CeMEB

CeMEB PROGRESS REPORT

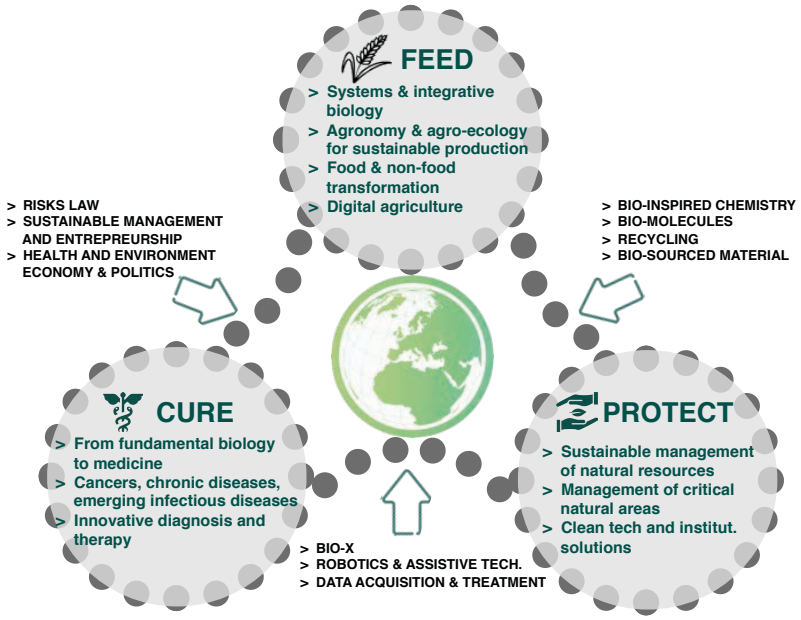
September 2018

MUSE
MONTPELLIER UNIVERSITÉ D'EXCELLENCE

www.labex-Cemeb.org

MONTPELLIER UNIVERSITY OF EXCELLENCE (I-SITE MUSE)

The « Montpellier University of excellence» (I-Site project gathers the forces of 19 institutions towards a common ambition: create in Montpellier a thematic research-intensive university that will be internationally recognized for its impact in the fiels of agriculture, environment and health. For all its consortium members, this university strives to act as the academic partner they can establish strong ties with, and on which they can fully rely.



The vision of a planet with seemingly unlimited resources is coming to an end, and the world needs to address increasing competition for limited and finite natural resources. Continuing human population growth increases the use of land to yield goods and services, resulting in substantial alteration of most ecosystems on Earth. At the same time, and in addition to their intrinsic pathologies, ageing populations faces novel health problems linked to environmental issues.

Muse intends to address three intertwined challenges:

- promoting an innovative agriculture to contribute to food security and environmental quality;
- fostering a transition towards an environmentally-friendly society;
- improving human health in changing environments.

The agriculture, environment and health sciences are Muse core sectors. However, as Muse aims at a radical transformation on these challenges, from a mono-thematic perspective to a more holistic approach, these sciences are fully connected to chemical, social, natural and computational and engineering sciences. The six Labex of Montpellier are at the core of Muse, with the unified long-term ambition to make Montpellier one of the European capitals for health and agro-environment, a true European portal for scientific issues of the Southern countries.

Dr. François Pierrot
University of Montpellier/CNRS, Executive Director of Muse

'The Cemeb Labex was created in 2011 to study the structure and dynamics of biodiversity in a context of global change based both on core disciplines such as ecology and evolution and on an interdisciplinary approach with other research fields. This is fully in line with the main scientific pillars of the Isite Muse (feed, care and protect), especially the last one. There is no question that Cemeb has reached his initial objectives in terms of research, training and transfer, going beyond initial expectations and pushing back research frontiers in many fields. No surprise that the University of Montpellier ranks first in Ecology in the 2018 Shanghai ranking, given the quality of research, and the visibility and attractivity of Cemeb scientific community. Cemeb also plays a major structuring role in Montpellier by fostering cooperation among scientific communities, but also with a large number of partners in biodiversity, from the local to the international level. This progress report presents an impressive set of activities, as well as of goals achieved by Cemeb. Cemeb is now a major player for the scientific ecosystem in Montpellier, and we are really proud of its achievements and international visibility'.

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CEMEB IN BRIEF

The Cemeb Labex ('cluster of excellence') was created in 2011 in the framework of the French Program of Investments to the Future ("Programme d'Investissement d'Avenir"). It brings together 10 laboratories of Montpellier and involves 12 partners, led by the University of Montpellier.

One of the main challenges facing society is global change, including abiotic and biotic changes at all spatial scales on Earth, setting strong pressure on biodiversity - the 6th extinction crisis. Cemeb was created to address this challenge through the reinforcement of core biodiversity sciences in order **to understand and predict the future of biodiversity in a changing world** and to bring renewed answers and solutions on a research-intensive basis. The general idea is to favor excellence and the emergence of new science fronts, the development of new technologies and tools, to strengthen international collaborations, to foster links and collaborations between research and the non-academic world (stakeholders and citizens) to speed up the transfer of research results, and to train the students, research staff and biodiversity managers of tomorrow. A main objective is also to structure the Montpellier community in biodiversity and to enhance links both among Cemeb research units and with other academic partners in an interdisciplinary perspective. Overall, the idea is to create a single, highly visible entry for all partners with regard to biodiversity issues, and to become a top player at world scale and the main European entry for Southern countries.

To meet this challenge, Cemeb develops a general strategy and policy, and a set of activities in research, training and transfer / outreach. This document cannot obviously be an exhaustive report of these activities, but provides an overview of Cemeb achievements over the 2011-2017 period (in fact, includes also activities from early 2018) **with a marked rise in activities since 2015**. I hope that the reader will be convinced that Cemeb achievements are significant, and Cemeb brings much to its scientific community and to all its partners and the society.

Dr. Philippe Jarne
Chairman of the Cemeb Labex

PEOPLE & AWARDS

1300 scientific staff (850 permanent)

13 ERC, 8 IUF members
2 members of French Academy of Sciences
13 scientific medals (CNRS)

COLLABORATIONS

16 national academic collaborations
41 international academic collaborations
35 socio-economic partnerships

HUMAN RESOURCES

12 PhD fellowships (7 defended)
16 post-doctoral fellowships (6 on-going)
41 Master internships
5 technical staff

INTERNATIONAL

H2020 Teaming BIOPOLIS project (Portugal)
CBD and IPBES meetings

12 invited foreign scientists

RESEARCH

61 research projects supported
93 scientific events (50-3000 attendees)
350 invited speakers (half international)

TRANSFER - INNOVATION

3 innovation projects supported
36 research projects with non-academic partners
10 science-society events organized

FACILITIES

Creation of a network of mutualized facilities (eg. genomics, chemical ecology..).
Acquiring high-level scientific equipment (1.7 M€)
Hiring technical staff (160 months)

PUBLICATIONS

734 publications in total (360 since 2015)
48 by PhD students and post-docs

TRAINING

39 pedagogic actions (including international)
2 professional events co-organized
9 junior research team projects (PhD-master)
120 videos produced

BUDGET

6.3 M€ of allocated ANR budget

Leverage effect (total investment / ANR contribution): 2.5

CEMEB PROJECT

OBJECTIVES AND SCIENTIFIC STRUCTURE

THE SCIENTIFIC COMMUNITY

GOVERNANCE

RESOURCE ALLOCATION

1 OBJECTIVES AND SCIENTIFIC STRUCTURE

Cemeb aims to address the environmental challenges faced by biodiversity on a research-intensive basis at the best international level, and to create a highly visible entry in biodiversity issues at world scale.

Cemeb was created to address the environmental challenges faced by biodiversity through the reinforcement of core biodiversity sciences (e.g., ecology, evolution). Its scientific project revolves around three main lines:

- **Understanding** the origin, dynamics and functioning of biodiversity, from genes to ecosystems, over various spatial and temporal scales, with a focus on adaptation and diversification and on relationships between biodiversity levels;
- **Predicting** the biological impacts of global change and assessing ecosystem dynamics and functioning in order to produce reliable and robust **scenarios** (towards a predictive ecology);
- **Proposing solutions** to societal problems, especially with regard to the consequences of global change on ecological services, by **transferring results** from research, *i.e* contributing to conservation biology *sensu lato*.

These main lines are developed and organized in much more precise topics, questions, or scientific fields in Cemeb activities in research, training and transfer / outreach (see Table PR1).

The general idea of Cemeb project is to favor excellence and the emergence of new science fronts, the development of new technologies and tools, to strengthen international collaborations, to foster links and collaborations between research and the non-academic world (stakeholders and citizens) to speed up the transfer of research results, and to the train students, research staff and biodiversity managers of tomorrow.

This is based on:

- A broad perspective ('integrative ecology') calling for input from other research fields such as the social or digital sciences in an interdisciplinary approach. This means that the activities of human societies are formally taken into account;
- Studying all forms of living beings in various types of ecosystems, from highly anthropized to pristine (if any), and from tropical to boreal, with a special focus on the Tropics and in the Mediterranean areas as highly threatened biodiversity hotspots;
- Developing research programs combining theoretical approaches, observations (including long-term ones in structured observatories) and experimental work. All these approaches are increasingly based on high-throughput and high-tech methods and fast-evolving data management calling for high-level technical competence, technological watch, and collaborative perspective.

In practice, these lines are developed through working tools and activities in **research**, **transfer** and **training**. **Interdisciplinary** topics are tackled both internally (Cemeb hosts scientists from different disciplines) and externally, especially with other Labex in Montpellier and the Maison des Sciences de l'Homme (human and social sciences topics). '**International**' is a key word in all activities, with an emphasis on human mobility. See the general scientific organization in p.8.
A main objective is also to structure the Montpellier community in biodiversity and to enhance links both among Cemeb research units and with other academic partners in an interdisciplinary perspective. Overall, the idea is to create a **single, highly visible entry for all partners with regard to biodiversity issues**, and to become a top player at world scale and the main European entry for Southern countries.

TOPICS	QUESTIONS	DISCIPLINES & METHODS
ADAPTATION, EVO-DEVO	Genetic adaptation and phenotypic plasticity in contemporary evolution	Quantitative genetics, experimental evolution, population genomics
	Epigenetics and rapid evolutionary processes	Epigenetics, experimental evolution
	Relating phenotype to genotype	Quantitative genetics, experimental evolution and ecology, population genomics
	Genomic regions involved in adaptation	Population genomics, experimental evolution
SYSTEMATICS AND CONSERVATION	Integrated approaches in systematics, including targeted organisms (pests, endangered species, quarantine...)	Molecular barcoding, systematics, e-DNA, phylogenetics
	Estimating specific and genetic diversity to identify and protect endangered taxa	Molecular barcoding, systematics, conservation, recapture experiments, biologging, e-DNA
LONG-TERM EVOLUTION	Phylogenetic analyses (molecules, traits), including mutualistic (*sensu lato*) interactions	Molecular phylogeny, systematics, paleontology
	Evolution of species assemblages in changing environments	Molecular phylogeny, systematics, paleontology, community ecology
EVOLUTION OF SPECIES RANGE (including epidemiology)	Characterizing species climatic niches and predicting their evolution under climate change scenarios	Species distribution modelling, spatial ecology, population genetics
	Characterizing host-vector-pathogen interactions	Molecular epidemiology, immunology, host recognition, ecological networks
	Effect of climate and land-use change on species interactions and assemblages	Community and population ecology, SDM, physiology, chemical ecology, ecological networks
ECOSYSTEM FUNCTIONING	Biodiversity and ecosystem functioning and resilience in a context of global changes	Bio-geochemical cycles, community and functional ecology, soils
	Quantifying ecosystem services associated to diversity and environmental characteristics, and predicting their stability	Environmental economics, social sciences, population and community ecology
	Evolution of ecosystem services (including collapse)	Environmental economics,ecology, social sciences, participatory approaches
SOCIO-ECONOMIC ANALYSES AND MITIGATION STRATEGIES	Evaluating and improving the "avoid-reduce-offset" sequence	Ecological engineering, ecology, conservation, habitat evaluation
	Optimizing spatial management of local externalities, improving cost-benefit analyses and providing decision-support tools	Environmental economics, theoretical economics, choice experiments

TABLE PR1* • Some general topics and questions addressed by Cemeb, and the relevant disciplines and methods. This is by no means an exhaustive list.

** Progress Report*

GENERAL SCIENTIFIC ORGANIZATION

2 THE SCIENTIFIC COMMUNITY

Cemeb includes since 2015 the 10 joint research units from Montpellier focusing on 'wild' biodiversity and a rich diversity of high-profile staff in research and training on biodiversity, ecosystems and environment. Each research unit brings its specificities - they are briefly described below (also in 'descriptive sheet' in Appendix). Cemeb and its constituent units gathers 12 partners, including National Research Organizations (NROs: Cirad, CNRS, Ifremer, Inra, Inrap, IRD) and higher education institutions (EPHE, Montpellier SupAgro, University Paul Valéry Montpellier, University of Nîmes, University of Perpignan), led by the University of Montpellier. The overall number of permanent staff of these unit is *ca.* 850 (37% women) and almost 450 non-permanent staff (Figure PR1).

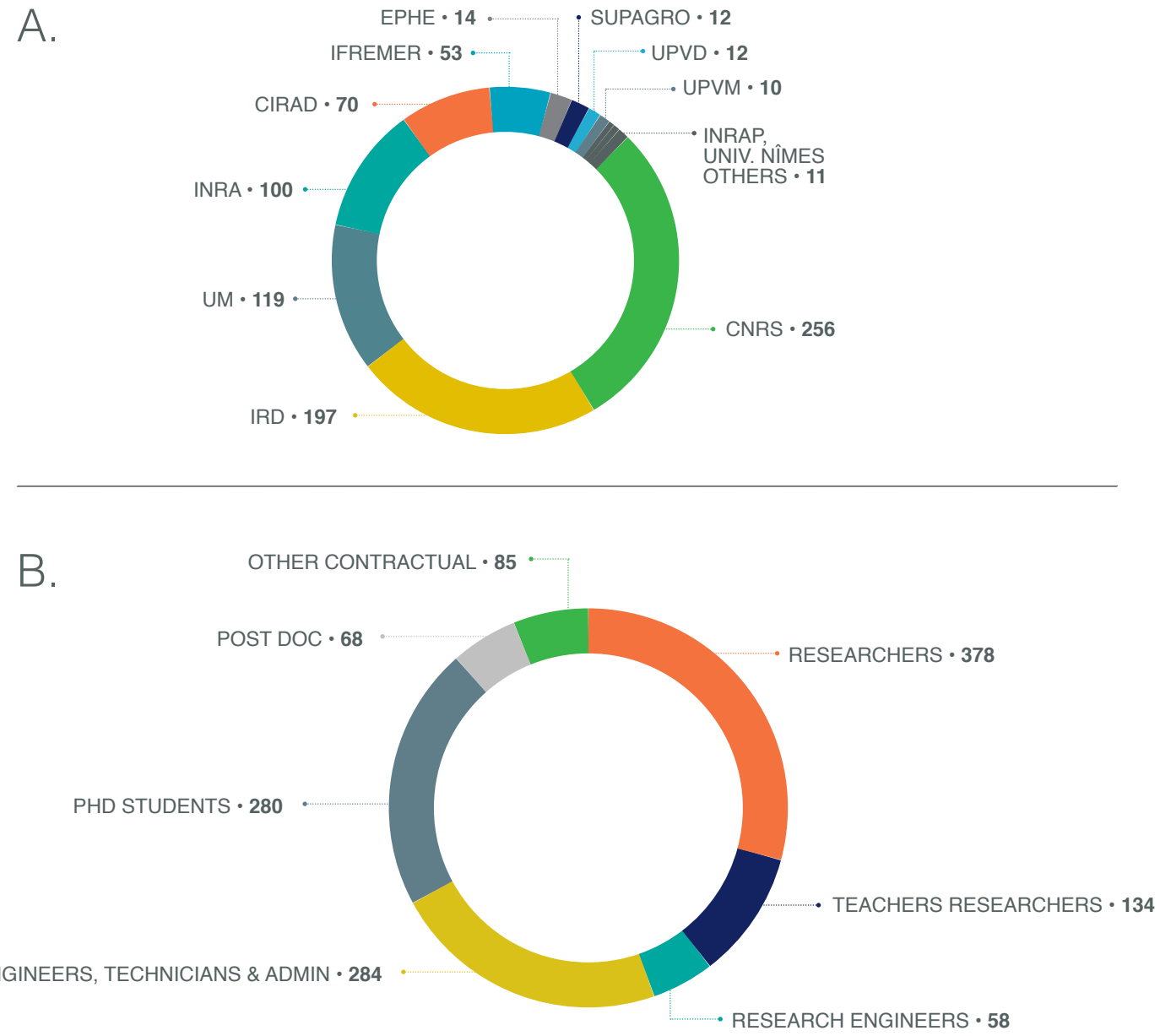


FIGURE PR1* • Permanent staff (A; total 854) with their employers and overall staff (B; total 1287) ranked by status

RESEARCH UNITS MEMBERS OF CEMEB

Amap • botAny and Modelling of Plant Architecture and vegetation (director: T. Fourcaud; **www.amap.cirad.fr/fr/index.php**; 73 permanent staff). Interdisciplinary basic research on plants and plant communities for predicting ecosystem responses to environmental forcing, in terms of biodiversity distribution, crop production, carbon storage in plants, environmental management and ecosystem services. Research on Mediterranean, temperate and tropical plant communities. Innovative research in botany, plant ecology, agronomy, forestry and in computer sciences, applied statistics and mathematics.

CBGP • Biological Center for Population Management (director: F. Vanlerberghe; **www6.montpellier.inra.fr/cbgp**; 80 permanent staff). Research in systematics, genetics and ecology relevant to the management of populations and communities for the purposes of agriculture, public health and biodiversity. CBGP characterizes biodiversity in order to understand its structure and underlying factors and to predict its evolution in a context of global changes. Basic research leads to the elaboration of scenarios or decision-making tools dedicated to the management of pest and diseases or the conservation of endangered species.

CEE-M • Center for Environmental Economics-Montpellier (ex Lameta; director: B. Magdalou; **www.cee-m.fr** ; 41 permanent staff). Research expertise on environmental public policies and behavioral economics. Research addresses themes of major interest for Cemeb (environment, natural resources and biodiversity) by relying on several methodologies (modeling, data analysis, experiments). It is strongly involved in providing policy recommendations related for instance to the biodiversity offset and mitigation hierarchy.

Cefe • Center for Evolutionary and Functional Ecology (director: R. Joffre; **www.cefe.cnrs.fr** ; 136 permanent staff). Basic research on the dynamics of biodiversity, global change, and sustainable development. Development of scenarios on the evolution of biological systems, and strategies for their conservation / restoration. Disciplines span evolutionary genetics to functional and landscape ecology, with transversal and interdisciplinary research on the ecology of human impacts. Research is conducted in a great variety of field sites around the world, with major expertise in Mediterranean and tropical ecosystems.

Eco&Sols • Functional Ecology & Biogeochemistry of Soils and Agrosystems (director: J.-L. Chotte; **www.umr-ecosols.fr**; 76 permanents staff). Research on the role of soil organisms and plants, and their interactions and environment, in biogeochemical cycles (mainly C, N and P) in agroecosystems. The biogeochemical cycles of carbon and nutrients (N / P) are studied mainly in Mediterranean and tropical areas with regard to soil component, plants and the atmosphere. Biotic and abiotic determinants of the C and nutrient flows are studied in a range of agronomic situations taking into account changing land use and climate change.

European Ecotron of Montpellier (director: A. Milcu; **www.ecotron.cnrs.fr**; 6 permanent staff) • A world-class experimental research infrastructure dedicated to the study of ecosystems, organisms and biodiversity in the context of environmental changes. The Ecotron entails three experimental platforms (Macrocosms, Mesocosms and Micocosms) that are open to national and international scientific consortia. The facilities allow to simultaneously control the climatic conditions and automatically measure ecosystem matter and energy fluxes.

IHPE • Host-Pathogen-Environment Interactions (director: G. Mitta; **https://ihpe.univ-perp.fr**, 36 permanent staff). Research on interactions involving invertebrate species of medical or veterinary interest (gastropods), aquaculture (bivalves) and ecology (corals). The influence of environmental parameters on these interactions is analyzed based on Integrative approaches, from molecular mechanisms to host-parasite communities, at the interface between (epi)genetics, ecology and evolution.

Isem • Institut for Evolutionary Sciences - Montpellier (director: A. Mignot; **www.Isem.univ-montp2.fr** ; 161 permanent staff). Research in evolutionary biology and paleontology. Evolutionary mechanisms underlying functional and structural aspects of life and biodiversity are being explored with particular interest in organism and community responses to global change. Research is based on conceptual approaches and on developing experimental tools and models (expertise in experimental evolution). Research is also conducted on the management and conservation of biodiversity, domestication and aquaculture.

Marbec • MARine Biodiversity, Exploitation & Conservation (director: L. Dagorn; **www.umr-marbec.fr** ; 139 permanent staff). Research on marine biodiversity in lagoon, coastal and offshore ecosystems, from molecules to community and includes human use of this biodiversity. Main objectives are to describe marine biodiversity and ecosystems to understand their dynamics, to analyze the impact of anthropogenic pressure on ecosystems and to propose scenarios, and to reconcile exploitation (e.g., fisheries) and conservation in order to face social expectations.

Mivegec • Infectious Diseases and Vectors: Ecology, Genetics, Evolution and Control (director: F. Simard; **www.mivegec.ird.fr** ; 96 permanent staff). Integrative and transdisciplinary research on the genetics, ecology, epidemiology and evolution of pathogenic agents, in order to improve their control. To address the conditions and mechanisms underlying the biology and transmission of (re)emergent human pathogens, Mivegec develops theoretical and experimental research, as well as new tools and strategies for sustainable control and prevention, on shared facilities and via its international establishments.

Cemeb scientific community studies a wide range of organisms (from virus to whales and trees) in all biomes, as seen from the brief description above. The core activities are genetics, evolution, ecology and paleontology, but Cemeb also includes a fraction of staff from the digital sciences, the social sciences and humanities. Some striking characteristics of this community:

- **The University of Montpellier ranks 1st in ecology in the 2018 Shanghai ranking;**
- The first French community in biodiversity, producing 20% of national publications in ecology and evolution and *ca.* 1200 indexed publications per year (20-25 in top journals) and with an H2 of 35 (35 scientists with an H factor > 35);
- 13 ERC laureates, eight IUF members and two members of the French Academy of Sciences;
- A pillar of the regional scientific community and a major constituent of the I-Site Muse project, with strong relationships with the other scientific communities (including all the PIA projects);
- Hosts world-class facilities such as the European Ecotron of Montpellier and a network of facilities (Repeb);
- An extraordinarily dense network of international collaborations, whether in developed or emerging countries, and a large number of teams (12% permanent staff) positioned abroad and in French ultramarine territories (see Figure PR2);
- Trained thousands of master and PhD students with a reputation of excellence who now occupy academic positions or work as biodiversity managers everywhere in France and abroad.

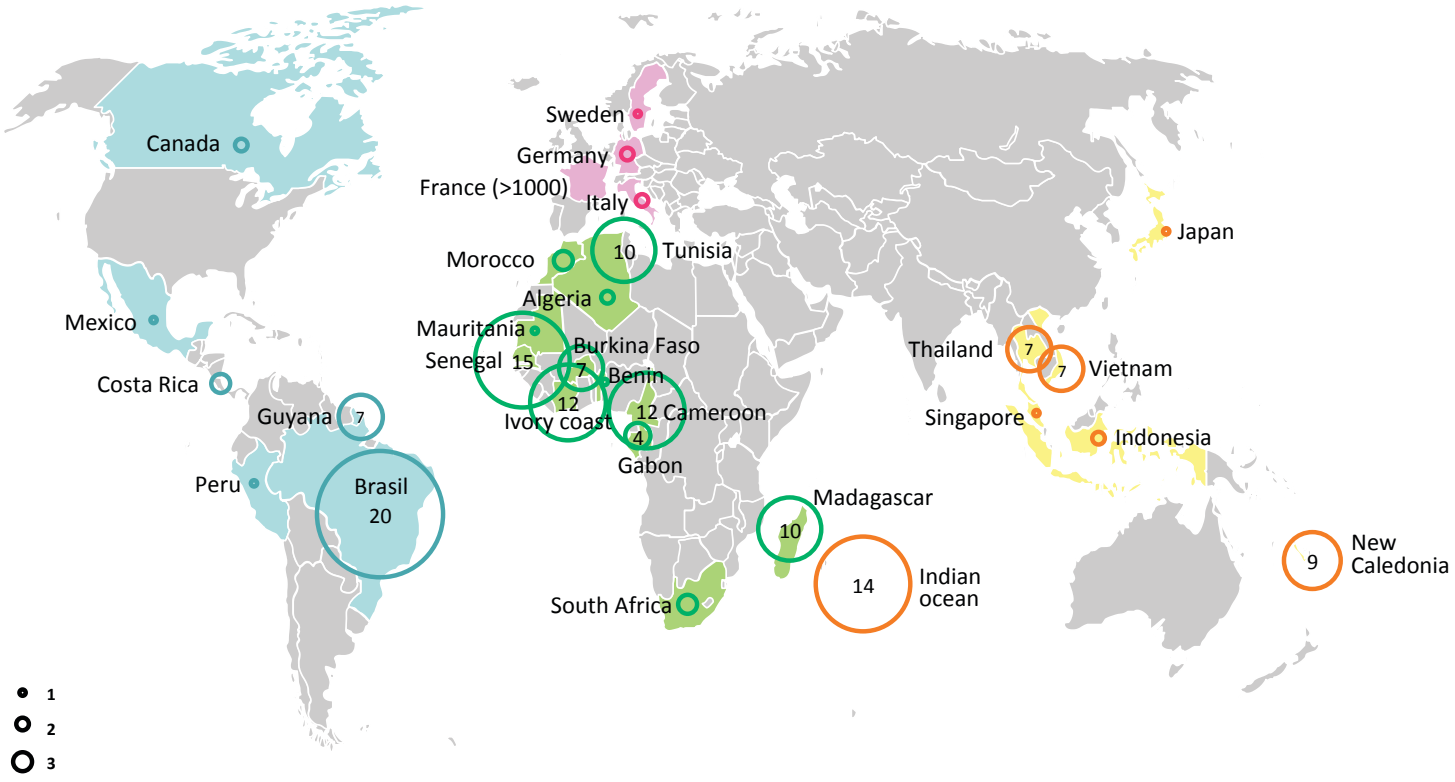
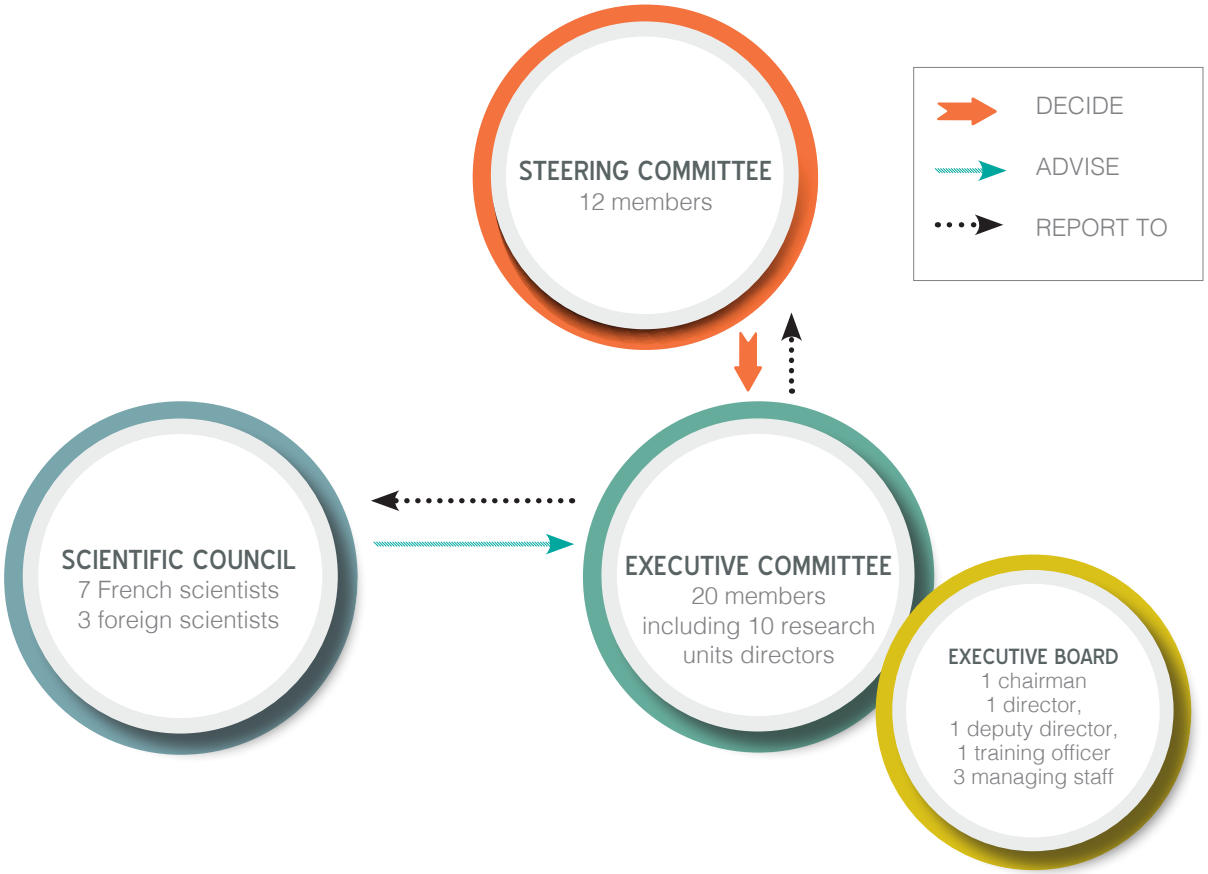


FIGURE PR2 • Geographical distribution of Cemeb staff
(number in circles, including PhD students)

3 GOVERNANCE

The bodies that ensure Cemeb governance are the council of institutional partners (or steering committee in the project), the scientific council, and the executive committee. The executive board is in charge of Cemeb management, and participates to the meetings of all governance bodies.



Council of institutional partners - Composed of a representative of each institutional partner (12 members) and chaired by the University of Montpellier, the council provides strategic and operational advices to Cemeb. It reviews the achievement and projects of Cemeb, and approves budget allocation. It meets once a year, in presence of (among others) representatives of the Region Occitanie or of the French ministry for research.

Scientific council - Composed of 10 members (foreign and French renowned researchers, representative of strategic non-academic partners and other Labex), the scientific council analyzes the strategy and activities of Cemeb, suggest sdevelopments and innovation, especially in an international perspective. It takes part in the evaluation of some projects. Meets once a year.

Executive committee - Composed of the 10 directors of research units, of 10 members elected among staff of the Cemeb community, and of the executive board, it meets 5 to 8 times per year. The committee discusses all aspects of Cemeb life (strategy, policy and activities). It takes part in the evaluation of some projects.

Executive board - Composed of Cemeb chairman, its director and deputy-director, a representative for training issues, and the management team (project manager, two assistant project managers). Meeting once a week, the board is in charge of all daily management, including the meetings of the governance bodies, and of proposing a strategy and activities to the governing bodies. Each member is in charge of specific activities.

Pr. Christophe Thébaut
University of Toulouse 1,
Chairman of Cemeb
scientific council

'The Cemeb Labex investigates the origins and maintenance of biodiversity, without restriction to organism and with a focus on the natural environment in a context of large-scale habitat loss and alterations and shrinking biodiversity. Two particular strengths of Cemeb are in the area of understanding fundamental ecological and evolutionary principles underlying organismal diversity and the interactions between organisms and their environments, and in the use of these foundations to predict the fate of biodiversity in ever-changing environments and transfer research-based solutions to the society.

Cemeb rallies a world-class research community with top international visibility and attractivity, as revealed by the recent Shanghai ranking with the University of Montpellier being ranked 1st before Oxford, UC Davis, and UC Berkeley. Cemeb uses state-of-the-art tools and technologies to develop and intensify its research activities, and it has been very successful at linking fundamental outputs to both applied and translational research. Training is also a major strength of Cemeb, with a strong involvement of the community in teaching at both undergraduate and graduate levels. Cemeb provides support to young researchers (pre-PhD and early postdocs) through a 'junior research team' program and also to a number of small curiosity-driven and exploratory projects.

What I find really impressive when examining Cemeb outputs is the large number of high-profile publications that include many significant discoveries that have attracted a lot of attention internationally. Cemeb and its research community are also organizing this Summer the largest and most international Evolutionary Biology meeting ever organized, with the four largest academic societies in the field and 2700 attendees from 60 countries.
For me, Cemeb, with no possible doubt, is today a central player for structuring and developing a research of excellence in the field of biodiversity, ecology, and evolution at the level of France and also Europe.'

RUNNING THE CEMEB PROJECT

Cemeb has been very active to foster thinking in research, training and transfer based on top-down approaches (commissioned by Cemeb) and bottom-up approaches (e.g., open call for ideas in 2015), requiring large numbers of meetings with many partners (2 to 3 / week). Cemeb organized working groups on specific themes of all aspects of its scope, whether scientific (e.g., epigenetics, ecological compensation), technological (e.g., biologging, microbiology) or organizational (e.g., network of facilities, collections). Most activities were launched based on competitive open calls for projects (2 to 3 /year), including detailed evaluation procedures, and projects were evaluated by internal (Cemeb scientific community) and external reviewers.

Cemeb set procedures to reach its objectives and to ensure quality assurance on all activities. Transparency results from open discussions in all governance bodies and fast reporting of activities and decisions. The executive board presents its activities very regularly to all participants. The Cemeb day (every year, in conjunction with the scientific council) allows returning results in research and training. The whole chain of procedures is discussed, written down, and evaluated in an auto-recursive process.

Cemeb built a list of performance indicators (see Appendix), including the ones that are asked for by ANR in the annual reports. Cemeb has also built an evaluation sheet that is sent to all funded projects and one dedicated to Cemeb technological facilities. This allows continuous adjustments to take into account success, failures and opportunities in a fast-evolving (French) academic world.

A marked rise in all activities can be noticed in the presentations below after 2014 with the hiting of a project manager and the anlargement of the executive board in (late) 2014.

4 RESOURCE ALLOCATION

The total budget initially allocated to Cemeb by the PIA program is 6.3 M€ (*ca.* 0.7 M€ / year). Budget allocation is proposed by the executive board, and validated by the executive committee and by the council of institutional partners. As the result of a rising increase in activities, **81% of the budget was spent during the 2015-2018 period (17% for 2011-2014)**. The remaining part has already been committed (and partly spent) for the 2018-2021 period (ANR allowed the Labex to spend funds till 2022).

Given the relatively limited budget, strong choices were made on Cemeb strategies and activities. Cemeb chose to sustain tools that can be used by the whole community (e.g., up-to-date facilities), to push exploratory projects (seed-money; rather than costly flagship projects) and to strongly invest in scientific meetings of all kinds and in networking.

For the 2011-2018 period, more than 80% of the budget has been devoted to research activities (Figure PR3). The PhD and post-doctoral programs accounted for 35%, and the exploratory research program (initiated in 2016; running until the end of 2020) for 12%. Cemeb allocated one third of its resources to Repeb, the network of technological facilities (equipment and staff). 4% were devoted to inviting colleagues, and 5% to organizing meetings, workshops, conferences and seminars. Training accounted for less (3%) including the original 'junior research teams' program - note though that part of the money allocated to PhD programs or technological facilities are relevant to training. Transfer and outreach accounted for about 3% (networking is not extremely costly, though time-consuming). 12% was devoted to project management (essentially staff salaries). International and interdisciplinary aspects were indeed sustained through most of these activities.

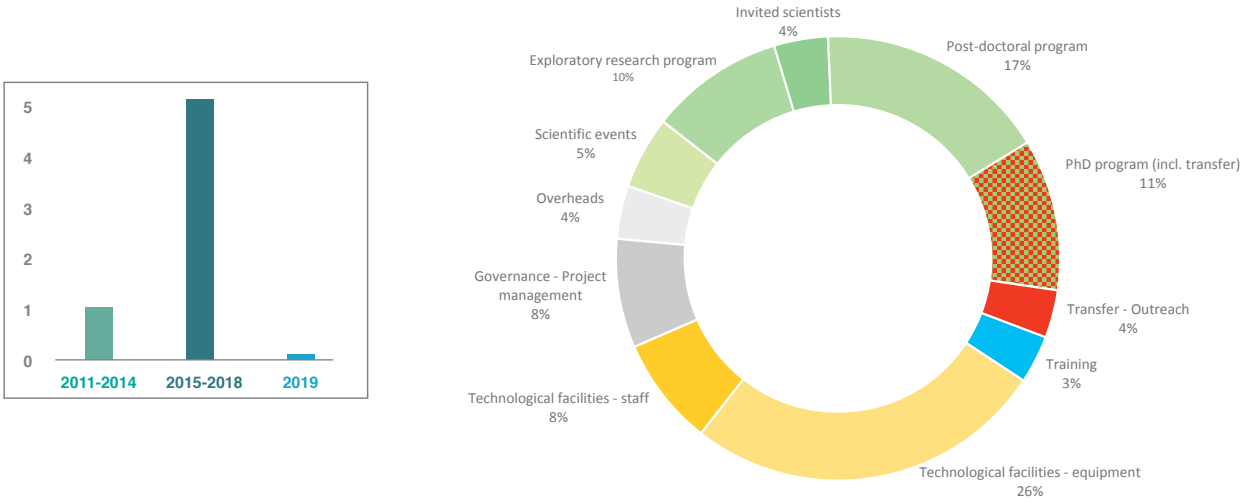


FIGURE PR3 • Cemeb resource allocation over the 2011-2018 period (overall ANR budget is 6.3 M€). 80% spent since 2015, see insert

Cemeb benefited from co-funding (5.2 M€ ; Table PR2) from various sources, especially with regard to facilities and PhDs. Cemeb partners (institutional partners and other external partners, such as the Occitanie region), contributed a total amount of 4.4 M€ for facilities, including large-scale projects such as building new greenhouses (2.5 M€) or creating the regional cluster on volatil organic compounds (0.8 M€). Co-funding for PhD and post-doctoral programs came from other Labex, institutional partners and private foundations (e.g., tour du Valat), non-academic partners from the public (e.g., French Agency for Biodiversity) and the private sector (e.g., NGOs, private companies). The total amount was 0.8 M€.

Cemeb plays a leading role in some European projects, such as the H2020 teaming Biopolis project with the University of Porto (www.up.pt) - this project was pre-selected, and should return *ca.* 15 M€ (2 M€ for the French part) if selected at the end of 2018. Moreover, Cemeb funds, whether awarded directly to research teams (e.g., exploratory research projects) or to facilities, serve as a basis for more ambitious national and international projects (e.g., ANR, ERC).

	ANR BUDGET	EXTERNAL FUNDING
PHD FELLOWSHIP PROGRAM	695 000	360 000
POSTDOCTORAL PROGRAM	1 070 000	425 000
TECHNOLOGICAL FACILITIES EQUIPMENT	1 620 000	4 380 000
TOTAL	3 385 000	5 165 000

TABLE PR2 • Additional external funding generated by Cemeb ANR activities (2011-2018)

CEMEB ACTIVITIES

RESEARCH

TRANSFER AND OUTREACH

TRAINING

INTERNATIONAL ATTRACTIVITY

INTERDISCIPLINARITY

STRUCTURING EFFECT

PUBLICATIONS

1 RESEARCH

Unsurprisingly, research has been at the center of Cemeb strategy and activities. The Labex indeed aims at developing research excellence, mutualization of technological means, promoting the emergence of new themes, approaches and technologies, within Cemeb community and with other communities, especially targeting young researchers and international collaborations. Cemeb set up working groups and organized tens of meetings to foster scientific thinking on a variety of topics, questions, disciplines and methods (Table PR1). In practice, Cemeb sustained four main activities, *i.e.* research projects, scientific meetings, hiring young researchers and foreign colleagues, and network of facilities. They are presented in turn below, together with a focus on specific aspects.

RESEARCH PROJECTS

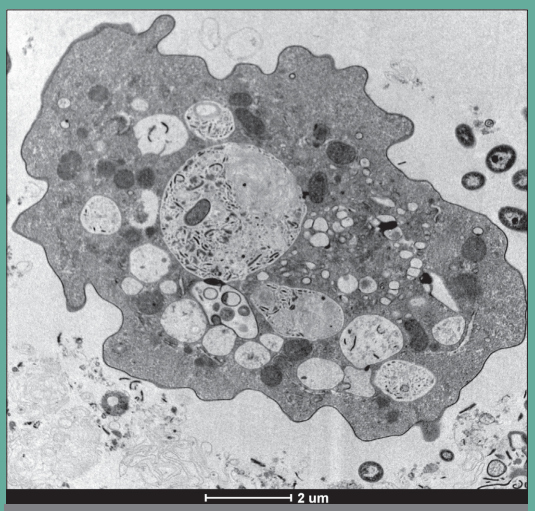
Cemeb sustains exploratory research projects based on newly established collaborations between Cemeb research units (2017 & 2018; 25 K€/project; 25 projects) that will serve as foundations for more ambitious projects (e.g., ANR or ERC) covering a wide range of themes with e.g. seven including genomics and epigenomics (Table PR3). Publications will come later. At least two projects gave rise to ANR projects in 2018.

Project title	PI	Host units	International partner
Functioning of soils under wetland raised-field agriculture	D.McKey / P. Hinsinger	Cefe / Eco&Sols	_
Biotic responses of faunas and floras to abiotic changes in deep time	C. Girard B. Meyer-Berthaud	Isem Amap	–
Exploring marine amoebae and their endosymbionts as an environmental intracellular adaptive niche for pathogen emergence	G. Charrière O. Duron / JC Auguet	IHPE Mivegec / Marbec	–
Olfaction, hearing, evolutionary history behaviour, Anatomy, CT scan, Cetartiodactyla	A. Célérier M. Orliac	Cefe Isem	–
Investigating the role of sex chromosomes in reproductive isolation and speciation	PA Crochet F.Veyrunes	Cefe Isem	CIBIO Portugal
Puumala diversity and evolution	G. Castel / F. Chevenet	CBGP / Mivegec	_
Effect of (xeno)estrogens in skeleton development: a comparative approach in chondrichthyan and teleost fishes	M. Debiais-Thibaud E. Farcy	Isem Marbec	–
Domestication impacts on plant-insect-bacteria interactions	E. Kazakou MP Chapuis	Cefe CBGP	–
Plant functional biogeography in the Mediterranean	E. Garnier / E. Véla	Cefe / Amap	CIDE, Spain
Environmental and evolutionary drivers of species distributions and range limits	G. Guila C. Brouat	Isem CBGP	Wits University South Africa
Zimbabwe bat viruses screening	F. Liegeois / S. Morand	Mivegec / Isem	University of Zimbabwe
What biological mechanisms link biodiversity to tropical forest functioning? A tree experiment in Brazil	J. Guillemot X. Morin / E. Nicolini	Eco&Sols Cefe/ Amap	University of São Paulo, Brazil
Uncertainty in scenarios of biodiversity	Y. Shin / P. Verley	Marbec / Amap	_
Wild host diversity: How to estimate and detect pathogens?	E. Miguel S. Chamaillé-Jammes	Mivegec Cefe	University of Zimbabwe
Epigenetics of inbreeding depression	P. David / C. Grunau	Cefe / IHPE	_
Disentangling functional and effective dispersal in a nest ectoparasite of colonial seabirds and its eco-epidemiological consequences	K. McCoy R. Choquet	Mivegec Cefe	–
Evaluating the aesthetic value of biodiversity	N. Mouquet B. Schatz / J. Deter	Marbec Cefe / Isem	–
Convergent evolution in ape malaria agents: from genotype to phenotype	F. Prugnolle R. Galinier	Mivegec IHPE	–
Rapid adaptation of plants to global change: exploring the role of epigenetics	PO Cheptou E. Imbert	Cefe Isem	–
Evolutionary rescue of bacterial populations facing bacteriophages, antibiotics and a combination of both stresses	R. Froissard G. Martin	Mivegec Isem	–
Role of viral haplotypes in viral fitness	JM Escoubas JC Avarre & O. Kaltz	IHPE Isem	–
Does personality explain spatial spread of invasive wild mice in Senegal? Behavioral ecology and population genomics approaches	C. Brouat C. Smadja	CBGP Isem	–
Relaxed selection at immunity genes in insular populations? A test using a population genomics approach	B. Nabholz C. Doutrelant	Isem Cefe	CIBIO Portugal
Nitrogen associated nutrient cycling strategies among jointly growing plant species and their implications for ecosystem services	Z. Mao I. Bertrand	Amap Eco&Sols	Chinese Academy of Sciences (CAS), China
Identification of novel mechanisms to study differential responses to salinity stress in the euryhaline teleost Dicentrarchus labrax	C. Lorin-Nebel C. Cosseau	Marbec IHPE	–

TABLE PR3 • Exploratory research projects sustained by Cemeb (2017-2018)

FOCUS The AmibAdapt project (IHPE / Mivegec / Marbec)

Exploring marine AMoebae and their endosymbionts as an environmental intracellular ADAPTive niche for pathogen emergence - This project was proposed by researchers from three research units from Cemeb, Guillaume Charrière (IPHE), Olivier Duron (Mivegec) and Christophe Auguet (Marbec), in the framework of the 2017 'Exploratory research projects'. It will be conducted in 2018-2019.



© Etienne Robino

An amoeba belonging to the *Vannella* genus using transmission electron microscopy to explore its internal complexity and visualize endosymbiotic bacteria. This amoeba was isolated from a seawater sample from the Thau lagoon in France.

The project focuses on free-living amoebae that are bacteria predators feeding by phagocytosis. Some bacteria have evolved strategies of resistance to amoeba predation and behave as facultative or obligatory endosymbionts. Among the diversity of freshwater amoeba endosymbionts, a majority belongs to clades that contain known pathogens for humans and other metazoans, including Legionnellales.

Two amoebae endosymbionts from this group have recently been described from marine isolates. In addition, the PIs found that some Vibrionaceae can behave as facultative intracellular pathogens and resist predation by marine amoebae. Therefore, some pathogens may emerge by acquiring resistance and virulence traits under selection by amoebae. The project objective is to investigate the untapped diversity of free-living amoebae endosymbionts in marine environments to characterize this potential adaptive niche for emerging pathogens. It will develop in three directions: (i) exploring the diversity of marine amoebae endosymbionts, (ii) defining the co-evolutionary history of marine amoebae with their endosymbionts, and (iii) characterizing the mechanisms of interactions between amoebae and bacteria. The project is based on analyzing strain diversity and relationships using genomic and phylogenetic approaches, and amoeba-bacteria interactions through trait phenotyping from the individual to the population level. It will make heavy use of Cemeb network of facilities, especially in genomics and bioinformatics.

SCIENTIFIC MEETINGS

Cemeb organized working groups on various themes, and sustained one large meeting (500 to 3000 attendees) per year and smaller, more focused meetings organized in Montpellier (Table PR4). Cemeb also organizes a weekly seminar in ecology and evolution (initiated in 1979) and the prestigious annual Thaler lecture (e.g., R. & P. Grant in 2016, J. Bascompte in 2017). Overall Cemeb organized / co-organized 30 meetings and funded 47 meetings since 2015 *vs.* 16 over the 2011-2014 period.
Several conferences were filmed (see Cemeb website). Table PR4 provides an overview of the diversity of meetings since 2015 - note that the large conferences (L) were organized by scientific societies and are mentioned when Cemeb funded them and participated to (part of) the organization.

Years	Name	Partners	Attendees
2015	JD Lebreton jubilee	Cefe	M
	Scientific days of the Montpellier experimental greenhouses network	Resem	M
	Environment, society and climate change: impacts and scenarisation		L
	Microbiome worshop		S
	International & European congress for conservation biology		L
2016	Epigenetics in ecology and evolution		M
	Ecosummit		L
	Philosophy of Nature in the Anthropocene		S
	Research in natural protected areas	French agency for biodiversity	M
	Association for tropical biology and conservation		L
2017	Ecological compensation and mitigation hierarchy	Occitanie region, Dreal	M
	CRISPR Cas 9: from biology to ethics	Agro and EpiGenMed Labex	M
	Biologging	Numev Labex	S
	Plant modelling	Agro and Numev Labex	S
	Presentation of Cemeb platforms and associated research projects		S
	1st French science society assizes	MSH	M
	Tribute to Isabelle Olivieri	Isem	M
2018	Adaptation of organisms to their environment	Agro and Tulip Labex	M
	Greenhouses professionnal network conference	Resem	M
	Vectopole - Innovative strategies to control insects vectors	Mivegec, EID	S
	Scientific strategy of the French agency for biodiversity	French agency for biodiversity	M
	Nagoya Protocol - Access and Benefit-Sharing	Agro Labex and FRB	M
	Evolution 2018		L
	Ecological fonctions of cultivated soils	Eco&Sols	S
Recurrent	Ecolotech (5 years)	IEGB Master	M
Recurrent	Cemeb scientific days (2 years)		M
Recurrent	Resem Greenhouses professionnal network conference (2 years)	Resem	M

TABLE PR4 • Main scientific meetings (co)organized by Cemeb since 2015
Audience: **S**: less than 100 attendees - **M**: between 100 and 400 attendees - **L**: more than 400 attendees
Resem: network of scientific greenhouses in Montpellier; MSH: house of human sciences;
IEGB: ecological engineering and biodiversity management

FOCUS CRISPR-Cas 9: from biology to ethics

A meeting co-organized by the Agro, Cemeb and EpiGenMed Labex (2017, Montpellier, 400 participants). CRISPR-Cas9 is increasingly used in biology to edit genomes in a targeted fashion, because of its efficiency, its superiority to all previous alternatives and its limited costs. It is routinely used in functional genomics, and increasingly in bio-health, agronomy and biodiversity sciences. However, it is also problematic in many respects, going from biological (e.g., off-targets), agronomical / ecological (e.g., genetic dissemination) and ethical / societal (e.g., GMOs) aspects. This one-day meeting gathered scientists from biology, agronomy, ecology, law and philosophy who exposed the state of the art and current / potential uses. The last part of the meeting was devoted to a round-table on the societal and ethical consequences of using CRISPR-Cas9 – the debate was supervised by a scientific journalist specialized in these issues. The meeting was deemed very useful in technological terms, but also for arising the consciousness of scientists on hard ethical issues.

HIRING YOUNG RESEARCHERS AND INVITING FOREIGN COLLEAGUES

Cemeb develops an active policy in human resources targeting three categories of scientists (PhD students, post-doctoral associates and foreign colleagues), as well as master students. Cemeb (co)funded 12 PhD theses (5 initiated since 2015) and 16 post-doctoral fellowships (all since 2015) to develop projects either with other Labex in Montpellier or with non-academic partners (Tables OPR4 & PR5). Themes were again very diverse, with e.g. three on modelling and four on societal issues (conservation biology). These young researchers have been very productive, with a rising number of publications (40 since 2015). Importantly, six of these post-doctoral associates (out of eight finished) have already found a permanent position, either in France (three) or abroad (Canada, Germany and Ivory Coast). 41 master internships were also funded by Cemeb (ca. 3 K€ / student), especially to conduct work on the technological facilities, and in the exploratory research and junior team projects.

Cemeb also funded 12 visits of foreign scientists from both Northern and Southern countries, all since 2015 (2 to 3 months fellowships with most visitors staying for longer periods, up to one year; Table PR7). They again worked on a variety of topics, generally on projects involving two research units from Cemeb. They all contributed to Cemeb dynamics, giving seminars (compulsory), teaching courses and/or organizing scientific meetings. They have already published 14 articles in collaboration with Cemeb scientists.

Period		Name	Project	Host unit
2011	2014	Laetitia Blanc	Population dynamics in rare and elusive species: the case of the European lynx	Cefe
2012	2015	Alaaedine Hammoudi	Mathematical analysis of a nonlinear model of soil carbon dynamics	Eco&Sols
2013	2016	Simon Potier	Ecology of birds: visual abilities in raptors	Cefe
2013	2016	Florian Holon	Species richness and anthropogenic pressures in French coralligenous assemblages	Isem
2013	2016	Coralie Merle	Improvements of sequential importance sampling algorithms for likelihood inference of demographic parameters	CBGP
2013	2016	Diane Bouchet	Ecological succession and influence of mowing in road slopes plant communities in Mediterranean southern France	Amap
2014	2017	Maeva Leitwin	Assessing genome-wide impact of hatchery strain individuals into local, wild Mediterranean populations of brown trout (Salmo trutta)	Isem
2015	2018	Emeline Sabourin	Dynamic of fasciolosis in a highly anthropized environment : the Camargue area	Mivegec
2015	2018	Tangi Le Bot	Influence of a predictable, anthropogenic source of food on the spatial ecology, the eco-energetics and the populational dynamics of a marine predator	Cefe
2016	2018	Sebastien Villon	Video-based automated estimation of the biodiversity and of the abundance of coral fishes by means of an deep-learning algorithm	Marbec
2016	2019	Orianne Tournayre	Conservation of Rhinolophus ferrumequinum in Poitou-Charentes: structure, genetic diversity and viability of colonies	CBGP
2017	2020	Ghais Zriki	Integrative study of interactions within a loose association (host - micropredator - non-hematophageous arthropods): toward an agroecological management of poultry livestock buildings.	Cefe

TABLE PR5 • PhD theses (co)funded by Cemeb. The seven first have been defended


Florian Holon

FOCUS

Florian Holon did his PhD between 2013 and 2015 at Isem in partnership with the private company Andromede Oceanologie (France) on the subjet 'Interactions between marine ecosystems and anthropogenic pressures, with applications for the monitoring and the management of Mediterranean coastal waters'. He proposed the first cartography of both *Posidonia oceanica* seagrass beds and coralligenous reefs along the French Mediterranean coastline, and modelled the decline of seagrass beds in relation with human pressure. This led to the definition of management priority areas, to seven publications and two participations in international workshops. F. Holon has since then been associate manager of Andromede. The results are available online for public and professional use (Medtrix platform), and used in the European Directives DCE and DCSMM. The project also has very interesting outputs, since a second thesis has been engaged by Isem and Andromede funded on Cifre money (a national program devoted to interface research), and to new collaborations with the Marbec research unit. It also led to the creation of the Air to Sea LabCom funded by ANR for three years, and the hiring of a post-doctoral researcher.

Period		Name	Country	Host unit	Project
2015	2016	Olga Bykova	Canada	Cefe	Reproduction under water stress and predictions of oak species distributions in a changing world
2015	2016	Ludovic Ahoua Alou	Benin	Mivegec	The repulsive against the transmission of vectorial diseases in a changing world
2015	2016	Florentine Riquet	France	Isem	HipposScope: genetic monitoring of sea horses populations in partnership with the actors of the territorial development and a company of state-of-the-art genotyping
2015	2016	Anne-Charlotte Vaissière	France	CEE-M	Ecological compensation : environmental performances and economical efficiency of an emergent public policy
2015	2017	Matthijs Van der Geest	Netherlands	Marbec	Can mutualistic networks increase resilience of seagrasses to global change?
2015	2017	Vincent Bourret	France	Cefe	Biomedical and ecological approaches for the conservation of Albatros populations threatened by infectious diseases
2015	2017	Eve Miguel	Hong-Kong	Mivegec	Understanding the role of camels in the epidemiology of MERS (Middle East Respiratory Syndrome Coronavirus) outside the Arabic Peninsula
2017	2019	Vincenzo Gervasi	Italy	Cefe	Sharing space with large carnivores in a human-dominated continent: An interdisciplinary approach to understand coexistence patterns and build trans-boundary management tools for Europe
2017	2019	Nicolas Rode	France	CBGP	Spatio-temporal variation in insecticide resistance in the invasive spotted wing *Drosophila suzukii*
2017	2019	Coralie Calvet	France	Cefe	Ecological compensation : modelling the organization of the territory and predicting its evolution to anticipate and plan the application of mitigation hierarchy
2017	2019	Thierry Chambert	France	Cefe	Adaptive monitoring of Golden eagle populations in the French national parks: differentiated and complementary strategies for large-scale populations
2017	2019	Álvaro Mateos González	Espagne	Isem	Asexual adaptation under mutation selection and drift : stochastic and deterministic dynamics
2017	2019	Cynthia Tedore	US	Cefe	The role of efficient coding in mate choice
2017	2019	Vitor Pavinato	Brasil	Cefe	Detection of loci under selection from temporal population genomic data through ABC random forest
2017	2019	Elcio Abrahão	Brasil	Cefe	Lingua Franca in agriculture and biodiversity
2017	2019	Benjamin Linard	France	Isem	Orthology prediction: bridging the gap between graph-based and gene-tree-based methods in the era of high-throughout sequencing

TABLE PR6 • Post-doctoral fellowships (co)funded by Cemeb


Eve Miguel

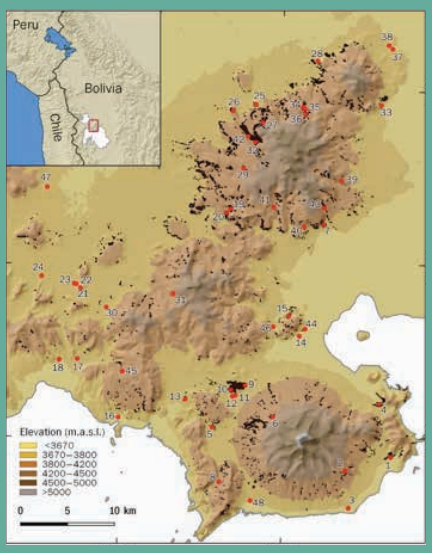
FOCUS

Eve Miguel, after a PhD completed in 2012 at the University of Montpellier and a post-doc at Imperial College, London, was hired by Cemeb on a two-year post-doctoral position (2015-2017) to develop a project entitled 'MERS-CoV (Middle East Respiratory Syndrome Coronavirus) outside the Arabian peninsula' in the Mivegec research unit. Human cases of MERS-CoV have indeed exploded in the Arabian peninsula, due to spillover from dromedaries. The project aimed at characterizing the virus dynamics outside the Arabian peninsula based on population genetic and phylogeographic approaches. It involved colleagues from three African and two Asian countries allowing wide-scale sampling, and several students from these countries did their Master internship (in ecology or veterinary sciences) on the MERS project. The study showed that the virus is very common in African camelids, but absent from central Asia. The African form also seems less likely to be transmitted to humans. Moreover, the project set the focus on the role of commercial exchange and camelid management on population structure. It resulted in five publications (one in PNAS), four communications (including at meetings co-organized by the World health organization) and four seminars. Importantly, E. Miguel got a (very competitive) permanent IRD position in 2017 to go on with this project at Mivegec in a wider thematic and geographic perspective. She since then secured two grants from the NIH (USA; 175000$) allowing to hire an Ethiopian student to do his PhD in Montpellier, in collaboration with the University of Hong-Kong.

Period		Name	University	Country	Host unit	Project
2015	2016	Ulrich Mayer	University of British Columbia	Canada	Eco&Sols	Coupling Root architecture and functions with reaxrive transport processes in soil
2015	2015	Philipp Gerrish	University of New Mexico	USA	Isem	Quantitative prediction of adaptation trajectories under realistic mutational models - The promise of recombination inhibitors as alternative antimicrobial agents
2016	2016	Donald Waller	University of Wisconsin	USA	Isem	Identifying the ecological and genetic determinants of species persistence in the context of global change.
2016	2016	Pablo Cruz	Instituto Interdisciplinario Tilcara	Argentina	Cefe	Long-term agro biodiversity: Collecting archaeological, paleo-ecological, and genetic data for a 2000-year perspective on quinoa cultivation in the arid Andean highlands
2016	2016	Robert Myers	IUCN	USA	Marbec	The development of the international databases and the "data mining"
2016	2016	Ruth Hufbauer	Colorado State University	USA	CBGP	To specialize or not: testing theoretical predictions for the evolution of specialists and generalists
2017	2017	Mohamad Hassan	Tichreen University	Syria	Isem	Demarcation of stocks and demographic inferences on populations of halieutic interest from scans high-density genomics: Mediterranean study case
2017	2017	Joanna Bridger	Brunel University London	United Kingdom	IHPE	Nuclear spatial storage of epigenetic information
2017	2017	Yiqi Luo	University of Oklahoma	USA	Ecotron	Development of an Ecotron real-time model-experiment system
2017	2017	Denis Reale	Université du Québec à Montréal	Canada	Cefe	Personality, plasticity of the decisions of reproduction, and protection of assets to the blue tit
2017	2017	Nathan Ran	Hebrew University of Jerusalem	Israel	Cefe	Movement Ecology, migrating birds and parasites and vulture foraging studies
2017	2018	Gregory Lanzaro	University of California, Davis	USA	Mivegec	Characterization of malaria transmission in Madagascar: population genomics of malaria vectors

TABLE PR7 • Scientists invited by Cemeb for 2-3 months stays

FOCUS




Pablo Cruz

Pablo Cruz is a researcher at Conicet in Jujuy, Argentina, working on issues at the border between archeology and biodiversity. He spent three months in 2016 at Cefe funded by Cemeb and hosted by Drs. Thierry Winkel and Richard Joffre. They worked on historical agro-biodiversity based on archeological, paleo-ecological and genetic data to reconstruct the history of quinoa cultivation in the arid Andean highlands over the last two millenia. This stay is part of a wider project including field work and GIS analyses of field sites by the whole team. The project allowed to strengthen collaborative work between scientists working on current and past biodiversity in an interdisciplinary perspective.

This work resulted in two papers, one in Scientific Advances that was widely publicized by CNRS (see map of the area surveyed on the left), and several are in preparation. Dr. P. Cruz gave two seminars on different facets of his work, including the current project. The collaboration is going on, and gave rise to another project (Panachi) that was recently funded by the MSH Sud in Montpellier, including other teams in humanities from Montpellier.

THE NETWORK OF TECHNOLOGICAL FACILITIES

Cemeb sustained shared facilities, now a recognized network (Repeb, holding for network of facilities in environment-biodiversity) created in 2018 and managed by Cemeb. Cemeb also sustains the activities of Ecotron (the most-visited research facility of Montpellier by foreign delegations). Repeb is made of six facilities (Table PR8), and each might be subdivided (e.g., environmental genomics includes genomics, epigenomics, qPCR, cytogenomics and degraded DNA). Repeb sustains hundreds of research projects per year, including high profile ones (e.g., all ERC projects work on at least one facility), some of which using several facilities at once (e.g., genomics and bioinformatics). It stimulates new research directions, organizes scientific meetings, training and technical courses, technological watch and the development of new methodologies, and fosters collaborations and networking with other regional and national facilities. Cemeb organized/funded equipment acquisition (*ca.* 170 K€/year), hired high-level technical staff (24 months/year; e.g., engineer developing computer codes on MBB facility), and organized / improved procedures (tending towards ISO-like certification).

Cemeb, through Repeb, developed an extremely ambitious policy and got strong leverage effect (2.5), being leader in the creation of new facilities in Repeb (epigenetics and vectopole in 2017), or in large-scale projects. This includes the creation of new greenhouses (2.5 M€) or of a regional pole on volatile organic compounds gathering research groups and facilities in ecology, food-processing and industrial use (1.6 M€) with Cemeb partners and the Occitanie region. Repeb is extremely productive with 305 publications over the 2015-2017 period, the development of an open software in chemical ecology and of several methods. Three non-permanent staff working in Repeb got permanent positions from Cemeb partners.

Technological facilities	Name Hosting unit/structure	Mission and activities
Environmental genomics	**Genotyping & sequencing** Isem	Genetic and genomic analyses of biodiversity: automated preparation and quality control of DNA and RNA samples, library preparation and sequencing / genotyping using standard or NGS sequencing
	Epigenomics IHPE	Epigenetic and epigenomic analyses of chromatin marks (bisulfite sequencing, ChIP-seq): from library preparation to sequencing and data analysis
	Analysis of degraded DNA Isem	Extraction and quality control of DNA from degraded or contaminated samples (non-invasive samples, museum specimens, herbals, archeological remains…)
	Evolutionary cytogenomics Isem and CBGP	Chromosome preparation and observation from all types of organisms (caryotypes, *in situ* hybridization…) for genome architecture studies, analysis of gene / chromatin / chromosome functions
	High-throughput qPCR UMS Biocampus	High-throughput quantitative PCR for gene expression analyses and genotyping
Bioinformatics	**Montpellier Bioinformatics & Biodiversity** Isem	Development and implementation of online software and data storage, databases for statistical analyses in ecology and evolution
Green experimentations	**Tropical ecology** Eco&Sols	Storing, preparation and analysis (e.g., microbial biomass, biological activity) of tropical soil samples submitted to quarantine regulations (L2 level)
	Experimental fields Cefe	Infrastructures for plant or animal experimentations in natural or controlled conditions (greenhouses, land plots, population cages…), conservation of biological resources, and on-demand provision / manufacturing of specific tools / prototypes
Chemical ecology	**Chemical analyses in ecology** Cefe	Analysis of organic and mineral compounds in various environmental samples (chemiometry, chemical ecology, soil ecology) - unique national competence in chromatography in ecology
X-Ray microtomography	**X-Ray microtomography** Isem and Montpellier RIO Imaging	Non-destructive 3D X-ray imaging of living and fossil samples. Workstation and software for data analysis
Vectopole	**Vectopole** Mivegec	Building and facilities dedicated to the study (rearing, phenotyping, molecular analyses) of arthropod vectors and associated diseases (e.g., dengue), including fully-equipped secure SL2 and SL3 insectaries and laboratories

TABLE PR8 • Cemeb network of facilities - each facility may be organized in several platforms. The name of the research unit hosting facilities is also indicated

FOCUS Environmental genomics (EG)

Anaïs de Quincey
Research assistant Environmental genomics

Environmental genomics (EG) – Molecular markers (*sensu lato*) for studying biological diversity have a long history in Montpellier; allozymes were used in the early 1970's in small mammals and mosquitoes. Their use grew and diversified in time, with more and more sophisticated and high-throughput methods, approaches and equipment. Quite naturally, an EG facility was created with the Cemeb project including genotyping and sequencing, cytogenomics, fragile DNA and qPCR. This facility is the most widely used by Cemeb scientific community with hundreds of users / projects per year, covering all living forms from all environments and environmental DNA, extending to non-living forms (e.g., ancient DNA), and providing help from sampling / experimental design to data analysis. EG evolved in time; with the rise of epigenomics, a new facility was created in 2017. A general idea guiding the development of EG is to 'keep at home' what could reasonably be developed locally – for example, high-throughput sequencing is largely outsourced. This means acquiring equipment and hiring staff to run these high-tech devices. Funding comes from Cemeb, but also from institutional partners, external partners and functioning (users pay a reasonable extra cost). EG is also involved in training, regularly organizing technical courses and workshop. New technical developments are conducted, sometimes with the help of Master students (funded by Cemeb). The projects conducted on EG are extremely productive with 34 papers per year on average, and largely contribute to Cemeb visibility and attractivity.

© Illumina

EG MiSeq benchtop sequencer – Illumina

Projects carried out on EG generate increasing amount of data, especially sequence data, which should be analyzed by increasingly sophisticated methods (some of which, e.g. in phylogeny and population genetics, developed in Cemeb research units). It is extremely convenient for users that EG developed strong links with MBB (Montpellier Bioinformatics Biodiversity), the Cemeb facility dedicated to data storage and analysis. MBB not only offers a large panel of expertise and access to methods / software, but can also help scientists to develop their own software with an engineer hired by Cemeb dedicated to this task.

2 TRANSFER AND OUTREACH

Transfer and innovation generally take a classical economic meaning epitomized by patents, but this hardly covers what happens in the field of biodiversity (proposing solutions to threatened biodiversity is one objective of Cemeb), where innovation is certainly useful. However, transfer should more broadly include socio-economic players involved in biodiversity management and outreach - an area sub-optimally connected to research and under-funded compared to classical innovation. This defines Cemeb view that was presented at InEE CNRS assizes (2017), and drives its transfer activities along four lines (Table PR9):

- Stimulating innovation: in collaboration with the SATT AxLR (a state agency funding innovation), Cemeb systematically evaluated whether research projects from its community (especially all those submitted to Cemeb calls for projects) can lead to innovation and therefore to further discussion / activities with project leaders. Cemeb also launched several calls for projects (Table PR9), the last of which in collaboration with the I-site Muse and AxLR (on-going);

- Stimulating partnerships with the non-academic world: Cemeb actively developed partnerships with ca. 98 partners from both the public (non-academic) and private sectors in order to speed up the transfer of research results. The most visible aspect was (co)funding PhD and post-doctoral projects co-supervised by Cemeb researchers and non-academic players, such as engineering companies and National parks, on a variety of topics (see the portraits of F. Holon and A.-C. Vaissières in this report), three of which obtained a non-academic position. Cemeb also co-organized events gathering researchers, biodiversity managers, and the private sector. The largest is the yearly “Salon de l’écologie” (Table PR9);

- Influencing public policies on environmental issues: Cemeb develops a strong partnership (the only Labex to do so) with the French Agency for Biodiversity (Ministry for Ecological and Solidary Transition) developing research projects on biodiversity management through PhD, post-doctoral and engineer hiring to sustain the link between fundamental research and practical solutions to biodiversity issues (Table PR9). Cemeb is strategically involved in developing the ‘biodiversity offset and mitigation’ hierarchy from both an ecological and economical point of view with regional and national partners (Table PR9).

- Linking science and society: Cemeb sustains / organizes outreach and participatory and citizen sciences to reinforce this link on critical issues at the heart of Cemeb project (e.g., the evolutionary theory, the biodiversity crisis) through project and meeting funding (see an interesting example in Table PR9) and video production. Cemeb also sustains focused outreach activity (e.g., through the Evolution2018 congress).


Anne Charlotte Vaissière

FOCUS

Anne-Charlotte Vaissière did her PhD (2011-2014) on implementing biodiversity offset policies in the marine environment (Ifremer Brest). She was hired by Cemeb on a two-year post-doctoral position (2015-2017) at CEE-M in partnership with the private company Biotope (funding research costs) to work on ‘Implementing biodiversity offsets in the French context: environmental performances and stakeholders’ acceptability’, based on economical and ecological approaches. The study includes modelling, surveys and interviews with farmers and theoretical thinking. She showed that considering ecological compensation leads to more efficient offsetting, and pointed out the kind of offsetting contracts (e.g., amount of money, duration) that can more efficiently engage farmers into compensation. She also showed that offsetting might be more efficient and accepted when undertaken in areas offering more ecological services. Five papers were published from this work which was presented in eight national and three international conferences, including Cemeb congress on ‘Biodiversity offset and mitigation’ (2017). AC Vaissière was also auditioned by the French Senate on compensation issues. She got a permanent CNRS position in 2017 following an extremely competitive exam, and continues collaborating with Biotope. Cemeb and Biotope are working on other projects related to biodiversity management.

Objective	Activities	Partners
Support to innovation and outreach	Creation of (open source) software for chromatogram processing in chemical ecology	Cefe - Chemical ecology facility
	Development of a LED light projector for greenhouse experiments with a widened spectral quality	Ecotron and Illubel company
	Innovation research prize	SATT AxLR (2016 and 2018 call for projects in partnership with Muse)
Partnerships with the non-academic world	Co-funding of 20 doctoral and post-doctoral research projects, in partnership with 25 socio-economic partners	National Office for Hunting and Wildlife, French Association of Zoological Parks, The National Fishing Federation, The Natural Reserves of the Seven Islands, The National Nature Reserve of the Southern Lands, the Wildlife Conservation Society (USA), The National Office for Forests, CPIE Bassin de Thau, the French Agency for Biodiversity, National Parks of France, etc.
	Co-organization of Resem (network of experimental greenhouses in Montpellier) show	Resem
	Co-organization of the Ecology show, involving business partnerships (more than 500 attendees) Chairman of the scientific committee of the Ecolo'Tech congress (methodological innovations in ecology)	University of Montpellier IEGB master program
Influencing public policies	Biological offset and hierarchy mitigation: coordination of a working group with partners Funding of two post-docs Organization of a 2-day national symposium (2017, 400 people)	Regional Agency for Environment (Dreal), Occitanie Region, French agency for biodiversity
	Post-doc fellowship on research in French national parks (T. Chambert - Cefe, "Adaptive monitoring of golden eagle populations")	Five national parks
	Organization of high-level training on environmental DNA (3 days, 2016), for national park managers	National parks, French agency for biodiversity
	Development of common strategy on applied research on biodiversity => contractual partnership (2017 -...)	French agency for biodiversity
Linking science and society	Citizen sciences: support to various participatory science activities and to the 2017 first national assizes	Cefe, Maison des Sciences de l'Homme Sud
	Production of 120 videos of scientific presentations, available on Cemeb website	

TABLE PR9 • Transfer, innovation and outreach in Cemeb: a few examples of activities and involved partners

3 TRAINING

Cemeb is strongly involved in training on a research-intensive basis, targeting young researchers, developing countries and the society, and in-service training. This is performed in collaboration with the training structures from its partners and Muse, especially the master programs and doctoral schools (especially Gaia, see below; Gaia opens *ca.* 12 PhD fellowships/year to Cemeb research unit in a very competitive exam) - the interactions have been enhanced over the last two years, but also with socio-economic partners. From a strategic point of view, Cemeb aims at offering high-level training, drawing heavily on its strong research / teaching community, increasing the autonomy of students, fostering interdisciplinarity and group-working, and enhancing international attractivity and mobility (including students from all countries).

The long-term objective is to improve the employability of students, whether in the public or in the private sectors. Importantly, Cemeb developed activities that are complementary to what its academic partners can offer. It should be noted that Cemeb researchers significantly contributes to teaching (out of duty) with >20h / year for 25% of them, especially at master and PhD levels, connecting research and training.

'The Cemeb Labex was created in 2011 to study the structure and dynamics of biodiversity in a context of global change. The core disciplines of Cemeb, such as ecology, paleontology and evolution, are also pillars of the Gaia doctoral school, and a large fraction of PhD students of Cemeb research units are registered at Gaia. One major objective of Cemeb is to train PhD students in these core disciplines at the best international level, but also to transfer research results towards the non-academic world. Cemeb achievements goes here beyond expectations with a large number of PhD fellowships and the very original 'Junior research team' program, training students to team working. Cemeb also developed interdisciplinary programs with other local scientific communities. On the whole, no surprise that PhD students from Cemeb easily find post-doctoral positions all over the world, or with biodiversity managers, whether from the public or the private sector. It is an immense pleasure to attract very bright students in Montpellier and to offer them this unique environment in biodiversity sciences.'

Dr. Marc Bouvy
University of Montpellier, director of the Gaia doctoral school and of Muse doctoral college

Cemeb policy is developed through the already-mentioned PhD projects and junior research teams and 15 courses (1-3 days; Table PR10) on technological / methodological issues through facilities. Training also targets biodiversity managers on rising techniques (e.g., environmental DNA, 2016) and colleagues from developing countries (two Summer schools in Africa on vectors) (see Table PR11). More originally, Cemeb sustained short-term stays abroad of Cemeb technical staff, PhD and post-doc fellows to acquire new techniques and know-how (Table PR12). Most courses, conferences, lectures and congresses are filmed, available on Cemeb website and widely used (*ca.* 120 movies) - a form of e-learning.

PI (PhD)	Host unit	Project
Paul Jay	Cefe	Preservation of polymorphism and choice of sexual partner in the *Heliconius numata* butterfly in Peru
Morgane Maillard	Cefe	Effect of deer on potential soil microbial activity in Haida Gwaii forests
William Perrin	Cefe	Monitoring of flying insect foraging
Alexis Thoumazeau	Eco&Sols	Validation of an indicator of soil carbon stability in order to develop a mobile application
Alexis Simon	Isem	Transmissible cancer in blue mussels
Alexandre Suire	Isem	Phonetic symbolism and sexual selection
Yasmine Mansour	Isem	Genome assembly based on transposable elements in the mosquitoe *Culex pipiens*
Jean-Charles Latourte	CEE-M	Use of new technologies for environmental management
Emeline Sabourin	Mivegec	Communities of mollusks and fasciolosis transmission in a strongly anthropized environment (Camargue)

TABLE PR10 • Junior research teams sustained in 2018.
They allow a PhD student to develop an aspect of his/her project through a Master internship (three to six months). Both students are requested to move abroad (e.g., congress, fieldwork).

FOCUS Junior research team «Transmissible cancer in blue mussels»


Alexis Simon

Alexis Simon is doing his PhD (2016-2019) under the supervision of Dr. N. Bierne at Isem on "Spatial demo-genetic and genomics of an invasion with introgression, based on empirical and theoretical approaches". The work is conducted in the *Mytilus edulis* species complex (mussels) which shows an interesting mosaic pattern of introgression in Europe due to incomplete reproductive isolation. Data analysis is backed by theoretical development to predict hybrid fitness in collaboration with J. Welch at the University of Cambridge, UK. Recently, a new transmissible cancer has been discovered in the Pacific species *Mytilus trossulus*. Some evidence for the presence of this cancer has then been found in Europe by the team in population genetics data of A. Simon's PhD work.

The goal of BlueCancer was to use standard methods in population and evolutionary genetics to trace back the history and evolution of this transmissible cancer, based on the detection and genotyping of new cancer clones. The Master internship was done in the first part of 2018 by M. Hammel in Cambridge where both A. Simon and N. Bierne were visiting J. Welch's group. Based on the genotyping of more than 3000 samples and new methods, the ERJ team showed that the cancer occurs at low prevalence (< 2%) in European species, and differs from the Pacific one suggesting multiple emergences or horizontal genetic transfers between host and cancer cells. The results have already been presented as a poster in an international conference in Cambridge and will be part of a publication to come. M. Hammel will initiate a PhD in October 2018 on the same subject in co-supervision between N. Bierne and G. Charrière (IHPE), funded by grants from the I-site Muse (project also entitled BlueCancer) and ANR. The ERJ project clearly set the basis to this larger project, and is therefore extremely successful in all respects. BlueCancer also allowed eliciting collaborations with Dr. E. Murchison in Cambridge, a world leader in the study of transmissible cancers in mammals.

Year	PI	Title	Site
2015	Florence Fournet, Catherine Moulia	Medical and veterinary entomology (field school)	Burkina Faso
	Sylvie Blangy, Christian Reynaud	Participatory sciences: Tools & methodology	Montpellier
	Christelle Tougard	Post-treatment AVIZO software (microtomography)	Montpellier
	Erick Desmarais, Khalid Belkir	Genotyping by sequencing	Montpellier
	Frédérique Carcaillet	Still-motion animation	Montpellier
2016	Sylvie Blangy, Isabelle Chuine	Participatory sciences: Advanced course	Montpellier
	Florian Fort	Ecology and evolution of ultivated plant species: interest for agroecology (summer school)	Montpellier
	Florence Fournet	Medical and veterinary entomology (field school)	Burkina Faso
	Marc Choisy, Anne-Laure Banuls	Computational biology (Summer school)	Hanoi, Vietnam
	Anne Poinsignon	Quantitative PCR (Summer school)	Ivory Coast
	Sonia Kéfi, Pierre Couteron	Detecting the early signs of tipping points in ecosystems	Montpellier
	Gauthier Dobigny, Sophie Boutin	Environmental DNA and biodiversity management	Montpellier
2017	Emmanuelle Artige, Suzanne Jicquel	Training to GBIF (Global Biodiversity Information Facility) tools	Montpellier

TABLE PR11 • Courses (co)organized by Cemeb, including several Summer schools. Duration goes from one day to four weeks with 15 to 70 participants


Amandine Gamble

FOCUS

Amandine Gamble is doing her PhD at Cefe (2015-2018) on the 'Ecology of infectious agent circulation in colonial birds: inference using serological approaches' under the supervision of Dr. T. Boulinier. The approach is based on cross-sectional studies focusing on a sentinel species (a threatened albatross from the Indian ocean) at the wildlife-human interface and on detailed long-term studies of host exposure to infectious agents in the wild. Cemeb sustained a three-weeks stay of Amandine in the US (Dr. J. Lloyd-Smith, UCLA and dr. L. Aubry, Colorado state University) in 2018 to acquire methods allowing to integrate multiple sources of data for understanding and managing avian cholera dynamics in the albatross colony she is studying. In practice, she worked on Bayesian approaches applied to eco-epidemiology (including R codes). This gave Amandine the opportunity to present her work in the labs she visited, and opens the possibility of future post-docs and collaborations. She will present the methods she acquired in a seminar in Montpellier. A paper is in preparation based on the analyses conducted with this approach.

Year	Student	Project	Host institute
2015	Philippe Bousses*	Taxonomy of Culicidae: sample preparation, preservation and development of an entomological collection of medical interest	Smithsonian Institute, Maryland, USA
	Damien Dezette*	In Vitro culture of arbuscular Mycorrhizal Fungi	Université catholique, Louvain, Belgium
	Menad Beddek	Statistical analyses in spatial ecology	CIBIO, Porto, Portugal
2016	Julie Perez*	Techniques of molecular cytogenetics: fluorescent in situ hybridization on fish chromosomes	Institut de biologie, Paris, France
	Elodie Flaven* and Juliette Pouzadoux*	Genotyping techniques and allelic incompatibility	LGEPV, Villeneuve d'Asq, France
	Rodolphe Hamel	Development of Northern-blot techniques using cold probes, experimental infections of mosquitoes by blood meal and development of new cellular lineages of mosquitoes.	Duke-NUS, Medical School, Singapour
	Nicolas Lemenager	Acquiring, processing, saving and archiving behavioral videos in a quality approach	UMR ECOBIOP, UMR EGCE, France
	Alicia Dalongeville	Spatial analyses in ecology	Fortin's Le Lab, University of Toronto, Toronto, Canada
	Gildas Yahouedo	Analysis of the ultrastructure and composition of insect cuticle	Foundation for Research & technology, Hellas, Greece
2017	Cécile Molinier	Genetic characterization of a genetic sex determantion in Daphnia pulex	Arizona State University, Tucson, USA
	Thierry Valero*	Tools and data management : REDCap	Pasteur Institute, Pnomh Penh, Cambodia
2018	Mallorie Hide*	Bioinformatic techniques of NGS data analyses (Leishmania model)	Anvers, Belgium
	Amandine Gamble	Understanding avian cholera dynamics in an albatross colony: integrating multiple sources of individual data	UCLA, Los Angeles, USA
	Jorian Prudhomme	Acquisition of breeding techniques of phlebotomes and experimental infections with Leishmania parasite	Charles University, Prague, Czech republic
	Etienne Robino	Interactions between vibrios and marine amoebas: role in pathogen emergence in marine environment	University of Madison, Wisconsin, USA
	Youssoupha Niang	Systematics of helminth parasites of African rodents	University of Barcelona, Spain

TABLE PR12 • Outgoing mobility funded by Cemeb. PhD students, post-doctoral associates and technical staff* were eligible. Stays from two to four weeks

4 INTERNATIONAL ATTRACTIVITY

The Cemeb community is highly attractive to international scientists and is located in many countries (Fig. PR2). Cemeb also developed an international policy based on networking and new activities (its calls for projects always target “international”, and are in English), articulated with that of its partners. Activities include human mobility, both hosting foreign researchers for 2-3 month periods and sustaining out-going international mobilities (Tables PR7 & 12), the weekly seminar in ecology and evolution (given by a majority of foreign speakers), the prestigious Thaler lecture, and at least one world-class conference per year (e.g., Evolution2018 in Montpellier). Cemeb applied to international calls for projects, such as the H2020 Teaming project with Portugal to mentor the upgrade of CIBIO/InBIO into a laboratory of excellence in R&D&I in biodiversity. Cemeb also participated to international events (e.g., European Community seminar in Brussels on alternative agricultures, CBD bio-bridge program meeting in Minsk) or favor the local development of international activities (e.g., attracting an IPBES working group in Montpellier for 2018-2020).

Cemeb developed an active strategy and many activities to promote visibility of its community from the local to the international scale. It is also now known on its own, especially at regional and national level, but also within its international network of partners. Contributing to this strategy are an active web site (www.labex-cemeb.org; French and English), which relays information about Cemeb activities (e.g., calls, events, facilities…), includes the video library mentioned above and links to other web sites in biodiversity (e.g., Agropolis international, FRB). Moreover, Cemeb requires to be cited or acknowledged in all sustained actions (e.g., logo, paper acknowledgments …).


Ruth Hufbauer

FOCUS

Ruth Hufbauer is Professor in applied evolutionary biology at Colorado State University (USA) with an outstanding track-record in evolutionary biology. She spent a sabbatical year in Montpellier in 2016-2017 funded by Cemeb and by Agropolis foundation, hosted by Dr. Arnaud Estoup at CBGP. R. Hufbauer also serves as a member of the scientific council of Cemeb. She collaborated with people at CBGP for studying the biology and host use of the invasive pest *Drosophila suzukii* to evaluate its host range and (successfully) develop a model system for testing basic theory, showing that this generalist pest species may not be able to evolve greater specialization, although this remains to be thoroughly studied. This work resulted in two papers published in 2017 (Mol. Biol. Evol. and PCI Evol. Biol.). She also collaborated with PhD student Laure Olazcuaga, and this mentoring activity will continue with several publications in preparation (Laure will visit Ruth’s lab in spring 2019). She gave three seminars in Montpellier and was invited by the French academy of agriculture in Paris to present her work. She also participated actively to the life of CBGP and developed interactions with numerous researchers in Montpellier, especially at Cefe and Isem (given the proximity in research interests) with very useful reciprocal feedbacks. These interactions have been revivified during the Evolution2018 congress (strongly supported by Cemeb).

5 INTERDISCIPLINARITY

Interdisciplinarity is of vital importance for addressing biodiversity issues, and is therefore one of the tenets of Cemeb. Its research units host, beyond ecologists and evolutionary biologists, paleobiologists / paleontologists, human and social scientists and mathematicians. Interactions between research and biodiversity managers also generally pertain to interdisciplinarity. It was systematically fostered in Cemeb research calls and activities, both within its community and with other scientific communities in Montpellier through a vigorous policy. This includes collaborative and co-constructed activities with the other PIA projects from Montpellier (Labex and convergence institute) and with the Maison des sciences de l'homme SUD (http://www.mshsud.org/; humanities and social sciences). Strong connections were for example built with the Agro and Numev labex on issues such as agroecology or the digital transition, but also with EpiGenMed on eco-health issues. Interdisciplinarity is also at the heart of the Muse project which developed several tools to foster it - let's mention the key initiatives that are projects internal to Muse covering transversal themes (e.g., Sea&Coast, Waters ; created in 2018) with which Cemeb already established projects in common. The Cemeb and Agro labex will collaborate to build the agro-environment-biodiversity pole of Muse in a largely interdisciplinary perspective.

Cemeb set up a range of tools to enhance interdisciplinarity - this includes hiring 13 PhD students and post-doctoral scientists (an open call for post-docs with the Numev and Agro labex was especially successful: 50% of the 30 proposed projects involved teams with no past collaborations). Two of the Cemeb post-docs hired on permanent positions have interdisciplinary profiles. Cemeb also organized/funded *ca.* 20 interdisciplinary meetings (especially with other Labex in Montpellier; see e.g. the focus on CRISPR-Cas 9 above).

FOCUS


Vitor Pavinato

Vitor Pavinato was hired as a post-doctoral associate (2017-2019) following a competitive joint call between the Agro, Cemeb and Numev Labex and the DigitAg Convergence Institute that was targeting interdisciplinary projects between Labex (seven post-docs hired overall). V. Pavinato works in theoretical population genetics at the border between mathematics and biology (Cemeb supervisor: Dr. Miguel Navascués, CBGP – the co-supervisor is Dr. Jean-Michel Marin, director of the Mathematical Institute A. Grothendieck). The project is entitled 'ABC selection, and aims at detecting loci under selection from temporal population genomic data through ABC random forest'. This represents an interesting approach since population genetics still largely remains based on spatial data. Temporal data are more informative about the current processes acting on populations. However, the nature and amount of data is changing with the advent of high throughput sequencing technologies, calling for new statistical approaches. Preliminary results from V. Pavinato's research suggest that the approach he has developed permits a joint estimate of demography and selection, allowing for the first time to distinguish from genetic data the true demography (census population size) and genetic drift (effective population size). These results open a wide range of new applications and development; in particular, they represent the basis for the research that M. Navascués will develop as a Marie Curie Fellow at Uppsala University (from August 2019) on the Neolithic transition in Europe from ancient and modern DNA.

6 STRUCTURING EFFECT

Cemeb plays a major role in structuring research, training and transfer in biodiversity, from the local to the international scale, as a result of its strategy, policy and activities (e.g., intense networking and cofunding). This holds for the project partners (both local and national) - Cemeb develops **bi- and multilateral relationships with all 'metastructures'** from partners (e.g., research departments, training departments, doctoral schools, internal administrations), both for developing collaborative activities and for ensuring a smooth development of Cemeb projects. For example, Cemeb was a driving force in the creation of the **network of research greenhouses in Montpellier** with the Agro community. It also developed interactions with the master programs and doctoral schools in biodiversity in Montpellier, contributing to proposing renewed graduate schools.

Of particular importance to Cemeb is the I-site Muse project (http://muse.edu.umontpellier.fr/): Cemeb is one of its scientific pillars, providing an extraordinary opportunity to enhance Cemeb structuring role in research, training and transfer. Cemeb is for example **strongly involved in Muse key-initiatives** 'Sea & coast', in its policy for facilities development, in its transfer policy (networking / cofunding) and in the Institute of Advanced Studies. Cemeb is also participating to the building (on-going) of the agro-environment-biodiversity pole of Muse, interacting with the Agro Labex and the NGO Agropolis International. A first objective is to create a network of facilities, extending Repeb (Cemeb network of facilities) to this scale.

Cemeb has also developed many activities (e.g., scientific meetings, post-doctoral fellowships …) with the six other Labex and the convergence institute from Montpellier in order to foster **interdisciplinarity**. Cemeb organized a **national meeting of all Labex in biodiversity** (2017) to exchange practices and expertise in project management, which led to further activities (e.g., scientific meeting with Tulip Labex from Toulouse in February 2018).

Cemeb developed a strategy, **networks and activities with non-academic partners** including public authorities (Occitanie region, Ministry of ecology, the newly created French agency for biodiversity, the national foundation for research on biodiversity ...), private companies and NGOs, and the general public (e.g., citizen science). The objective was to help researchers to transfer results towards the non-academic world through expertise, patents, and any kind of economic development, by co-funding / co-developing research, training and transfer projects (see section above). For example, the partnership with the **French agency for biodiversity** results in specific training courses for biodiversity managers, co-funding PhDs and post-doctoral researchers and a common call for research projects (on-going). Cemeb partnered with the SATT AxLR for sustaining innovation, via for example the Innovation prize (see section 2).

The Cemeb community is integrated in dense, highly-connected international networks (see section 1). Cemeb also developed a strategy on its own to structure and densify these networks. For example, **Cemeb is the PI of a H2020 teaming project with CIBIO/InBIO in Portugal.** An **international network of 32 partner universities** was developed in a training project in 2017. Cemeb is also active in the Council of scientific partners of the Convention of biological diversity (through Agropolis International) and developed links with the **IPBES** (hosting an IPBES group from 2018 to 2020).

7 PUBLICATIONS

We present a few statistics about publications (N = 734 in total) obtained from projects supported by Cemeb. They are essentially related to three types of activities (see above for description), *i.e.* doctoral and post-doctoral fellowships (48; 40 after 2015), technological facilities (671; 39 of which involving two facilities), and invited scientists (15, *i.e.* one per stay; all after 2015). We also recall that Cemeb scientific community produces an average of *ca*. 20 publications per year in top journals (Nature, Science, PNAS, Current Biology, PLoS Biology). Note that these values under-estimate the actual number of publications, because of the difficulty to track all publications that were supported by Cemeb. Several activities that were initiated after 2016 (e.g., interdisciplinary post-doctoral fellowships, exploratory research projects) have not produced publications yet, but they undoubtfully will in the near future.

Full lists are provided on theCemeb website, and we retained here some representative examples.

1- PhD students (*) and post-doctoral fellows

Blanc, L., *et al*. (2013). Abundance of rare and elusive species: Empirical investigation of closed versus spatially explicit capture-recapture models with lynx as a case study. *Journal of Wildlife Management*, 77(2): 372-378. **[Ph-D]**

Bykova, O., *et al*. (2018). Water deficit disrupts male gametophyte development in Quercus ilex. *Plant Biology*, 20(3): 450-455. **[post-doc fellow]**

Chu, D. K. W., *et al*. (2018). MERS coronaviruses from camels in Africa exhibit region-dependent genetic diversity. *Proceedings of the National Academy of Sciences, USA*, 115(12): 3144-3149. **[post-doc fellow]**

Débarre, F., *et a*l. (2018). Gender equity at scientific events. *Evolution Letters*, 2(3): 148-158. **[post-doc fellow]**

Galan, M., *et al*. (2018). Metabarcoding for the parallel identification of several hundred predators and their preys: application to bat species diet analysis. *Molecular Ecology Resources*, 18(3): 474-489. **[Ph-D]**

Gimenez, O., *et al*. (2014). Fitting occupancy models with E-SURGE: hidden Markov modelling of presence-absence data. *Methods in Ecology and Evolution*, 5(6): 592-597. **[Ph-D]**

Hammoudi, A., *et al*. (2015). Mathematical analysis of a nonlinear model of soil carbon dynamics. *Differential Equations and Dynamical Systems*, 23(4): 453-466. **[Ph-D]**

Holon, F., *et al*. (2015). The impact of 85 years of coastal development on shallow seagrass beds (Posidonia oceanica L. (Delile)) in South Eastern France: A slow but steady loss without recovery. *Estuarine, Coastal and Shelf Science*, 165: 204-212. **[Ph-D]**

Jacob, C., *et al*. (2016). Investigating the inclusion of ecosystem services in biodiversity offsetting. *Ecosystem Services*, 21: 92-102. **[post-doc fellow]**

Leitwein, M., *et al*. (2017). A dense brown trout (Salmo trutta) linkage map reveals recent chromosomal rearrangements in the Salmo genus and the impact of selection on linked neutral diversity. *G3 Genes, Genomes, Genetics*, 7(4): 1365-1376. **[Ph-D]**

Levrel, H., *et al*. (2017). Should we be wary of mitigation banking? Evidence regarding the risks associated with this wetland offset arrangement in Florida. *Ecological Economics*, 135: 136-149. **[post-doc fellow]**

Merle, C., *et al*. (2017). Resampling: an improvement of importance sampling in varying population size models. *Theoretical Population Biology*, 114: 70-87. **[Ph-D]**

Potier, S., *et al*. (2018). Visual field shape and foraging ecology in diurnal raptors. *Journal of Experimental Biology*, 221: Pt 14. **[Ph-D]**

Tribot, A.-S., *et al*. (2016). Taxonomic and functional diversity increase the aesthetic value of coralligenous reefs. *Scientific Reports*, 6: 34229. **[Ph-D]**

2- Technological facilities [facility names]

Aguilée, R., *et al.* (2016). Pollen dispersal slows geographical range shift and accelerates ecological niche shift under climate change. *Proceedings of the National Academy of Sciences, USA,* 113(39): E5741–E5748. **[Bio/eco-informatics]**

Assogba, B., et al. (2016). The Ace-1 locus is amplified in all resistant *Anopheles gambiae* mosquitoes: fitness consequences of homogeneous and heterogeneous duplications. *PLoS Biology*, 14: e2000618. **[Bio/eco-informatics & Genomics]**

Bonneau, M., *et al.* (2018). *Culex pipiens* crossing type diversity is governed by an amplified and polymorphic operon of Wolbachia. *Nature Communications*, 9(1): 319. **[Genomics]**

García-Palacios, P., *et al.* (2016). Temporal dynamics of biotic and abiotic drivers of litter decomposition. *Ecology Letters*, 19(5): 554-563. **[Chemical ecology & Experimental fields]**

Jarvis, E. D., *et al.* (2014). Whole-genome analyses resolve early branches in the tree of life of modern birds. *Science*, 346(6215): 1320-1331. **[Bio/eco-informatics]**

Milcu, A., *et al.* (2018). Genotypic variability enhances the reproducibility of an ecological study. *Nature Ecology & Evolution*, 56: 958-958. **[Chemical ecology]**

Mourlam, M. J., *et al.* (2017). Infrasonic and ultrasonic hearing evolved after the emergence of modern whales. *Current Biology*, 27(12): 1776-1781.e1779. **[Tomography]**

Noel, E., *et al.* (2017). Experimental evidence for the negative effects of self-fertilization on the adaptive potential of populations. *Current Biology*, 27(2): 237-242. **[Genomics]**

Romiguier, J., *et al.* (2014). Comparative population genomics in animals uncovers the determinants of genetic diversity. *Nature*, 515: 261–263. **[Bio/eco-informatics]**

Roullier, C., *et al.* (2013). Historical collections reveal patterns of diffusion of sweet potato in Oceania obscured by modern plant movements and recombination. *Proceedings of the National Academy of Sciences, USA*, 110(6): 2205-2210. **[Genomics]**

Roux, C., *et al.* (2016). Shedding light on the grey zone of speciation along a continuum of genomic divergence. *PLoS Biology*, 14(12): e2000234. **[Bio/eco-informatics]**

Roy, J., *et al.* (2016). Elevated CO2 maintains grassland net carbon uptake under a future heat and drought extreme. *Proceedings of the National Academy of Sciences, USA*, 113(22): 6224-6229. **[Chemical ecology]**

Soler, C. C. L., *et al.* (2012). Evidence for intersexual chemical mimicry in a dioecious plant. *Ecology Letter*s, 15(9): 978-985. **[Chemical ecology & Experimental fields]**

Thompson, J., *et al.* (2013). Evolution of a genetic polymorphism with climate change in a Mediterranean landscape. *Proceedings of the National Academy of Sciences, USA*, 110(8): 2893-2897. **[Chemical ecology]**

Tine, M., *et al.* (2014). European sea bass genome and its variation provide insights into adaptation to euryhalinity and speciation. *Nature Communications*, 5: 5770. **[Genomics]**

Vives, V., *et al.* (2015). Pharmacological inhibition of Dock5 prevents osteolysis by affecting osteoclast podosome organization while preserving bone formation. *Nature Communications*, 6: 6218. **[Tomography]**

3- Invited scientists

Ash, J. D., *et al.* (2017). Tracking lags in historical plant species' shifts in relation to regional climate change. *Global Change Biology*, 23(3): 1305–1315.

Cruz, P., *et a*l. (2017). Rain-fed agriculture thrived despite climate degradation in the pre-Hispanic arid Andes. *Science Advances*, 3(12): e1701740.

Facon, B., *et al.* (2017). Mating status influences cold tolerance and subsequent reproduction in the invasive ladybird Harmonia axyridis. *Frontiers in Ecology and Evolution*, 5: 108.

Johnson, S. E., *et al.* (2016). Large, connected floodplain forests prone to flooding best sustain plant diversity. *Ecology*, 97(11): 3019-3030.

Li, D., *et al.* (2017). Can functional traits account for phylogenetic signal in community composition? *New Phytologist*, 214(2): 607-618.

Stewart, G. S., *et al.* (2017). The power of evolutionary rescue is constrained by genetic load. *Evolutionary Applications*, 10(7): 731-741.

Szucs, M., *et al.* (2017). Rapid adaptive evolution in novel environments acts as an architect of population range expansion. *Proceedings of the National Academy of Sciences, USA*, 114(51): 13501-13506.

Waller, D. M., *et al.* (2018). Do metacommunity mass effects predict changes in species incidence and abundance? *Ecography*, 41(1): 11–23.

Weiss-Lehman, C., *et al.* (2017). Rapid trait evolution drives increased speed and variance in experimental range expansions. *Nature Communications*, 8: 14303.

4- Publications by the Cemeb community in Science, Nature, PNAS, Current Biology and PLoS Biology [research unit)

Alizon, S., *et al.* (2018). Reconciling Pasteur and Darwin to control infectious diseases. *PLoS Biology*, 16(1): e2003815. **[Mivegec]**

Allahverdiyeva Y., et al. (2013). Flavodiiron proteins Flv1 and Flv3 enable cyanobacterial growth and photosynthesis under fluctuating light. *Proceedings of the National Academy of Sciences, USA*, 110(10): 4111-4116. **[Eco&Sols]**

Baniel, A., *et al.* (2017). Male violence and sexual intimidation in a wild primate society. *Current Biology,* 27(14): 2163-2168. e2163. **[Isem]**

Basset, Y., *et al.* (2012). Arthropod diversity in a tropical forest. *Science*, 338(6113): 1481-1484. **[CBGP]**

Chew, Y. H., *et al.* (2014). Multiscale digital Arabidopsis predicts individual organ and whole-organism growth. *Proceedings of the National Academy of Sciences, USA*, 111(39): E4127-E4136. **[Amap]**

Delsuc, F., *et al.* (2016). The phylogenetic affinities of the extinct glyptodonts. *Current Biology*, 26(4): R155-R156. **[Isem]**

Facon, B., *et al.* (2011). Inbreeding depression is purged in the invasive insect Harmonia axyridis. *Current Biology,* 21: 424-427. **[CBGP]**

Graham, N. A. J., *et al.* (2015). Predicting climate-driven regime shifts versus rebound potential in coral reefs. *Nature*, 518(7537): 94-97. **[Marbec]**

Hochberg, M. E., *et al.* (2015). Assessing resistance to new antibiotics. Nature, 519(7542): 158-158. **[Isem]**

Lievens, E. J. P., *et al.* (2016). Maladaptive sex ratio adjustment in the invasive brine shrimp Artemia franciscana. *Current Biology*, 26(11): 1463-1467. **[Cefe & Mivegec]**

Mbengue, A., *et al.* (2015). A molecular mechanism of artemisinin resistance in Plasmodium falciparum malaria. *Nature*, 520(7549): 683-U246. **[Mivegec]**

Mouillot, D., *et al.* (2011). Protected and threatened components of fish biodiversity in the Mediterranean Sea. *Current Biology*, 21(12): 1044-1050. **[Isem & CBGP]**

Noel, E., *et al.* (2017). Experimental evidence for the negative effects of self-fertilization on the adaptive potential of populations. *Current Biology*, 27(2): 237-242. **[Cefe & Isem]**

Perry, C. T., *et al.* (2018). Loss of coral reef growth capacity to track future increases in sea level. *Nature*, 558(7710): 396-400. **[Marbec]**

Roy, J., *et al.* (2016). Elevated CO2 maintains grassland net carbon uptake under a future heat and drought extreme. *Proceedings of the National Academy of Sciences, USA*, 113(22): 6224-6229. **[Ecotron & Cefe]**

Rutledge, G. G., *et al.* (2017). Plasmodium malariae and P. ovale genomes provide insights into malaria parasite evolution. *Nature*, 542(7639): 101-104. **[Mivegec]**

Schwendemann, A. B., *et al.* (2011). Morphological and functional stasis in mycorrhizal root nodules as exhibited by a Triassic conifer. *Proceedings of the National Academy of Sciences, USA*, 108: 13630-13634 **[Amap]**

Selosse, M.-A., *et al.* (2011). The plant-fungal marketplace. *Scienc*e, 333(6044): 828-829. **[Cefe & Isem]**

Wallbank, R. W. R., *et al.* (2016). Evolutionary novelty in a butterfly wing pattern through enhancer shuffling. *PLoS Biology*, 14(1): 16. **[Cefe]**

Xia, J. Y., *et a*l. (2015). Joint control of terrestrial gross primary productivity by plant phenology and physiology. *Proceedings of the National Academy of Sciences, USA*, 112(9): 2788-2793. **[Eco&Sols]**

CEMEB APPENDIX

RESEARCH UNITS DESCRIPTIVE SHEETS

KEY PERFORMANCE INDICATORS

1 RESEARCH UNITS DESCRIPTIVE SHEETS

The research themes of the 10 research units participating to Cemeb have been briefly described above. We provide here descriptive sheets for each unit in the following order:

Amap (botAny and Modelling of Plant Architecture and vegetation)

CBGP (Biological Center for Population Management)

CEE-M (Center for environmental economics - Montpellier; formerly Lameta)

Cefe (Center for Evolutionary and Functional Ecology)

Eco&Sols (Functional Ecology & Biogeochemistry of Soils and Agrosystems)

Ecotron (European Ecotron of Montplellier)

IHPE (Host-Pathogen - Environment Interactions)

Isem (Institut for Evolutionary Sciences - Montpellier)

Marbec (Marine Biodiversity, Exploitation & Conservation)

Mivegec (Infectious Diseases and Vectors: Ecology, Genetics, Evolution and Control)

AMAP – botAny and Modelling of Plant Architecture and vegetation

Director: Thierry FOURCAUD

Partners

An interdisciplinary research unit conducting basic research on plants and plant communities for predicting ecosystem responses to environmental forcing, in terms of the distribution/conservation of species and biodiversity, crop production, carbon storage in plant biomass, environment protection and ecosystem services. Research concerns Mediterranean, temperate and tropical plant communities. Innovative research in botany, plant ecology, agronomy, forestry and in computer science, applied statistics and mathematics.

Major French joint research unit in tropical botany with strong quantitative expertise

Researchers	Teachers-Researchers	Research engineers	Technical & admins staff	PhD	Post-Docs	Others	Total
36	3	19	14	22	8	18	**122**

Major research grants (since 2011)	
ANR grants: 3 projects (396 K€) **Marie Curie fellowships**: 2 grants (93 K€)	**PhD fellowships: 8 (**from French doctoral schools) **CIFRE PhD fellowships**: 3 (396 K€) **Post-doc fellowships**: 6

International collaborations	Number (2011-2018)	Countries involved
JEAI (IRD-associated junior research team)	1	Ivory Coast
Other major bilateral fundings	5 (1 Guyamazon, 1 Cefipra, 1 BioAsia, 1 PHC Dumont-Durville, 1 PHC Protea)	Brasil, India, Thailand, New-Zealand, South-Africa
EU-funded collaborative projects or networks	4 (1 ERA-NET, 2 ACP-EU, 1 FONASO)	23 (18 in Africa)
France-funded collaborative projects or networks	5 (2 FRB-CESAB, 1 Euromediterrannée, 1 INRIA, 1 PIA Infrastructure)	11 (7 developed)

Peer-reviewed publications (2011-2018)	743

5 major publications :

Meyer-Berthaud B, Decombeix A-L (2012) In the shade of the oldest forest. *Nature* 483 (7387): 41-42.

Munoz, F., Couteron, P., Hubbell, S. P., (2012) Comment on "Global Correlations in Tropical Tree Species Richness and Abundance Reject Neutrality". *Science*, 336 (6089) : 1639.

Dray, S., **Pélissier, R., Couteron, P.,** Fortin, M. J., Legendre, P., Peres-Neto, P. R., Bellier, E., Bivand, R., Blanchet, F. G., De Cáceres, M., Dufour, A. B., Heegaard, E., Jombart, T., **Munoz, F.**, Oksanen, J., Thioulouse, J., Wagner, H. H., (2012) Community ecology in the age of multivariate multiscale spatial analysis. *Ecological Monographs*, 83 (2) : 257-275.

Dangles, O., Herrera, M., **Anthelme, F.**, (2013) Experimental support of the stress-gradient hypothesis in herbivore–herbivore interactions. *New Phytologist*, 197 (2) : 405–408.

Roumet, C., Picon-Cochard, C., Birouste, M., **Ghestem, M.**, Osman, N., Vrignon-Brena, S., Cao, K. F., **Stokes, A.**, (2016) Root structure - function relationships in 74 species: evidence of a root economics spectrum related to carbon economy. *New Phytologist*, 210 (3) : 815-826.

Rowe, N. P., (2018) Lianas. *Current Biology*, 28 (6) : R249-R252.

Scientific or academic awards (since 2013)	3 medals from the Academy of Agriculture, 1 IUF, 2 Michael Cichan awards (Botanical Society of America), 2 doctoral awards

CBGP – Biological Center for Population Management

Director: Flavie VANLERBERGHE

Partners: INRA SCIENCE & IMPACT, cirad, IRD Institut de Recherche pour le Développement FRANCE, Montpellier SupAgro

CBGP carries out research in the fields of systematics, genetics and ecology relevant to the management of populations and communities for the purposes of agriculture, public health and biodiversity. CBGP characterizes biodiversity in order to understand its structure and underlying factors and to predict its evolution in a context of global changes. Basic research leads to the elaboration of scenarios or decision-making tools dedicated to the management of pest and diseases or the conservation of endangered species.

Major research unit for population studies and management in species of agronomical interest

Researchers	Teachers-researchers	Research engineers	Engineers, technicians and admin	Phd	Post-docs	Others	Total
31	3	9	37	11	5	7	**103**

Major Research Grants (since 2011)	
ANR grants: 32 projects (4,3 M€) **Marie Curie fellowships**: 2	**PhD students**: 55 (31 from French Doctoral School and 24 from foreign universities) **Post-docs attracted**: 33

International (bilateral) structuring partnerships	Number (2011-2018)	Countries involved
JEAI (IRD-associated junior research team)	2	Senegal, Benin, Burkina Faso, Niger
GDRI-Sud « West African Network on Biological Invasions - **WAN@BI** ».	1	Senegal, Benin, Niger
ANR-funded	1	Germany
UE-funded networks	6	

Peer-reviewed publications (2011-june 2018)	766

5 major publications :

Robert CP et al. (2011) Lack of confidence in approximate Bayesian computation model choice. *Proceedings of the National Academy of Sciences of the United States of America* 108 (37): 15112-15117.

Basset Y et al. (2012) Arthropod diversity in a tropical forest. *Science* 338 (6113): 1481-1484.

Tayeh A et al. (2015). Biological invasion and biological control select for different life histories. *Nature Communications* 6: 5 (OA) (10.1038/ncomms8268)

Calatayud J et al. (2016) Geography and major host evolutionary transitions shape the resource use of plant parasites. *Proceedings of the National Academy of Sciences, USA* 113 (35): 9840-9845.

Dobigny G et al. (2017) Chromosomal polymorphism in mammals: an evolutionary perspective. *Biological Reviews* 32 (1): 1-21.

Scientific or academic awards (since 2011)	1 price Academy of Agriculture; 1 price academy of Sciences

Technological facilities hosted	▪ **Evolutionary Cytogenomics (CeMEB label)** ▪ Molecular biology ▪ Collections and imaging ▪ Greenhouses, farming, arthropod phenotyping

CEE-M : Center for Environmental Economics - Montpellier

Director: Brice MAGDALOU

Partners: UM, CNRS, INRA, SupAgro

CEE-M's project lies at the interface between society and the environment. Adopting an interdisciplinary perspective, it aims to address two scientific challenges: the transition to an environmentally friendly society; the promotion of an innovative and multifunctional agriculture.

A major player at French scale in environmental economy, and CeMEB major opening to social sciences

Researchers	Teachers-researchers	Research engineers	Engineers, technicians and admin	PhD	Post-docs	Other contractual staff	Total
11	17	3	10	24	2	2	69

Major Research Grants (since 2011)	
ANR grants: 13 projects (1,2 M€) **Post-docs attracted**: 11	**PhD students**: 75 (50 from French Doctoral School and 25 from foreign universities) **CIFRE PhD fellowships:** 3 (61 K€)

MAJOR INTERNATIONAL COLLABORATIONS / NETWORKS

US, Canada, Netherlands, Spain, Italy, Switzerland, UK

Peer-reviewed publications (2011-2016)	

5 major publications:

Chervier C et al. "When the Implementation of Payments for Biodiversity Conservation Leads to Motivation Crowding-out: A Case Study from the Cardamoms Forests, Cambodia", *Ecological Economics*, In Press.

Costello C et al. (2017). "Private eradication of mobile public bads", *European Economic Review* 94, pp. 23-44.

Courchamp et al. "Massive yet massively underestimated global costs of invasive insects", *Nature Communications 7*, 12986, October 4, 8.

Courtois P et al. (2014). "Conservation priorities when species interact: The Noah's Ark metaphor revisited", *PLoS ONE* 9 (9), pp. 1-8.

Faurie C et al. (2017). "Evidence of genotypic adaptation to the exposure to volcanic risk at the dopamine receptor DRD4 locus", *Nature Scientific Reports*, forthcoming.

Publications in 2018, Rank 1 (top economic journals according to the CNRS ranking) :

Roussey L., Soubeyran R. : `Overburdened judges', International Review of Law and Economics, vol. 55, pp. 21-32, 2018.

Magdalou B. : `Income inequality measurement: a fresh look at two old issues', Social Choice and Welfare, 2018 (forth.).

CEFE – Center for Evolutionary and Functional Ecology

Director: Richard JOFFRE

Partners:

CEFE performs basic research on the **dynamics of biodiversity, planetary environmental change, and sustainable development**. One of the main objectives is to develop scenarios on the evolution of biological systems, as well as strategies for their conservation and their restoration. Disciplines span evolutionary biology and population genetics to functional and landscape ecology, with transversal and interdisciplinary research on the ecology of human impacts. Research is conducted on a great variety of field sites around the world, with major expertise in Mediterranean and tropical ecosystems.

Main French laboratory in functional and evolutionary ecology with major international reputation

Researchers	Teachers-researchers	Research engineers	Engineers, technicians and admin	PhD	Post-docs	Other contractual staff	Total
61	34	9	39	58	27	47	**275**

Major research grants (since 2011)	
ERC grants: 6 (6,5 M€) **ANR grants:** 68 projects (10,9 M€) **Marie Curie fellowships**: 10 grants (1,8 M€) **European projects**: 5	**PhD fellowships**: 135 (124 from French doctoral schools, 3 from foreign universities and 8 in co-supervision) **Post-doc fellowships**: 68

International (bilateral) structuring partnerships	N (2011-2018)	Countries involved
LIA (Associated Internat. Laboratory)	3	Gabon, Portugal, South Africa
GDRI (Internat. Research Group)	2	Canada
PICS (Internat. Program for Scientific Cooperation)	5	Thailand, China, Canada, Spain
Other major bilateral fundings	3	Canada, US, Norway
ANR-funded	4	Mexico, Canada, UK, South Africa, Portugal, Norway
EU-funded networks (ERA-NET, Marie Curie…)	5	Europe

Peer-reviewed publications (2011-2018)	1832

5 major publications:

Thompson J et al. (2013) Evolution of a genetic polymorphism with climate change in a Mediterranean landscape. *PNAS* 110 (8): 2893-2897.

Violle C et al. (2014) The emergence and promise of functional biogeography. *PNAS* 111 (38): 13690-13696.

Martin JL et al. (2016) The need to respect nature and its limits challenges society and conservation science. *PNAS, USA* 113 (22): 6105-6112.

Poirotte C et al. (2016) Morbid attraction to leopard urine in Toxoplasma-infected chimpanzees. *Current Biology* 26 (3): R98-R99.

Lievens EJP et al. (2016) Maladaptive sex ratio adjustment in the invasive brine shrimp *Artemia franciscana*. *Current Biology* 26 (11): 1463-1467.

Scientific or academic awards	5 medals (1 IUF, 3 CNRS, 1 agricultural academy), 1 academic palms
Civil awards	1 legion of honor, 2 medals of merit

Technological facilities hosted	▪ **Chemical ecology (CeMEB label)** ▪ **Experimental fields and greenhouses (CeMEB label)** ▪ Genetic markers ▪ Long-term field programs ▪ (Geographic) Information systems

MONTPELLIER EUROPEAN ECOTRON

Director: Alexandru MILCU

Partner:

The European Ecotron of Montpellier (www.ecotron.cnrs.fr) is an experimental research infrastructure dedicated to the study of ecosystems, organisms and biodiversity in the context of environmental changes. It is open to national and international research consortia in the fields of ecology, climate change, agronomy and evolution. The Ecotron allows for precise control of environmental conditions while automatically measuring multiple ecosystem processes related to biogeochemical cycles.

A world-class, high-throughput infrastructure in experimental ecology with high-tech instruments

Researchers	Teachers-researchers	Research engineers	Engineers, technicians and admin	PhD	Post-docs	Other contractual staff	Total
1	0	2	2.6	0	1	4	10.6

Major Research Grants (since 2011)	
ANR grants: 4 projects (148 K€) **Marie Curie fellowships**: 1 grant (185 K€)	**PhD students**: 3 (from French Doctoral Schools)

	Number (2011-2017)	Countries involved
International (bilateral) structuring partnerships	2	Germany, Australia
EU-funded collaborative projects	6	Spain, Germany, Austria, Italy

Milcu A et al. (2014) Functional diversity of leaf nitrogen concentrations drives grassland carbon fluxes. *Ecology Letters*, 17(4): 435–444.

Lange M et al. (2015) Plant diversity drives soil carbon storage by increased soil microbial activity. *Nature Communications*, 6:60707.

Resco de Dios V et al. (2015) Processes driving nocturnal transpiration and implications for estimating land evapotranspiration. *Scientific Reports*, 5:10975 (doi.org/10.1038/srep10975).

Roy J et al. (2016) Elevated CO_2 maintains grassland net carbon uptake under a future heat and drought extreme. *Proceedings of the National Academy of Sciences, USA* 113 (22): 6224-6229.

Milcu, A., et al. (2018). Genotypic variability enhances the reproducibility of an ecological study. *Nature Ecology & Evolution* 2: 279–287.

Scientific or academic awards	J. ROY, member of the Academy of Agriculture

- **Macrocosms**

- **Mesocosms**

- **Microcosms**

IHPE – Host-Pathogen-Environment Interactions

Director: Guillaume MITTA

Partners: Université Perpignan Via Domitia, CNRS, Ifremer

Research at IHPE focuses on interactions involving invertebrate species of interest in medical or veterinary research (gastropod mollusks), aquaculture (bivalve mollusks) and ecology (corals). The influence of environmental parameters on these interactions is analyzed based on holistic approaches, from the finest molecular mechanisms to populations and evolutionary levels, at the interface between (epi)genetics and population biology, ecology and evolution.

Strong positioning at the border between basic biology and ecology, and unique expertise in epigenetics

Researchers	Teachers-researchers	Research engineers	Engineers, technicians and admin	Phd	Post-docs	Other contractual staff	Total
11	12	2	12	13	2	3	55

Major Research Grants (since 2011)	
ANR grants: 11 projects (1,8 M€) **Marie Curie fellowships**: 1 grant (101 K€) **European projects**: 1 H2020 project	**PhD students**: 36 (29 from French Doctoral School and 7 from foreign universities) **Post-docs attracted**: 11

Major funded networks	Countries involved
1 FP7, 3 PHC, 1 Wellcome Trust, 1 WHO, 1 NIH	Europe, 7 African countries, 3 South American and Caribbean countries, USA, Canada

Peer-reviewed publications (2011-2016)	322

5 major publications:

Boissier J et al. (2016). Outbreak of urogenital schistosomiasis in Corsica (France): an epidemiological case study. *Lancet Infectious Diseases*, 16: 971-979.

Adema C et al. (2017). Whole genome analysis of a schistosomiasis-transmitting freshwater snail. *Nature comm.* 8: 15451.

Brener Raffalli K., Clerissi C., Vidal-Dupiol J., Adjeroud M., Bonhomme F., Pratlong M., Aurelle D., Mitta G., Toulza E. (2018). Thermal regime and host clade, rather than biogeography, drive Symbiodinium and bacterial assemblages in the scleractinian coral Pocillopora spp. *Microbiome,* 6 : 39.

Gourbal B., Pinaud S., Beckers G.J.M., Van Der Meer J.W.M., Conrath U., Netea M.G. (2018). Innate immune memory: an evolutionary perspective. *Immunological Reviews,* 283 : 21-40.

Roquis D., Taudt A., Geyer K.K., Padalino G., Hoffmann K.F., Holroyd N., Berriman M., Aliaga B., Chaparro C., Grunau C., De Carvalho Augusto R. (2018). Histone methylation changes are required for life cycle progression in the human parasite Schistosoma mansoni. *PLOS Pathogens,* : May 21;14(5):e1007066.

Technological facilities hosted	▪ **Epigenomics (CeMEB label)** ▪ Bioenvironnement platform (includes microscopy, proteomics, high-throuput DNA quantification & quality control, NGS, bioinformatics)

ISE-M – Institut for Evolutionary Sciences - Montpellier

Director: Agnès MIGNOT

Partners:

ISE-M develops high-level research in evolutionary biology and paleontology. We investigate the evolutionary mechanisms underlying functional and structural aspects of life and biodiversity, from genomes to phenotypes, with a particular interest in organism and community responses to global change, management and conservation of biodiversity, domestication and aquaculture. Research at ISE-M is based on conceptual approaches and on developing experimental tools and models (expertise in experimental evolution, theoretical biology, bioinformatics, morphometry). .

The main French institute in evolutionary biology with world reputation

Researchers	Teachers-researchers	Research engineers	Engineers, technicians and admin	Phd	Post-docs	Other contractual staff	Total
75	32	7	47	55	17	6	**239**

Major Research Grants (since 2011)	
ERC grants: 3 (5,4 M€) **ANR grants:** 40 projects (10 M€) **Marie Curie fellowships**: 4 grants (700 K€) **European projects**: 7	**PhD students**: 97 (66 from French Doctoral School and 31 from foreign universities) **Post-docs attracted**: 48

International structuring partnerships	N (2011-2017)	Countries involved
LIA (Associated International Laboratory)	5	South Africa, Morocco, Gabon, Portugal, Armenia
GDRI (International Research Group)	3	Canada, Sweden, Russia, Thailand, China, Philippines, Switzerland, Germany, Scotland, Belgium, Greece
Other major bilateral fundings	7	Canada, UK, Spain, Portugal, India
Belmont forum fundings	2	Canada, Sweden, Finland, Russia, China, Canada, US, Brazil, Belgium, Morocco, China
France-funded (ANR, RTPi, SEEG)	5	New Caledonia, Thailand, Laos, Cambodia, Gabon, Benin, Portugal
EU-funded collaborative projects/networks	15	

Peer-reviewed publications (2011-2016)	1422 (2012-2017)

5 major publications:

Ali AA et al. (2012) Control of the multi-millennial wildfire size in boreal North America by spring climatic conditions. *PNAS* 109: 20966-20970.

Derex M et al. (2013) Experimental evidence for the influence of group size on cultural complexity. *Nature* 503 (7476): 389-391.

Macke E et al. (2014) Local mate competition mediates sexual conflict over sex ratio in a haplodiploid spider mite. *Current Biology* 24 (23): 2850-2854.

Romiguier J et al. (2014) Comparative population genomics in animals uncovers the determinants of genetic diversity. *Nature* 515 (7526): 261-U243.

Roux C et al. (2016) Shedding light on the grey zone of speciation along a continuum of genomic divergence. *PLoS Biology* 14 (12): e2000234.

Scientific or academic awards	2 IUF, 2 CNRS medals, 1 academic palms, 1 legion of honor

Technological facilities hosted	**CeMEB label: Genotyping – Sequencing (GENSEQ), Degraded DNA, Evolutionary Cytogenomics, Microtomography, Montpellier Bioinformatics & Biodiversity** **Others:** Wild mouse genetic conservation, collections, visual scientific communication, bio-indicators ("Carpo-Anthraco", "Palyno-Sédimento", "Dendro"), aquaculture, morphometry

MARBEC - MARine Biodiversity, Exploitation & Conservation

Director: Laurent DAGORN

Partners:

MARBEC focuses on the study of marine biodiversity in lagoon, coastal and offshore ecosystems, at different integration levels (from molecules to community) and human use of this biodiversity. Main objectives are to describe marine biodiversity and ecosystems to understand their dynamics, to analyze the impact of anthropogenic pressure on ecosystems and to propose scenarios, and to reconcile exploitation (e.g., fisheries) and conservation in order to social expectations.

A key national player on ecological approaches to the marine environment

Researchers	Teachers-researchers	Research engineers	Engineers, technicians and admin	PhD	Post-docs	Other contractual staff	Total
62	17	14	41	66	15	28	243

Major Research Grants (since 2015)	
ANR grants: 13 (2 M€) **Marie Curie fellowships:** 2 (375 K€)	**PhD students**: 113 **Post-docs attracted**: 49

International (bilateral) structuring partnerships	Number (2015-2017)	Countries involved
JEAI (IRD-associated junior research team)	1	Vietnam (South East Asia)
LMI (International Mixed Laboratory)	5	Tunisie, Afrique du Sud, Vietnam, Brésil, Pérou
Other major bilateral fundings		
EU-funded collaborative projects	22, including 6 H2020 - 7 FEAMP 3 Biodiversa including 2 which starts in 2019	

Peer-reviewed publications (2015-2018)	658

5 major publications:

- Bundy, A., Chuenpagdee, R., Boldt, J. L., de Fatima Borges, M., Camara, M. L., Coll, M., Diallo, I., Fox, C., Fulton, E. A., Gazihan, A., Jarre, A., Jouffre, D., Kleisner, K. M., Knight, B., Link, J., Matiku, P. P., Masski, H., Moutopoulos, D. K., Piroddi, C., Raid, T., Sobrino, I., Tam, J., Thiao, D., Torres, M. A., Tsagarakis, K., van der Meeren, G. I., Shin, Y.-J. (2017). Strong fisheries management and governance positively impact ecosystem status. *Fish and Fisheries* 18, 412–439. doi:10.1111/faf.12184
- Andrello, M., Guilhaumon, F., Albouy, C., Parravicini, V., Scholtens, J., Verley, P., Barange, M., Sumaila, U. R., Manel, S., Mouillot, D., (2017). Global mismatch between fishing dependency and larval supply from marine reserves. *Nature Communications* 8, 16039. doi:10.1038/ncomms16039
- Salvatteci, R., Field, D., Gutiérrez, D., Baumgartner, T., Ferreira, V., Ortlieb, L., Sifeddine, A., Grados, D., Bertrand, A. (2018). Multifarious anchovy and sardine regimes in the Humboldt Current System during the last 150 years. *Global Change Biology* 24, 1055–1068. doi:10.1111/gcb.13991
- Bettarel, Y., Halary, S., Auguet, J.-C., Mai, T. C., Bui, N., Bouvier, T., Got, P., Bouvier, C., Monteil-Bouchard, S., Christelle, D. (2018). Corallivory and the microbial debacle in two branching scleractinians. *The ISME Journal* 12, 1109–1126. doi:10.1038/s41396-017-0033-5.
- Tribot, A.-S., Carabeux, Q., Deter, J., Claverie, T., Villéger, S., Mouquet, N. (2018). Confronting species aesthetics with ecological functions in coral reef fish. *Nature : Scientific Reports* 8, 11733. doi:10.1038/s41598-018-29637-7

Scientific or academic awards	2 IUF, 1 CNRS medal, 1 IFREMER trophy, 2 prices of the French Society of Ecology
Civil awards	1 legion of honor

Technological facilities hosted	Chemistry, Plancton, Bacteriology, Plateforme Microbex, Flux cytometry, Benthos, Physio-Histology, Sclérochronology , Molecular biology

MIVEGEC – Infectious Diseases and Vectors: Ecology, Genetics, Evolution and Control

Director: Frédéric SIMARD

Partners:

MIVEGEC develops integrative and transdisciplinary research on the genetics, ecology, epidemiology and evolution of pathogenic agents, in order to improve their control. To address the conditions and mechanisms underlying the biology and transmission of (re)emergent human pathogens, MIVEGEC develops theoretical and experimental research projects, as well as new tools and strategies for sustainable control and prevention, on shared facilities and via its international establishments.

The main French institute on the ecology and evolution of pathogenic agents and vectors

Researchers	Teachers-researchers	Research engineers	Engineers, technicians and admin	PhD	Post-docs	Other contractual staff	Total
52	9	7	39	38	15	28	**188**

Major research grants (since 2011)	
ERC grants since 2007: 2 (3,5 M€) **ANR grants:** 35 projects (19,2 M€) **Marie Curie fellowships**: 1 grant (185 K€)	**PhD fellowships**: 52 (28 from French doctoral schools, 5 from foreign universities and 19 in co-supervision) **Post-doc fellowships**: 20

International (bilateral) structuring partnerships	Number (2011-2017)	Countries involved
JEAI (IRD-associated junior research team)	8	Vietnam, Cambodia, Laos, Ivory Coast, Burkina-Faso, Cameroon, Vietnam, Mauritania, Thailand
GDRI (International Research Group)	2	Vietnam, Cambodia, Laos, Cameroon, Gabon, RCA, Congo
LMI (International Mixed Laboratory)	3	Vietnam, Cambodia, Laos, Gabon, Ivory Coast, Burkina Faso
EU-funded collaborated projects	10	

Peer-reviewed publications (2011-2016)	1002

5 major publications:

Prugnolle F et al. (2011) African monkeys are infected by Plasmodium falciparum nonhuman primate-specific strains. ***PNAS*** 108 (29): 11948-11953.

Neafsey DE et al. (2015) Highly evolvable malaria vectors: The genomes of 16 Anopheles mosquitoes. ***Science***. 347: 1258522.

Bernard E, Hamel R, Neyret A, Ekchariyawat P, Moles JP, Simmons G, Chazal N, Desprès P, Missé D & Briant L (2015) Human keratinocytes restrict chikungunya virus replication at a post-fusion step. ***Virology***. 476: 1-10.

Makanga B et al. (2016) Ape malaria transmission and potential for ape-to-human transfers in Africa. ***PNAS*** 113 (19): 5329-5334.

Bradshaw CJA, Leroy B, Bellard C, Roiz D, Albert C, Fournier A, Barbet-Massin M, Salles JM, Simard F, Courchamp F (2016) Massive yet grossly underestimated global costs of invasive insects. ***Nature Communications*** 7: 12986.

Scientific or academic awards	1 CNRS medal, 1 academic palms
Civil awards	1 legion of honor

Technological facilities hosted	**Vectopole** (secured insectarium – biosafety levels BSL2 and BSL3) – **CeMEB label**

ECO&SOLS - Functional Ecology & Biogeochemistry of Soils and Agrosystems

Director: Jean-Luc CHOTTE

Partners:

Eco&Sols works on the role of soil organisms and plants, their interactions and environment, in biogeochemical cycles (mainly C, N and P) in agroecosystems**. The biogeochemical cycles of carbon and nutrients (N / P)** are studied mainly in Mediterranean and tropical areas with regard to soil component, plants and the atmosphere. Biotic and abiotic determinants of the C and nutrient flows are studied in a range of agronomic situations taking account changing land use and climate change.

A unique international expertise on soils and their biodiversity with a strong focus on agrosystems

Researchers	Teachers-researchers	Research engineers	Engineers, technicians and admin	Phd students	Post-docs	Other contractual staff	Total
50	1	2	23	25	3	0	104

Major Research Grants (since 2011)	
ANR grants: 15 projects (2.1 M€) **European projects**: 14 including 2 H2020 **Post-docs attracted**: 17 I-Site Muse: 2 (150 K€)	**PhD students**: 55 (24 from French Doctoral School and 31 from foreign universities) **CIFRE PhD fellowhips**: 2

International (bilateral) structuring partnerships	Number (2011-2018)	Countries involved
JEAI (IRD-associated junior research team)	3	Ivory Coast, Benin, Thailand/Laos
LMI (International Mixed Laboratory)	2	Senegal/Burkina Faso, Thailand/Vietnam/Laos
Other major bilateral partnerships	4	Thailand, Madagascar, Vietnam, Costa Rica
EU-funded collaborative projects	14	EU, Vietnam, Brazil, Costa Rica, Nicaragua, Kenya, India, Senegal, Cameroun, Tchad, Niger, Mali, Uganda, Ghana, ...

Peer-reviewed publications (2011-2018)	495

5 major publications :

Razanamalala, K.et al. (2017). "Soil microbial diversity drives the priming effect along climate gradients: a case study in Madagascar." *The Isme Journal*. 12:451

Guillemot, J et al. (2017). "Environmental control of carbon allocation matters for modelling forest" *New Phytol* Apr; 214(1):180-193

Christina M et al. (2015) "Measured and modeled interactive effects of potassium deficiency and water deficit on gross primary productivity and light-use efficiency in *Eucalyptus grandis* plantations". *Global Change Biology*. 21: 2022-2039.

Loreau, M.et al. (2013). "Unifying sources and sinks in ecology andEarth sciences." *Biological Reviews* 88 (2): 365-379

Penuelas, J. et al. (2013) "Human-induced nitrogen-phosphorus imbalances alter natural and managed ecosystems across the globe" *Nature Communication* 7

Technological facilities hosted	
	▪ **ECOTROP (CeMEB label)** ▪ Life science platform ▪ Biochemistry platform ▪ Molecular biology platform ▪ Physico-chemistry platform

2 KEY PERFORMANCE INDICATORS

KPI #	RESEARCH	
1	N peer-reviewed publications of Cemeb community	*ca.* 1200/year
2	N peer-reviewed publications in top journals	136
3	N peer-reviewed publications directly derived from Cemeb-funded activities	734
4	Prices and honors	13 ERC, 8 IUF members, 2 members French Acad. Sci., 13 scientific medals, 9 civil medals
5	N supported research projects	106
6	N post-doc fellowships (co)funded by Cemeb	16
7	N academic collaborations (national / international)	16 / 41
8	N technical staff hired on technological facilities (months)	5 (160)
9	N permanent positions obtained by Cemeb-hired staff	6
10	N organized scientific events (congresses, workshops)	35
11	N supported scientific events (congresses, workshops)	58
	TRAINING	
12	N masters scholarships offered through Cemeb	41
13	N PhD fellowships offered through Cemeb	12
14	N training sessions organized (including in-service)	13
15	N out-going mobility for training	17
16	N video items broadcasted on the website	120
	INTERNATIONAL ATTRACTIVITY AND EXCHANGES	
17	N invited speakers (for seminars, conferences…)	350
18	N visiting scientists	12
	TRANSFER & SOCIO-ECONOMIC IMPACT	
19	N patents (total vs. directly resulting from the project)	0
20	N start-ups created (total vs. directly resulting from the project)	0
21	N research projects with non-academic partners	36
22	N innovation projects supported	3
23	N science-society events organized	10
	TRANSFER & SOCIO-ECONOMIC IMPACT	
24	Leverage effect (total investment/ANR contribution)	2,5
25	Amount of external funding attracted (K€)	5,17 M€
26	Fraction of Cemeb permanent staff acting as PIs in projects (structuring effect)	20%
27	N calls for projects	23
28	N staff hired by Cemeb	86

TABLE PR13 • Key performance indicators (KPIs) and their values over the 2011-2018 period. Interdisciplinarity is not identified as a category *per se* since it is part of actions quantified in several KPIs. N = number of


CeMEB