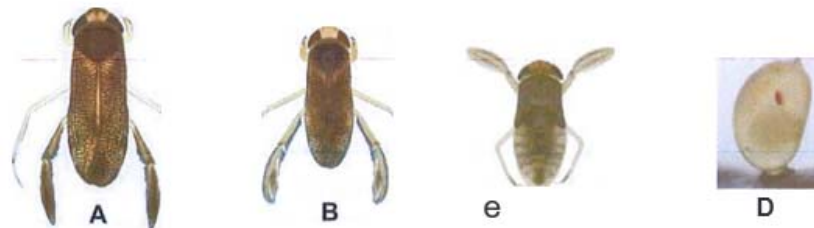


Fig. 3. Different stages of *Trichocorixa verticalis verticalis*: (A) Adult female; (B) Adult male; (C) Nymph and (D) Egg.

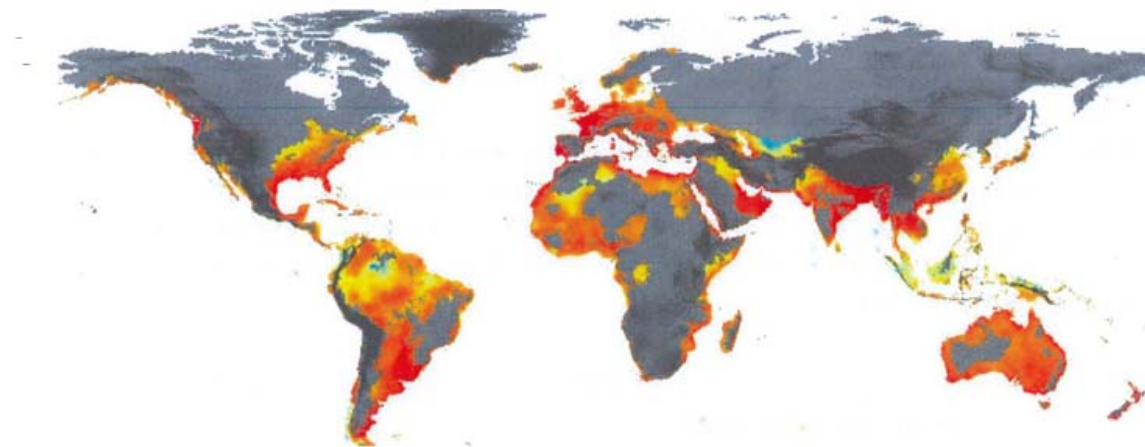


Fig. 4. Climatic suitability within the current potential distribution. Map of worldwide current potential distribution of *Trichocorixa verticalis verticalis*. showing the climatic favorability from red (very high suitability) to light blue (very low suitability).

These results, taken as a whole, point to some of the main challenges for the conservation of aquatic macroinvertebrate biodiversity (biodiversity surrogates, reserve performance and biodiversity threats) and provide useful information about important topics asked of and by protected area managers and conservationists.

AUTOR: Xavier Benito Granell

TÍTULO DEL TRABAJO: Benthic diatoms and foraminifera as indicators of coastal wetland habitats: application to palaeoenvironmental reconstruction in a Mediterranean delta

DIRECTORES: Dres. Manola Brunet India, Rosa Trobajo Pujadas, Carles Ibáñez Martí

FECHA DE PRESENTACIÓN: 15 febrero 2016

Deltas are dynamic ecosystems, where geological processes occur at human scale (50-100 yr), and the interaction between biotic and abiotic factors are intense and complex. Deltas can be considered “natural laboratories” to study changes over historical (millennia) and recent (decades) periods. This information can be then used for proposing management measures to mitigate ongoing and future climate change impacts.

The Ebro Delta (NE Iberian Peninsula) is one of the most ecologically important coastal wetlands of the Western Mediterranean due to its faunal and vegetal biodiversity. In addition, it supports an important economic activity for the regional population by means of rice agriculture, tourism and coastal fisheries. Despite that the ecology of the Ebro Delta has been largely studied since the 1980s, there is a lack of scientific understanding about its natural and human-driven evolution at millennial and decadal-centennial time scales. At millennial time scale, this necessity is also justified by the fact that hypothesis about the Ebro Delta’s origin was exclusively based on personal interpretations from Roman written records, suggesting that the delta plain began its development 2000 yr ago approx. starting from an estuarine coast. An alternative hypothesis was based on geological and cartographic data, and concluded that the Ebro Delta had already an important development 6000 yr ago, and that was coeval with other Mediterranean deltas such as Rhone (France), Nile (Egypt) or Po (Italy). At decadal-centennial time scale, Ebro Delta’s evolution was driven by natural factors mainly associated with changes in the river mouth area. This natural equilibrium was stopped by 19th century, where human colonization transformed the majority of the deltaic habitats (marshes, coastal lagoons) for rice cultivation purposes.

In transitional aquatic ecosystems such as estuaries or tidal wetlands, benthic communities of diatoms (unicellular siliceous algae) and foraminifera (unicellular calcareous protozoa) have been largely studied, yet their use in Mediterranean coastal habitats is limited. Despite the absence of tidal influence, Mediterranean deltas have a diverse array of habitats, ranging from the inner deltaic plain (e.g. fresh and brackish marshes, coastal lagoons, shallow semi-enclosed bays), to the outer deeper prodelta. To identify and characterize the whole range of deltaic habitats using benthic diatoms and foraminifera not only will provide information about their autoecology, but also will determine modern analogues for palaeoenvironmental reconstructions. In addition, the study of diatoms and foraminifera will help to advance in their application as biological indicators to fulfil environmental legislations of habitat restoration and management (e.g. Water Framework Directive).

This thesis combines the study of present, past and future habitats of the Ebro Delta (Figure 1). Different approaches are applied in each of the three temporal scales: i) in the present, the utility of benthic diatoms and foraminifera as ecological indicators of the Ebro Delta habitats, ii) in the past, the use of subfossil, well-preserved benthic foraminiferal assemblages to reconstruct natural (origin and evolution) and human-driven (rice field impacts) changes, and iii) in the future, the potential habitat distribution across the Delta plain assuming a scenario of no human disturbance using statistical models (Generalized Additive Models, GAM) coupled with Geographic Information Systems (GIS).

The results showed that, in the Ebro Delta, the distribution of benthic diatoms and foraminifera is mostly related to environmental gradients of conductivity (as a proxy of salinity), water depth (shallowness), and sediment characteristics (including the proportions of sand and organic matter). From these results, conductivity and water depth were identified as the single environmental variables most structuring diatom and foraminiferal assemblages respectively, and therefore, realistic diatom-based conductivity and foraminifera-based water depth transfer functions could be derived. On the other hand, GAM-based models showed that potential habitat distributions could be predicted by ecogeographical variables (elevation and ‘distances’ predictors). Then, habitat maps were constructed, illustrating where coastal and inland habitats could potentially exist across the whole deltaic plain, to inform future environmental restoration as a function of scenarios of sea level rise and coastal retreat.

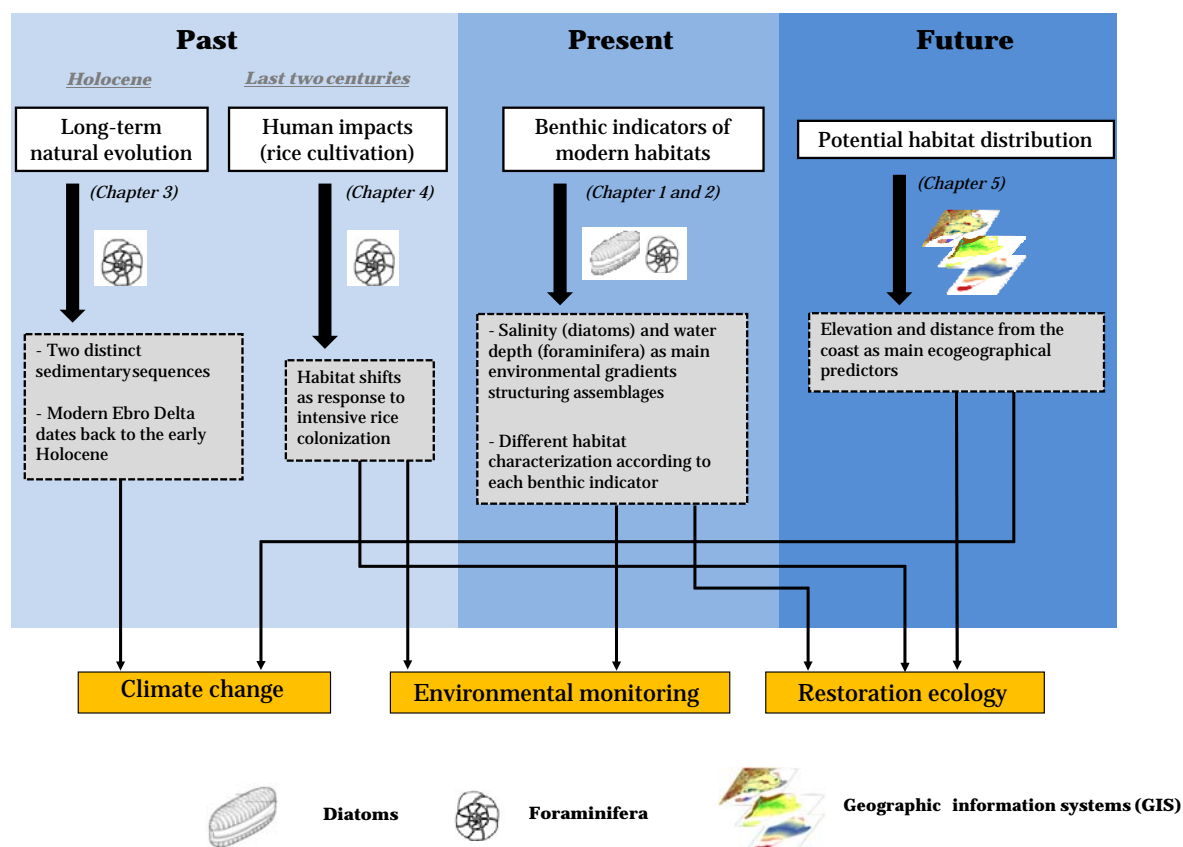


Figure 1 Diagram of the main results derived from the present thesis (grey boxes) with their corresponding elements of analysis (diatoms, foraminifera and GIS). Blue colours indicate the temporal framework that comprise the thesis (past, present and future), and orange boxes indicate the main implications of the results.

Different habitats within the whole range of the Delta environments (i.e. from the deltaic plain to the adjacent marine area) were characterized using diatoms and foraminiferal assemblages. Benthic diatoms identified a total of five habitat types, namely salt marshes, brackish marshes, brackish coastal lagoons and bays, coastal lagoons with fresher conditions, and nearshore open sea. Benthic foraminifera (living and dead assemblages) identified four habitat types: salt and brackish marshes, coastal lagoons and inner bays, nearshore and outer bays, and offshore. For each of the habitat types identified, diatom and foraminiferal indicator species were recognised, which complemented pretty well habitat characterisation obtained using transfer functions (i.e. conductivity and water depth). Dead foraminiferal assemblages which integrate seasonal and post-depositional (taphonomic) effects on the modern assemblages, were found to be similar enough to the living ones to allow the modern assemblages to be used for the interpretation of buried foraminiferal assemblages. Concerning diatoms, unfortunately no well-preserved valves were found in sediments below ca 10 cm depth, so that it was impossible to infer past environmental conditions based on this indicator. Thus, for past reconstructions, the thesis focused on foraminiferal assemblages, which were well preserved (including both agglutinated and calcareous tests) and therefore allowed us to reconstruct palaeoenvironmental changes registered in the Ebro Delta sediments.

With the objective of assessing future habitat changes as function of sea level rise and coastal retreat, the identification of different indicator species (either diatoms or foraminifera) can complement habitat distribution models, since these models were sensitive to elevation and distance from the coast. For instance, the conversion of *Salicornia* marshes into open water will likely come through gradual submergence in low-lying areas of the Ebro Delta (e.g. at the two semi-enclosed bays in Alfacs and Fangar). Then, it is expected a substitution of diatom species from *Salicornia* marshes habitat type (e.g. *Navicymbula pusilla*, *Amphora* sp.1 *Mastogloia braunii*, *Mastogloia aquilegiae* and *Amphora* cf. *roettgeri*) to coastal lagoons habitat type (e.g. *Cocconeis scutellum*, *Achnantes* sp.1, *Seminavis strigosa*, *Cocconeis* cf. *neothumensis* var. *marina*, *Nitzschia pararostrata*) (Figure 2). Likewise, the conversion of rice fields and adjacent fresh-brackish marshes to higher salinity marshes could be result of enhanced subsurface salt intrusion.

The identification of groups of diatom and foraminifera indicator species in the Ebro Delta habitats has provided a complementary and novel approach to the individual species' response to single variables. That is, even if quantitative predictions of conductivity and water depth could be inferred using diatoms and foraminifera, respectively, the habitat type would not be necessarily the same. For instance, for the same range of conductivity (e.g. 30–40 mS/cm), both salt marshes and coastal lagoons could be possible. Instead, groups of diatom indicator species were able to discriminate

between them. Likewise, for the same range of water depth (e.g. 2–3 m), foraminifera indicator species can discriminate between two distinct subtidal habitats (i.e. coastal lagoon, and nearshore/ outer bay habitats).

It is important to bear in mind that the usefulness of one type of indicator or the another (i.e. diatoms, foraminifera), should be assessed by different factors: i) the environmental information gained: diatoms alone discriminated up to five habitat types (i.e. salt marshes, brackish marshes, brackish coastal lagoons and bays, coastal lagoons with fresher conditions, and nearshore open sea), while foraminifera detected four (i.e. salt and brackish marshes, coastal lagoons and bays, nearshore and outer bays, and offshore); ii) the time needed for the analysis of each type of indicator (i.e. the analysis of benthic foraminifera is more-cost effective, with easier taxonomy and less diverse communities than benthic diatoms); and iii) the target environmental variable to be reconstructed (i.e. conductivity or water depth).

A total of seven sedimentary sequences from the Ebro Delta were analysed on the basis of foraminiferal content and sediment proxies (sand content and organic matter): these were obtained from two boreholes and five short cores. The two boreholes (Carlet and Sant Jaume, ca 20 m depth both) were radiocarbon-dated and provided a fine-grained habitat reconstruction. First, it was shown that the Ebro Delta had already undergone a major development in the early Holocene (7500 yr BP), since the Carlet borehole already recorded close modern analogues of deltaic plain habitats (i.e. coastal lagoons) at this time. These findings rejected hypotheses that the Ebro Delta was an estuary prior to the Roman period, as previously suggested by some authors. Second, the Sant Jaume borehole (younger and located nearer the present coastline than Carlet) allowed identification for the first time of a differential progradation of the last three Ebro Delta lobes (Riet Vell, Riet de Zaida and Mijorn), using micropalaeontological evidences, and also placed such lobes in a more accurate chronological framework (Figure 2).

The five shorter sediment cores (ca 80 cm depth) were also dated via a ²¹⁰Pb-based chronology. The down-core foraminiferal assemblages revealed clear habitat shifts during the last 150 years, as a result of the introduction of intensive rice cultivation in the Ebro Delta. The foraminiferal record showed a replacement of calcareous-dominated assemblages by agglutinated-dominated ones, this change being significantly correlated with the increase of sediment organic matter due to inputs of agricultural runoff. Overall, the identification of these habitat changes provides a management tool not only for assessing baseline environmental conditions but also for habitat restoration in the context of ongoing climate change impacts in the Ebro Delta (i.e. sea level rise, sediment deficit).

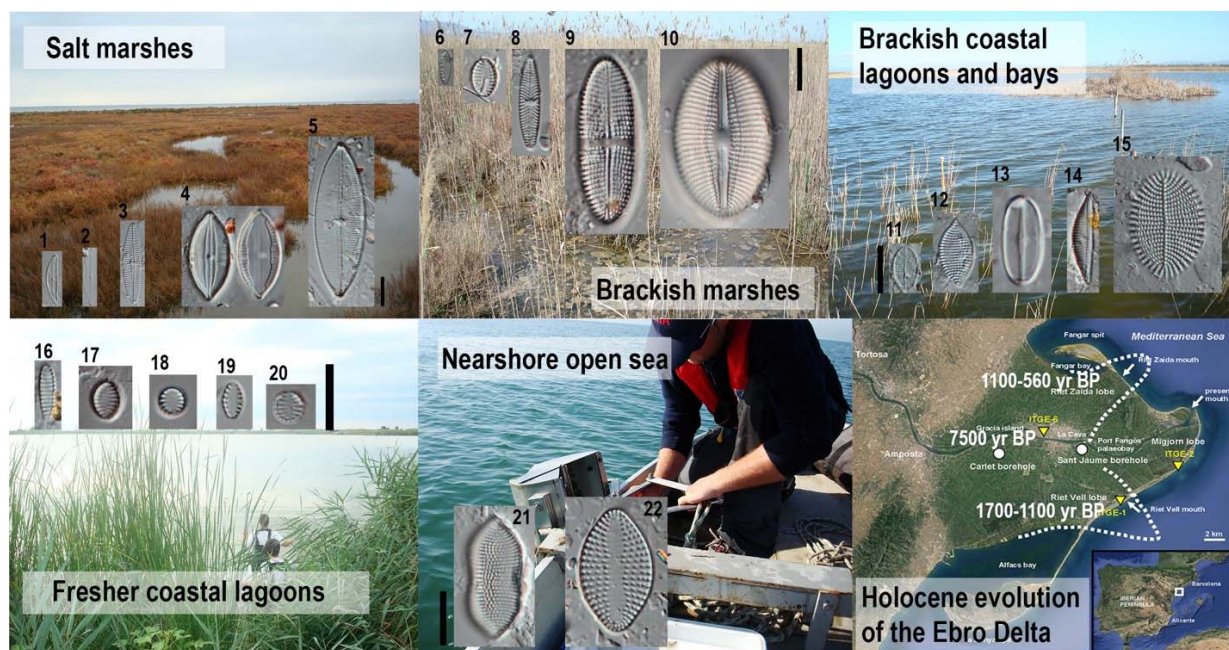


Figure 2 Habitats identified according to diatom composition and abundance in the Ebro Delta samples, and Holocene (last ca 8000 years) evolution of the Ebro Delta as reconstructed from micropaleontological record. Some of the diatom indicator species are illustrated: 1) *Amphora* sp. 1, 2) *Amphora* cf. *roettgeri*, 3) *Navicymbula pusilla*, 4) *Mastogloia braunii*, 5) *Mastogloia aquilegiae*, 6) *Nitzschia inconspicua*, 7) *Fragilaria* cf. *neoeffelliptica*, 8) *Navicula microcari*, 9) *Achnanthes brevipes* var. *intermedia*, 10) *Diploneis smithii*, 11) *Cocconeis* cf. *neothumensis* var. *marina*, 12) *Nitzschia pararostrata*, 13) *Achnanthes* sp. 1, 14) *Seminavis strigosa*, 15) *Cocconeis scutellum*, 16) *Fragilaria gedanensis*, 17) *Fragilaria* cf. *elliptica*, 18) cf. *Fragilaria* sp. 2, 19) cf. *Fragilaria* sp. 1, 20) *Fragilaria* cf. *sopotensis*, 21) *Delphineis sirella*, 22) *Nitzschia coarctata*. Scale bar represents 10 μ m.

Libros y otras publicaciones



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