

REPORT ON THE RESEARCH UNIT:
Evolutionary Biology and Ecology of Algae
(EBEA)

UNDER THE SUPERVISION OF THE
FOLLOWING INSTITUTIONS AND
RESEARCH BODIES:

Centre National de la Recherche Scientifique –
CNRS

Université Pierre et Marie Curie - UPMC

Pontificia Universidad Católica de Chile

Universidad Austral de Chile

Station Biologique de Roscoff - SBR

ÉVALUATION CAMPAIGN 2017-2018

GROUP D

This report is the sole result of the unit's evaluation by the expert committee, the composition of which is specified below. The assessments contained herein are the expression of an independent and collegial reviewing by the committee.

UNIT PRESENTATION

Unit name:	Evolutionary Biology and Ecology of Algae
Unit acronym:	EBEA
Requested label:	UMI
Application type:	Renewal
Current number:	UMI 3614
Head of the unit (2017-2018):	Ms Myriam VALÉRO
Project leader (2019-2023):	Ms Myriam VALÉRO
Number of themes:	3

COMMITTEE MEMBERS

Chair: Mr Xavier VEKEMANS, Université de Lille (representative of CoNRS)

Experts:

- Mr Debashish BHATTACHARYA, Rutgers University, USA
- Mr Dominique DE VIENNE, Université de Paris-Sud
- Mr Arthur GROSSMAN, Carnegie Institute Stanford, USA
- Mr Xavier NESME, Inra Lyon (supporting personnel)
- Ms Carole SMADJA, CNRS Montpellier (representative of CNU)

HCERES scientific officer:

Mr Steven BALL

Representatives of supervising institutions and bodies:

- Ms Martine HOSSAERT, *Centre national de la recherche scientifique*
- Mr Stéphane REGNIER, *Université Pierre et Marie Curie*

INTRODUCTION

HISTORY AND GEOGRAPHICAL LOCATION OF THE UNIT

The UMI 3614 laboratory of Evolutionary Biology and Ecology of Algae (EBEA) was created in 2014 with five hosting institutions: CNRS and UPMC in France, and PUC and UACH in Chile. In France, the UMI is one of the units of the SBR. This international laboratory is spread across three distinct sites: Roscoff (France), Santiago and Valdivia (Chile).

The scientific collaboration between members of the French and Chilean teams dates back to the 1990s, but administratively the joint laboratory started in 2003 with the creation of an international associated laboratory between SBR and PUC.

MANAGEMENT TEAM

The management team is composed of the unit director, Ms Myriam VALÉRO (France), and the deputy director, Mr Sylvain FAUGERON (Chile).

HCERES NOMENCLATURE

SVE1_2. Évolution, écologie, biologie des populations.

SCIENTIFIC DOMAIN

The UMI 3614 research activities address the fields of evolutionary biology, ecology, and conservation biology with a specific focus on marine “algae” organisms (in a broad sense) including both unicellular (“microalgae”) and multicellular (“seaweed”) taxa. These scientific activities combine fundamental research objectives in relation to the study of biodiversity tackled with theoretical, empirical, and experimental approaches as well as applied research goals in relation to the exploitation of algal bioresources.

UNIT WORKFORCE

Unit workforce	Number 30/06/2017	Number 01/01/2019
Permanent staff		
Full professors and similar positions	2	2
Assistant professors and similar positions	3	4 to 5
Full time research directors (Directeurs de recherche) and similar positions	1	1
Full time research associates (Chargés de recherche) and similar positions	1	1
Other scientists (“Conservateurs, cadres scientifiques des EPIC, fondations, industries, etc.”)	0	
High school teachers	0	
Supporting personnel (ITAs, BIATSSs and others, notably of EPICs)	5	6 to 7
TOTAL permanent staff	12	14 to 16

Non-permanent staff		
Non-permanent professors and associate professors, including emeritus	0	
Non-permanent full time scientists, including emeritus, post-docs	3	
Non-permanent supporting personnel	11	
PhD Students	5	
TOTAL non-permanent staff	19	
TOTAL unit	31	

GLOBAL ASSESSMENT OF THE UNIT

The research activities of the unit are of high quality and tackle three important topics in evolutionary ecology with distinct methodological approaches while sharing a common set of original biological models (micro and macro-algae). Such biological models have remained poorly investigated taxonomically and ecologically, although they possess some very interesting evolutionary properties such as alternation of autonomous haploid and diploid phases and/or within species co-occurrence of sexual and asexual reproduction, and have sometimes important ecological functions.

The unit is taking strong benefit from its international status which allows a relevant combination of expertise, excellent opportunities to access to natural populations of distinct biological models with complementary properties, large access to a wide diversity of funding sources, and synergistic scientific interactions between sites. In addition, unit members have an excellent dynamics for student training, fund raising, international collaborations, outreach activities, and for developing high profile international research in Chile.

The main weakness could lay in the unit involvement in too many questions on too many model species, taking into account the personal resources of the Unit. However, the knowledge and expertise about numerous biological models coupled with new technologies, some of which are currently set up in the unit, are a driving force that will generate novel findings and create new research directions.

DETAILED ASSESSMENT OF THE UNIT

CRITERION 1: QUALITY OF SCIENTIFIC OUTPUTS AND ACTIVITIES

A – Scientific outputs and activities, academic reputation and appeal

Scientific outputs and activities, academic reputation and appeal From 01/01/2012 to 30/06/2017	Number
Articles: scientific articles	83
Articles: review articles	3
Scientific articles with a unit member as last author	35
Medical articles (if relevant)	n/a
Books: scientific book edition	0
Books: book chapters	3
Symposia, meetings: articles in meeting proceedings	3
Academic research grants: European (ERC, H2020, etc.) and international (NSF, JSPS, NIH, World Bank, FAO, etc.) grants	5
Academic research grants: national public grants (ANR, PHRC, FUI, INCA, etc.)	15
Academic research grants: local grants (collectivités territoriales)	7
Academic research grants: PIA (Labex, Equipex etc.) grants	2
Academic research grants: grants from foundations and charities (ARC, FMR, FRM, etc.)	0
Visiting scientists (more than one month in the unit)	5
Post-docs (more than 12 months in the unit)	5
Electronic tools and products: softwares	1
Editorial activities: participation to journal editorial boards (books, collections)	4
Peer reviewing activities: participation to institutional committees and juries (CNRS, INSERM, etc.)	4
Peer reviewing activities: reviewing of journal articles	36
Peer reviewing activities: participation to lab site visit committees (HCERES etc.)	2
Peer reviewing activities: grant evaluation (public or charities)	87

Scientific recognition: prizes	0
Scientific recognition: distinctions	0
Scientific recognition: chair of learned and scientific societies	1
Scientific recognition: invitations to meetings and symposia (out of France)	6

Strengths

The scientific production of the Unit is quantitatively very good (see table) relative to the small number of permanent positions (13), with some excellent, original work on the modelling of the evolution of sexual reproduction and its consequences. Many other aspects of the work performed by the unit have strong potential, especially if coupled to more advanced technologies. The unit published a total of 83 research papers, most in strong but specialized journals (e.g. *Evolution*, *Genetics*, *J. Evolutionary Biology*, ...), and twelve in more generalist journals with IF > 6, including 1 *PLoS Biology* (First and corresponding authors are unit members) 1 *PLoS Genetics* (co-author in a collaboration), 7 *Molecular Ecology* (5 as corresponding authors) , 1 *Current Biology* (co-author in a collaboration) , 1 *Ecology resources* (collaboration driven by the unit) and 1 *The ISME Journal* (co-author in a collaboration). The attractiveness and reputation of the members of the Unit in the fields of seaweed evolution, adaptation and domestication in relation with life-cycles and life-history traits is high, as attested by the number of visiting scientists/postdoctoral researchers (10) and PhD students (16) who have been hosted in the Unit, by the invitations in international congresses (6), by the editorial activity and congress/symposia organization, etc. The success in obtaining grants is impressive: 90% of the budget comes from grants with a total of 29 grants from international, European, national and local sources (see Table above). They have also performed extensive peer review and editorial activities and have served as a reference unit for international scientific collaboration in Chile.

Weaknesses

Given the size of the unit, even if many projects are being done in collaboration with other labs, the diversity of biological models being examined by this unit is high. Therefore, the unit may consider a stronger focus on fewer models. Also, the unit has not exploited comparative genomics and considered using some of the latest genome and postgenomic technologies (proteomics, epigenetic analyses, single cell analyses, transcriptomics, post-transcriptional control, ...), or expanded its work into some of the new and relevant areas, including biotic interactions (impact of microbiome on cell cycle progression, sexuality).

Assessment of scientific outputs, reputation and appeal

The committee considers the scientific output of the UMI EBEA unit to be very good with some excellent aspects. The latter concerns modelling work done on the topic of evolution of sex and its consequences. The unit's ability to raise external funds was deemed to be excellent for such a small group and its appeal was considered as very good, based on publication in strong, specialized journals and invitations to international meetings.

B – Interactions with the non-academic world, impacts on economy, society, culture or health

Interactions with the non-academic world, impacts on economy, society, culture or health From 01/01/2012 to 30/06/2017	Number
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Technical expert or standardization reports	2
Socio-economic interactions: industrial and R&D contracts	1
Socio-economic interactions: Cifre fellowships	0
Socio-economic interactions: creation of labs with private-public partnerships	0
Socio-economic interactions: start-ups	0
Socio-economic interactions: patents, licenced patents and inventions	0
Public outreach: radio broadcasts, TV shows, magazines	0
Public outreach: journal articles, interviews, book edition, videos, etc.	6
Public outreach other popularization outputs	3
Public outreach: debates on science and society	4

Strengths

The UMI expertise in algae biology translates into significant interactions with socio-economic partners to meet societal demands on issues regarding the preservation and the sustainable management of marine diversity. The France-Chile partnership has promoted collaborative actions (e.g. under the PIA IDEALG project) in the management of marine protected areas, ecosystem services and aquaculture (seaweed farming), with outputs such as the creation of a National Reference Laboratory for seaweed resources (Chilean State Secretary of fisheries and aquaculture), and is involved in a R&D contract in Chile (technological consortium IFAN) and several competitiveness clusters in France. The unit also engages in very good public outreach activities in both countries, with participation to debates on science and society and conferences for the general public and scholars, France-Chile forums, discovery days, articles, as well as outreach initiatives such as one bilingual book for children or hosting of an Art and Science project.

Weaknesses

The unit is partly involved in applied research and does have some interactions with companies, but has not been involved in generating patents and other intellectual property, although it has contributed to establish a seaweed collection in Chile.

Assessment of the interactions with the non-academic world

Overall, the interaction with the non-academic world is very good. There is limited interaction with the private sector, but there is very good interactions with decision makers and public conservation structures both in France and in Chile. The unit also engages in very good outreach activities.

C – Involvement in training through research

Involvement in training through research From 01/01/2012 to 30/06/2017	Number
Habilitated (HDR) scientists	6
PhD students	16
Defended PhDs	11
Mean PhD duration	54 months (39 for the French PhDs)
Mean number of publications per student	3
Educational outputs: books	0
Educational outputs: e-learning, MOOCs, multimedia lessons, etc.	0

Strengths

The unit participates to teaching courses for undergraduate but also graduate degree programmes in France and Chile, and has produced one educative book chapter. It is also actively involved in high-quality and international training through research activities: it has supervised 23 Master students and 16 PhD students (11 defended, all funded) in the reference period, across several universities in France, Chile, Brazil and Portugal, and with three universities that have signed a joint-degree agreement. It further demonstrates its implication in research training for Chilean students by organising collaborative courses and research visits in international laboratories. The quality of the unit training activities translates in good PhD duration (on average 4 years and 4 months but due to longer PhDs in Portugal and Chile), high-quality scientific productions, and excellent student's entry to the job market. In addition, some members were involved in the organisation of an international summer school (Austral Summer School, Chile), and were part of "degree steering committees" (doctoral school MNHN and director of the master programme).

Weaknesses

The involvement of the researchers of the Unit in bachelor/master courses (participation, conception) seems to be modest, and the PhD students are not encouraged to seize the opportunity of the local courses to have initial teaching experience. The PhD students from the three different sites never meet each other, although this should be instructive for them. The Unit should think about a way to organise regular contacts, even electronically.

Assessment of the involvement in training through research

Involvement of the Unit in training through research is both strong and diverse, not only in France but also abroad. In particular, almost 40 master and PhD students have been welcome during the period, and most of them have found job thereafter. The Unit is excellent for this criterion.

CRITERION 2: UNIT ORGANISATION AND LIFE

Unit organisation and life From 01/01/2012 to 30/06/2017	Number
Women/men ratio in the unit	43%/57%
Women/men ratio among unit scientists	40%/60%
Women/men ratio among unit PhD students	60%/40%
Women/men ratio among team leaders, unit head and deputy heads.	22%/78%

Strengths

The UMI is spread on three sites in two countries, France and Chile, which is a challenge in terms of scientific life. To overcome this obstacle, there are regular meetings by videoconference: monthly meetings for all the staff and weekly meeting for the representatives of the three sites. The administrative manager writes the minutes, circulates information by e-mail and updates regularly the website. Finally, every year there are around 10 trips of the representatives (53 over the period), including missions of the technical staff allowing harmonisation of the experimental protocols. Thus, in spite of the distance, the cohesion of the UMI is maintained. The committee noted that the role of the administrative manager was essential with this respect, although this position has not yet been secured on a permanent basis. On the Chilean side, the unit's organization is used as a reference for an international collaboration framework.

Regarding training, the UMI organises international research training for Chilean Master's students.

Weaknesses

Although communication is very good overall within and between the sites, some organization problems seem to be caused by a lack of anticipation and/or communication between project leaders and the support staff, in particular in terms of schedule and dimensioning of experimental projects.

In terms of infrastructure, some problems of office cleaning and office space limitation due to clutter have been noticed. Technical problems associated with the videoconference infrastructure have been identified and will be dealt with. Office space in Chile for visitors from France also seems to be limiting.

Assessment of the unit's life and organization

The committee judges that the unit's life and organization is excellent in spite of the difficulties associated with multiple sites on two distinct continents, and despite the necessity to share support staff members with other structures. On the Chilean side, the unit's organization is used as a reference for international collaboration framework.

CRITERION 3: SCIENTIFIC STRATEGY AND PROJECTS

Strengths

The scientific strategy and research objectives are clearly in line with those tackled during the current contract period and in most cases, they are consistent with the ongoing projects. However, the unit will benefit from past investments leading to several recent major improvements in methodology (e.g., development of an innovative toolbox for theoretical investigations on quantitative traits; development of an experimental evolution methodology in the lab on a new biological model) or in the availability of genomic resources (genome-wide molecular markers in several model species; fully assembled genomes; collections of differentiated genotypes) and high-quality ecological databases on the target taxa that will secure the production of high quality results.

In most cases the strategies being used by the unit to study the evolution of sexual reproduction, key factors influencing speciation and adaptation, and studies of domestication and conservation/sustainability, are classical and strong. These strategies will lead to important insights into these processes

In terms of feasibility, most research objectives are associated with currently funded projects or with projects that are under evaluation. In addition, two new permanent staff members (one in each of the Chilean universities) will be recruited before the launch of the next contract, leading to a substantial increase in areas of competence and in the work force.

Weaknesses

The main difficulty that the UMI will have to deal with is the ever-increasing number of studied organisms and, for most of them, the necessity to sample in widely separated geographic regions and divergent ecological conditions. This is needed to fulfil the objective of assessing the relationship between environmental variables, functional diversity, and spatial patterns of genetic structure. The plan, in terms of the number of taxa investigated and the number of questions being addressed with each taxon, may prove to be a drawback in terms of a lack of resolution in the results, or a lack of technical or conceptual innovation because of limited resources and effort per model taxon.

Another difficulty concerns the conceptual and methodological transition from population genetic approaches, using mostly neutral molecular markers to infer historical, demographic and, indirectly, adaptation processes, to functional population genomic approaches aimed, in addition, to identifying functional genetic factors involved in sex and adaptation. Such a transition is a major step which necessitates associations of expertise (bioinformatics; population genomic statistical inference; functional genomics), and it is not clear that all such expertise will be present in the unit or that the expected collaborations will be sufficient to fill the gaps. Also the involvement in such population genomic approaches necessitates in general a focus on a very limited number of model organisms, and/or on a very limited number of focal questions, which does not appear to be the strategy followed by UMI 3614.

Opportunities offered by new technologies in functional genomic analyses (e.g. GWAS, single cell technologies, genome and transcriptome sequencing, epigenetic, or comparative genomics), and novel approaches focusing for instance on the impacts of biotic interactions and the potential involvement of infochemicals, could have received more attention to orient future directions;

Assessment of the scientific strategy and projects

The scientific strategy and projects of the unit have been considered on the whole very good.

RECOMMENDATIONS TO THE UNIT

A – Recommendations on scientific production and activities (criterion 1)

Scientific production is very good quantitatively but could be improved qualitatively, by identifying combinations of emerging technologies and original focal questions that could lead to highly innovative results that,, published in higher impact, generalist journals, would reach a broader scientific audience..

B – Recommendations on the unit's organization and life (criterion 2)

The committee suggests exploring modern information technology tools to stimulate scientific exchange among PhD students and other members of the unit from different sites. Also, top priority should be given to resolution of the videoconference infrastructure issues. Improving communication between project leaders and the support staff about forthcoming experimental projects would be useful.

C – Recommendations on scientific strategy and projects (criterion 3)

The committee strongly encourages the Unit to reconsider the use of such a large number of biological models. Focusing on the most promising ones would allow more detailed and ambitious analyses.

The expertise of the unit could be insufficient to tackle full population genomic approaches. Relevant collaborations could compensate these methodological gaps.

THEME BY THEME ANALYSIS

Theme 1: Evolution of sexual reproduction and its consequences
 Theme leader: Mr Denis ROZE and Ms Marie-Laure GUILLEMIN

THEME SCIENTIFIC DOMAINS

This research topic combines theoretical and empirical research that addresses the causes and consequences of the evolution of sex and mating systems.

THEME WORKFORCE

Theme workforce	Number 30/06/2017	Number 01/01/2019
Permanent staff		
Full professors and similar positions	0.35	0.35
Assistant professors and similar positions	0.95	1.1
Full time research directors (Directeurs de recherche) and similar positions	0.2	0.2
Full time research associates (Chargés de recherché) and similar positions	0.75	0.75
Other scientists ("Conservateurs, cadres scientifiques des EPIC, fondations, industries, etc.")	0	0
High school teachers	0	0
Supporting personnel (ITAs, BIATSSs and others, notably of EPICs)	1	1
TOTAL permanent staff	3.25	3.4
Non-permanent staff		
Non-permanent professors and associate professors, including emeritus	0	
Non-permanent full time scientists, including emeritus, post-docs	0.75	
Non-permanent supporting personnel	0.7	
PhD Students	1.7	
TOTAL non-permanent staff	3.15	
TOTAL theme	6.4	

Global assessment of the theme

Understanding the evolution of sexual reproduction and its consequences is one of the major challenges in evolutionary biology, and members of the unit working on this theme are internationally recognised leaders in this field of research.

Across several collaborative projects, members of the unit have developed theoretical work to explore (i) the evolution of self-fertilisation and its consequences on the effectiveness of natural selection using models that include the effects of gene interactions; (ii) the interactions between the genetic and ecological effects on the evolution of life cycles and the maintenance of two-stage life cycles, as observed in many seaweeds; (iii) quantitative trait models to study how selective pressures can favour sex in stable or varying environments. These theoretical developments complement empirical approaches developed in the unit on several algae species to explore the role of niche differentiation between haploid and diploid individuals in the maintenance of the haploid-diploid life cycle, and the factors favouring clonality or sexual reproduction in macro and micro-algal species. This topic has involved several PhD students and postdocs in the reference period and has promoted collaboration with several research units in Chile, France and other European countries.

The unit proposes to pursue research on this main topic for the next 5 years with the same coordinators. The projects on the evolution of sexual reproduction and its consequences are original and will have a strong impact on fundamental issues such as theoretical understanding of the effect of genetic architecture of the sexuality loci (single vs. multilocus genetic determination), the topography of the adaptive landscape, or the mode of asexual reproduction, on adaptation across time or space. These theoretical developments will be associated with studies using an elegant and very original experimental evolution approach using the rotifer model *Brachionus* allowing testing hypotheses about the role of environmental factors on driving the evolution of sexual reproduction. These studies will also contain functional and evolutionary genomic components with the aim to identify the genes and genomic regions responsible for sex determination in largely unexplored red algal models. These three types of approaches are highly complementary and the research projects are highly competitive at the international level, thanks to the reputation of the scientists involved, including both the members of UMI and their scientific collaborators

Quality of scientific outputs and activities:

The theoretical work developed in the unit is at the forefront of this field of research and has led to considerable advances in our understanding of the conditions under which sex may evolve and its consequences in terms of adaptation to environmental change. In addition, new biological systems to the study of the evolution of sex have emerged from innovative empirical work on algae that offer novel opportunities to better understand the evolution of life cycles and the consequences of genetic systems on adaptation to drastic environmental change such as the recent earthquake and its associated tsunami in Chile. The quality of scientific production (peer-reviewed articles, software, contributions at international conferences) of this theme is outstanding, especially given the very small number of colleagues involved, with an excellent publication record in the leading journals in *Evolutionary Biology* (e.g. *Evolution*, *Genetics*, *The American Naturalist*, *J. of Evolutionary Biology*) or generalist journals (e.g. *PloS Genetics*, *Current Biology*), and a large impact on the scientific community.

Academic reputation and appeal:

This research relies on long-term collaborations with partners both in Chile and in France. Moreover, over the reference period, research on this main topic has been supported by four ANR funded projects, among which three collaborative projects involving several other research units in France and one early career researcher project. This excellent funding situation is likely to continue for the next contract term, as some of the research directions proposed for the next five years have already secured some funding (ANR SexChange, ANR GENASEX, GDRI DEBMA). In addition, the organisation of international conferences on the topic (Jacques Monod conference, Roscoff, April 2013, upcoming Spring 2018), edition of a special issue in a specialised journal, or membership to the editorial board of a high-quality journal (*Evolution*) reflect the academic reputation of the unit on this theme and its willingness to be a key actor in this field of research.

Strengths

Importance of the research topic to the field of evolutionary biology and quality of scientific outputs and activities: the highly innovative research outputs (new theoretical models and novel biological systems to address

the evolution of sex and genetic systems) combined with an outstanding publication record and impact on the academic community place the research unit as a leader in this field of evolutionary biology.

International renown and attractiveness: the unit is recognised as a key international actor in this field of research on the evolution of sexual reproduction and genetic systems and has gained international reputation, as demonstrated by its involvement in several collaborative projects on the topic, its successful funding (four ANRs on the topic), its leadership of research projects (one ANR project coordinated by the unit) and its involvement in high-quality community services such as the organisation of international conferences (Jacques Monod conferences and associated special issue), expertise for national or international funding bodies (ANR, ERC,...), or action as associate editor (*Evolution* journal).

Weaknesses and recommendations

There are no major weaknesses identified. The only point that can be raised is the fact that this theme relies on two permanent PIs only, each of them working in two different countries (Chile and France). This situation may limit the development of this research topic in the unit, and future recruitments of researchers or researcher-lecturers in the unit would help structuring and reinforcing the theme further.

Theme 2: Understanding speciation processes and the ecological and evolutionary limits of adaptation

Theme leader: Mr Christophe DESTOMBE, Mr Peter VON DASSOW and Mr Pablo SAENZ

THEME SCIENTIFIC DOMAINS

Life Science domain SVE1 Agronomie, Biologie Végétale, Écologie, Environnement, Évolution; sub-domain SVE1_2 Évolution, écologie, biologie des populations.

THEME WORKFORCE

Theme workforce	Number 30/06/2017	Number 01/01/2019
Permanent staff		
Full professors and similar positions	0.4	0.4
Assistant professors and similar positions	1	1.7
Full time research directors (Directeurs de recherche) and similar positions	0.4	0.4
Full time research associates (Chargés de recherché) and similar positions	0.25	0.25
Other scientists ("Conservateurs, cadres scientifiques des EPIC, fondations, industries, etc.")	0	0
High school teachers	0	0
Supporting personnel (ITAs, BIATSSs and others, notably of EPICs)	0.9	0.9
TOTAL permanent staff	2.95	3.65
Non-permanent staff		
Non-permanent professors and associate professors, including emeritus	0	
Non-permanent full time scientists, including emeritus, post-docs	1.8	
Non-permanent supporting personnel	2.2	
PhD Students	2.8	
TOTAL non-permanent staff	6.8	
TOTAL theme	9.75	

Global assessment of the theme

The second theme of the UMI EBEA brings new insights to the understanding of speciation process in relation with ecology and evolutionary processes. As a primary output, one must underline the effort provided by the unit to genetically delineate cryptic species that are very common but yet too poorly described in the marine environment. Indeed, as explained in a seminal review written in the frame of the GDR Marco, the inventory of biodiversity in marine environments is lagging behind, hampering the work of molecular ecologists whose gene flow analyses are based on species delimitation models. Thus, thanks to the conceptual framework developed to genetically delineate cryptic species, works were carried out by the UMI EBEA to genetically delimit cryptic species and describe their distribution for some large seaweed taxa of economic or ecological interests.

The secondary outputs originate from the UMI EBEA's ability in delimiting cryptic species and typing populations at the intra-specific level, which allows the unit to evaluate (or re-evaluate) the importance of cryptic species in various circumstances. This includes studies done to gain basic knowledge on seaweed cultivation and domestication, to distinguish pre- from post-zygotic barriers in haplo-diploid species through an elegant 'life-cycle' approach (featured in the News & Views section of *Molecular Ecology*), or to reassess the phylogeographic and biogeographic patterns observed in European and South Pacific seaweeds and the historical events that "created" them. As a remarkable result, the unit showed that the parapatric process of speciation appears to be recurrent along coastlines in Brittany, (and no vicariance that was the most frequently suggested process of speciation for marine organisms to date).

Questions about coevolution and local adaptation were also addressed. To the pending question of the possible coevolution of hosts and parasites, the unit showed that the co-evolution of both parasites and hosts is possible even during a single bloom, so in a very short period of only a few weeks. In addition, by characterizing the spatio-temporal variation in the biodiversity of kelp forests confronted with global changes, the unit found a mosaic of abiotic conditions with contrasted spatio-temporal characteristics that can explain differences in genetic diversity patterns in different kelp species as well as of associated understorey species. The unit found that the diversity correlates with a mosaic of different environments at relatively small scales (such as pockets of cold water surrounded by warmer water), meaning that populations are not interchangeable. Such a fine distribution of the biodiversity is often ignored in niche models that predict change in species distributions, but it must be considered to influence the strategies proposed to define protected marine areas or natura zones.

Strengths

As computed from the report for theme 2, 18 papers have been produced for an average IF of 3.60 among which 1 review in *Mol Ecol*. The most cited journals are *Mol Ecol* (3 ; IF=6.09), *J Ecol* (1 ; 5.81). Two papers received particular distinctions: 1 review in *Mol Ecol* recommended in F1000Prime Jan. 2015) and 1 featured in the News & Views section of *Mol Ecol*.

The major output of theme 2 is the conceptual framework in which species delimitation can be formalized as a falsifiable hypothesis allowing revisiting evolutionary/speciation questions with more accurate and more relevant data. This expertise is also very important for applied research projects to develop techniques for seaweed breeding and selection programs.

In relation with theme 2, the UMI EBEA was involved in GDR Marco (partner); PIA project IDEALG (partner); ANR projects Ecokelp (coordinator), HySea and Paralex (partner). The UMI EBEA was invited to participate in several projects at local, regional national and international levels involving contracts with the Iroise Marine Park, PIA IDEALG, European BiodivERsA ERA-NET project MARFOR, H2020 project GENIALG.

The involvement of theme 2 in training through research relates with 2 PhD (A. MONTECINO, leading to 2 main papers in the frame of theme 2 and M. ROBUCHON).

The strategy for the next contract is in continuity with previous research activities about mechanism of speciation, genetic basis of speciation and relationship between speciation and diversity... The projects are devoted to the study of speciation and adaptation processes and are addressing classical questions about the role of geographic or demographic contexts as well as intrinsic factors on the processes of speciation and adaptation. However, these will be studied with modern population genomics tools and they concern groups of organisms that have been largely unexplored, despite substantial ecological importance (e.g., the keystone kelp species) or economic value (harvested algae species). Building on strong preliminary knowledge for some of the groups investigated, the project proposes elegant comparative analyses of pairs of taxa living either in parapatry or sympatry, or presenting varying levels of historical divergence, or having developed either extrinsic or intrinsic

reproductive barriers. Marine organisms sometimes show strong spatial structure despite the occurrence of stages of the life cycle with a dispersal ability expected to be high. In the project, some objectives are related to the search for factors involved in the occurrence of local adaptation in some of the models investigated, or to the study of the effect of global warming on colonization ability. Again the questions addressed and the tools that will be used are not particularly innovative, but the choice of models is original and will possibly lead to important results of general relevance. Also, the relevant choice of scientific collaborators with complementary expertise, such as the expertise in functional genomics from an IFREMER team in Brest for a project on the toxic dinoflagellate *Alexandrium minutum*, is a strong asset for the production of internationally visible results.

Question can be asked however if enough force will be available to perform all those subjects taking into account also the diversity of models investigated

Weaknesses and recommendations

While the strategy for the next contract is essentially a continuation of ongoing projects, moving toward population genomic approaches focusing on a limited selection of models and on emerging questions should be the opportunity to develop new tracks of research. Alternatively, the great variety of biological models studied by the unit could bring instead a unique opportunity to develop comparative studies to tackle specific questions such as investigating the major mechanisms underlying the speciation process in algae. This would definitively increase the scientific appeal of the unit.

Theme 3: Public policy support for societal issues involving the conservation of biodiversity from anthropic pressures: domestication and cultivation, management of genetic resources and global change

Theme leader: Mr Sylvain FAUGERON, Ms Marie-Laure GUILLEMIN and Ms Myriam VALÉRO

THEME SCIENTIFIC DOMAINS

THEME WORKFORCE

Theme workforce	Number 30/06/2017	Number 01/01/2019
Permanent staff		
Full professors and similar positions	0.25	0.25
Assistant professors and similar positions	1	1
Full time research directors (Directeurs de recherche) and similar positions	0.4	0.4
Full time research associates (Chargés de recherché) and similar positions	0	0
Other scientists ("Conservateurs, cadres scientifiques des EPIC, fondations, industries, etc.")	0	0
High school teachers	0	0
Supporting personnel (ITAs, BIATSSs and others, notably of EPICs)	1.3	1.3
TOTAL permanent staff	2.95	2.95
Non-permanent staff		
Non-permanent professors and associate professors, including emeritus	0	
Non-permanent full time scientists, including emeritus, post-docs	1.5	
Non-permanent supporting personnel	2.7	
PhD Students	1	
TOTAL non-permanent staff	5.2	
TOTAL theme	8.15	

Global assessment of the theme

Domestication, cultivation and genetic resource management applied to seaweeds are major ecological and agro-industrial issues in the context of human pressures on climate and biodiversity. In this context, the projects conducted in the UMI are particularly relevant. Conceptually, the approaches and techniques are very close to those used in plant breeding and plant genetic resource management, but the haplo-diploid life cycle of these algae models raises specific questions.

Combining archaeological and genetic data in *Gracilaria chilensis*, a red alga extensively exploited in Chile, the Unit revealed a reduction of diversity as compared to the New Zealand original form, which has never been harvested or cultivated. Thus the Chilean form could not represent a sustainable seaweed-farming model. On the other hand, two QTL detection projects were initiated, one on *Ectocarpus* to map QTLs of tolerance to temperature and salinity, the other on the brown alga *Saccharina latissima*. In the latter case, an interesting and original aspect is the comparison of the QTLs for agronomic traits detected in the haploid and the diploid phases.

The projects deal mainly with the evolutionary biology of domestication, focusing on *G. chilensis*, *Macrocystis pyrifera* and *S. latissima*. In *G. chilensis*, the domestication process led to modifications of the life cycle and mating system (in particular shifting from sexual to asexual populations). Genomic signatures of domestication, consequences of transoceanic colonization events and bottlenecks, and adaptation to diverse habitats will be analyzed from large samplings in different sites, using various genotyping-by-sequencing techniques and non-linear regression methods developed in the lab. In *S. latissima*, the goal is to gain better knowledge of the genetic resources in wild populations from Brittany and European coasts, taking also into account the tidal level. In *Macrocystis pyrifera*, ecophysiological experiments are planned to analyze possible local adaptation along Chilean coast. For these last two models, genotyping-by-sequencing techniques will also be used.

Another aspect of the domestication project deals with the biosynthesis of macromolecules, in particular for dermo-cosmetic applications. Genetic homogeneity and high concentration of the desired compounds of the material are the selection criteria.

The algal breeding project concerns the yield and other traits of agronomic interest (content in various biomolecules, stress and disease resistance) in the two brown algae *S. latissima* and *M. pyrifera*. On *S. latissima*, wild and recently cultivated forms will be compared. Similar approaches will be followed in *M. pyrifera*.

The last aspect of the Unit's project is on restocking and restoration, mainly for *G. chilensis* that is over-exploited. The challenge is here to prevent the possible negative effects of restocking.

Strengths

The expertise of the Unit in population and evolutionary genetics is excellent. It constructed various interesting segregating progeny for genetic purpose and continues to harvest and maintain biological materials of about 10 species for two decades. The genomic techniques are now available or in development for various algal species. The complementarity between the Roscoff and the Chilean labs is a valuable asset.

Weaknesses and recommendations

The unit manages numerous projects on various species, with only a dozen of permanent people. Even if none of the scientific goals seems to be irrelevant, the committee suggests prioritizing to gain in efficiency. Regarding economic issues related to seaweed exploitation, the committee suggests that contacts should be opened with economic and scientific partners from Asian countries which are the major players in worldwide seaweed production. In this regard, Chile, although a producer of food grade agar and animal feed from *Gracilaria*, represents less than 2% of world production. China and Indonesia produce 98% of these products (Kim et al. 2017; *Algae* 32:1-13).

CONDUCT OF THE VISIT

DATE(S)

Start: Friday 8th December 2017 at 08h30

End: Friday 8th December 2017 at 18h30

VISIT SITE

Institution: UMI EBEA – CNRS, Université Pierre et Marie Curie - Roscoff

Address: Station Biologique de Roscoff

CONDUCT OR PROGRAM OF THE VISIT

08h30-09h10	General presentation of the UMI by the unit director + discussion
09h10-09h40	Topic 1: evolution of sexual reproduction and its consequences
09h40-10h20	Topic 2: understanding speciation process and the evolutionary and ecological limits of adaptation
10h40-11h15	Topic 3: domestication and cultivation, management of genetic resources and global change
11h15-11h40	Meeting with ITA
11h40-12h00	Meeting with PhD and post-doc
12h00-12h30	Meeting of the experts committee with UPMC (in visioconference) and CNRS representatives
12h30-13h00	Discussion with members of the unit in Chile (in visioconference)
13h45-14h00	Meeting with researchers and professors
14h00-14h30	Meeting of directors and co-directors of the UMI
14h30-18h30	Closed-door meeting of the experts committee

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