

IX Congrés Ibèric de Gestió
i Planificació de l'Aigua

IX Congreso Ibérico de Gestión
y Planificación del Agua

IX Congresso Ibérico de Gestão
e Planeamento da Água

Aigua, ciutat i salut dels ecosistemes:
Integrar perspectives, proposar solucions.

Agua, ciudad y salud de los ecosistemas:
Integrando perspectivas, proponiendo soluciones.

Água, cidade e saúde dos ecossistemas:
Integrando perspetivas, propondo soluções.

València, 7-9 setembre 2016
Universitat de València
Campus dels Tarongers

LLIBRE D'ACTES
LIBRO DE ACTAS
LIVRO DE ATAS

FUNDACIÓN NUEVA CULTURA DEL AGUA (Editor)



PONÈNCIES

<i>Bau, J.:</i> POLÍTICAS DE PRIVATIZAÇÃO DO ABASTECIMENTO DE ÁGUA NO CONTEXTO DE UMA EUROPA EM CRISE	12
<i>Egea Fernández, J.M.; Egea Sánchez, J.M.:</i> AGRICULTURA DE PROXIMIDAD, AGROECOLOGÍA Y SOSTENIBILIDAD: EL PAPEL DE LOS REGADÍOS TRADICIONALES	33
<i>Sales Martínez, V.:</i> USOS DEL AGUA EN ESPACIOS AGRARIOS PERIURBANOS: LAS HUERTAS AL NORTE DE LA CIUDAD DE VALENCIA	44
<i>Ribeiro, L.:</i> EL LEGADO DE LAS ANTIGUAS CIVILIZACIONES AMERÍNDIAS EN EL PATRIMÓNIO CULTURAL DEL AGUA	54
<i>Perales-Momparler, S.; Andrés-Doménech, I.:</i> RETOS PARA LA INTEGRACIÓN DE LOS SISTEMAS DE DRENAJE SOSTENIBLE EN LOS PROCESOS DE PLANIFICACIÓN VIGENTES.....	61
<i>Borrás Calvo, G.:</i> AGUA, AGRICULTURA, BOSCOS I CANVI CLIMÀTIC (*)	79

COMUNICACIONES

Àrea temàtica 1: Aigua, model de gestió i democràcia

<i>Alini Meier, M.; Silva Costa, F.; Barros, D.; Basso, L.A.:</i> A PARTICIPAÇÃO PÚBLICA NO PROGRAMA DE MEDIDAS DA REGIÃO HIDROGRÁFICA DO DOURO/PORTUGAL: ALGUNS RESULTADOS RELATIVOS AO PRIMEIRO CICLO DE PLANEAMENTO.....	90
<i>Bagué Tova, E.:</i> HACIA UNA CULTURA Y GESTIÓN DEMOCRÁTICA DEL AGUA; LA MUNICIPALIZACIÓN DEL ABASTO DE AGUA EN TERRASSA, CATALUNYA, ESPAÑA.....	99
<i>Cabello Villarejo, V.; Flores Baquero, O.; Lara García, A.; del Moral Ituarte, L.; Vargas Molina, J.; Paneque Salgado, P.; de la Lastra Valdor, I.:</i> ¿QUÉ FIRMAN CUANDO DICEN PACTO SOCIAL POR EL AGUA PÚBLICA? IMPLICACIONES CONCEPTUALES PARA EL SEGUIMIENTO A SU IMPLEMENTACIÓN.....	108
<i>Carrinho, M.:</i> ÁGUAS DO RIBATEJO: UM CASO DE SUCESSO EM PORTUGAL NA GESTÃO INTERMUNICIPAL DOS SERVIÇOS DE ÁGUA.....	122
<i>Francés Silva, A.:</i> EL PLAN DE ACCIÓN TERRITORIAL DE ABASTECIMIENTO DE AGUA EN LA RESERVA DE LA BIOSFERA DE URDAIBAI: UNA PROPUESTA DESDE LA GESTIÓN INTEGRADA	133
<i>García Lucea, J.:</i> ESTRATEGIAS PARA LA GESTIÓN EFICIENTE DEL AGUA EN LAS CIUDADES. EL CASO DE ZARAGOZA.....	145
<i>Gómez Sellés, E.; Corbacho, R.; Cabrera Marcet, E.:</i> DERECHO HUMANO AL AGUA Y PRINCIPIO DE RECUPERACIÓN DE COSTES, PILARES CLAVE Y COMPATIBLES DE LA GESTIÓN DEL AGUA URBANA. .	157
<i>Henriques, C.; Neto, S.:</i> A CIDADE HÍBRIDA PARA UM NOVO ENQUADRAMENTO DA GESTÃO DO CICLO URBANO DA ÁGUA	169
<i>Hernández-Mora, N.; Cabello, V.; De Stefano, L.; Del Moral, L.:</i> REDES CIUDADANAS POR UNA NUEVA CULTURA DEL AGUA: POTENCIAL DE TRANSFORMACIÓN DE LAS ESTRUCTURAS DE PODER EXISTENTES EN LA GESTIÓN DEL AGUA.....	177

<i>Jiménez García, A.:</i> LA GESTIÓN SUPRAMUNICIPAL DEL CICLO URBANO DEL AGUA EN PEQUEÑAS POBLACIONES.....	197
<i>Kleiman, M.:</i> ACESSO AO ABASTECIMENTO POR REDES DE ÁGUA POTÁVEL EM FAVELAS DO RIO DE JANEIRO: LIMITES E PROBLEMAS QUANTO À EQUIDADE SOCIAL.....	205
<i>Lapuente Ojeda, E.:</i> LA POLÍTICA TARIFARIA EN EL RECIBO DOMÉSTICO DEL AGUA. CASO ESTUDIADO: LA COMUNIDAD VALENCIANA	213
<i>Lara García, Á.; Otero Monrosi, L.; del Moral, L.:</i> GESTIÓN PARTICIPATIVA DEL CICLO URBANO DEL AGUA EN LA REHABILITACIÓN DE BARRIADAS. APLICACIÓN A LA BARRIADA DE LAS HUERTAS (SEVILLA).....	230
<i>Lazo Ruíz, J.N.; Ibáñez Hernández, O.F.:</i> LO QUE FALTA PARA QUE SE CUMPLA EL DERECHO HUMANO AL AGUA EN MÉXICO.....	243
<i>Mondragón, J.; Juaristi, P; Elizondo, A.; Mokoroa, J.L.; de la Peña, A.:</i> RELACIONES INTERGUBERNAMENTALES EN LA POLÍTICA DEL AGUA: LA INTERACCIÓN ENTRE LAS COMUNIDADES AUTÓNOMAS Y LA ADMINISTRACIÓN GENERAL DEL ESTADO EN LA GESTIÓN DE LA PLANIFICACIÓN HIDROLÓGICA.....	253
<i>Paneque Salgado, P.; Lafuente Fernández, R.; Vargas Molina, J.; Rodríguez Díaz, V.:</i> APOYO SOCIAL A DISTINTAS ALTERNATIVAS DE GESTIÓN DEL AGUA EN ANDALUCÍA (2004-2013)	266
<i>Pérez Lázaro, R.:</i> BASES PARA UN MODELO GESTIÓN PÚBLICA E INTEGRADA DEL AGUA EN LA RESERVA DE LA BIOSFERA DE URDAIBAI	278
<i>Rica Izquierdo, M.; López Gunn, E.; Villarroya, F.:</i> ¿QUIÉN GOBIERNA EL AGUA SUBTERRÁNEA? LA ACCIÓN COLECTIVA EN EL USO DE AGUAS SUBTERRÁNEAS EN ESPAÑA: EXPERIENCIAS, LOGROS Y RETOS	290
<i>Sánchez Jiménez, E.H.; Cubillo González, F.:</i> SMART WATER CITY: LA VISIÓN DE SMART CITY DE CANAL GESTIÓN PARA EL CICLO DEL AGUA EN LA COMUNIDAD DE MADRID.....	301
<i>Thierschmann T.:</i> PUBLIC PARTICIPATION IN URBAN WATER MANANGEMENT OF BERLIN.....	311
<i>Zucco Soares, E.; Silva da Costa, F.:</i> UMA AVALIAÇÃO SOBRE A EXECUÇÃO DO PROGRAMA DE MEDIDAS DO PLANO DE GESTÃO DE REGIÃO HIDROGRÁFICA DO RIO DOURO	319

Àrea temàtica 2: Ciutat i territori rural: interdependències

<i>Banos González, I.; Martínez Fernández, J.; Esteve Selma, M.A.:</i> EL MODELO DINÁMICO DE LA HUERTA DE MURCIA: TENDENCIAS PREVISTAS Y VERIFICACIÓN CON DATOS RECIENTES	330
<i>Beltrán, M.J.; Fernández, S.:</i> CRITICAL ANALYSIS OF THE "RICE AREA MODERNIZATION PROYECT" OF DOÑANA MARSHES, SOUTHERN SPAIN	341
<i>Conde Campos, O.:</i> RECUPERAR LA HUERTA DE ZARAGOZA PARA ABASTECER A LA CIUDAD. EL PROYECTO HUERTAS LIFE KM 0.....	358
<i>Cueva Navia, T.; González, B.B.; Hurtado, E.A.; Mestre Sanchis, F.:</i> PRODUCCIÓN PORCINA: SISTEMA DE CAMA PROFUNDA UNA ALTERNATIVA RESILIENTE EN EL USO DE AGUA ANTE EL CAMBIO CLIMÁTICO.....	366

<i>González Castrillón, E.; Velásquez Sanin, J.D.:</i> LOS BIENES Y SERVICIOS AMBIENTALES EN LAS RELACIONES. URBANO RURALES.....	376
<i>Macías Rodríguez, D.; del Espino Hidalgo, B.; Pérez Cano, M.T.:</i> LAS RELACIONES CAMPO-CIUDAD EN LAS CIUDADES MEDIAS DE ANDALUCÍA: EL AGUA EN LA CIUDAD DE PUENTE GENIL.....	387
<i>Soler Giménez, M.A.; Mauri de los Ríos, J.; Monferrer Ariete, C.:</i> REC COMTAL. UN ANTIGUO RECURSO CON NUEVOS USOS.....	398
<i>Paladini San Martín, B.; Benjelloun, I.:</i> HACIA EL METABOLISMO ECOSOCIAL DEL FUTURO: NEOAGRARIO-RECUPERADOR. CASOS PIONEROS Y PROPUESTAS DE ORDENACIÓN.....	410
<i>Ricart Casadevall, S.; Roset Pagès, D.; Ribas Palom, A.; Pavón Gamero, D.:</i> PUESTA EN VALOR DEL PATRIMONIO VINCULADO A LOS REGADÍOS HISTÓRICOS DEL BAJO TER.....	419
<i>Rivero Camacho, C.; Solís Guzmán, J.; Marrero M.:</i> HUELLA HÍDRICA EN EL CICLO DE VIDA DE EDIFICIOS RESIDENCIALES. ETAPAS DE URBANIZACIÓN Y CONSTRUCCIÓN	428
<i>Sampedro Sánchez, D.:</i> ESCENARIOS TRAS LA MODERNIZACIÓN. INTENSIFICACIÓN Y NUEVOS PAISAJES DE REGADÍO EN EL GUADALQUIVIR.....	441
<i>Tijero de las Heras, D.:</i> HUERTOS URBANOS Y GESTIÓN PARTICIPATIVA PARA EL CIERRE DE CICLOS ECOLÓGICOS EN EL BARRIO DE SAN INAZIO (BILBAO).....	449

Àrea temàtica 3: L'aigua i els rius a l'entorn urbà

<i>Amorena, A.; Arregui, C.; Fermín Costero, J.; Inarrea, K.; Jaso, C.; Rives, L.:</i> HACIA UNA GESTIÓN INTEGRAL DE LOS PARQUES FLUVIALES URBANOS Y PERIURBANOS EN LA COMARCA DE PAMPLONA/IRUÑERRIA	461
<i>Anastasia, C.:</i> TRES TRAMOS, TRES CANALES, UN RÍO: EL CURSO BAJO DEL TER (CATALUÑA).....	469
<i>Ballester Ciuró, A.; Parés Franzi, M.; Fernández Plé, C.:</i> EVALUACIÓN DE CAPACIDADES SOCIALES FRENTE AL RIESGO DE INUNDACIÓN.....	484
<i>Costa, F.; Troleis, A.; Zucco Soares, E.:</i> O PROGRAMA DE MEDIDAS NO PLANEAMENTO E GESTÃO DO ABASTECIMENTO DE ÁGUA DA REGIÃO HIDROGRÁFICA 2 (CÁVADO/AVE/LEÇA).....	502
<i>Cuello Gijón, A.:</i> RÍOS DE APRENDIZAJE, UN PROGRAMA DE EDUCACIÓN AMBIENTAL PARA EL CONOCIMIENTO DE LOS RÍOS GADITANOS.....	513
<i>De la Lastra Valdor, I.; Barrionuevo Ferrer, A.; Delgado López, C.:</i> LA DINAMIZACIÓN SOCIAL DE LOS EMBALSES COMO LUGARES PÚBLICOS DEL TERRITORIO. UNA CUESTIÓN PENDIENTE. LOS EMBALSES DE MINILLA Y GERGA EN SEVILLA	525
<i>Andrés-Doménech, I.; Escuder Bueno, I.; Mañá Bonfill, M.; Comes Gracia, M.:</i> LOS SISTEMAS DE DRENAJE SOSTENIBLE COMO SOLUCIÓN EFICAZ A PROBLEMAS DE CALIDAD DE AGUA EN NUESTROS CAUCES.....	539
<i>Fornell Muñoz, A.:</i> USO Y GESTIÓN DE LAS LAGUNAS EN LAS CIUDADES ROMANAS. ALGUNOS EJEMPLOS BÉTICOS	551
<i>García, X.; Benages, M.; Vall, P.; Pavón, D.; Ribas, A.:</i> PUBLIC PARTICIPATION GIS FOR ASSESSING SOCIAL VALUES IN URBAN STREAMS	562

<i>González Rojas, D.</i> : PLANIFICACIÓN HIDROLÓGICA Y RÍOS EN ENTORNOS URBANOS. EL CASO DE ANDALUCÍA.....	576
<i>Guillén, J.; Simarro, G.; Coral, A.</i> : LAS PLAYAS DE LA CIUDAD DE BARCELONA (2001-2015): EL DIFÍCIL EQUILIBRIO ENTRE SU GESTIÓN Y LOS PROCESOS MORFODINÁMICOS.....	590
<i>Gutiérrez Caiza, C., Andrés-Doménech, I.; Sánchez Brito, H.</i> : SIMULACIÓN HIDROLÓGICA DE LA CUENCA DEL RÍO ALAMBI EN NANEGAL (ECUADOR), FRENTE AL CAMBIO DE USO DEL SUELO Y SU IMPACTO EN EL RECURSO HÍDRICO	600
<i>Jiménez Puig, P.; Herrera-Grao, T.</i> : ANÁLISIS CRÍTICO Y COMPARATIVO DEL PRIMER CICLO DE LOS PLANES DE GESTIÓN DEL RIESGO DE INUNDACIÓN EN ESPAÑA	613
<i>Jiménez, S.; Estrela, T.; Fidalgo, A.; Nardini, A.; Jormola, J.; Ortega, T.</i> : LA RESTAURACIÓN FLUVIAL EN EL PLAN HIDROLÓGICO DEL JÚCAR. COLABORACIÓN CON EXPERTOS INTERNACIONALES PARA ASEGURAR LA CONTRIBUCIÓN DE ESTAS MEDIDAS A LA IMPLEMENTACIÓN DE LA DMA.....	625
<i>Ladrera, R.; Prat, N.</i> : LAS POLÍTICAS EUROPEAS Y EL CONSENSO CIENTÍFICO EN MATERIA DE GESTIÓN Y CONSERVACIÓN DE AGUAS NO LLEGAN A LA ESCUELA	637
<i>Martínez Morlanes, M.P.</i> : SEGUIMIENTO DE PROYECTOS DE RESTAURACIÓN FLUVIAL.....	649
<i>Pérez Martín, C.; García Balaguer, E.; Sanz Azcárete, L.; Vizcay Urrutia, N.</i> : CAMBIO DE LA PERCEPCIÓN SOCIAL DE LOS RÍOS EN LOS TRAMOS BAJOS DEL ARGA Y ARAGÓN (NAVARRA)	666
<i>Piñeiro Rebolo, R.; Horario, J.; Álvarez-Campana Gallo, J.M.</i> : LA REHABILITACIÓN FLUVIAL EN EL ÁMBITO URBANO. ESTUDIO DE CASO: EL RÍO SAR (GALICIA, NO PENÍNSULA IBÉRICA).....	677
<i>Portugués Mollá, I.</i> : PROYECTO Y REALIDAD DEL JARDÍ DEL TÚRIA (VALENCIA), TREINTA AÑOS DESPUÉS	690
<i>Rieradevall, M.; Fortuño, P.; Ladrera, R.; Bonada, N.; Verkaik, I.; Becerra, M.; Menéndez, S.; Prat, N.</i> : LA APLICACIÓN RIU.NET: CIENCIA Y CONCIENCIACIÓN CIUDADANA AL ALCANCE DE TODOS.....	701
<i>Rodríguez Rojas, M.I.; Huertas-Fernández, F.; Moreno Escobar, B.; Martínez Montes, G.; Muñoz Ubiña, A.; Requena Álvarez, F.</i> : SISTEMAS URBANOS DE DRENAJE SOSTENIBLE. UNA EXPERIENCIA PILOTO EN GRANADA	710
<i>Santassusagna Riu, A.; Tort Donada, J.</i> : LA TRANSFORMACIÓN RECIENTE DE LOS ESPACIOS URBANOFLUVIALES Y SU REGENERACIÓN COMO OPERACIÓN DE ÉXITO. EL CASO DE SANT ADRIÀ DE BESÒS	722

Àrea temàtica 4: Ecosistemes i cicle urbà de l'aigua

<i>Alcácer Santos, C.; Rodríguez García, S.; Sáenz Albanes, A.J.; Salas Rodríguez, J.J.</i> : SWIRL: UN LABORATORIO VIRTUAL PARA LA MEJORA DE LA GESTIÓN DE LOS RECURSOS HÍDRICOS	733
<i>Baeza Sanz, D.; Arrojo Agudo, P.</i> : EL PROYECTO PRESA DE MULARROYA, SU INVIABILIDAD BASADA EN EL ANÁLISIS HIDROLÓGICO Y ECONÓMICO.....	743
<i>Baeza Sanz, D.; Atienza Pertusa, I.; Rodríguez, I.</i> : RELACIÓN ENTRE LAS ACCIONES PROPUESTAS EN EL PLAN DEL DUERO Y LOS ESPACIOS RED NATURA.....	752
<i>Baeza Sanz, D.; Ragel Bernal, M.J.; Moura, B.</i> : OBRAS HIDRÁULICAS Y DIRECTIVA MARCO DE AGUA: ANÁLISIS DE CASOS Y PERSPECTIVAS	765

<i>Banos-González, I.; Martínez Fernández, J.; Esteve Selma, M.A.</i> : THE ASSESSMENT OF THE WATER-ENERGY BINOMIAL ON ARID ISLANDS.....	773
<i>Borrego-Marín, M.M.; Riesgo-Álvarez, L.</i> : MEASURING THE SUSTAINABILITY OF WATER PLANS IN SPAIN	782
<i>Bravo Bustamente, A.; Simba Ochoa, L.; Cadme Arévalo, M.; González Ozorio, B.B.; Mestre, F.; Zambrano, C.E.; Vivas Moreira, R.</i> : AFECTACION DE LA CALIDAD DEL AGUA DEL RIO VINCES POR ACTIVIDADES ANTROPOGÉNICAS.....	794
<i>Britto, A.L.; Oliveira Barbosa, P.S.; O. da Silva, C.H.</i> : PLANEJAMENTO URBANO E AMBIENTAL NA BACIA HIDROGRÁFICA DE JACAREPAGUÁ NO MUNICÍPIO DO RIO DE JANEIRO: UMA ANÁLISE NA PERSPECTIVA DO PLANEJAMENTO SENSÍVEL À ÁGUA.....	803
<i>Condesso de Melo, M.T.; Ribeiro, L.</i> : LA IMPORTANCIA DE DISTINGUIR ENTRE CONTAMINACIÓN ANTROPOGÉNICA Y ORIGEN NATURAL EN LAS AGUAS SUBTERRÁNEAS.....	814
<i>Cubillo, F.; Martínez-Codina, Á.</i> : CÓMO ENFRENTARSE A LOS CAMBIOS Y MEDIR LA RESILIENCIA DE UN SISTEMA DE ABASTECIMIENTO DE AGUA	824
<i>Del Moral Ituarte, I.; Cabello Villarejo, V.; de la Lastra Valdor, I.; Flores Baquero, Ó.; Lara García, Á.; Paneque Salgado, P.; Vargas Molina, J.</i> : MEGAPROYECTOS Y ESTRATEGIAS ALTERNATIVAS PARA EL CICLO URBANO DEL AGUA: EL CASO DEL SISTEMA DE ABASTECIMIENTO DE SEVILLA.....	838
<i>Díez López, J.; Barrutia Sarasua, O.; Ruíz González, A.; Zuazagoitia Rey-Baltar, D.</i> : EL CICLO URBANO DEL AGUA. CONOCIMIENTO, PRINCIPALES ERRORES CONCEPTUALES Y RETOS PARA UNA NUEVA CULTURA DEL AGUA	852
<i>Gómez Goiri, M.</i> : RESUMEN DEL DIAGNÓSTICO DE LA ADAPTACIÓN AL CAMBIO CLIMÁTICO EN LA PROVINCIA DE AZURDUY (BOLIVIA)	862
<i>González García, M.; Fernández-López, C.; Pedrero Stefan Trapp, F.</i> : ESTUDIO DE LA PRESENCIA DE CONTAMINANTES EMERGENTES EN AGUAS REGENERADAS PROCEDENTES DE UNA EDAR DESTINADAS AL RIEGO DE CULTIVOS HORTÍCOLAS BAJO INVERNADERO	873
<i>Jordá-Capdevila, D.; Rodríguez-Labajos, B.</i> : UNA EVALUACIÓN DE LOS SERVICIOS ECOSISTÉMICOS EN CINCO PASOS PARA INFORMAR SOBRE LA GESTIÓN CONFLICTIVA DE CAUDALES: EL CASO DEL RÍO TER.....	881
<i>Ladrera, R.; Gomà, J.; Rieradevall, M.; Prat, N.</i> : DIDYMOSPHEMIA GEMINATA: NUEVA ALGA INVASORA EN RÍOS DE MONTAÑA FAVORECIDA POR EMBALSES PARA REGADÍO Y ABASTECIMIENTO DE ZONAS URBANAS.....	885
<i>Lafuente Fernández, R.; Paneque Salgado, P.; Vargas Molina, J.</i> : LA CONFIANZA INSTITUCIONAL COMO FACTOR EXPLICATIVO DEL APOYO A DISTINTOS MODELOS DE GESTIÓN DEL AGUA.....	896
<i>Lara García, Á.; Otero Monrosi, L.; del Moral, L.</i> : AQUARIBA: GUÍA PARA LA INCORPORACIÓN DE LA GESTIÓN SOSTENIBLE DEL AGUA EN ÁREAS URBANAS. APLICACIÓN A LA REHABILITACIÓN DE BARRIADAS EN ANDALUCÍA	908
<i>Martín Monerris, M.; Guillem Avivar, A.; Regidor Perona, M.C.; Ferruses, F.J.; Hernández-Crespo, C.; Lassalle, M.; Vera García, P.</i> : INFRAESTRUCTURAS VERDES EN EL CICLO DEL AGUA. OPORTUNIDADES EN UN CONTEXTO DE ESCASEZ HÍDRICA.....	921

<i>Martínez Fernández, J.; Banos-González, I., Esteve Selma, M.A.; Carrión-Tacuri, J.:</i> IDIS: UNA METODOLOGÍA DE DEFINICIÓN DE INDICADORES DE SOSTENIBILIDAD DEL AGUA. APLICACIÓN AL CASO DE LAS ISLAS GALÁPAGOS	933
<i>Martínez-Paz, J.; Pellicer-Martínez, F.; Perni, Á.; Dios-Palomares, R.:</i> EVALUACIÓN DE LA SOSTENIBILIDAD EN LA GESTIÓN DEL AGUA A NIVEL DE CUENCA	946
<i>Moltó Linares, J.; Silvestre Jover, J.; Llorens Berenguer, J.:</i> L'AQUÍFER DEL MOLINAR EN PERILL: QUAN ELS INTERESSOS ESPECULATIUS PASSEN PER DAMUNT DEL PRINCIPI DE PRECAUCIÓ	958
<i>Moya Sánchez, N.; Navarro Sánchez, F.J.; Gadea Gadea, A.:</i> IGNIS FUNGUS: OBTENCIÓN DE LODOS DE EDAR DE ALTO PODER CALORÍFICO MEDIANTE ENRIQUECIMIENTO DE HONGOS OLEAGINOSOS	968
<i>Moya Sánchez, N.; Nevado Santos, S., Serna Box, T.R.; Sánchez Sánchez, E.:</i> LIFE SIAMEC: SISTEMA ANAEROBIO INTEGRADO PARA EL TRATAMIENTO A TEMPERATURA AMBIENTE DE AGUAS RESIDUALES EN CLIMAS EUROPEOS.....	979
<i>Neyra Souplet, R.; Alvarado Carrasco, N.:</i> AMAZONIA EN PELIGRO: MINERAS, PETROLERAS Y MEGAREPRESAS	988
<i>Pellicer Martínez, F.; Martínez-Paz, J.; Gallego-Conesa, C.; Colino, J.:</i> CONTABILIDAD DE LA HUELLA HÍDRICA DEL AGUA DESALADA.....	996
<i>Peñas Sánchez, V.; González Castrillón, E.:</i> LA REALIDAD POLIÉDRICA DE LA SOSTENIBILIDAD DEL MEDIO HÍDRICO BAJO LA CONVERGENCIA DE CINCO NOCIONES: EFICACIA, EFICIENCIA, EQUIDAD, AHORRO Y CONSERVACIÓN.....	1007
<i>Pla, E.; Borràs, G.; Pascual, D.; Savé, R.; Vicente-Serrano, S.; Zabalza, J.:</i> IMPACTS OF CLIMATE AND LAND USE CHANGE ON HISTORICAL STREAMFLOW IN THREE HEADWATERS IN CATALONIA	1020
<i>Salat, J.; Pascual, J.; Borràs, G.:</i> CANVI CLIMÀTIC, CANVI GLOBAL I METEOROLOGIA LOCAL: EL CAS DE LA CONCA DE LA MUGA (CONQUES INTERNES DE CATALUNYA).....	1030
<i>Sánchez Plaza, A.; Broekman, A.:</i> BEWATER: SOCIETY ADAPTING TO GLOBAL CHANGE.....	1042
<i>Sastre Merlín, A.; Pérez Martínez, S., Bienes Allas, R., Zalacáin Domench, D.:</i> SEGUIMIENTO DE LOS EFECTOS DEL RIEGO CON AGUA REGENERADA EN VARIOS PARQUES DE LA CIUDAD DE MADRID .	1052
<i>Sesma Martín, D.; Rubio Varas, M.M.:</i> THE WATER-ENERGY CHALLENGE: A FIRST APPROACH TO THE NUCLEAR WATER FOOTPRINT IN SPAIN	1064
<i>Soria, J.M.; Jover, M.:</i> LA EUTROFIZACIÓN DE LA ALBUFERA DE VALENCIA COMO CONSECUENCIA DE LA CALIDAD DE LAS APORTACIONES: 30 AÑOS DE SEGUIMIENTO	1076
<i>Soria, X.; Vicente, E.; Ferriol, C.; Soria, J.M.:</i> EVOLUCIÓ DE LA EUTRÒFIA ALS EMBASSAMENTS DE LA CONCA DE L'EBRE DESTINATS A L'ABASTIMENT DE POBLACIONS: 25 ANYS D'ESTUDIS	1084
<i>Soriano Martínez, L.:</i> INDICADORES DE SOSTENIBILIDAD DE LA GESTIÓN INTEGRAL DE LAS AGUAS DE LLUVIA EN ENTORNOS URBANOS. APLICACIÓN A LA CIUDAD DE ZARAGOZA.....	1092
<i>Vargas Molina, J.; Paneque Salgado, L.:</i> PROPUESTA METODOLÓGICA PARA LA EVALUACIÓN DE LA VULNERABILIDAD AL RIESGO DE SEQUÍA A ESCALA DE DEMARCACIÓN HIDROGRÁFICA	1105

<i>Vera, P.; González, P.; Martín, M.; Rodrigo, M.A.; Benedito, V.; Saccó, M.; Guillem, A.; Moreno, L.; Regidor, M.C.; Juan F.:</i> HUMEDALES ARTIFICIALES: HERRAMIENTAS PARA LA MEJORA DEL ESTADO DE CONSERVACIÓN DE LA AVIFAUNA DE L'ALBUFERA DE VALENCIA MEDIANTE LA MEJORA DE LA CALIDAD DEL AGUA	1118
<i>Vila, M.; Berdalet, E.; Viure, L., Alechaga, È.; Àlvarez, J., Arasa, R.; Biel, L.; Caixach, J.; Domingo-Dalmau, A.; Estrada, M.; Farràs, J.; Hernández-Llamas, S.; Isern-Fontanet, J.; Lacorte, S.; Moyano, S.; Placios, Ó.; Sánchez, J.; Abós-Herràndiz, R.:</i> THE MICROALGAE <i>Ostreopsis cf. ovata</i> BLOOMING IN NW MEDITERRANEAN COASTAL AREAS: A MULTIDISCIPLINARY APPROACH TO UNDERSTAND THEIR IMPACTS ON HUMAN HEALTH	1130
<i>Villarín Clavería, M.C.:</i> MODELADO LINEAL PARA EL ANÁLISIS DE LOS FACTORES EXPLICATIVOS DEL CONSUMO DOMÉSTICO DE AGUA. APLICACIÓN PRÁCTICA EN EL MUNICIPIO DE SEVILLA.....	1141
<i>Villarín Clavería, M.C.; Rodríguez Galiano, V.:</i> LA INTELIGENCIA ARTIFICIAL COMO HERRAMIENTA PARA EL MODELADO DE LA DEMANDA DE AGUA: APLICACIÓN DE ÁRBOLES DE REGRESIÓN AL CASO DE LA CIUDAD DE SEVILLA	1149

PÒSTERS

Àrea temàtica 1: Aigua, model de gestió i democràcia

<i>Moreno L.; Lassalle, M.; Ribera, L.; López, E.; Martín, M.; Hernández-Crespo, C.; Regidor, M.; Juan, F.; Guillem, A.; Vera, P.; Giménez, M.:</i> COMUNICACIÓN Y PARTICIPACIÓN EN HUMEDALES ARTIFICIALES: LA EXPERIENCIA DEL LIFE+ALBUFERA.....	1158
<i>Sindicatos europeos de Servicios Públicos (FSESP):</i> INICIATIVA CIUDADANA EUROPEA: EL DERECHO AL AGUA Y EL SANEAMIENTO COMO DERECHO HUMANO.....	1159

Àrea temàtica 4: Ecosistemes i cicle urbà de l'aigua

<i>Calvo S.; Flor, J.; Pérez, J.; Soria, J.; Romo, S.:</i> LA INFLUENCIA DE LAS AVENIDAS DE AGUA EN EL ESTADO DE LA ALBUFERA DE VALENCIA: SEGUIMIENTO POR MEDIO DE TELEDETECCIÓN.....	1161
<i>Gomis, A.; Mena, E.; Nevado, S.; Moya, N.:</i> CÁLCULO DE LA HUELLA DE CARBONO DEL CICLO URBANO DEL AGUA: LA EXPERIENCIA DE AGUAS DE MURCIA.....	1162
<i>Herrera-Grao, T.; Cañedo-Argüelles, M.; Hermoso, V.; Fortuño, P.; Prat, N.; Bonada, N.:</i> EL USO DE HERRAMIENTAS DE PLANIFICACIÓN SISTEMÁTICA PARA DEFINIR RESERVAS NATURALES FLUVIALES EN ESPAÑA: EL PROYECTO RESERVIAL.....	1175
<i>Jover Cerdá, M.; Soria, J.:</i> COMPARACIÓN DE CAUDALES VERTIDOS POR LAS GOLAS DEL LAGO DE LA ALBUFERA DE VALENCIA DURANTE LOS PERIODOS 1973-1980, 1981-1989 Y 2006-2012.....	1176
<i>Llavador Colomer, F.; Serrano, A.M.; Blundell, E.:</i> EVALUACIÓN PRELIMINAR DE LA HUELLA DE CARBONO ASOCIADA A LA DEPURACIÓN DE AGUAS RESIDUALES EN LA COMUNITAT VALENCIANA.....	1177
<i>Nevado, S.; Felú, J.; Navarro, F.J.:</i> SOSTENIBILIDAD ENERGÉTICA DE LA EDAR DE MURCIA ESTE....	1178
<i>Sancha Navarro, E.F.:</i> LA SEQUÍA DEL AÑO 2014-2015 EN LA COSTA VALENCIANA: LA DURA ADVERTENCIA DEL CAMBIO CLIMÁTICO SOBRE UNAS ÁREAS URBANIZADAS.....	1189

Comitè científic
Comisión científica
Comissão científica

Co-Presidents: Paula Chainho (Universidade de Lisboa) i Leandro del Moral (Universidad de Sevilla)

Iñaki Antigüedad, Universidad del País Vasco / Euskal Herriko Unibertsitatea
Pedro Arrojo, Universidad de Zaragoza
Domingo Baeza, Universidad Autónoma de Madrid
Damià Barceló, Instituto de Diagnóstico Ambiental y Estudios del Agua, CSIC
Alba Ballester, Universitat Autònoma de Barcelona
Nuria Bonada, Universitat de Barcelona
Francisco Cubillo, Canal de Isabel II Gestión
Agustín Cuello, Diputación de Cádiz
Josep Espluga, Universitat Autònoma de Barcelona
Santiago Fernández, Universidad Carlos III
Marisa Feijóo, Universidad de Zaragoza
Graciela Ferrer, Fundació Nova Cultura de l'Aigua
Joan García, Universitat Politècnica de Catalunya
Ernest García, Universitat de València
Samuel Garrido, Universitat Jaume I
Nuria Hernández-Mora, Universidad de Sevilla
Tony Herrera, Fundació Nova Cultura de l'Aigua
Abel La Calle, Universidad de Almería
Julia Martínez, Fundació Nova Cultura de l'Aigua
Rosa Miracle, Universitat de València
Jaime Morell, Asociación Española de Operadores Públicos de Abastecimiento y Saneamiento-AEOPAS

Joan Mateu Vallés, Universitat de València
Susana Neto, University of Western Australia y Universidade de Lisboa
Jorge Olcina, Universitat d'Alacant
Alfredo Ollero, Universidad de Zaragoza
Enrique Ortega, Centro de Estudios y Experimentación de Obras Públicas-CEDEX
Guillermo Palau, Universitat Politècnica de València
João Pedroso de Lima, Universidade de Coimbra
Anna Ribas, Universitat de Girona
Jordi Salat, Instituto de Ciencias del Mar, CSIC
Eugenio Sequeira, Conselho Nacional do Ambiente e do Desenvolvimento Sustentável
Lucía Soriano, Universidad de Zaragoza

Comitè organitzador
Comisión organizadora
Comissão organizadora

President: Francesc La-Roca (Universitat de València)

Carlos Bragança dos Santos, Universidade do Algarve
Violeta Cabello, Universidad de Sevilla
Joan Corominas, Fundació Nova Cultura de l'Aigua
Fito Jiménez, Fundació Nova Cultura de l'Aigua
Mar Ortega, Universitat Politècnica de València
Marina Requena, Universitat de València
Laura Sánchez, Fundació Nova Cultura de l'Aigua
Antonio Viñas, Fundació Nova Cultura de l'Aigua

THE MICROALGAE *Ostreopsis cf. ovata* BLOOMING IN NW MEDITERRANEAN COASTAL AREAS: A MULTIDISCIPLINARY APPROACH TO UNDERSTAND THEIR IMPACTS ON HUMAN HEALTH

Magda Vila¹, Elisa Berdalet¹, Laia Viure¹, Èlida Alechaga², Josep. Àlvarez³, Raúl Arasa⁴, Laura Biel¹, Josep Caixach⁵, Anna Domingo-Dalmau⁴, Marta Estrada¹, Jaume Farràs², Soraya Hernández-Llamas¹, Jordi Isern-Fontanet¹, Sílvia Lacorte⁵, Encarnación Moyano², Òscar Palacios⁵, Josep Sànchez¹, Rafael Abós-Herràndiz⁶

¹ Institut de Ciències del Mar (ICM-CSIC) magda@icm.csic.es

² Universitat de Barcelona

³ Agència de Salut Pública de Catalunya (Departament de Salut, Generalitat de Catalunya)

⁴ MeteoSim

⁵ Institut de Diagnòstic Ambiental i Estudis de l'Aigua (IDAEA-CSIC)

⁶ Institut Català de la Salut (Departament de Salut, Generalitat de Catalunya)

ABSTRACT

Ostreopsis is a tropical dinoflagellate that produces the potent biotoxins, palytoxin and analogues. *Ostreopsis* species thrive in shallow waters as epiphyte, mainly embedded in a self-produced mucilage sheath covering macroalgae, corals or rocks. In tropical zones, *Ostreopsis* has been related to human seafood borne intoxications. Recent data indicate the potential expansion of this organism in temperate waters, including the Mediterranean, likely linked to climate warming and anthropogenic impacts in the coastal zone. Since the late 90s, *Ostreopsis* recurrent proliferations in these latitudes have been associated with respiratory irritation outbreaks in humans and mass mortalities of benthic invertebrate fauna. Thus, *Ostreopsis* blooms constitute both, a health and an environmental emergent problem. The project OstreoRisk (2015-2017) provides a multidisciplinary approach to the problem by integrating ecology, meteorology, toxicology and public health in an area of the Catalan coast particularly affected by recurrent *Ostreopsis cf. ovata* blooms.

L'*Ostreopsis* és una dinoflagel·lada que produeix potents biotoxines, la palitoxina i els seus anàlegs. L'*Ostreopsis* prolifera en aigües someres, principalment com a epífit de macroalgues, coralls o roques, als quals s'hi adhereix produint una capa mucil·laginosa. A zones tropicals, l'*Ostreopsis* s'ha relacionat amb intoxicacions alimentàries per ingestió d'aliments marins que havien bioacumulat la toxina. Dades recents indiquen la possible expansió d'aquest organisme a aigües temperades, inclosa la Mediterrània, probablement relacionada amb l'escalfament global i els impactes antropogènics a la zona costanera. Des dels anys 90, proliferacions recorrents en aquestes latituds s'han associat amb brots d'irritacions respiratòries en humans i mortalitats massives d'invertebrats marins bentònics. Per tant, els blooms d'*Ostreopsis* constitueixen un problema emergent sanitari i ambiental. El projecte OstreoRisk (2015-2017) adreça el problema de manera multidisciplinària integrant-hi ecologia, meteorologia, toxicologia i salut pública en una àrea de la costa catalana afectada per proliferacions recorrents d'*Ostreopsis cf. ovata*.

Paraules clau: microalgues nocives, irritacions respiratòries, mortalitats massives, aigües costaneres, *Ostreopsi*.

1. Introduction. The problems associated to *Ostreopsis* blooms

The outbreaks of harmful marine microalgae constitute one of the relevant threats to coastal marine ecosystems and human health worldwide (Berdalet, 2016 and references there in). Understanding the ecological dynamics of the so-called "harmful algal blooms" (HABs) and their effects on marine organisms and humans are essential to design appropriate prevention and intervention plans. While there is a large knowledge on the ecology and toxicity of planktonic HABs and they are well-monitored at least in developed countries, benthic HABs (BHABs) are an emerging problem in temperate areas and their potential risk has not been well evaluated yet.

The toxic benthic dinoflagellate genus *Ostreopsis* produces strong toxins, palytoxin (PLTX) and analogues (ovatoin, ostreocin; e.g. Ciminiello et al. 2013). *Ostreopsis* grows well in shallow waters as epiphyte of macroalgae, corals, sand and rocks. In temperate waters, *Ostreopsis* species bloom in the summer-autumn season and produce a distinctive rusty-brown colored mucilaginous film covering the substrate (Figure 1A-C). In addition, high cell densities can be found in the water column and, especially in summer, at the water-air interface forming high dense floating aggregates (Figure 1D).

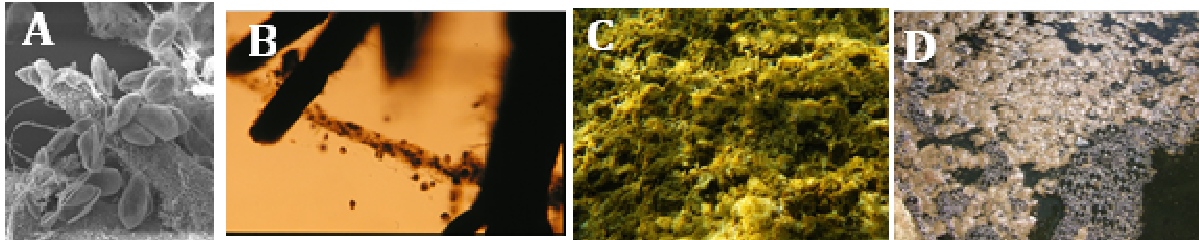


Figure 1. Details of an *Ostreopsis* bloom event in Llaner. (A) Scanning Electron Microscopy and (B) optical images of the *Ostreopsis* cells and the mucus attached to a macroalga. (C) In situ macroalgae covered by the mucus containing the *Ostreopsis* bloom community and (D) floating *Ostreopsis* aggregates. Images: M. Vila, J.M. Fortuño (ICM).

During the last 15 years, recurrent blooms of *Ostreopsis* are occurring in the Mediterranean coasts (Mangialajo et al. 2011) and other temperate waters (Rhodes 2011). Two species thrive in the Mediterranean, *O. cf. siamensis* and *O. cf. ovata*, this last one being the one causing the blooms in the Llaner hot spot. For simplicity, the term *Ostreopsis* will be used in this document throughout. Recent observations suggest the potential expansion of this organism into temperate waters as a result of climate warming. *Ostreopsis* outbreaks negatively affect human health (sea-borne food intoxications, respiratory and cutaneous irritations) and the marine environment (Shears and Ross 2009). Sant Andreu de Llaner beach (38 km North of Barcelona) constitutes a hot spot where yearly recurrent *Ostreopsis* proliferations, since the first reported outbreak in 1998, are associated to negative human health and environmental impacts (Vila et al. 2016; more details provided below). This site offers an ideal scenario to address some key, unresolved and novel questions concerning the *Ostreopsis* bloom dynamics and impacts in order to find prevention strategies to mitigate their effects.

1.1. Food intoxication associated to *Ostreopsis* blooms. In tropical latitudes, *Ostreopsis* is associated to food intoxications after ingestion of clupeid fishes, crabs or sea urchins (Randall 2005) contaminated with bioaccumulated PLTX. This toxin and its analogues, hydrosoluble macromolecules (ca. 2700 Dalton), are among the most potent toxins of marine origin (lethal dose 50 -LD50-: 0.75 µg/kg intraperitoneal in mice). Intoxication by PLTX includes hypersalivation, abdominal cramps, nausea, severe diarrhea, muscle spasms and difficulty in breathing followed by death in the most severe cases.

In the Mediterranean, food intoxications related to the PLTX-like group have not been demonstrated yet, although the palytoxin analogues have been already detected in certain marine fauna (e.g. Biré et al. 2013). The recent expansion of this dinoflagellate in coastal areas constitutes an unknown risk for the natural products obtained from commercial fishing or aquaculture and from recreational fishing at the affected beaches. The fact that *Ostreopsis* has both benthic and planktonic phases facilitates dispersion and widens the spectra of the potentially contaminated sea products. The toxins from the planktonic stages can bioaccumulate in filter-feeding bivalves (e.g. mussels), while the benthic cells could enter the food chain from the herbivores that feed on macroalgae or marine fanerogams (e.g. sea urchins, crabs, gastropods, salps) to omnivores and carnivores.

Whereas there is no regulation for PLTX levels in seafood, in 2009 the Panel on Contaminants in the Food Chain (CONTAM Panel) of the EFSA assessed the risks to human health related to the presence of PLTX-group toxins in shellfish, and recommended a maximum concentration of 30 µg eqPLTX/kg fresh weight. As a reference, more than 200 µg eqPLTX/kg fresh weight were measured in the meat of mussels (*Mytilus galloprovincialis*) collected in zones of southern France affected by *O. cf. ovata* blooms (Biré et al., 2012). PLTX exceeding the EFSA thresholds were detected in samples of sea urchins collected in Sant Andreu de Llavaneres (40 km North of Barcelona) during an *Ostreopsis* bloom in 2011 (Riobó, Vila, unpublished). The few available data suggest a potential, still not well evaluated, risk of seafood intoxication in Mediterranean areas affected by recurrent *Ostreopsis* blooms. In consequence, the possible transfer and accumulation of the PLTX-like group through the food web up to humans should be investigated.

1.2. Health disorders associated to *Ostreopsis* blooms in the Mediterranean, including the Spanish coasts. In several Mediterranean beaches (Argel, Spain, France, Italy and Greece), human health affectations (rhinorrhea, fever, general malaise, eyes and nose irritation, etc.) through inhalation of suspected toxic aerosols or cutaneous irritation through skin contact have been documented coinciding with massive blooms of *Ostreopsis* (Vila et al. 2016 and references there in). People seek medical care in hospital emergency departments after expending time on recreational or working activities in beaches where high numbers of *Ostreopsis cf. ovata* had been recorded. It has been hypothesized that these disorders could be caused by exposure to aerosols containing toxins and/or allergenic substances produced by *Ostreopsis*, its cells or fragments and/or the accompanying microbiota (Casabianca et al. 2013). A similar mechanism, aerosol exposure, has been confirmed as the cause of respiratory irritation symptoms during toxic *Karenia brevis* blooms in the Gulf of Mexico, from near 30 years of multi-institutional studies (e.g. Fleming et al. 2005). The huge scientific investment done in this area has provided sound knowledge that has already materialized in the appropriate management of the ecological and health risks. However, many gaps remain concerning our fundamental understanding of the *Ostreopsis* bloom dynamics, as we

describe next. In the Mediterranean while the *Ostreopsis* blooms usually persist for more than two months, health symptoms, paradoxically, lasted only for a short time. Thus, the direct link between the *Ostreopsis* blooms and the respiratory diseases has not been clarified yet. On another hand, PLTX-like toxins have been rarely found in the aerosols. Thus, the irritative agents have not been clearly identified yet.

2. Background on *Ostreopsis* blooms along the Catalan coast.

Considerable background information on *Ostreopsis* blooms along the Catalan coast has been generated during the last 20 years. However, whereas *Ostreopsis* is known to be present in tropical waters since its description in 1902, little is known on their presence and abundances before. In fact, records in the Mediterranean Sea before the 90s in the area are scarce. As far as we know, in the Mediterranean Sea, this genus was first observed in Villefrance-sur-mer in the 80s. Vila et al. (2001) revealed the presence of *Ostreopsis* between 1995 and 1999 in several Catalan harbors and characterized the microalgal epiphytic assemblages in a shallow protected rocky habitat in Palamós (Costa Brava). In August 1998, high *Ostreopsis* concentrations ($2 \cdot 10^5$ cells·L⁻¹) in the water coincided with a mass mortality of invertebrates (mussels and sea urchins) in the Sant Andreu de Llanereres area (hereafter referred to as Llanereres and LLAV). Since then, the invertebrate community of LLAV beach has not been recovered yet.

In the summer of 2004, relatively high *Ostreopsis* concentrations ($>10^4$ cells·L⁻¹), considered as "blooms", were detected in 2% of the 234 Catalan beaches sampled. Concurrently, the "Agència de Salut Pública de Catalunya" (ASPC, Public Health Agency of Catalonia) reported respiratory irritation episodes in LLAV beach and sought the collaboration of the ICM to understand the phenomenon. For the first time, the possible link of the health disorders with the *Ostreopsis* presence was hypothesized (Àlvarez et al. 2005). This situation occurred again in 2006 (unpublished data), while similar events were concomitantly reported elsewhere in the Mediterranean (see Vila et al. 2016 for a complete list of references).

In response to the growing international concern regarding the consequences of the *Ostreopsis* blooms, the Spanish Ministry for Science and Innovation funded the "Study of the biological and toxinological aspects of benthic dinoflagellates related to human health risks" (EBITOX; 2009-2011). The main outcomes from the studies focused on the *Ostreopsis* blooms in the Llanereres hot spot were morphology and genetic identification of the strains blooming in Llanereres (Battocchi et al. 2010), namely *O. cf. ovata* (dominant) and *O. cf. siamensis*, and the characterization of the environmental conditions that modulate *Ostreopsis* proliferations in Llanereres; and the description of the *Ostreopsis* life cycle (sexual, vegetative, cyst stages). The toxin content in natural samples (planktonic and benthic matrices) and *Ostreopsis* strains in culture was determined combining chemical (LC-FLD, LC-MS) and biological (hemolytic assay) methods (Riobó et al. 2012). In spite of the large invested effort combining high capacity filtering systems (40 m³/h), PLTX was not detected in the air (Casabianca et al. 2013). In contrast, qPCR assays developed by the EBITOX team revealed the presence of *Ostreopsis* material in the aerosol samples during the outbreaks (Casabianca et al. 2013); putative *Ostreopsis* cells were visualized in microscopic inspections (Vila, unpublished). Prospective exploration of the PLTX presence in the biota growing in the *Ostreopsis* affected area exceeding the EFSA thresholds were detected in samples of sea

urchins collected in Llanereres during an *Ostreopsis* bloom in 2011 (Riobó, Vila, unpublished).

Later on, given the recurrence of the health problems in Llanereres, aware of the problems posed by *Ostreopsis* in the Mediterranean and its possible expansion, the ICM collaborated with the ASPC, which included the topic within its priorities. Thus, in summer 2013 the ICM and the ASPC conducted the first joint ecological and epidemiological study (Vila et al. 2016). The obtained results generated new hypotheses that will be tested by *Ostreorisk* (Figure 2).

The study was performed on a permanent cohort constituted by the entire staff (16 people) of an indoor-outdoor restaurant in Llanereres beach. Because the building is located 10 meters from the hot spot, the staff is directly exposed to marine aerosols, at least eight hours daily. All of them experienced the same acute illness symptoms (general malaise, eyes and nose irritation, rhinorrhea) already recorded by the Public Health system on previous occasions. In 2013, the *Ostreopsis* proliferation exhibited the typical seasonal trend (Figure 2) described previously (Mangialajo et al. 2011), but symptoms were only noticed during an interval of a few days.

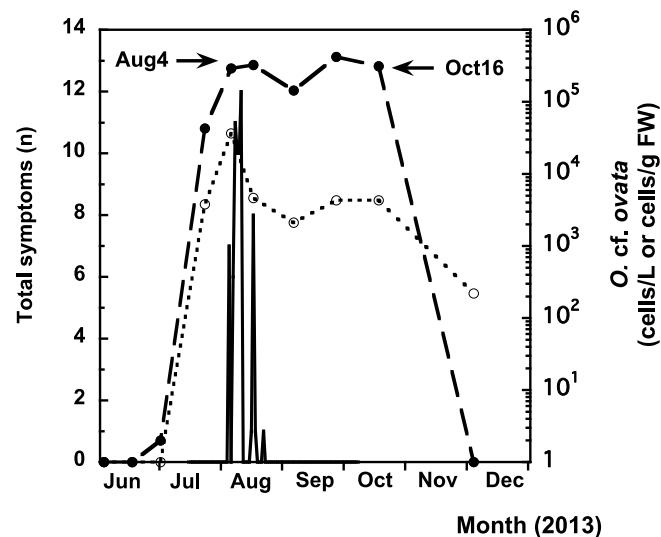


Figure 2. Symptoms (left y-axis, continuous line) and *Ostreopsis cf. ovata* cell concentrations (right y-axis) in the water (open symbols, dotted line; cells/L) and covering the macroalgae (closed circles, dash line; cells/gram of macroalgae fresh weight). Vila et al. (in press).

This study provided the first evidence that irritative symptoms occur only during a particular time window along the development of the *Ostreopsis* bloom (Figure 2). The health disorders coincided with the transition from the exponential to the stationary phase of the *Ostreopsis* population, with high cell concentrations both in the water and covering the macroalgae. This field observation is consistent with the variation of the cellular toxin concentration observed in cultures, in relationship with the physiological phase and environmental forcing (e.g. Bolli et al. 2007). The present project will thus explore the ecophysiological variability of selected chemical compounds along the bloom.

More recently, during the 2014-2015-2016 summer-fall seasons, we have been conducting joint ecologic and epidemiologic studies again involving the Sant Andreu de Llavaneres Municipality, Local Health Authorities, Primary Health Centers, pharmacies, Regional Hospital (in Mataró), Red Cross beach watchers and the Balís Harbor, in coordination with the ASPC. This collaboration sponsored the collection of marine samples by the ICM team. The epidemiology data is being analysed by the ASPC to investigate, among other, different levels exposure of humans to the sea conditions. OstreoRisk addresses a well-documented environmental and human health problem in the Mediterranean coastal zone. Paradoxically, while the *Ostreopsis* proliferations persisted along the summer-fall season in the Mediterranean (Mangialajo et al. 2011), the reported health symptoms lasted only for a few days (Vila et al. 2016 and references there in). Furthermore, most reported cases corresponded to people sporadically and shortly exposed to marine aerosols. Our joint epidemiology and ecological studies are helping to establish the direct link between *Ostreopsis* blooms and the observed health disorders (see next section 3).

3. Main questions and objectives of the OstreoRisk project and its approach.

Along the *Ostreopsis* blooms the microalgae themselves and/or some chemical compounds are released to the medium cause negative effects on other organisms of the ecosystem and toxicity to humans via transmission through the food web, respiratory symptoms by aerosolized compounds and skin irritations by direct contact with the water. These effects on human health and the environment recorded in Mediterranean coastal areas may threaten aquaculture and tourism activities. OstreoRisk is a multidisciplinary project that integrates marine ecology, organic and analytical chemistry, medicine, meteorology, and involves end-users and public authorities, structured to address the following objectives:

Objective A) To ascertain the potential risk of seafood intoxication and macrofauna mortality associated to *Ostreopsis* blooms, by investigating the possible transfer of the toxin through the food web.

Objective B) To identify the compounds produced by the *Ostreopsis* community in order to explain the temporal association between *Ostreopsis* bloom dynamics and irritative health disorders in humans.

Objective C) To develop communication channels to inform the general public, stakeholders and policy-makers, about the *Ostreopsis* outbreaks and to devise alert protocols to minimize health impacts.

The expected results will contribute with new knowledge on the *Ostreopsis* blooms for the elaboration of prevention plans in collaboration with stakeholders and public authorities. Additionally, we aim to contribute to ascertain the possible historical presence of the *Ostreopsis* in the Mediterranean.

OstreoRisk is centered in field sampling and field experiments in collaboration with epidemiologists, meteorological and air quality modelers, and emphasizes outreach activities and communication with the stakeholders and policy-makers at local, regional and international levels. The field studies and field experiments are conducted in the LLAV area. As mentioned earlier, background information on the temporal dynamics of *Ostreopsis* blooms (e.g. Figure 2 and Vila et al. 2008) has been obtained in the LLAV area since 2007. However, to appropriately address the OstreoRisk specific objectives, it is mandatory to

characterize at least two yearly blooms. Thus, during the first two years of the project, the LLAV area is being sampled twice a month (June, September, October) and weekly (July, August). The recurrence of the blooms guarantees obtaining all the ecological samples and high probabilities of recording respiratory impacts.

4. Some ongoing activities of the OstreoRisk project.

To achieve the objectives indicated above, some specific questions have been addressed and the corresponding activities have been designed.

4.1. Which are the morphological / structural characteristics of the areas colonized by *Ostreopsis* blooms? Why the blooms occur in certain sites only?

OstreoRisk aims to characterize the submersed continental platform in Llanerxes and surrounding areas by Autonomous Underwater Vehicles (AUV) surveys to delimit the area affected by *Ostreopsis* blooms. The submersed morphology of the LLAV hot spot is characterized by the presence of wide submersed rocky bars (100-150 m wide) that extend for 3-4 km parallel to the coast. These rocky bars support important macroalgal densities that in turn are the substrate for epiphytic microalgae such as *Ostreopsis*. However, some beaches in Catalonia have submersed rocky bars that have never been sampled for benthic microalgae. Because *Ostreopsis* is commonly detected in plankton samples from many Catalan beaches, it is necessary to determine whether any of these beaches having the morphology described above are colonized by macroalgae and *Ostreopsis*. In such cases, the risk of important *Ostreopsis* blooms would be high. Given that the benthic microalgae assemblage develops mainly on macroalgae (*Corallina*, *Jania*, *Padina*, *Halopteris*, ...), the extension of coastal substrate covered by them constitutes a proxy of the potential area for *Ostreopsis* colonization and blooming.

A first mapping on the LLAV bottom has been done in order to determine the extension (km) of the macrophyte beds (potentially substrate of *Ostreopsis* bloom) in LLAV by scanning the coastal platform with an AUV. The whole scanned area spans through a littoral front of about 3,5 km, from Port de Mataró to Port Balís. Surveys will be organized to cover three 2 km x 300 m subareas. The general picture of the zone has been obtained by a high frequency (868 kHz) sidescan survey with the AUV navigating at a fixed depth (2 or 3 m below the surface), in transects with a swath coverage of 30 m. Continuous still geo-referenced image recording (2 Hz) is conducted. From the obtained data, a second survey will be performed with the vehicle navigating at 1-2 m above the bottom, to obtain higher resolution images of the macroalgal distribution. Specific phytobenthos samples will be taken by scuba divers.

In addition, 6 selected beaches will be sampled (planktonic and epiphytic microalgae, chlorophyll concentration) by scuba divers from July to September of the first two years of the project.

4.2. Are toxins produced by *Ostreopsis* the causative of respiratory and cutaneous irritation in humans?

Since 2013 we are elaborating of a joint ecological and epidemiological data base in order to get insight on the temporal association between the *Ostreopsis* bloom and the health

disorders in the Llanereres hot spot. We combine the epidemiologic studies in the Llanereres area with all the ecological data. The health study is conducted by the external collaboration of the ASPC, which follow the national and international procedures and ethical policies, which are already integrated in its professional routines (e.g. informed consent, confidentiality, etc.). *Ostreorisk* has not access to the personal data. The epidemiologic study includes a long term, high resolution, continuous record of health disorders (respiratory, cutaneous, other) potentially related to *Ostreopsis* blooms in the human population inhabiting nearby the LLAV hot spot, and/or temporarily visiting the area. The official ASPC protocol includes the distribution of a questionnaire (containing a list of *Ostreopsis*-related symptoms, to be completed every day) among the selected people. Under important health disturbance episodes, an alert epidemiology surveillance protocol will be followed. In addition, the meteorological conditions at small scale are characterized by *Meteosim* S.L. The first results complementing the graphic shown in Figure 2 above, have been shown in detail in Vila et al. 2016.

4.3. Toxins produced by Mediterranean *Ostreopsis* are bioaccumulated through the food web? If so, there is a real risk on seafood safety? Are they the main cause of invertebrate mass mortalities?

The PLTX-like group of toxins produced by *Ostreopsis* can negatively affect the benthic macrofauna and be also transmitted up through the food web to humans (seafood intoxication). To evaluate these risks different approaches are done:

- a) PLTX and its analogues are being quantified in a range of marine macrofauna (fishes, shellfish, crabs, sea urchins) taken from the LLAV hot spot along the *Ostreopsis* blooming period and beyond. The qualitative and quantitative analysis of the different toxins present should indicate the potential degree of seafood-borne intoxication.
- b) Ecotoxicological assays with model invertebrate (*Daphnia*) and vertebrate (*Zebra fish*) organisms to clarify the toxicity mechanisms of the *Ostreopsis*-produced toxins. Depending on the results obtained, other ecotoxicological tests will be designed with sea urchins and mussel's larvae. These experiments will indicate the sensitivity of the fauna exposed to *Ostreopsis* blooms.

4.4. How varies toxin concentration along the bloom cycle? Is only related to *Ostreopsis* abundance or other environmental parameters (temperature, turbulence, nutrients, salinity, and irradiation) play a role?

High resolution analytic methods have been set up at the University of Barcelona (Alechaga et al. in prep) to measure PLTX and ovatoxins (OVTXs) in *Ostreopsis* cells and soon it will be implemented for the analysis of animal tissues. Using a UHPLC-HRMS with a sub-2 μm C18 column and quadrupole-Orbitrap mass spectrometer the toxin concentration in along the *Ostreopsis* bloom in 2015 have been characterized. *Ostreopsis* reached high abundances (above 10^5 cells/g FW macroalgae) during July and August. Total toxin content (PLTX plus OVTXs) followed a parallel pattern reaching total toxin concentrations above 13 μg toxin/g FW macroalgae (Fig 4A). Toxin per cell fluctuated along the bloom between (1-20 pg toxins/g FW macroalgae), reaching its maximum on August, 11 (Fig 4B). The preliminary results will be presented at the International Conference on Harmful Algae (ICHA17; Berdalet et al.).

Furthermore, we are studying the variability of toxin cell concentration with water motion, a key element in the aerosolization of the possible irritation factors environmental factors. Experiments with pure cultures in the laboratory suggest that the toxin concentrations in still conditions are higher than under calm (Vila et al. poster to be presented at the ICHA17).

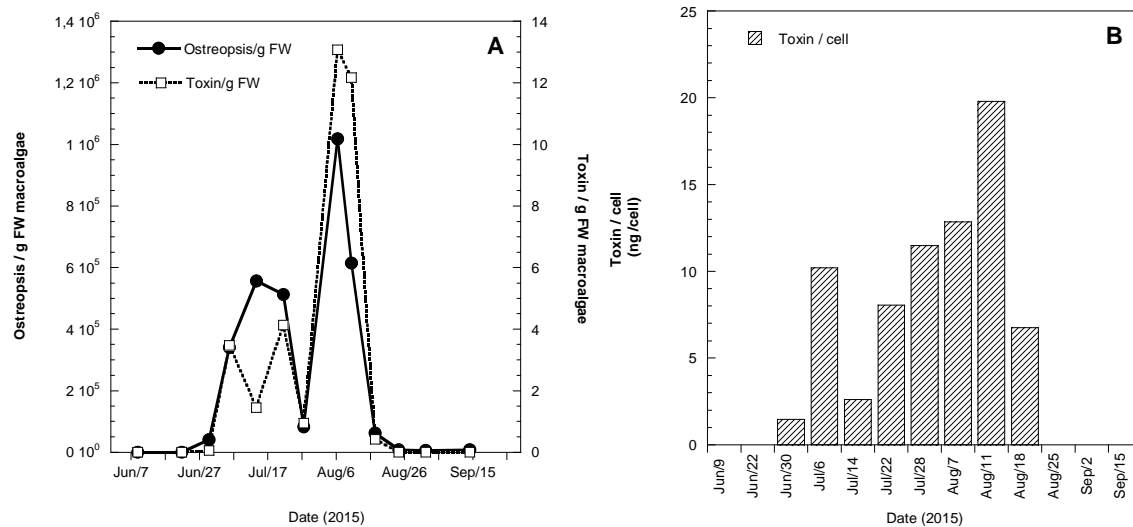


Figure 4. The *Ostreopsis* bloom in Llanereres during summer 2015. Epiphytic *Ostreopsis* abundances and epiphytic toxin concentration (A). Variability on toxin concentration per cell along the bloom period (B).

Conclusions

The data available make difficult to determine whether *Ostreopsis* is an alien species in the Mediterranean Sea or whether it was present at low concentrations and suddenly started to bloom. What is clear is that, nowadays, several coastal sites are affected by these blooms, and in some cases they have been related to negative effects to the human population and to the ecosystem. Human activities are affecting coastal habitats in different ways, increasing coastal semiconfined water areas with different constructions such as harbors or breakwaters (Vila et al., 2001), which in turn modify current circulation and sand redistribution. Beach nourishment involves large extraction of sand in certain beaches that barefoot sediment, leaving bare rock sediment, which could be highly colonized by macroalgae. This is the case of Sant Andreu de Llanereres beach rock. The OstreoRisk hypothesis is that as *Ostreopsis* is a toxic species it deters herbivorous consumers becoming an oasis for macroalgae, and in turn, for *Ostreopsis*. During particular meteorological conditions (not well understood yet), *Ostreopsis* cells, fragments, or chemical or biological components (bacteria, virus, toxins or others) are aerosolized and are breathed by people close to the shore, that suffers from the cited health problems. The cementation of the littoral (roads, buildings and walking paths) together with wetlands and dunes destruction prevents the natural beach regeneration. The blooms outbreaks happening in Llanereres are probably an example of destruction of natural habitats entailing a change on flora and fauna communities, and in this specific case, has been favorable to a benthic HAB species, which will also be favored by increasing temperatures in the Mediterranean Sea.

Acknowledgements

This work has been supported by the Spanish projects EBITOX (CTQ2008-06754-C04-04) and OSTREORISK (CTM2014-53818-R). We are very grateful to the Aceña family of the Restaurant Pins Mar (Sant Andreu de Llavanes), who, year after year kindly offered us the use of their facilities in Llavanes.

References

- Àlvarez, J., Pedrol, A., Parrón, I., Goxencia, J., de Torres, M., Manzanera, M., Planas, C., Coscolluela, G., López, A., Masó, M., Vila, M. And R. Isalt (2005): Brote Epidémico de sintomatología irritativa en Sant Andreu de Llavanes: ¿el origen está en el mar? In: Proceedings of the XXIII Reunión de la Sociedad Española de Epidemiología, Las Palmas de Gran Canaria, Spain. Gaceta Sanitaria 19(Supl. 1): 3-139.
- Battocchi, C., Totti, C., Vila, M., Masó, M., Capellacci, S., Accoroni, S., Reñé, A., Scardi, M. and A. Penna (2010): Monitoring of toxic microalga *Ostreopsis* (Dinoflagellate) species in coastal waters of the Mediterranean Sea using molecular PCR based assay combined with light microscopy method. Marine Pollution Bulletin 60:1074-1084.
- Berdalet, E., Fleming, L. E., Gowen, R., Davidson, K., Hess, P., Backer, L. C., Moore, S. K., Enevoldsen, H. and P. Hoagland (2016): Marine Harmful Algal Blooms, Human Health and Wellbeing: challenges and opportunities in the 21st century. Journal of the Marine Biology Association of the United Kingdom, 96 (Special Issue 01): 61-96
- Biré, R., Trotureau, S., Lemée, R., Delpont, C., Chabot, B., Aumond, Y. and S. Krys (2013): Occurrence of palytoxins in marine organisms from different trophic levels of the French Mediterranean coast harvested in 2009. Harmful Algae 28: 10-22.
- Bolli, L., Llaveria, G., Garcés, E., Guadayol, Ò., van Lenning, K., Peters, F. and E. Berdalet (2007): Modulation of ecdysal cyst and toxin dynamics of two *Alexandrium* (Dinophyceae) species under small-scale turbulence. Biogeosciences 4: 559-67.
- Casabianca, S., Casabianca, A., Riobó, P., Franco, J.M., Vila, M. and A. Penna (2013): Quantification of the toxic dinoflagellate *Ostreopsis* spp. by qPCR assay in marine aerosol. Environ. Sci. Technol. 47: 3788-3795.
- Ciminiello, P., Dell'Aversano, C., Dello Iacovo, E., Fattorusso, E., Forino, M., Grauso, L., Tartaglione, L., Guerrini, F. And R. Pistocchi (2010): Complex paly- toxin-like profile of *Ostreopsis ovata*. Identification of four new ova- toxins by high-resolution liquid chromatography/mass spectrometry. Rapid Commun. Mass Spectrom. 24: 2735-2744.
- Fleming, L.E., Kirkpatrick, B., Backer, L.C., Bean, J.A., Wanner, A., Dalpra, D., Tamer, R., Zaias J., Cheng, Y.S., Pierce, R., Naar, J., Abraham, W.M., Clark, R., Zhou, Y., Henry, M.S., Johnson, D., Van De Bogart, G., Bossar, G.D., Harrington, M. and D. Baden (2005): Initial evaluation of the effects of aerosolized Florida red tide toxins (brevetoxins) in persons with asthma. Environm. Health Persp. 113: 650-657.
- Mangialajo, L., Ganzin, N., Accoroni, S., Asnaghi, V., Blanfune, A., Cabrini, M., Cattaneo-Vietti, R., Chavanon, F., Chiantore, M.C., Cohu, S., Costa, E., Fornasaro, D., Grossel, H., Marco-Miralles, F., Masó, M., Reñé, A., Rossi, A.M., Sala, M.M., Thibaut, T., Totti, C., Vila, M.

and R. Lemée (2011): Trends in *Ostreopsis* proliferation along the Northern Mediterranean coasts. *Toxicon* 57: 408-420.

Randall, J.E. (2005): Review of clupeotoxism, an often fatal illness from the consumption of clupeoid fishes. *Pacif. Sci.* 59: 73-77.

Riobó, P., Franco, J.M., Bravo, I., Fraga, S., Ramilo, I., Rial, P., Rodríguez, F., Reñé, A., Sala, M.M. and M. Vila (2012): Determination of palytoxins in samples from *Ostreopsis* outbreaks in Llanerres (NW Mediterranean coast). In: Pagou, P. and Hallegraeff, G. (eds). Proceeding of the 14th International Conference on Harmful Algae. ISSHA and IOC of UNESCO, pp. 33-35.

Rhodes, L (2011): World-wide occurrence of the toxic dinoflagellate genus *Ostreopsis* Schmidt. *Toxicon* 57: 400-407.

Shears, N.T., Ross, P.M. (2009): Blooms of benthic dinoflagellates of the genus *Ostreopsis*; an increasing and ecologically important phenomenon on temperate reefs in New Zealand and worldwide. *Harmful Algae* 8: 916-925.

Vila, M., Abós-Herràndiz, R., Isern-Fontanet, J., Àlvarez, J. and E. Berdalet. (2016): First combined ecology and epidemiology study to establish the link between the *Ostreopsis* cf. *ovata* blooms and their impacts on human Health. *Scientia Marina* (in press).

Vila, M., Arin, L., Battocchi, C., Bravo, I., Fraga, S., Penna, A., Reñé, A., Riobó, P., Rodríguez, F., Sala, M.M., Camp, J., de Torres, M. and J.M. Franco (2012): Management of *Ostreopsis* blooms in recreational waters along the Catalan coast (NW Mediterranean Sea): cooperation between a research project and a monitoring program. *Cryptogamie, Algologie* 33: 143-152.