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## A history of teaching in a marine laboratory, the Laboratoire Arago of Banyuls-sur-Mer

Raphaël Lami

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## A HISTORY OF TEACHING IN A MARINE LABORATORY, THE *LABORATOIRE ARAGO* OF BANYULS-SUR-MER

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MARINE STATIONS  
MARINE BIOLOGY  
OCEANOGRAPHY  
HISTORY OF TEACHING  
HIGHER EDUCATION PEDAGOGY  
TEACHING PRACTICES  
HENRI DE LACAZE-DUTHIERS

**ABSTRACT.** – The Laboratoire Arago (Oceanological Observatory of Banyuls-sur-Mer) is a marine research center (Sorbonne Université and CNRS) located on the French southeast coast. Since its foundation in 1882 by Henri de Lacaze-Duthiers, a professor from La Sorbonne in Paris, this laboratory has welcomed more than 60,000 students. This article tells the history of teachings in this center, detailing why students have joined this lab for their studies, how their interest has evolved throughout time to diversified scientific fields and explains how the teachers working in this institution have transmitted their skills and their high-level scientific knowledge. Overall, this story relates the continuous interest in developing innovative teachings and pedagogies in marine laboratories since the 19<sup>th</sup> century, and how to connect these teachings to the most recent research in all the fields of marine sciences.

INTRODUCTION . . . . .	152	A HISTORY OF THE ORGANIZATIONAL ASPECTS OF TEACHING ACTIVITIES AT THE LABORATORY . . . . .	164
THE FOUNDATION OF THE LABORATORY AS A CONSEQUENCE OF THE THIRD REPUBLIC'S EDUCATIONAL POLITICS . . . . .	153	<i>Teaching team</i> . . . . .	164
FIRST COURSES DELIVERED AT THE LABORATORY: FIELD SAMPLINGS, OBSERVATION OF ORGANISMS, AND EXPERIMENTATION . . . . .	153	<i>Evolution of spaces dedicated to teaching</i> . . . . .	164
<i>The pioneer period (1882-1901)</i> . . . . .	153	<i>Hosting students at the laboratory</i> . . . . .	165
<i>Teachings organized from 1901 to 1944</i> . . . . .	156	<i>Organizing teaching activities during crises (WWI, WWII, and the COVID-19 pandemic)</i> . . . . .	166
DIVERSIFICATION OF TEACHINGS AFTER THE SECOND WORLD WAR (1946-2022) . . . . .	157	PEDAGOGICAL SPECIFICITIES OF COURSES OFFERED AT THE LABORATORY . . . . .	167
<i>1946: from natural science courses to the introduction to ecology</i> . . . . .	157	<i>The laboratory as an ideal place for pedagogical innovations</i> . . . . .	167
<i>1950: development of a European curriculum in phycology</i> . . . . .	158	<i>Continuing professional education</i> . . . . .	168
<i>1956: creation of a DEA in biological oceanography</i> . . . . .	159	<i>Opening the laboratory to international students</i> . . . . .	168
<i>1958: scuba diving internships</i> . . . . .	162	<i>A living community</i> . . . . .	169
<i>1995: implementation of courses in molecular, cell, and developmental biology</i> . . . . .	162	ACKNOWLEDGMENTS. . . . .	171
<i>2005: curriculum development in microbial ecology</i> . . . . .	163	BOX 1 – LIST OF PEOPLE WHO HAVE TAUGHT AT THE LABORATOIRE ARAGO . . . . .	171
<i>2013: development of courses in ecotoxicology</i> . . . . .	163	BOX 2 – RESEARCH TEAMS AND LABORATORIES HOSTED AT THE LABORATOIRE ARAGO . . . . .	174
		REFERENCES . . . . .	178

## INTRODUCTION

The *Laboratoire Arago*, also named the *Observatoire Océanologique de Banyuls*, is a marine station operated by the *Sorbonne Université*<sup>1</sup> and the *Centre National de la Recherche Scientifique* (CNRS). Located along the French Catalan Mediterranean coast, this institution is mainly dedicated to scientific research, education, and the observation of Mediterranean ecosystems. This article proposes a history of the teaching activities that have been conducted in this laboratory since its foundation. This institution was built in 1882 by a professor from *La Sorbonne*, Henri de Lacaze-Duthiers, who also created a

<sup>1</sup> Before 1896 this establishment was not a university, but the *Faculté des Sciences de Paris* (1811-1896), the main institution of higher education in France. The institution was located in a building named *La Sorbonne* which, by extension, provided its name to the *Faculté des Sciences de Paris*. The universities were created again in 1896, and *La Sorbonne* was then named *Université de Paris* (1896-1970), and the *Faculté des Sciences* was part of this new institution. In 1964, some of the activities were transferred to the 5<sup>th</sup> arrondissement of Paris, to a place named the *Campus Universitaire de Jussieu*. The establishment built there acquired the status of a university (named *Université Pierre et Marie Curie* (1971-2017)) when the *Université de Paris* was dismantled (Tuilier, 1994). Since 2018, the institution has been called the *Sorbonne Université* (2018-today) after a merger of all activities with the *Université Paris IV*. In this text, the name used corresponds to the name in vigor in the year the event described took place.

public aquarium associated with the lab. The transmission of knowledge to students and to a wider general audience has been clearly central in the missions of this marine station since its creation. An analysis of the archives<sup>2</sup> reveals that more than 60,000 students have been welcomed at the laboratory since 1882 (Fig. 1) and trained in marine and terrestrial zoology and botany but also, among other disciplines, in ecology, oceanography, marine microbiology, cell biology, developmental and molecular biology, and ecotoxicology. Since its creation, the laboratory has been a place particularly adapted to the transmission of knowledge. An easy access to the Mediterranean coast and field samplings has facilitated students' scientific observations and experimentations. Since the 19th century, laboratory instructors have never ceased to create new teaching material and adjust the transmitted contents and pedagogical approaches to the innovative scientific questions and debates of their field of research. In addition, these instructors have continuously improved their pedagogical approaches to deliver knowledge and research methodologies. Therefore, teaching activities taking place at the laboratory must be analyzed in light of the higher education policies implemented in France and of the evolution of the relations between science and society.

<sup>2</sup> My main sources are the archives of the *Laboratoire Arago*, which have been preserved at the laboratory's library, and the archives of the *Académie des Sciences* (Paris). Also press articles were consulted at <http://www.retronews.fr>.

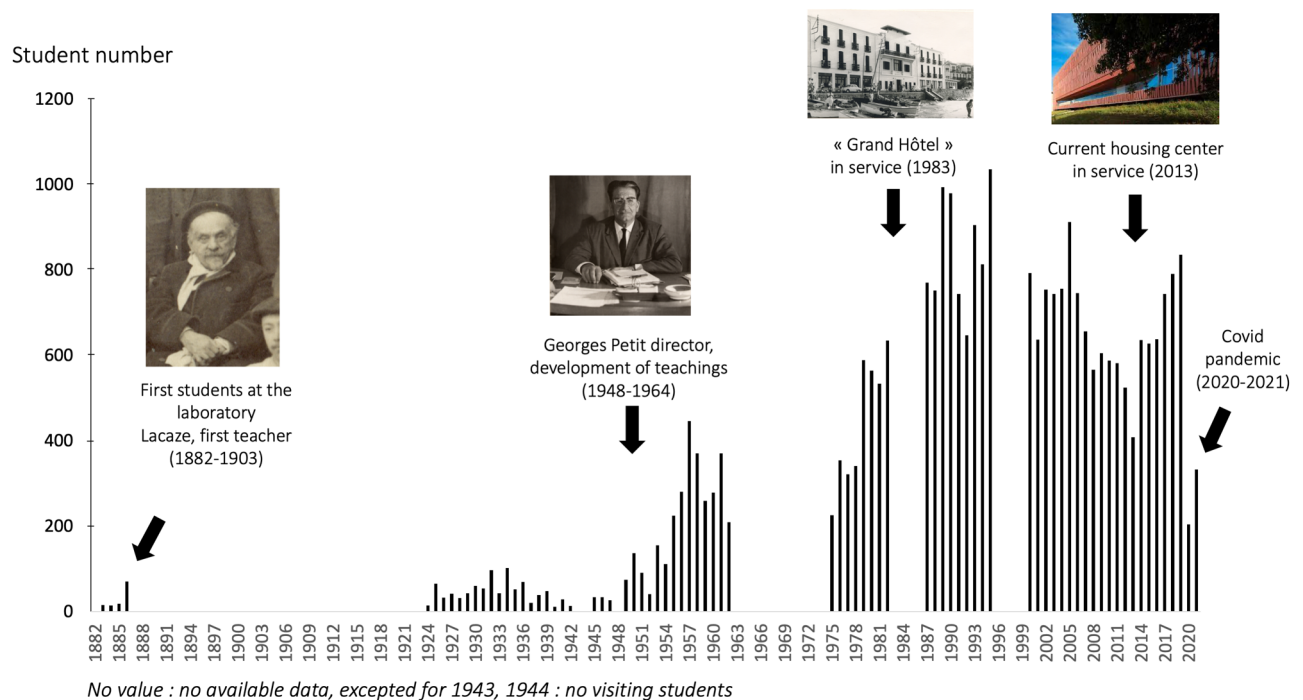


Fig. 1. – Evolution in the number of students studying at the *Laboratoire Arago* from 1882 to 2020. Pictures: Archives of the *Laboratoire Arago*.

## THE FOUNDATION OF THE LABORATORY AS A CONSEQUENCE OF THE THIRD REPUBLIC'S EDUCATIONAL POLITICS

After 1851 and his *coup d'état*, Napoleon III reigned over France. During this regime – the *Second Empire* – the higher education system was organized around a few university faculties located in major cities and was not a priority for politicians. However, the situation drastically changed after 1870. The French army was defeated in Sedan by the Prussians, which led to the departure of Napoleon III and to the proclamation of the Third Republic. The French intellectual elite questioned the origins of this defeat and attributed it to, among other factors, the inferiority of the French education system. This analysis led to massive investments in education and research during the Third Republic: the budget allocated to universities increased from 7.6 million francs in 1875 to 23.2 million francs in 1913, and the number of teachers increased from 488 in 1865 to 1416 in 1919 (Verger & Charle 2012). Many new institutions were created, such as the *Ecole Libre des Sciences Politiques* in 1872 and the *Ecole des Hautes Etudes Commerciales* (HEC) in 1881. Many astronomical observatories were also founded, for example in Meudon (1876) and Nice (1881). Interestingly, many of these institutions were not established in Paris but in the French regions to enhance the country's unity and the democratization of the educational and scientific system (Debaz 2016).

Zoology is one of the disciplines in which French researchers had encountered difficulties during the *Second Empire*. Thus, the Third Republic fostered the creation of many zoological stations on the French coast, for example in Luc-sur-Mer (1874), Sète (1881), and La Seyne-sur-Mer (Tamaris) (1891), to name a few. Henri de Lacaze-Duthiers, a fervent republican and professor at *La Sorbonne*, aimed to sustain the development of his discipline (“experimental zoology”) and participated in the country's reconstruction after the defeat of 1870. He received the support of republican politicians to build the zoological stations of Roscoff (1872) and Banyuls-sur-Mer (1882). In Paris, he was supported by Albert Dumont and Louis Liard, Directors of Higher Education at the Ministry. Jules Ferry, the iconic Minister of Public Instruction during the Third Republic, personally intervened to support the efforts of Henri de Lacaze-Duthiers in promoting the potential acquisition of land in Port-Vendres, which initially appeared ideal as a place to build the laboratory.<sup>3</sup>

Moreover, the building of the laboratory and the delivery of the first courses in this institution were conducted at a time in which the positivist movement strongly influ-

enced scientific life. This philosophical current, inherited from the *Lumières* and greatly fostered during the Third Republic, was founded by Auguste Comte. For positivists, scientific knowledge represents the maturity of the human mind, which surrenders an understanding of the ultimate reason for phenomena to occur and only focuses on studying *how* these phenomena occur. Positivists practice science by repeating observations and experiences, believing in the capacity of science to rationally explain the world around them and in the benefits of science for the entire society. For positivists, experience has a crucial role since it provides access to facts. The pedagogical principles of Republicans such as Henri de Lacaze-Duthiers were deeply rooted in this positivist philosophy (Dayrat 2016).

## FIRST COURSES DELIVERED AT THE LABORATORY: FIELD SAMPLINGS, OBSERVATION OF ORGANISMS, AND EXPERIMENTATION

### *The pioneer period (1882-1901)*

Starting in 1891, Henri de Lacaze-Duthiers first implemented an annual course<sup>4</sup> at the laboratory, which took place during two weeks in early April (at Easter); the content of the course was also linked to summer field courses taking place at the marine station of Roscoff and courses organized during the year in his Parisian laboratory at *La Sorbonne*. Teachers and students studying for the *agrégation* (a national competition to become a high school teachers) or for the *Licence* used to meet at the *Gare de Lyon* and reached Banyuls-sur-Mer after a 26-hour train ride. As soon as the laboratory was built, it aroused the interest of professors in natural sciences in Montpellier and Toulouse. These professors came with their students and organized courses similar to those put in place by Henri de Lacaze-Duthiers in Roscoff<sup>5</sup>. These courses were based on three types of teaching contents: lectures, zoological excursions and scenic tours (Figs 2, 3). The pedagogy was mainly based on precise observation of animals and plants or algae collected in the field, complemented by aquarium-based observations and experimentations.

<sup>4</sup> While the first courses organized by Henri de Lacaze-Duthiers for Sorbonne's students were established in 1891, instructors from Toulouse and Montpellier had first organized courses in 1882, at the opening of the *Laboratoire Arago*, with the help of Lacaze-Duthiers. Indeed, the founder of the *Laboratoire Arago* initially dedicated Banyuls' laboratory to research purposes.

<sup>5</sup> The archives of the *Laboratoire Arago* have preserved many documents related to these lectures and their organization (visitor recordings and personal notes of Henri de Lacaze-Duthiers).

<sup>3</sup> Henri de Lacaze-Duthiers's personal notes, preserved at the *Archives du Laboratoire Arago*.



Fig. 2. – Student field trips at Llança (Spain, 1893) (A and B), on the Balearic Islands (Spain, 1905) (C), onboard “Le Roland” (Easter session, 1907) (D). Pictures: Archives of the *Laboratoire Arago*.

Most of the lectures were led by Henri de Lacaze-Duthiers himself or by the teachers hired in his laboratory. The lectures aimed at presenting the main zoological groups and were well connected to the most recent research conducted in the field, as each professor usually presented the biological group in which he had acquired scientific recognition. For example, in 1893, while Henri de Lacaze-Duthiers delivered a lecture about corals and methods to fish them, Louis Boutan delivered a lecture about scientific scuba fishing techniques, and Jean Guitel lectured about fish found in Banyuls<sup>6</sup>. Many teachers from all over France and other countries proposed courses as well; for example, Professor Prouho from Lille (previously a member of Lacaze-Duthiers’ laboratory) lectured about echinoderms, and others lectured on other topics: Professor Yung from the University of Geneva (on fishing and the biology of *Amphioxus*), Professor Marion from Marseille (on the comparison between the fauna of Banyuls and Marseille), Professor Topsent (on sponges

in the Gulf of Lion), and Professor Halles from Lille (on the biology of Turbellarians). Professor Charles Flahault from the University of Montpellier offered lectures about phycology and organized botanical excursions along the seashore and in the Pyrenees (up to the summit of the Canigou) to transmit his knowledge about alpine botany. Geology was not forgotten with lectures by Professor Deperret from the University of Lyon, who also organized geological excursions in the village of Millas to observe fossil fauna dating back to the marine Pliocene. The possible industrial applications of this knowledge were also highlighted. For example, in 1891, Lacaze’s students visited an oyster farm in Rosas, Spain<sup>7</sup>. Indeed, the professor wanted to initiate this type of oyster breeding in Banyuls and promote its development along the French Mediterranean coasts.

Zoological excursions were frequently conducted aboard the *Roland* (the laboratory’s ship) to collect marine organisms. Then, many living organisms were observed in

<sup>6</sup> *L’Alliance*, March 12, 1893, and Henri de Lacaze-Duthiers’s personal notes (*Archives du Laboratoire Arago*).

<sup>7</sup> *Le Soleil*, May 7, 1891, and Henri de Lacaze-Duthiers’s personal notes.

**ÉCOLE DES HAUTES ÉTUDES**  
**LABORATOIRE ARAGO**  
BANYULS-SUR-MER (Pyrénées-Orientales)

**EXCURSIONS ZOOLOGIQUES**  
DES VACANCES DE PAQUES  
(du 25 mars au 10 avril 1893)

Le Professeur **H. DE LACAZE-DUTHIERS**, fondateur, dirigera les travaux

**CONFÉRENCES ET EXCURSIONS**

<b>MM.</b>		
<b>YUNG,</b>	Professeur à l'Université de Genève.	Pêche et Histoire de l' <i>Amphioxus</i> .
<b>MARION,</b>	Professeur à la Faculté des Sciences de Marseille.	Faunes comparées de Marseille et de Banyuls.
<b>DEPERET,</b>	Professeur à la Faculté des Sciences de Lyon.	Excursion paléontologique à Milas.
<b>HALLES,</b>	Professeur à la Faculté des Sciences de Lille.	<i>Turbellariées</i> .
<b>PRUVOT,</b>	Professeur à la Faculté des Sciences de Grenoble.	Conférence à bord de l'embarcation à vapeur du Laboratoire : Les Frangues et leurs produits.
<b>TOPSENT,</b>	Professeur à l'École de Médecine de Reims.	<i>Eponges du Golfe</i> .
<b>PROUHO,</b>	Maitre de Conférences à Lille.	<i>Echinodermes</i> .
<b>BOUTAN,</b>	Maitre de Conférences à Paris.	Pêche au scaphandre.
<b>GUTTEL,</b>	Assistant à Banyuls.	<i>Poissons de Banyuls</i> .
<b>H. DE LACAZE-DUTHIERS,</b>		<i>Coraül</i> , sa pêche à l'aide des embarcations à vapeur: Essai d'orientation dans le Vivier d'expériences.

**EXCURSION FINALE** : Exploration de la Côte de Banyuls-sur-Mer à Rosas; Cap Creus; Cadaques; Ruines du Monastère de San Pedro de Roda.

Le Président de la Section des Sciences naturelles des Hautes Études, membre de l'Institut.  
**H. DE LACAZE-DUTHIERS,**  
Président de l'Académie des Sciences.

**AVIS IMPORTANT.** — Le trajet de Paris à Banyuls sera direct, avec compartiments réservés. — Les personnes qui s'inscriront au Laboratoire de Zoologie expérimentale de M. DE LACAZE-DUTHIERS, à la Sorbonne, jusqu'au 22 mars, payeront au total 46 francs, aller et retour. — Départ le samedi soir 25 mars.

Universitat de Barcelona  
Facultat de Ciències  
Curso de 1901 á 1902

*Excursión Zoológica*  
al Laboratorio Aragón  
(Banyuls sur mer)

dirigida por el profesor Odón de Buen  
con el concurso del profesor G. Pruvot, director del Laboratorio

Salida de Barcelona, el 1.º de Noviembre próximo, en el tren de Francia,  
á las 5h 10' de la mañana

Visita al Laboratorio  
y experiencias en el Acuarium  
Excursión con el vapor "Roland"  
Visita al Sanatorium de niños escrofulosos

Conferencias á cargo de los doctores:

Mr. Georges Pruvot, director del Laboratorio Aragón.  
D. Andrés Martínez Vargas, catedrático de enfermedades de los niños en la Facultad de Medicina.  
D. Carlos Calleja, catedrático de Histología en la misma Facultad.  
D. Marcelo Rivas Mateos, catedrático de Zoología en la Facultad de Farmacia.  
D. Luis Suñé y Molist, secretario perpetuo de la Academia de Medicina de Barcelona.  
D. Manuel Cazorro, catedrático en el Instituto de Gerona.  
D. José Fuset, catedrático en el Instituto de Palma de Mallorca.  
D. Manuel Carbó, jefe de trabajos prácticos de Zoología en la Facultad de Ciencias de Barcelona.  
D. Odón de Buen

Los excursionistas rendirán el debido homenaje á la memoria del sabio fundador del Laboratorio Mr. Henri de Lacaze Duthiers, fallecido en Junio último, y cuyos restos han de ser en breve trasladados á Banyuls.  
Barcelona 15 de Octubre de 1901.

Fig. 3. – Publicity poster to advertise for the field trip organized in 1893 by Henri de Lacaze-Duthiers (1<sup>st</sup> session of teaching at the lab organized by Lacaze-Duthiers) and in 1901 by Odon de Buen for Spanish students. Pictures: Archives of the *Laboratoire Arago*.

aquariums or dissected by the students under microscopes. These observations were compared with those published in the literature available in the library (Chapaux 1900). The students were even sometimes authorized to use the diving suit produced based on research developed at the laboratory by Louis Boutan, which also reveals an interesting connection between research (the development of new technologies at the laboratory) and teaching. Many experiments on marine organisms were conducted in the aquariums or in the *vivier*, a marine pool outside the lab designed to keep marine organisms alive. Some observations were also conducted thanks to the electrical light installed by Lacaze-Duthiers. For example, when the weather was inclement, the professor showed his students the spawning of cephalopods thanks to the lights near the aquariums. This innovative device also enabled students to work in the evenings<sup>8</sup>.

During their internships, students were free to conduct their own work. They were invited to observe by themselves, discuss, and sample, as Chapaux described in 1900: “I have seen how much, despite the complete

freedom left to them, most (students) show initiative” (Chapaux 1900). Similarly, Henri de Lacaze-Duthiers explained that “[students] are allowed to choose their own subjects, take them away, study them at their own rhythm”<sup>9</sup>. Lacaze-Duthiers’s lectures were described as “talks” rather than formal conferences: “The course of Henri de Lacaze-Duthiers [...] was quite curious: instead of a didactic course, it was rather a talk where he tried to caution us against theories, always bringing us back to practice and common sense” (Guiart & Jeannel 1948).

Scenic excursions were also frequently organized and provided opportunities to escape from Banyuls, sometimes several hundred kilometers away. Jean Guiart and René Jeannel in 1948 in the *Archives de Zoologie Expérimentale et Générale* related excursions organized in 1892 in the region of the extinct volcanoes of Olot and Mallorca<sup>10</sup>. These excursions included a cultural component with the discovery of local touristic curiosities, such as the monastery of Sant Pere de Rodes, the castle

<sup>9</sup> *La Lumière*, May 5, 1891.

<sup>10</sup> Confirmed by documents preserved in the archives of the *Académie des Sciences* in Paris and at the *Laboratoire Arago*.

<sup>8</sup> *Le Soleil*, May 7, 1891; *L'Eclair*, May 5, 1891.



Fig. 4. – Courses in natural science (A) in 1934 with Odette Tuzet, (B) in 1948 along coastal lagoons with Georges Petit, (C) with Yves Coineau, probably in the 1980s and (D) with Gilles Boeuf at the Massane forest reserve in the 2010s. Pictures: Archives of the *Laboratoire Arago* and Gilles Boeuf.

of Peralada in Spain, or “*the museum and monuments of Perpignan*”<sup>11</sup>. Nevertheless, zoological, botanical, and geological aspects were also explored during these scenic excursions to broaden students’ grasp of the diversity of terrestrial and marine Mediterranean organisms.

#### *Teachings organized from 1901 to 1944*

Henri de Lacaze-Duthiers died in 1901. Unfortunately, testimonies and documents about courses organized between 1901 and 1946 are quite rare. The few pieces of information available indicate that Georges Pruvot (director 1900-1922) organized courses during around Easter. Excursions to Spain went on until 1914 and were monitored by the Spanish professor Odon de Buen from the University of Barcelona (see the section below about international students) as well as by Georges Pruvot and Emile Racovitza (Duboscq *et al.* 1937). Articles published in the local press reveal the important development of scenic excursions before the First World War<sup>12</sup>. For

example, scenic tours were organized by Georges Pruvot and Emile Racovitza in Spain and included stops in Cadaques, Rosas, Sant Pere de Rodes, Peralada, Barcelona, Montserrat, the Cardona salt mines, Lerida, Tarragona, Barcelona, before the return to Banyuls. Destinations varied from year to year. Some years, scenic excursions were also organized in the Pyrenees and included stops in Mont-Louis, Villefranche-de-Conflent, and Amélie-les-Bains. The Balearic Islands constituted another regular destination as well.

Even fewer information is available about courses delivered at the lab between WWI<sup>13</sup> and WWII. A second natural science course may have been organized during the summer, in addition to the course that was maintained around Easter (Bougis 1982). However, these courses rotated each year and were also held at the marine station of Villefranche-sur-Mer, which was then administered by the laboratory. Octave Duboscq (director 1923-1937), Edouard Chatton (director 1939-1947), Odette Tuzet and Grégoire Tregouboff taught there in those years (Fig. 4). The same students frequently attended these courses in Banyuls and then the following year in Villefranche-

<sup>11</sup> *La Petite Gironde*, April 17, 1892.

<sup>12</sup> *L’Alliance*, March 24, 1907; *La Vie Montpelliéraine*, April 23, 1905; *L’Alliance*, March 20, 1904; *Le Signal*, March 15, 1904.

<sup>13</sup> World War 1 (WWI) and World War 2 (WWII)

sur-Mer. Edouard Chatton also used to deliver lectures in entomology, which indicates that terrestrial zoology was still taught at the laboratory (Bougis 1982).

### DIVERSIFICATION OF TEACHINGS AFTER THE SECOND WORLD WAR (1946-2022)

Since the first course organized in 1891 for Sorbonne's students, teaching at the *Laboratoire Arago* has been organized through a combination of field excursions and samplings, conferences led by teachers and researchers, and the involvement of technicians and engineers who worked in the lab. The overall objective has been to make it easy for students to acquire skills and knowledge and connect them to the field, to experimental work and to the latest research development – an approach that remains anchored in the philosophy of Lacaze-Duthiers. The presence of small student groups in the lab for a period of time entirely dedicated to work has always favored interactions and promoted learning. This teaching method has endured over time and is still foundational to the teaching that takes place at the *Laboratoire Arago*. However, although natural science courses are still present and represent an important part of the current teaching activity, courses have been greatly diversified since the end of WWII and in accordance to the development of new research activities.

#### *1946: from natural science courses to the introduction to ecology*

Courses started again after WWII in 1945 (33 students). Year after year, the summer session became the most emblematic session at the laboratory. Paradoxically, students' and teachers' testimonies about the content of the courses are lacking. However, the information that is available highlights the growing importance of ecology in the laboratory's curriculum, even if fundamental zoology and botany courses still constituted the core content of courses. Jean Théodoridès, who attended the summer session in 1947, provided some information about the knowledge that was transmitted there (Théodoridès 1982). He reported on the organization of entomological excursions around Banyuls under the leadership of Renaud Paulian, an instructor and renowned naturalist who would become the Rector of the University of Bordeaux at the end of his career. Théodoridès also explained that he studied the division of the sea urchin's egg, observed the microfauna of coastal sands, visited the cave of Pouade, participated in the collection of marine organisms onboard the lab boat, and attended conferences in embryology. Jean-Pierre Changeux, a famous French neurobiologist, attended the summer session in 1950. In his testimony, which was collected by R. Lami in 2021, he emphasized the importance of animal dissections, observations, and draw-

ings as part of the teachers' pedagogy. Paul Bougis also recalled the courses that were offered during the 1950s and remembered that field trips were organized in very poor conditions of comfort. He explained that participants were sitting on the benches of a truck where they used to "abundantly breathe the dust from the road" (Bougis 1982) when they were driven to the north of Argelès-sur-Mer to explore Mediterranean lagoons (Figs 4, 5, 6).

A summer course in Mediterranean ecology (named ECOMED<sup>14</sup>) is still organized each year at the laboratory and welcomes students from the *Sorbonne Université* and many other French universities. This course is a direct heritage of Henri de Lacaze-Duthiers's pedagogy. The pedagogical approach used there is still based on the discovery of terrestrial and marine organisms and still quite appreciated by the students. This summer school provides an overview of the richness and biodiversity of flora and fauna in the region and of the functioning of Mediterranean ecosystems. For example, coastal flora and fauna are sampled and observed, and the biological diversity and functioning of coastal lagoons are discussed. In terrestrial ecology, the focus is placed on freshwater animals and on the diversity of insects living in the Albères and Pyrenees mountains, for example in the Massane forest natural reserve. Currently, this internship is planned for approximately 20-30 students who are hosted for three weeks.

Aside from this emblematic summer course, many other courses in zoology, botany, and ecology have been offered at the laboratory. In particular, after WWII, Georges Petit (director 1948-1964) supported the development of terrestrial ecology at the laboratory. The *Centre d'Ecologie Terrestre* was founded at the Mas Reig in Banyuls in 1957. Teaching started in 1954 and was extensively developed after 1966 when the buildings and facilities were renovated to welcome students<sup>15</sup>. Teaching activities were very intense in this research center. Students from Perpignan, Montpellier, Toulouse, and many foreign universities (Germany, Great Britain, Ireland, Netherlands, and Belgium) were hosted (Coineau 1970, A. Fiala in Jacques & Desdevises 2021) (Figs 6, 7).

Since the Second World War, courses in Mediterranean Ecology have also been regularly organized for students studying for the CAPES<sup>16</sup> and *Agrégation*<sup>17</sup>, two competitive national exams high school biology teachers take and for which broad knowledge in the natural sciences

<sup>14</sup> *Ecologie Méditerranéenne*/Mediterranean ecology.

<sup>15</sup> Yves Coineau's personal notes, kept in the *Archives du Laboratoire Arago*; Yves Coineau (1967), *Le Centre d'écologie méditerranéenne du Mas de la Serre, Le Monde des Plantes*, Toulouse.

<sup>16</sup> *Certificat d'aptitude au professorat de l'enseignement du second degré*.

<sup>17</sup> *Agrégation des sciences de la vie, de la terre et de l'univers* (SVTU).



Stage N° 4		FRANCE
PAQUES 1965 8 - 22 Avril		
PROGRAMME		
Jeu	10h: Ouverture du stage 11h: Visite de l'Aquarium par MM. REYSS-GUILLE	14h: Les Spongiaires par M. REYSS
Ven	9h: Les Octocoralliaires par M. REYSS	14h: Les Rotifères par M. COINEAU
Sa	9h: Les Bryozoaires par M. LAUBIER	14h: Les Flagellés des Termites par Mme CAHET
Lu	9h: Les Polychètes par M. LAUBIER	14h: Les Ascidies par M. SOYER
Ma	9h: Sortie en mer Groupe I toute la journée le	14h: Sortie en mer Groupe II Plancton, par M. SOYER
Me	9h: Les Holothuries par M. GUILLE	14h: Les Poissons-Systématique par M. BOUTIERE
Je	9h: Les Poissons-Anatomie par M. BOUTIERE	14h: Les Pagures par M. SOYER
Ve	9h: Les Ophiures par M. GUILLE	14h: Excursion à terre par M. COINEAU
Sa	9h: Microarthropodes du sol par M. COINEAU	14h: Suite
Lu	9h: Excursion au cap l'Abeille par MM. SOYER-GUILLE	14h: Le Trottoir à <u>Maraca</u> par M. SOYER
Ma	9h: Les fonds coralligènes par M. LAUBIER	14h: Suite
Me	9h: Faune interstitielle des sables à Amphioxus par MM. GUILLE-SOYER	14h: L'Amphioxus par M. GUILLE
Je	9h: L'Herbier à <u>Posidonia</u> par M. REYSS	14h: Examen de fin de stage le staff en totalité

Le programme est susceptible de subir des modifications.  
Les manipulations seront confirmées chaque jour par voie d'affiche.

Fig. 5. – Program for the Easter break internship (*Stage de Pâques*) (1965).

remains important. For example, in the 1960s, Pierre Drach (director 1965-1976) mentioned the arrival of students from the *Université Pierre et Marie Curie* who were studying for the CAPES and the *Agrégation* in a 12-day course<sup>18</sup>. Currently, Parisian students from the *Sorbonne Université* no longer study for these exams in Banyuls (some teachers still teach these students on the Parisian campus). However, many students from the universities of Toulouse and Montpellier who study for these competitions use the laboratory facilities each year, which shows that this marine station still constitutes an ideal place for students to train. In addition, since the Second World War, many undergraduate students have visited the laboratory to be trained in Mediterranean Ecology. For example, courses such as “*Ecology and Biology of Organisms*” in the 1980s (A. Fiala in Jacques & Desdevises 2021), “*ECOBIO*”<sup>19</sup> in Mediterranean Ecology since the 2010s and the “*DIMAR*”<sup>20</sup> illustrate the diversity of Mediterranean biotic interactions. The last two courses in this list have been organized for 2nd-year Life Sciences students registered at the *Sorbonne Université*.

<sup>18</sup> Pierre Drach's personal archives, kept at the *Archives du Laboratoire Arago*.

<sup>19</sup> *Ecologie et biologie des organismes méditerranéens*/Ecology and biology of Mediterranean organisms.

<sup>20</sup> *Diversité des interactions marines*/Diversity of marine interactions.

Stage N° 6		FRANCE
STAGE D'ÉCOLOGIE TERRESTRE (Certificat de 3ème Cycle d'Ecologie) 10 - 22 Mai		
PROGRAMME		
Lun	10 - Ouverture du stage Remise du matériel	14h.- Généralités sur les Fyrénées Orientales, par M. TRAVE 16h.- Visite du Centre d'Ecologie du Mas Reig, par M. COINEAU
Ma	11 - 9h. Méthodes de récoltes en entomologie - Excursion dans les garrigues du littoral par M. COINEAU	Excursion dans la Vallée de la BAILLAURIE, par M. COINEAU
Me	12 - 9h. Généralités sur les micro- arthropodes du sol par M. COINEAU	14h.- Tardigrades Insectes Aptérygotes par M. COINEAU
Je	13 - 9h. Les Amphibiens par M. KNOEPFFLER	10h.30.- Départ de l'excursion dans la vallée d'ESPOLIA (Esp.). Récoltes her- pétologiques et entomologiques par MM. KNOEPFFLER - COINEAU
Ve	14 - 9h. Les microarthropodes du sol (suite); Les Acariens par M. TRAVE	14h.- Les Acariens (suite) par M. TRAVE
Sa	15 - Inauguration du buste de RACOWITZA	
Lu	17 - 9h. Les microarthropodes du sol (suite et fin): Arachnides par M. COINEAU	14h.- Myriapodes Insectes ptérygotes par M. COINEAU
Ma	18 - Excursion dans la Réserve de La Massane sous la conduite de M. TRAVE	
Me	19 - 9h. Les Rotifères par M. COINEAU	14h.- Les Rotifères (suite) par M. COINEAU
Je	20 - Excursion aux BOULLLOUSES : Récoltes entomologiques et observations sur l'étagement de la végétation dans les P.O. par M. COINEAU	
Ve	21 - 9h. Les flagellés des Termites par Mme CAHET	14h.- La végétation et la faune en- tomologique des sables littor- aux, par M. COINEAU
Sa	22 - 9h. La microfaune intersti- tielle, par Mme COINEAU	Remise du matériel

Fig. 6. – Program for the internship in terrestrial ecology (*Stage d'Ecologie Terrestre*) (1965).

### 1950: development of a European curriculum in phycology

In 1950, a new summer course entirely dedicated to marine phycology was created by Jean Feldman and René Delépine. In 1968, Michèle Peguy-Knoepffler reorganized it and turned it into one of the most famous courses to be offered at the lab in three decades. She succeeded in gathering a team of high-level European instructors in phycology (Boudouresque 2018). The course had different names over the years, depending on the funding obtained to support it. For example, in 1989, the course was chosen by the “Erasmus” program of the European Union<sup>21</sup>, and students came from the *Université Pierre et Marie Curie* and all over Europe to attend a laboratory course on the systematics and ecology of Mediterranean algae. The objective of the course was to provide participants with the tools required to identify the main primary producers (benthic macrophytes and phytoplankton) encountered on the Mediterranean coast and to deliver some content about their physiology. The internship was planned for 20 to 25 students, and 124 hours of teaching were provided. This course allowed for a whole generation of phycologists to be trained in Europe<sup>22</sup>. It lasted for a few years

<sup>21</sup> *L'Indépendant*, September 12, 1989.

<sup>22</sup> Michèle Peguy-Knoepffler's archives, kept at the *Laboratoire Arago*.



Fig. 7. – Courses with Claude Delamarre Deboutteville in the 1950s (A) and at the Mas de la Serre with Yves Coineau, probably during the 1980s (B). Training in scuba diving techniques (C).

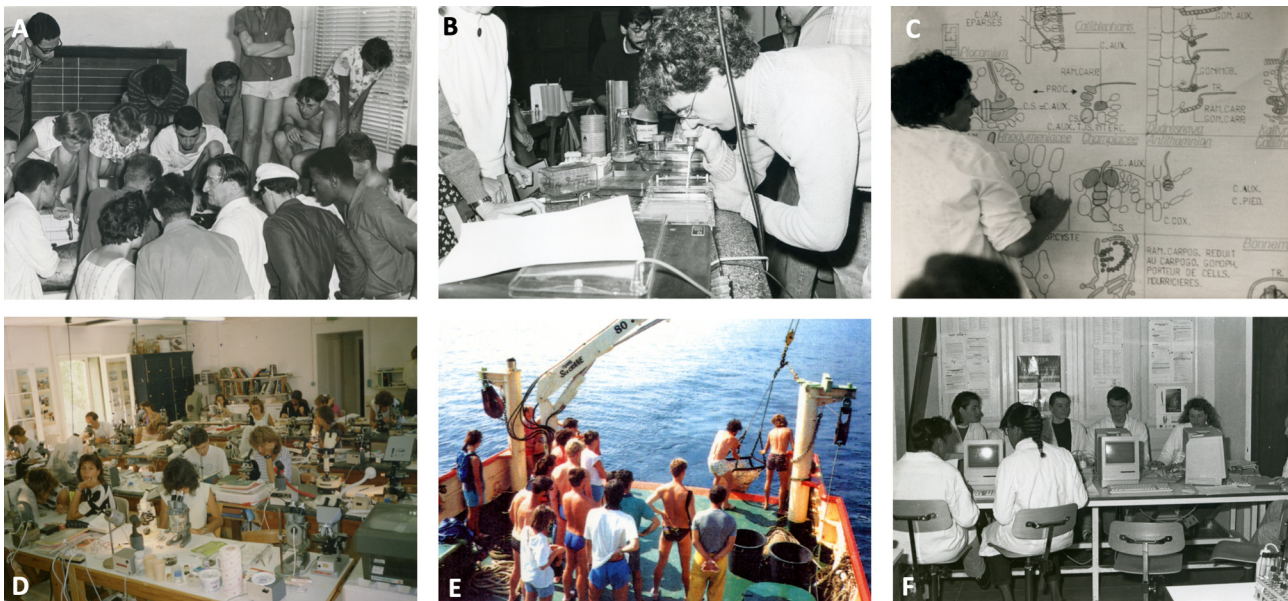


Fig. 8. – (A) Courses by Georges Petit, probably during the 1950s, (B) Erasmus course, practicum session in molecular biology in the 1990s, (C) lecture in cryptology by Michèle Peguy-Knoepffler in 1974 (D) and 1989, (E) Erasmus program in oceanography, onboard the *Laboratoire Arago* boat in 1989, and (F) courses in the “computer room” in the 1990s.

after the retirement of Michèle Peguy-Knoepffler in 2001 but is unfortunately no longer offered at the laboratory (Boudouresque 2018) (Fig. 8).

### ***1956: creation of a DEA<sup>23</sup> in biological oceanography<sup>24</sup>***

Since its creation, the *Laboratoire Arago* has been an ideal place to connect biology and oceanography: the first

<sup>23</sup> *Diplôme d'Etudes Approfondies* (3<sup>rd</sup> cycle of studies)

<sup>24</sup> Transcripts of Paul Nival's Interview (former director of the *DEA d'Océanographie Biologique*) and *Archives de la Faculté des Sciences (Sorbonne Université)-Master Sciences de la Mer*.

director was a zoologist (Lacaze-Duthiers), while the second director was an oceanographer (G. Pruvot). Thus, it is not surprising that a few years later, *La Sorbonne* and Banyuls laboratories in particular hosted a new and original training program in biological oceanography.

Gaston Berger, Director of Higher Education at the Ministry of National Education from 1953 to 1956, created a “3<sup>rd</sup> cycle of studies”<sup>25</sup> in French universities. A few years later, in 1964, the *Diplômes d’Etudes Approfondies* (DEA) were initiated. This program of studies aimed to support the development of many innovative scientific streams of research in French laboratories by enabling the training of highly specialized students, connecting them to research questions and methodologies. Students were then ready to be hired in research laboratories or the industry. In 1956, under the leadership of Pierre Drach, a new postgraduate program in biological oceanography was initiated; the program brought together the disciplinary strengths of the *Faculté des Sciences* (Sorbonne), the *Institut Océanographique*, the *National History Museum*, the *Institut des Pêches* and of the three marine stations of Roscoff, Banyuls-sur-Mer and Villefranche-sur-Mer. For the first time, multidisciplinary teaching connected oceanography with marine biology (Drach 1982).

The first cohort was recruited for the 1957-58 academic year; only four students were enrolled in the courses. The cohorts grew over time; there were 17 students in 1980-81 and approximately up to 30 in the 2000s. In the 1950s, students first studied in Parisian institutions and then moved to marine stations to study aboard oceanographic ships. During fishing campaigns, *President Théodore-Tissier* welcomed students onboard. During the first years of the program, numerous significant logistical difficulties emerged during the students’ stays; in fact, the archives include many documents that specify organizational modalities. Many financial and short pedagogical reports were sent to the *Faculté des Sciences*. Numerous letters were exchanged among directors and teachers working at the marine stations to define the pedagogical contents or students’ arrival and departure dates. In Banyuls-sur-Mer, students attended courses taught by various professors who transmitted their knowledge about Mediterranean algae (Jean Feldman), coastal fauna, sand microfauna (Claude Delamare-Deboutteville), Mediterranean coastal lagoons (Georges Petit), and seawater chemistry (Caville). In 1960, a microbiology course was developed under the leadership of Edmond Lagarde who delivered lectures and oversaw labs on the physiology and metabolism of bacteria and the control of biogeochemical cycles by microorganisms.

The curriculum was drastically modified in 1964 with the creation by the government of laboratory research internships. This pedagogical evolution was signifi-

cant because it allowed students to integrate laboratory research during their internships before graduation. The DEA curriculum was modified for a second time in 1986<sup>26</sup> when the program was merged with the DEA program at the University of Brest<sup>27</sup>, which allowed for the development of a new curriculum that included sections providing students with specialized courses. Some students were recruited to attend classes at Brest University, which specialized on fisheries, while others were dispatched between the Villefranche-sur-Mer, Roscoff and Banyuls-sur-Mer sites, which specialized in environmental studies.

In 1989, as this training program had become attractive and well connected to research laboratories, other universities merged their curriculum with that of the new DEA program, leading to the creation of the *DEA d’Océanographie Biologique et Environnements Marins* (OBEM)<sup>28</sup>. This program was highly selective (no more than 30 students were selected from a pool of approximately 300 applicants). After taking several courses in Paris at the *Institut Océanographique de Paris* (from October to December) and attending yearly conferences funded by this institute, the students were separated into sections (*options*) from January to June; these sections focused on algology (*Ecole Normale, Université Paris II, Marine laboratory of Roscoff*), the environment and biogeochemistry (Banyuls-sur-Mer, University of Perpignan), biomathematics and modelization (Villefranche-sur-Mer) and agronomy (University of Brest, Rennes School of Agronom – *ENSA Rennes*). Different universities’ laboratories also participated in lectures and conferences (IFREMER, Brest, *Université du Littoral* [Wimereux marine station]). Students were evaluated throughout the year after completion of their research project. Indeed, they had to present the results acquired during their research internship, write a research report and present the data during a seminar at the end of June. The results were used to rank the students and allocate Ph.D. grants (later, “doctoral schools” were created and became responsible for distributing dissertation support grants to students enrolled in several DEA programs affiliated with the school).

The *DEA d’Océanographie Biologique et Environnements Marins* lasted until 2003-2004. In 2002, the *Licence-Master-Doctorat* system was initiated, and in 2004, the DEA was transformed into the *Master des Sciences*

<sup>25</sup> Nowadays, Master 2.

<sup>26</sup> This date is estimated based on an analysis of the *Archives du DEA*, at the *Sorbonne Université*. The DEA acquired the name of *DEA d’Océanologie Biologique des Universités de Brest et Paris VI*.

<sup>27</sup> Current name: *Université Bretagne Occidentale*.

<sup>28</sup> The name was *DEA d’océanologie biologique et environnement marin des universités Paris VI, Brest, Lille, Perpignan*, and it came to include ENSA Rennes in the 1990s.

de la Mer<sup>29</sup>. Many instructors still regret the DEA structure, as it connected a broader network of universities and laboratories compared to the Master's program, which is more centered on the Sorbonne's research resources in the context of the political reform that led to the autonomy of universities. Nevertheless, this training curriculum has remained essential. Approximately 35 students are recruited in the program each year, and classes are still held in the three marine stations belonging to the *Sorbonne Université* and on its main campus. During the first year of the Master's program, students must enroll in one oceanography course on the main campus in Paris and one practicum in one of the marine stations and participate in a short research internship. The second year is dedicated to specializing in "biodiversity and conservation of marine ecosystems" or in the "function of marine ecosystems and global change." All students must spend the last five months of their master's program working in an internship in a research lab or a private company<sup>30</sup>.

<sup>29</sup> The use of the word "Master" in this text is not usually administratively correct but greatly simplifies the comprehension of this article. Indeed, all master's programs at the *Sorbonne Université* are organized in either "mentions", "parcours", or "spécialités".

<sup>30</sup> *Master des Sciences de la Mer* website. <http://sciencesdelamer.sorbonne-universite.fr/enseignements/organization.html>

STAGE DE 3 <sup>e</sup> CYCLE D'Océanographie Biologique	
31 Mai - 18 Juin	
Mardi 31	- 11h. : Distribution du matériel 14h,30 : Introduction au stage - Exposé du programme - Le supra et le medio littoral (J. SOYER)
Mercredi 1	- 8h,45 : Excursion au Cap l'Abeille (Pr. J.FELDMANN, J.SOYER). 14h,30 : Les Algues du trottoir à <i>Lithophyllum tortuosum</i> (Pr. J.FELDMANN).
Jeudi 2	- 9h. : Faune et Flore du trottoir à <i>Lithophyllum tortuosum</i> (Pr. J.FELDMANN, J.SOYER). 14h,30 : Faune du trottoir à <i>Lithophyllum tortuosum</i> (J.SOYER)
Vendredi 3	- 8h,45 : Excursion au Cap Creus (Espagne) - dragages sur le Coralligène.
Samedi 4	- 9h. : Les Algues du Coralligène (Pr. J.FELDMANN)
Lundi 6	- 8h,45 : Excursion algologique à Collioure (Pr. J.FELDMANN) 14h,30 : Détermination des Algues (Pr. J.FELDMANN)
Mardi 7	- 8h,45 : Dragages infralittoraux (A.GUILLE, J.SOYER) 14h,30 : Les fonds meubles infralittoraux (A.GUILLE, J.SOYER)
Mercredi 8	- 9h. : Faune des fonds meubles infralittoraux (A.GUILLE, J.SOYER). 14h,30 : Faune des fonds meubles infralittoraux (Idem)
Jeudi 9	- 8h,45 : Chalutage profond (D.REYSS)
Vendredi 10	- 9h. : Les Poissons (H. BOUTIERE, G. CAHET). 14h,30 : Les Poissons (H. BOUTIERE, G. CAHET).
Samedi 11	- 9h. : Les Invertébrés bathyaux (D.REYSS).
Lundi 13	- 8h,45 : Dragages circalittoraux sur substrats meubles (J.SOYER, A.GUILLE). 14h,30 : Les fonds meubles circalittoraux (J.SOYER, A.GUILLE).
Mardi 14	- 8h. : Faune des fonds meubles circalittoraux (J.SOYER, A.GUILLE). 14h,30 : Faune des fonds meubles circalittoraux (J.SOYER, A.GUILLE).
Mercredi 15	- 8h,45 : Dragages Herbier à Posidonies et Coralligène (D.REYSS). 14h,30 : L'Herbier à Posidonies (D. REYSS).
Jeudi 16	- 9h. : Le Coralligène (A.GUILLE) 14h,30 : Le Coralligène (A.GUILLE)
Vendredi 17	- 9h. : Généralités sur le Plancton de Banyuls (R.RAZOULS) 14h,30 : Les Larves planctoniques (C.RAZOULS, A.THIRIOT, M.BHAUD)
Samedi 18	- 9h. : Le meroplacton (C.RAZOULS) 14h,30 : Le meroplacton (C.RAZOULS)

Fig. 9. – Program for the *DEA d'Océanographie Biologique* (1966 or 1967).

On fait toute la semaine de la semaine 10 fois. Mercredi 55. Pour New Beau.

UNIVERSITÉ PIERRE ET MARIE CURIE  
PARIS VI  
LABORATOIRE ARAGO  
F - 6650 BANYULS-SUR-MER  
Téléphone : (66) 88.00.40++

26 novembre 1979

ENSEIGNEMENT BANYULS - D.E.A. D'Océanographie Biologique

**Cours à Paris :**  
M. J. SOYER : L'écosystème benthique - Méthodes d'études - Facteurs du milieu - Caractéristiques qualitatives et quantitatives - Transferts énergétiques.

**Cours à Banyuls :**  
M. H. BOUTIERE : Les milieux saumâtres : estuaires et lagunes.  
M. G. CAHET : Le cycle de la matière organique dans les sédiments.  
Mme A. FIALA : Ecophysiologie des organismes benthiques - Filtreurs et mangeurs de dépôts.  
Mme M. KNOEPFFLER : Les Algues - Taxonomie - Répartition - Phytosociologie  
M. C. RAZOULS : La production secondaire en mer - le cas du Golfe du Lion.

**Travaux dirigés et travaux pratiques**

En 1979, a été mise en place une nouvelle formule : quatre ateliers ont été organisés d'une durée d'une semaine chacun, qui sont suivis successivement par quatre groupes d'étudiants.

Cette méthode, bien que lourde pour les enseignants, permet une meilleure initiation pratique des étudiants aux méthodes utilisées dans les recherches en benthologie.

**Atelier 1 - Benthologie** : J. SOYER - J.-Y. BODIOU 4 x 35 h  
1 - Travail à la mer - Point en mer - Engins de prélèvements - Rendement.  
2 - Tri - Fixation - Analyse qualitative et quantitative - Densités Biomasses (expressions diverses) - Calorimétrie.  
3 - Sédiments - Caractéristiques physiques, chimiques, dosages du C, N - C/N - rH - pH - R.P.D.) - Numération bactérienne  
4 - Analyse des données - Applications de méthodes mathématiques au domaine benthique.  
5 - Mesure d'un métabolisme total et de métabolisme partiel (faune bactéries - D.C.O.).

- 2 -

**Atelier 2 - Phytosociologie marine** - M. KNOEPFFLER avec la collaboration de Ch.-F. BOUDOURESQUE. 4 x 35 h  
1 - Taxonomie, répartition des Algues.  
2 - Technologie des récoltes et des relevés - Indices - Cartographie  
3 - Leurs paramètres physico-chimiques - Peuplements  
4 - Problèmes particuliers du traitement mathématique des données en phytosociologie

**Atelier 3 - Ichtyologie**. H. BOUTIERE - J.-P. LABAT 4 x 35 h  
1 - Initiation à la systématique des Poissons  
2 - Engins de pêche : en mer - en milieu lagunaire  
3 - Etude du stock : étude de la population (taille, poids, scalimétrie) biométrie détaillée et rapports gonado-somatiques - croissance et âge (écailles et otolithes) - contenus stomacaux - coefficients.  
4 - Traitement des données : croissance - allométrie - décomposition en classes de taille - mortalité - simulation - les méthodes factorielles en dynamique de populations.

**Atelier 4 - Nutrition et métabolisme** - A. FIALA - G. CAHET - C. RAZOULS 4 x 35 h  
1 - Nutrition bactérienne (C<sub>14</sub>)  
2 - Nutrition - Excrétion phytoplancton (C<sub>14</sub>)  
3 - Nutrition d'un filtreur benthique et d'un filtreur pélagique - Taux de filtration - méthode fluorimétrique - Taux d'absorption - Scintillation liquide et double marquage H<sub>3</sub> - C<sub>14</sub>  
4 - Respiration - Métabolisme - Mesures chez les filtreurs benthiques  
5 - Calorimétrie : démonstration sur zooplancton.

Figs 10, 11. – Program for the *DEA d'Océanographie Biologique* (1979).

At the Banyuls marine station, teaching methods were modified over the years. Whereas Lacaze-Duthiers and pioneer's instructors taught systematics and field descriptive ecology, the originality of the DEA was to introduce new concepts from the 1950s to the 1970s in marine ecology and to develop avenues for students to learn sea sampling techniques and diving internships, which were also organized in Banyuls. In the 1980s, the DEA also enabled the diffusion of knowledge in functional ecology (for example, the course entitled "biology of organisms and populations" was organized by Aline Fiala-Médioni) (Figs 9, 10, 11).

Courses and conferences, as well as practicums and field trips, aimed to introduce the main groups of marine species, as well as the different biotopes and characteristics of marine and terrestrial populations (in marine environments such as coastal lagoons, beaches, sedimentary environments, hard substrates, sidewalks, seagrass beds, coralligenous, canyons, etc.); the curriculum also addressed the functioning of ecosystems, presenting diverse examples of planktonic organisms, benthic organisms, microorganisms, as well as the different types of food chains, the main functions associated with these groups of organisms (for example, nutrition and breathing), energy balances, types of interactions (such as trophic competitions, symbioses, parasitism, colonial life, etc.). Sampling strategies and technologies associated with aquatic environments were also developed. These strategies included the demonstration of sampling techniques such as dredging, trawling, developing plankton nets, and using CTD devices and included demonstrations onboard the Néréis or the Lacaze-Duthiers boats). Technical courses also took place in abyssal environments (for example in submersibles and ROVs), as this type of research was also being developed in labs in Banyuls. Measuring different types of biological parameters was also evoked, for example through the use of isotopic labeling and liquid scintillation techniques in oceanography, as well as HPLC or electron microscopy. Finally, major international programs in oceanology were presented as well as biological bases for shellfish farming and biodiversity conservation (i.e., programs such as LOICZ, GLOBEC, or GOOS<sup>31</sup>).

### 1958: scuba diving internships

Georges Petit initiated the first course in scuba diving in 1958. This innovative course was initially created at the request of Pierre Drach, who wanted to introduce students enrolled in the *DEA d'Océanologie Biologique* (see above) to scuba diving. The implementation of this course was fully in line with the need to train students in

underwater sampling techniques to better connect biology and oceanography, as explained in the previous paragraph. It was thus essential for students to acquire scuba diving techniques. Many lab instructors were involved in the organization of that course, which was operated by local scuba diving clubs; in fact, the course was also widely open to students who were not enrolled in the DEA (Jacquet 2012). At the beginning of the 1980s, the course was run by a university association. Thus, Banyuls-sur-Mer became a place where all students and members of the university could train in scuba diving if they wanted to. Over time, the laboratory also became a place for continuing education in scuba diving, with courses organized for the CNRS or *Université Pierre et Marie Curie* staff (G. Jacques, A. Fiala, in Jacques & Desdevises 2021) (Fig. 12).

### 1995: implementation of courses in molecular, cell, and developmental biology

The development of research in cell and molecular biology on marine model organisms started in the 1960s and continued to expand from the 1970s to the 1990s under the leadership of Marie Odile Soyer-Gobillard and André Picard, two CNRS researchers. Various training programs have been offered over the years by researchers working in this field and have benefitted Ph.D. students. Moreover, when Marie Madeleine Giraud-Guille (an instructor at the *Ecole Pratique des Hautes Etudes*), Gérard Peaucellier,

STAGE DU 1 AU 13 JUILLET 1966 *Stage de plongée*

Vendredi 1	9h.30.- Salle Conférence Equipement 10h.00.- Ouverture du Stage	15h.- Groupe I et II Tests de Natation	
Samedi 2	9h.30.- Groupe I Evolution - Plongée Canard - Equipement avec appareil.	15h.- Groupe 2 Idem	
Dimanche 3	9h.30.- Groupe I et II Plongée avec ap- pareil - Lestage - Evolution.	R E P O S	
Lundi 4	9h.30.- Groupe II - Lestage Equilibrage des oreilles.	15h.- Groupe I IDEM	
Mardi 5	9h.00.- Groupe I et II - Sortie en mer Néréis.		
Mercredi 6	9h.30.- Groupe I Equilibrage des oreilles.- Embout et masque.	15h.- Groupe 2 IDEM	17h.- Théorie Défendeur et blocs bou- teilles.
Jeudi 7	9h.30.- Groupe II - Vidage du masque - Désé- quipement au fond.	15h.- Groupe I IDEM	
Vendredi 8	9h.00.- Groupe I et II Sortie en mer Néréis.		
Samedi 9	9h.30.- Groupe I et II - Rééquipement au fond - Echange appareil.	14h.30.- Adaptation de l'homme au milieu sous-marin. Réanimation - noyade. Accidents de plongée. Accidents de décompression.	
Lundi 11	8h.30.- Sortie de la journée au Cap Creus. Groupe I et II. Exploration et sauvetage.		
Mardi 12	9h.30.- Groupe I. Respiration à deux sur un appareil. Révision	15h.- Groupe II. IDEM	
Mercredi 13	9h.00.- Epreuves. Brevet Élémentaire Brevet 1er Echelon		

Fig. 12. – Program for the diving internship (*Stage de plongée*) (1966).

<sup>31</sup> LOICZ = Land-Ocean Interactions in the Coastal Zone; GLOBEC = Global Ocean Ecosystem Dynamics; GOOS = Global Ocean Observing System

and Laurence Besseau were hired between 1990 and 1995 (and then Gilles Boeuf, the director from 2000 to 2005, got involved), it made it possible to offer the first courses in cell and molecular biology. These courses were part of the initial training delivered to students enrolled at the *Université Pierre et Marie Curie*. In 1995, courses were also delivered in Banyuls as part of the *DEA biologie cellulaire et moléculaire du développement* and the *DEA de physiologie des invertébrés* curricula.<sup>32</sup>

Courses in this field were then diversified year after year, as a laboratory entitled *Models in cell biology* was created in 1998. In 2002, students registered in the *DEA de biologie intégrée des invertébrés*, the *DEA de physiopathologie cellulaire et moléculaire*, and the *DEA de biodiversité, génétique, histoire, mécanismes de l'évolution* were also welcomed to attend important courses at the laboratory during their initial training in Banyuls. For example, in 2002, the *DEA biologie et physiologie des invertébrés* offered a course in Banyuls entitled "Cell cycle and development" (25 h, 15 students); the course addressed cell proliferation and was associated with a series of biochemical experiments on marine models (sea urchin eggs and starfish oocytes). Students were often in contact with researchers from the station and were even taught about cell microinjections in class, which was a fantastic experience for them. This opportunity was also available at the master's level as part of a developmental biology degree (35 h, 15 students) that offered a practical approach to the classical models of marine cell biology and reproductive biology. Meiosis and fertilization of oocytes, embryonic development, reproductive biology and strategies, and the implementation of the main body plans in relation to phylogeny were discussed. Currently, in the LMD organization, this content is delivered to students registered in the *Master de Biologie Intégrative et Physiologie*.

### 2005: curriculum development in microbial ecology

Marine microbial ecology is a recent discipline rooted in the technological evolution of the 1970s and 1980s; it was developed in the medical field and transferred to marine laboratories along with flow cytometry or epifluorescence microscopy, and molecular biology a few years later. This research revealed the existence of a large diversity of microorganisms in the (marine) environment and deeply shaped the functioning of marine ecosystems while presenting a potential for the valorization of human applications such as the production of original bioactive metabolites. The development of an important research in marine microbial ecology at the *Laboratoire Arago* led to

the creation of two research laboratories in this field: the Microbial Oceanography Lab (created in 2010 and called the *Laboratoire d'Océanographie Microbienne*) and the Microbial Biodiversity and Biotechnology Lab (created in 2015 and called the *Laboratoire de Biodiversité et Biotechnologies Microbiennes*). Since the first microbiologists were recruited, various courses related to this theme have been added to the *DEA d'Océanographie* curriculum. In 2005, the master's program entitled *Ecologie microbienne marine* and renamed *Ecologie microbienne* was launched by Philippe Lebaron (director 2005-2015) and Fabien Joux. In 2009, this master's program was restructured and overseen by both Fabien Joux in Banyuls and Vincent Maréchal in Paris. Since 2014, the master's program has been run by the *Sorbonne Université* and the *Muséum national d'Histoire naturelle*. These courses have enabled students to be taught about the taxonomic and functional diversity of microorganisms, the microbial production and degradation of organic matter, the quality of coastal waters, and the applications of environmental microbes for industrial processes (*i.e.*, microalgae culture and the innovative culture of microorganisms). Students have also been trained in sampling techniques of microbes at sea (*i.e.*, by sampling the sea surface microlayer at the air/water interface) and in using molecular-based tools to investigate the diversity and activity of microorganisms (in the period 2005-2015, they studied cloning-sequencing and fingerprinting techniques, and since then they have studied OMICs approaches and associated bioinformatic pipelines). In 2020, Raphaël Lami created a new summer school in marine microbial ecology to train French university students in these concepts and tools (the course is called "Microworlds").

### 2013: development of courses in ecotoxicology

The increasing pressure of human activities on marine ecosystems since the beginning of the industrial era has led to a massive reduction in marine biodiversity. The location of the *Laboratoire Arago* particularly allows for the study of these massive impacts. Since the 1970s, and mostly since 2010, many research projects have been deployed at the lab to understand the many impacts of marine pollution, including the release of pesticides, hydrocarbons, microplastics, sunscreen creams, and many other factors. While no specialized laboratory has been established in this field of research, many researchers have been involved in scientific programs dedicated to such studies, which have also been structured by a transversal research axis. Since 2013, many students registered in the *Master d'Ecophysiologie et Ecotoxicologie* (cre-

<sup>32</sup> CNRS (1995). *Guide des stations marines*. Éditions CNRS, Département des Sciences de la Vie, Département des Sciences de l'Univers.

ated in 2013) attended various courses organized at the lab<sup>33</sup>. Courses in ecotoxicology have been offered for a long time at the laboratory. However, the implementation of this master's program in Paris made it possible for students to be trained on questions and concepts specifically related to ecotoxicology. The growing importance of this research field has also led many colleagues to introduce ecotoxicology in their lectures as well as in practical sessions in other programs, either at the ecosystem, organismal, cell, or molecular level. This growing importance also led in 2022 to the hiring of a new assistant professor in this field and to the creation of a new European course with the partners of the 4EU+ Alliance, a European alliance of universities of which the *Sorbonne Université* is a member. In this course, students are closely connected to the research activities conducted at the lab: they attend courses about the impact of plastic debris on marine ecosystems, about genomic-based, chemical and microbiological methods to track pollution, and about marine organisms/communities as bioindicators of pollution. Again, a large part of the activities is dedicated to practical sessions, with field samplings and analysis, which allows, for example, the chemical and biological characterization of nonpolluted and polluted environments.

#### A HISTORY OF THE ORGANIZATIONAL ASPECTS OF TEACHING ACTIVITIES AT THE LABORATORY

Marine stations constitute small campuses located far from the main campus in Paris. Thus, teaching activities are organized in close association with housing and catering management. The *préparateurs* of Lacaze-Duthiers' laboratory were those who first organized all aspects of teaching, in close collaboration with the professor. However, with time, dedicated services and facilities were developed to support the increasing number of students hosted by the program.

##### *Teaching team*

In the years following the creation of the *Laboratoire Arago*, teaching activities were directly planned by the zoology laboratory at *La Sorbonne*. The professors and their *Maîtres de Conférences* were used to travelling to the marine station to teach during the internships. Nevertheless, a *préparateur*, usually a Ph.D. student, was also specially assigned to manage the laboratory (which involved managing the lab, welcoming visitors, communicating with local authorities, and organizing all other

aspects of everyday life, including teaching activities). Researchers and instructors greatly appreciated the weather conditions, the tranquility of Banyuls, and the excellent working conditions, and over the years they stayed longer. A few of these researchers acquired property in the village, as Paul Wintrebert did. After the Second World War, while the chair in zoology remained for a few years associated with a Parisian laboratory, instructors were assigned to work at the *Laboratoire Arago* all year-long. Under the leadership of Georges Petit, a teaching manager position was created to help the director manage the organizational aspects of the curriculum. The number of instructors permanently assigned to the laboratory grew from 2 to 10 between 1946 and 1961 to approximately 18 to 20 since 2005. Currently, 85 % of teaching activities are dedicated to master's students (15 % to undergraduate students). Approximately 25 % of the teaching activities correspond to courses delivered on the main campus in Paris. The teaching team provides approximately 3000 hours of lectures and practicums each year.

##### *Evolution of spaces dedicated to teaching*<sup>34</sup>

Little is known about the rooms where teaching took place before the Second World War. After 1946 and until 1976, there was only one classroom with 30 seats available for students to use. However, the important development of new courses led to organizational difficulties. The documents preserved in the archives and dating from the 1960s indicate that “*two practical work rooms would be essential*” and that “*the Laboratoire Arago has to refuse several internships each year*”. It was not until 1976 that a second room for practicums was created, adding a capacity of 20 seats. With the *Centre d'Ecologie Terrestre* at the *Mas de la Serre*, where teaching also took place, it was possible to welcome three simultaneous courses, for a total capacity of approximately 65 seats. A few years later, a conference hall with 50 seats was opened. In 2001, building B “*Alain Guille*” was inaugurated, making it possible to open a 120-seat amphitheater. In 2002, an extensive rehabilitation of the historic building permitted the renovation of the two teaching rooms (25 seats each) to create an additional room for lab sessions, a student computer room (offering 15 computers), and a room to wash and store glassware used in teaching activities. The objective of this project was to gain a “*greater cohesion of infrastructure within a space dedicated to education*”. The construction of the new aquarium and the “*Louis Boutan*” building in 2017 enabled the opening of a small amphitheater—the “*e-learning room*”; with a capacity of 27 seats, this room includes videoconferencing equip-

<sup>33</sup> David Siaussat, François Lallier 2017. Ecophysiologie/ Ecotoxicologie, une spécialité de master formant les spécialistes de demain en écophysiologie et écotoxicologie. hal-02791105

<sup>34</sup> Most of the documents consulted to write this section are available at the *Archives du Laboratoire Arago*, in the “*Fonds Pierre Drach*”.

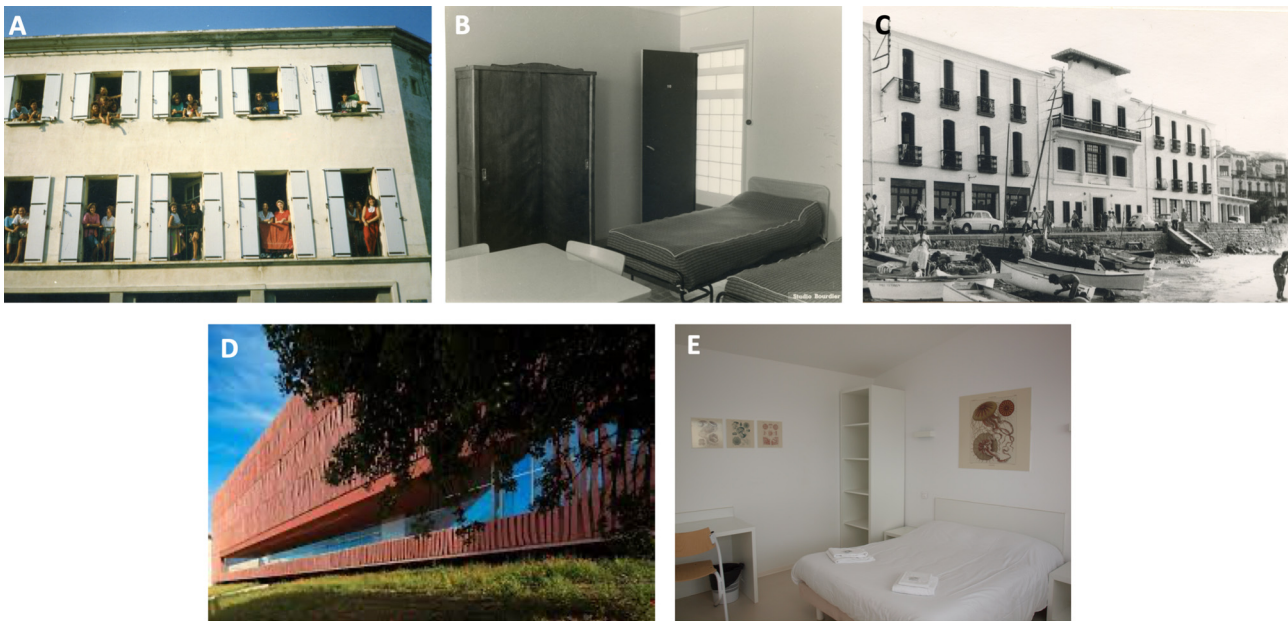


Fig. 13. – Students housed at *L'annexe* (A and B, 1989), (C) at the *Grand Hotel*, and in the current housing center (D and E).

ment and internet connections at all seats. Another room designed as the “*laboratoire pédagogique*” was opened in the same building and can accommodate the public or schoolchildren during aquarium visits for tailored practical work sessions (24 seats are available there). In 2020, a new rehabilitation project funded by a *Contrat de Plan État-Région* permitted the renovation of the historic building. In 2022, three new rooms used for teaching have replaced the old rooms in a fully renovated building. A computer room is no longer available, as the development of the internet now makes it possible for students to directly connect to pedagogical contents on the laboratory’s server from their computers.

#### *Hosting students at the laboratory*<sup>35</sup>

The construction of rooms to welcome researchers and students is not a specific feature of marine stations at the *Sorbonne Université*. Historians have shown that the decentralization policy implemented during the Third Republic, which allowed the creation of numerous astronomical observatories and marine stations, also supported the development in all these institutions of suitable hosting structures for instructors and researchers (Debaz 2016). However, until 1952, all the students were not hosted at the laboratory. The few rooms available were reserved for visiting researchers or Ph.D. students. In 1952, new hospitality facilities were created, in particular accommodations and rooms designed to host

the laboratory staff and a few visiting students. In 1957, when the building named “*the annexe*” was opened and offered new rooms, it slowly became possible to host students who attended courses in Banyuls. Although the comfort level was basic, “*the annexe*” accommodated up to 30 students each year. However, at the same time, it became increasingly challenging to host students in the village of Banyuls, and “*the annexe*” was not sufficient to cover the needs. The situation became critical in 1968; indeed, internal laboratory reports reveal significant difficulties and mention that “*keeping teaching activities at the current level and a fortiori possibly expanding them, which has been made necessary by the new programs, is seriously compromised by the fact that the infrastructure is insufficient both to conduct practical work and to provide essential hospitality*”.

In 1968, the Ministry of National Education allocated a budget of 3,600,000 francs to construct a new building comprising reception facilities (bedrooms, dining room, etc.), a marine aquarium and research facilities. The *villa Saint-Jean*, located near the laboratory and purchased in 1960, was targeted as an ideal place for constructing this center. Unfortunately, this beautiful historic villa<sup>36</sup> was destroyed in 1968 and the new building was never erect-

<sup>35</sup> Most of the documents consulted to write this section are available at the *Archives du Laboratoire Arago*, in the “*Fonds Pierre Drach*”.

<sup>36</sup> From July 1941 to November 1942, this villa, which had been built in the 19<sup>th</sup> century, housed the “nursery” of Banyuls-sur-Mer, an annex of the Swiss maternity of Elne that was managed by the Red Cross. It offered children and their mothers a pause to escape the misery of the Argelès, Saint-Cyprien and Rivelsaltes internment camps, which housed people in exile because of the *Retirada* and the war. During the war, many Jews were saved by Elizabeth Eidenbenz, the director of the institution.



ed: the political events of 1968 led to the cancellation of the allocated budgets. Thus, the situation for hosting students became even worse in the following years. Reports of lab activity emphasized the lack of rooms and that “*the current housing conditions are beyond mediocre; the rooms we offer (...) correspond to those of a hotel of the very last category*”. In 1975, *Le Grand Hôtel*, a building next to the laboratory (the current location corresponds to the building “Louis Boutan” and the aquarium), was on the market for 1,200,000 francs, much below the estimated sale price. An internal laboratory report indicated that acquiring that building “*would solve the problem of housing at the laboratory for half a century*”. However, real estate agents competed to buy the *Grand Hotel*, as the location was ideal for developing touristic activities. Pierre Drach activated the heavy administrative machine and all his political relationships and even contacted Prime Minister Raymond Barre to obtain funding on time. The building was finally acquired, and the renovations started in 1978; in 1983, the laboratory opened the renovated *Grand Hotel*. At that time, the laboratory had a total capacity of 88 beds to host students (Fig. 13).

The new infrastructure made it possible for students to be housed until the beginning of the 2000s. Nevertheless, the lack of investment led to difficulties in maintaining the building. In 2013, with the support of Philippe Lebaron (director 2005–2015), a new housing center was built on the plot of the old villa Saint-Jean, which had been destroyed in 1968. The new building includes a university restaurant, 64 rooms with a single bed, and four rooms with one double bed and a single bed, for a total capacity of 76.

#### ***Organizing teaching activities during crises (WWI, WWII, and the COVID-19 pandemic)***

Because of WWI, teaching and research activities ceased on August 3, 1914, when Deputy Director Emile Racovitza and Director Georges Pruvot decided to transform the building into a military hospital. Some teachers, such as Paul Wintrebert, were then involved in providing care to the soldiers. Unfortunately, the hospital encountered multiple material difficulties and had to close by the end of 1916 (Marinescu 1986).

During WWII, teaching activities were stopped for a second time at the laboratory. Unfortunately, there is little information about how the situation impacted teaching activities<sup>37</sup>. The archives show that students continued to be welcomed at the laboratory until 1942, although the number of students there had decreased since 1939<sup>38</sup>. Teaching conditions were complicated throughout the

war. During the German occupation, the rules imposed by the Ministry of Higher Education were very strict, as academic and individual liberties were strongly restricted and aligned with German directives. The laboratory director, Edouard Chatton, did his best to maintain some scientific activities. From 1939, traffic restrictions limited the possibility of traveling to Banyuls<sup>39</sup>. Various material restrictions also affected the courses delivered during the war. On September 11, 1939, the dean of the faculty of sciences drastically limited any expense that was not strictly essential, and authorizations were required for any purchase exceeding 1000 francs. In 1943, the state funds allocated to the laboratory were reduced to 2/12 of their value, and Edouard Chatton indicated in numerous documents his inability to face even essential maintenance and repairs. The laboratory had an obligation to spend substantial budgets on securing the staff and students in case of an attack. For example, a shelter was created in boulders behind the laboratory using dynamite purchased from the nearby factory of Paulliles; the shelter was protected by a door and an anti-shatter screen. Because of this lack of funding, research and education facilities were seriously damaged during the war. In 1943, Germans evacuated the inhabitants of Banyuls in anticipation of a possible landing by the Americans. The laboratory was closed, and courses probably stopped at that time. Édouard Chatton tried to maintain his scientific activity in a villa in Prades.

Teaching activities were halted for a third time in early 2020 and through 2021, as the new coronavirus SARS-CoV-2, causing the disease named COVID-19, appeared in China and spread around the world within a few months. The French authorities were constrained to establish many restrictions to limit the propagation of the virus by reducing all types of social interactions. On March 11, 2020, the French president Emmanuel Macron announced the closing of universities as of March 16. This decision implied sending the laboratory students back home as soon as possible. On their way back, French students did not encounter serious difficulties, but the situation was much more complicated for international students. Indeed, one after another, most European states announced the closing of their borders, forcing students to modify their travel plans a number of times. All face-to-face courses were canceled until September 2020, and distance learning became the usual way to deliver courses.

Students returned to the laboratory in early October. A particular organization had to be implemented in

<sup>37</sup> Most of the documents used for this section are available at the *Archives du Laboratoire Arago, Fond Edouard Chatton*.

<sup>38</sup> 38 students in 1938, 48 in 1939, 11 in 1940, 28 in 1941, 13 in 1942, no students in 1944 and 1945, 33 in 1946.

<sup>39</sup> In the laboratory archives, one can find a letter from a student who wished to complete his training in marine biology and would have enjoyed visiting Banyuls and Villefranche marine stations. He wrote to Edouard Chatton to tell him that he could not reach Banyuls because of, among other reasons, the travel difficulties caused by the restrictions. He chose to go to the Villefranche marine station, much closer to the place where he was staying.

classes to limit social interactions and the diffusion of the virus. The rules that were applied included the mandatory wearing of a mask and a limitation in the number of students that could share a room to no more than 50 % of the occupancy rate. Unfortunately, a second lockdown of the French population was announced on October 28, and once again, all students left Banyuls a few hours before new restrictions were put into force. The students returned to the lab on February 15, 2021. Spring courses remained very disturbed by the health crisis, and it was still mandatory to deliver classes online as much as possible. On March 31, 2021, a third lockdown was announced. The rules were less strict compared to the previous rules that had been applied. Thus, the 13 *Master des Sciences de la Mer* students were not sent back home and could complete their courses, which were reorganized to favor distance learning. However, several larger classes were nonetheless canceled in April and May. Students in research laboratories could carry on their work, but access to buildings was reduced. The students returned to the lab for the summer courses in July 2021. The 2021-2022 university year was still disturbed by the new waves of the virus, but the rule was to deliver classes face-to-face to limit the important impacts that the lockdown and the restrictions have had on the mental health of students and the quality of the teaching that had been delivered since early 2020.

### PEDAGOGICAL SPECIFICITIES OF COURSES OFFERED AT THE LABORATORY

As mentioned previously, teaching at the *Laboratoire Arago* has always been delivered based on the combination of field excursions and samplings, experimental approaches, the organization of conferences led by instructors and researchers, and the involvement of researchers, technicians and engineers; this organization allows for the easy connection between research and teaching. In addition, instructors have always been interested in experimenting with new teaching approaches and methodologies to enhance the acquisition of skills and knowledge by students. The organization of field trips in 1891 was a major pedagogical innovation, and many other innovations have been developed by the teaching team since the 19<sup>th</sup> century.

#### *The laboratory as an ideal place for pedagogical innovations*

The laboratory has always been ideal for pedagogical experimentation and innovation. At the time the laboratory was created, the implementation of field courses by Henri de Lacaze-Duthiers was already a major educational innovation. The naturalists of the 19<sup>th</sup> century sometimes traveled with their students along the French coasts to study marine organisms, but the foundation of

the marine stations, particularly in Roscoff and Banyuls-sur-Mer, enabled the development of this type of pedagogical approach at a large scale. Currently, the laboratory provides students with an easy access to Mediterranean marine organisms directly in their natural environment and with an easy access to aquariums to observe these live organisms so they can describe their way of life. Henri de Lacaze-Duthiers was also a pioneer teacher in the way he used photography in marine biology as a pedagogical tool and technological device to project pictures and observations on a white wall or a large white fabric<sup>40</sup>. He also quickly introduced research technologies in his pedagogical methods. For example, his students went under water with scuba equipment to observe organisms and were able to work at night once electricity had been installed in the aquarium.

Pedagogical innovations continued to take place after the Second World War. Indeed, several innovative courses were implemented in Banyuls, such as those related to the *DEA d'Océanologie*, which included training in scuba diving (see previous paragraphs). Lab instructors were also interested in experimenting with new pedagogical approaches. For example, in 1950, Paul Bougis and Claude Delamarre-Deboutteville organized a workshop with a group of students for the study of the ecology of marine sidewalks that were made of calcareous algae. In 1951, the group published all their observations in *Vie et Milieu* (Deboutteville & Bougis 1951). The inclusion of students in the research process has remained an innovative experimental pedagogical approach.

In the 2010s, lab instructors continued to innovate in pedagogy. In particular, they were involved in developing online courses and blended learning opportunities (Lami *et al.* 2021). These courses allow students to listen to lectures online at home before they come to the laboratory. The “face-to-face” teaching time is thus dedicated to practical and group work and actually enables more interactions between students and between the student and the instructor. This type of teaching has been adjusted to courses in a marine station situation and provides more time for experimental work or field sampling; therefore, less time is devoted to academic lectures. In 2019, the course on “*Diversité des interactions marines*”, in which second-year graduate students enroll, was the first to fully abide by this type of pedagogy.

The development of these courses was greatly favored by the e-marine lab project (2015-2017), which was managed at the laboratory level in collaboration with colleagues from the Villefranche-sur-Mer and Roscoff marine stations, as well as people on the main campus in Paris. The project aimed to develop this type of pedagogy and to train instructors in marine science. In 2017, this

<sup>40</sup> Henri de Lacaze-Duthiers's personal notes, kept at the *Archives du Laboratoire Arago*.

original project won the national PEPS prize (*Passion Enseignement et Pédagogie dans le Supérieur*) awarded by the Ministry of Higher Education and Research in the category “Digital innovation”<sup>41</sup> (Lami *et al.* 2021).

### ***Continuing professional education***

The first course in professional continuing education organized at the laboratory was dedicated to training steamship mechanical fitters. The course aimed at the young people of Banyuls and was led by members of the laboratory who worked in the mechanical workshops and used to work on the steamship *Le Roland II*, the boat used for scientific purposes by researchers at the station. Octave Duboscq specified that this course enabled some of these young people to get into mechanics schools in Lorient and Brest. This training continued after WWI but stopped when the steamship *L’Orvet* ceased its activity, circa 1932. Unfortunately, after that time, the laboratory no longer had a ship large enough to ensure the sustainability of this training, despite the support of the Banyuls municipal council (Duboscq *et al.* 1937).

After WWII, the *Centre d’Ecologie Terrestre et Méditerranéenne* was highly involved in creating workshops for professional continuing education. Researchers and instructors working at this center conducted numerous internships that were open to professionals. The archives reveal<sup>42</sup> that a program on acarology<sup>43</sup> was organized from May 3 to May 22, 1971. Instructors and researchers came from the laboratory and all of Europe to develop courses in anatomy, biology, and the systematics of acarids. This internship was open to any professional with a master’s degree in biology. In 1974, a continuing education course was developed for secondary school teachers and attracted up to 28 participants. This course was based on field trips, and the teaching was focused on the fundamental notions of ecology (“community, biomass, production, food chain, trophic levels, functional adaptations”). There was a significant degree of flexibility in the organization of these courses: the instructors indicated that they were able to adjust the program according to the participants’ requests.

There were also regular courses organized for Ph.D. students at the interface of their initial and continuous training. For example, in 1984 and 1989, two summer schools were funded by NATO on the theme of “experimental embryology of aquatic plants and animals”. In the 2000s, Hans-Jürg Marthy organized a course on *Life in*

*Space*, which was open to an international audience and discussed the effects of gravity on organisms (HJ Marthy in Jacques & Desdevises 2021). Professional continuing education has never dominated the curriculum, but the laboratory pedagogical team has always acknowledged its importance.

### ***Opening the laboratory to international students***

The first international students who visited the laboratory came from the University of Barcelona in Spain. Between 1882 and 1914, Professor Odón de Buen (1863-1945) from that university traveled twice a year with many of his students to Banyuls (Duboscq *et al.* 1937). He organized excursions for natural science purposes for his students and Lacaze-Duthiers’s students. He guided scenic tours in Barcelona and the Balearic Islands for his students and those coming from Paris. Odón de Buen was one of the founders of Spanish oceanology, an exceptional naturalist, and a great friend of Henri de Lacaze-Duthiers. Their scientific exchanges were numerous. Their friendship was not only rooted in scientific work but also in political affinity. Indeed, both were staunch republicans. Many details about these French-Spanish exchanges were provided by Daniel Faget and Isabelle Renaudet through an excellent conference<sup>44</sup>.

After WWII, thanks to the creation of the European Economic Community, the number of students from European universities increased significantly. The list of universities partnering with the laboratory is very long. Among others relations, those maintained over many years between Pierre Drach and instructors at the University of Utrecht enabled many students to attend courses in marine biology and sometimes to stay in Banyuls for their doctoral thesis. Students from universities in Amsterdam, Groningen, and Nijmegen regularly came to the laboratory (Geilenkirchen 1982). German students also started to be included in the laboratory after WWII. Before the war, they more frequently stayed at the zoological station of Naples, which had been founded by the German scientist Anton Dohrn. Once Europe was at peace, it was possible to establish new linkages with German institutions, and Georges Petit increased the number of his contacts with German universities. These exchanges led many German instructors to visit and stay at the laboratory with their students. Professor Von Buddenbrock from the University of Mainz was the first one to come in 1950 with 17 students. After 1955, German students were so numerous that the successive lab directors struggled to accept them all (Reinboth 1982). Among the most famous professors who visited the lab with many of their students was the Swiss professor Pierre Tardent from the University of Zurich, who frequently came with his wife, children and

<sup>41</sup> <https://www.enseignementsup-recherche.gouv.fr/fr/laureats-dela-seconde-edition-du-prix-peps-l-innovation-au-service-dela-transformation-pedagogique-47162>

<sup>42</sup> Documents preserved in the *Fond du Mas de la Serre* at the *Archives du Laboratoire Arago*.

<sup>43</sup> Acarians constitute a very diversified group of microscopic insects (arachnids), frequently known to provoke allergies.

<sup>44</sup> <https://www.youtube.com/watch?v=cKnADZiYprE>

grandchildren to the laboratory (Honegger & Honegger 2002).

At the end of the 1970s, a common European higher education policy was gradually initiated. In 1987, the Erasmus program was created to enable students to attend educational activities in various European countries. In 1989, the phycology course led by Michèle Knoepffler-Peguy received the “Erasmus” label and was officially recognized as a European course (see previous paragraph). In 1990, a new program labeled “Erasmus” was organized as a “European multidisciplinary course in evolutionary biology”. A total of 120 hours of lecturing and training were delivered by a local team of teaching staff and researchers from Germany, France, Spain, and Belgium. This program accepted 30 students and was co-organized by the *Laboratoire Arago* (Roger Fons) and the University of Valencia in Spain (Santiago Mas-Coma). The laboratory received 16,000 ECU (the European currency) to organize the program (organization, travel, and student accommodations).

During the 2000s and 2010s, the European Commission continued to develop programs to enhance the attractiveness of European higher education, the cooperation between institutions, and student mobility, while simplifying access to the available funding. Through the Erasmus Mundus program, the Commission supported, among other things, the creation of master’s programs organized by consortia of universities. The teaching staff at the laboratory, along with the *Sorbonne Université*, were quite active since 2008 in the Erasmus Master of Science in Marine Biodiversity and Conservation (EMBC) and then the EMBC+ program (2014), which has been replaced since then by the International Master of Science in Marine Biological Resources (IMBRSea) program (2017<sup>45</sup>). Students enrolled in this program deepen their personalized training by selecting courses across 10 different European universities that offer courses in marine sciences. Thus, each year, students of the IMBRSea Master come to Banyuls, for example to enroll in course on the “Concept and Practices in Biological Oceanography”, which takes place over nine weeks at the laboratory. In 2017, the lab received financial support from the university to develop an international exchange program with Dalhousie University in Halifax, Canada, (Dal@SU) for undergraduate students<sup>46</sup>. This English-speaking university has an “undergraduate” program in marine biology. Each year, up to six students enrolled in the “license” program in life sciences at the *Sorbonne Université* can enroll in the Dalhousie University program and take courses that are not offered in their own curriculum. In return, six students from this Canadian university who wish to internationalize their training attend first-year master’s courses

at the laboratory as part of the master’s in marine sciences, which is also open to students in the IMBRSea Master. Since its creation and up to this day, the laboratory has always hosted international students.

### *A living community*

The geographical isolation of Banyuls has contributed to the establishment of a community of students. Since the first courses were organized in the 19th century, meals have constituted moments in which the teaching staff and students socialize. Early on, those shared meals were also a time used to celebrate Henri de Lacaze-Duthiers as a way to thank him for his involvement<sup>47</sup> or thank the scientists for visiting Banyuls or other places in the countryside. For example, in 1893, a cocktail party was organized for excursionists by “the youth of Banyuls”, during which “several toasts, much applauded, were proposed”<sup>48</sup>. Reports show that since the 19th century many celebrations and meals took place. For example, Paul Bougis reported that excursions to Peyrefitte in the 1950s ended on the beach over a *cargolade*<sup>49</sup> (Bougis 1982). Parties were also regularly organized at the lab, sometimes including instructors and students (Fig. 14). For example, by the end of the summer program in Mediterranean ecology, a costume ball was regularly organized in the lab’s conference room. Such costumed parties went on until the mid-2000s when a large Brazilian community of students who hosted these events left. Social events are still organized for students from time to time in the laboratory, usually after they defend their Ph.D. thesis. An enduring tradition among the lab’s students has been the writing of school-related songs during the summer internships; these songs celebrate the excellent atmosphere of the internships. Ph.D. students have also created short humorous videos to be shown after their defense. Many couples met during their studies at the laboratory, such as Renaud Paulian, the rector of the Amiens and Bordeaux academies and his wife. Some famous personalities were students at the lab, such as the winner of the Nobel Prize in Physics Pierre-Gilles de Gennes<sup>50</sup>, the neurobiologist Jean-Pierre Changeux, the biologist Yves Boulingand<sup>51</sup>,

<sup>47</sup> *Le rappel de l’Aude*, April 10, 1891; *La Gironde*, April 23, 1895.

<sup>48</sup> *Le Petit Marseillais*, April 11, 1893.

<sup>49</sup> Grilled snails with garlic mayonnaise (traditional Catalan meal).

<sup>50</sup> <https://www.futura-sciences.com/sciences/actualites/physique-interview-pierre-gilles-gennes-energies-futur-education-recherche-11941/>

<sup>51</sup> [http://caphes.ens.fr/wp-content/uploads/2020/08/Inventaire\\_Boulingand.pdf](http://caphes.ens.fr/wp-content/uploads/2020/08/Inventaire_Boulingand.pdf)

<sup>45</sup> <http://www.imbrsea.eu>

<sup>46</sup> <http://dalasu.obs-banyuls.fr>



Fig. 14. – Community living at the *Laboratoire Arago*. Carnival, probably in the 1960s (A and B); Barbecue at the Mas de la Serre (1989) (C).

the biologist and unionist Marcel Prenant<sup>52</sup>, and the entomologist Renaud Paulian<sup>53</sup>. The community spirit that has developed among the lab's alumni and current students has been helpful for the laboratory. Among many examples, André Lwoff, Nobel Prize, worked in Banyuls when he was a young student and wrote on May 16, 1977, to the director of cultural relations at the French foreign office (the “Quai d’Orsay”) to take position in defense of the budgets allocated to the laboratory; using his weight as a recipient of the Nobel Prize in Medicine, he wrote, “*In the*

*absence of any operating funds [...] the Arago Laboratory will be unable to receive many eminent foreign researchers who have asked for hospitality [...] I hope that your budget will allow you to intervene effectively in this matter*”. Even more surprising, the lab's student community inspired novelists such as Pierre Castex in *Les pirates de l'uranium* (1960, GP) and Armand Lanoux in *Le berger des abeilles* (1974, Grasset).

Since its foundation in 1882, the *Laboratoire Arago* has remained an ideal place to teach marine sciences. During the 1880s, the pioneers, who were attracted by the rich biodiversity of the local marine life there, developed in Banyuls a teaching model based on observation, experimentation, and pedagogical innovation. This original mix has lasted until today thanks to steady efforts to find adapted material resources. Instructors in the 1950s

<sup>52</sup> Biologist, *Chef d'état-major national des F.T.P.*, member of the *comité central du P.C.F.* [https://www.lemonde.fr/archives/article/1983/07/20/m-marcel-prenant-est-mort\\_2836968\\_1819218.html](https://www.lemonde.fr/archives/article/1983/07/20/m-marcel-prenant-est-mort_2836968_1819218.html)

<sup>53</sup> Entomologist, rector of the University of Bordeaux.

created oceanography and ecology courses. In the 1990s, they started to train students in molecular approaches and developmental biology using marine organisms as models: at all times, the *Laboratoire Arago* has been an ideal place for the development of innovative teaching techniques that connect with scientific innovation. Fundamental research has always fueled the development of the curriculum and international exchanges, and foreign students have always been welcome. Hopefully, this history will be a source of inspiration for future instructors at the laboratory.

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## BOX 1 – LIST OF PEOPLE WHO HAVE TAUGHT AT THE LABORATOIRE ARAGO

### BEFORE 1970 AND THE DISSOLUTION OF THE FACULTY OF SCIENCES OF PARIS

Until 1945, there were no full-time instructors at the *Laboratoire Arago*. Nevertheless, many teachers from the *Faculté des Sciences de Paris* regularly came to lead classes. This was the case in particular for professors who held the *Zoologie et physiologie* chair and were also responsible for the *Laboratoire Arago* (the chair was entitled *Zoologie et physiologie comparées*, *Anatomie*, *Physiologie comparée et Zoologie* [1910?], *Anatomie et physiologie comparées* [1922], and *Anatomie et histologie comparées* [1923]). The professors involved were sometimes accompanied by the *préparateurs*<sup>1</sup> and the *Maîtres de Conférences*<sup>2</sup> who worked in their Parisian laboratories. Although some *préparateurs* spent a long time in Banyuls to conduct their research there, they were not officially assigned to the *Laboratoire Arago* independently from their Parisian laboratories. However, that issue has been debated; since 1912, the need for a year-long *préparateur*<sup>3</sup> has been mentioned in administrative documents. This list remains probably partial.

#### Chairholder: Henri de Lacaze-Duthiers (1882 in Banyuls-1900)

*Maîtres de Conférences* associated with the chair and known for their teaching activities in Banyuls:

L. Joliet, replaced by J. Joyeux-Laffuie until 1884, then replaced by Pruvot (1885-1893) and L. Boutan (1893-1918?).

*Préparateurs* associated with the chair and known for their teaching activities in Banyuls:

L. Boutan, *Préparateur* (1883-84)

F. Guitel, *Préparateur* (Banyuls 1893-1899, Roscoff 1889-1892)

L. Joubin, *Préparateur* (Banyuls 1882-1884, Roscoff, 1885-1888)

H. Prouho, *Préparateur* (Banyuls 1884-1892)

A. Robert, *Préparateur* (Banyuls 1894?-1897? ; Roscoff 1898-1901)

#### Chairholder: Georges Pruvot (1900-1923)<sup>4</sup>

*Préparateurs* associated with the chair and known for their teaching activities in Banyuls:

<sup>1</sup> Ph.D. student in charge of teaching and organizing the lab.

<sup>2</sup> Assistant professor

<sup>3</sup> *Préparateur* present all year long at the *Laboratoire Arago*.

<sup>4</sup> Director of the *Laboratoire de Zoologie Expérimentale* of the *Ecole pratique des Hautes Etudes* (August, 1900). *Chargé d'un cours d'anatomie comparée* at the *Faculté des sciences de Paris* (March, 1902). Resigned from the *Faculté des sciences de Grenoble* (March, 1902). *Professeur adjoint* at the *Faculté des sciences de Paris* (February 1, 1907). Professor of *Zoologie, anatomie et physiologie comparées* at *Faculté des Sciences de Paris* (November, 1910). From Charle C, Telkès E (1989), *Les Professeurs de la faculté des sciences de Paris, 1901-1939. Dictionnaire biographique* (1901-1939).

R. Jeannel, *Préparateur* (1909-1911)

R. Denis, *Préparateur* (1922- ?)

**Chairholder: Octave Duboscq (1923-1937), Chaire de biologie maritime<sup>5</sup>**

*Préparateurs* associated with the chair and known for their teaching activities in Banyuls:

Odette Tuzet, *Assistante, Chef de travaux, Régisseuse* (1923-1937)

Migot A, *Préparateur* (Dates ?)

**Chairholder: Edouard Chatton (1937-1947)**

From 1947 and the recruitment of Paul Bougis, the teachers were full-time assigned at the *Laboratoire Arago*. Georges Petit remains the professor holder of the *Chaire de Biologie maritime* in Paris, like Pierre Drach.

**Chairholder: Georges Petit (1947-1967)**

Maîtres de Conférences:

Paul Bougis, *Assistant, Chef de travaux* (1948-1956)

Claude Delamare-Douboutteville, *Chef de travaux, Sous-directeur* (1949-1960)

Jean Paris, *Assistant, Maître-Assistant* (1954-1966), *Sous-Directeur* (1960-1961)

Lucien Laubier, *Assistant et Maître assistant au laboratoire Arago, Sous-directeur* (1956-1968)

Henry Boutière, *Assistant, Maître-Assistant* (1959-1998)

Yves Coineau, *Assistant, Maître-Assistant* (1960-1971)

Daniel Reyss, *Assistant, Maître-Assistant* (1960-1968)

Alain Guille, *Assistant, Maître-Assistant* (1961-1973); *Professeur, Directeur* (1989-2001)

Jacques Soyer, *Assistant, Maître-Assistant, Professeur, Directeur* (1961-1989)

Guy Cahet, *Assistant, Maître-Assistant, Maître de Conférences* (1962-1997)

**Chairholder: Pierre Drach Professeur, Directeur (1964-1976)**

*Maîtres de Conférences* (including colleagues listed above):

Claude Razouls, *Assistant, Maître-Assistant* (1965-1996)

**AFTER THE UNIVERSITY OF PARIS: UNIVERSITÉ PIERRE ET MARIE CURIE (PARIS VI) AND SORBONNE UNIVERSITÉ**

Michèle Knoepffler-Péguy, *Assistante, Maîtresse Assistante, Maîtresse de Conférences* (1968-2001)

Aline Fiala-Médioni (1969-2005), *Assistante, Maîtresse de conférences, Professeur, Sous-Directrice* (1976- 1983) then *Directrice-Adjointe* until 1988.

Jean-Yves Bodiou, *Assistant, Maître de Conférences* (1970-2010)

Roger Prodon, *Assistant, Maître de Conférences* (1973-1988)

Jean-Philippe Labat, *Assistant, Maître de conférences* (1973-1989)

Marie-Madeleine Giraud-Guille, *Maîtresse de Conférences, Directrice d'études à l'EPHE* (1989-1999)

Gérard Peaucellier, *Professeur* (1994-2013)

Frédérique François-Carcaillet, *Maîtresse de Conférences* (1996?-2003?)

Christian Schwartz, *Maître de Conférences* (2003?-2007?)

Gilles Bœuf, *Professeur, Directeur* (2000-2005)

Laurent Urios, *ATER* (2004-2006)

Jean-Marc Guarini, *Professeur* (2005-2018)

Karine Alain, *ATER* (2006-2007)

Vincent Laudet, *Professeur, Directeur* (2015-2019)

Delphine Guillebault, *ATER* (2007-2009)

Leila Chapron, *ATER* (2021-2022)

**Teachers currently working at the Laboratoire Arago**

Philippe Lebaron, *Maître de Conférences* then *Professeur, Directeur* (1989)

François Lantoine, *Maître de Conférences* (1997)

Laurence Besseau, *Maîtresse de Conférences EPHE* (1996), *UPMC* (2000)

Fabien Joux, *Maître de Conférences* (1999)

<sup>5</sup> Paul Marie Joseph Wintrebert, 1923-1937 was Professor, chairholder and then *Professeur honoraire* until 1966. No clue that he taught in Banyuls even if it is very probable.

Pascal Conan, *Maître de Conférences* (2000)  
 Yves Desdevises, *Maître de Conférences, Professeur, Directeur* (2002)  
 Audrey Pruski, *Maîtresse de Conférences* (2003)  
 Julia Baudart-Lenfant, *Maîtresse de Conférences* (2006)  
 Sophie Sanchez-Brosseau, *ATER* (2007-2009), *Maîtresse de Conférences* (2009)  
 Stéphane Blain, *Professeur* (2008)  
 Jadwiga Rzeznik-Orignac, *Maîtresse de Conférences* (2008)  
 Nadine Le Bris, *Professeur* (2009)  
 Marcelino Suzuki - *Professeur* (2009)  
 Raphaël Lami, *ATER* (2009-2010), *Maître de Conférences* (2010)  
 Franck Lartaud, *ATER* (2009-2010), *Maître de Conférences* (2010), *Directeur Adjoint*  
 Stéphanie Bertrand, *ATER* (2010-2011), *Maîtresse de Conférences* (2011)  
 Laurence Méjanelle, *Maîtresse de Conférences*, UFR918<sup>6</sup> (2007)  
 Gilles Mirambeau, *Maître de Conférences*, UFR927<sup>7</sup> (2020)  
 Marc Besson, *Maître de Conférences* (2022)

#### **Teachers responsible for the teaching department**

Claude Delamare-Deboutteville (1947-1960)  
 Jean Paris (1960-1966)  
 Lucien Laubier (1966-1976)  
 Aline Fiala-Médioni (1976-2004)  
 Gérard Peaucellier (2005-2011)  
 Yves Desdevises (2011-2020)  
 Raphaël Lami (since 2020)

#### **Directors of the *Laboratoire Arago***

Henri de Lacaze-Duthiers (1882-1900)  
 Georges Pruvot (1900-1923)  
 Octave Duboscq (1923-1937)  
 Edouard Chatton (1937-1947)  
 Georges Petit (1947-1964)  
 Pierre Drach (1964-1976)  
 Jacques Soyer (1976-1989)  
 Alain Guille (1989-1999)  
 Gilles Bœuf (2000-2005)  
 Philippe Lebaron (2005-2015)  
 Vincent Laudet (2015-2019)  
 Since 2020: Yves Desdevises

<sup>6</sup> Faculty of Ecology, Sorbonne Université

<sup>7</sup> Faculty of Biology, Sorbonne Université



## **BOX 2 – RESEARCH TEAMS AND LABORATORIES HOSTED AT THE LABORATOIRE ARAGO**

**The teams and laboratories are listed under their original French names.**

From 1882 to 1983, only one laboratory was established, mostly called the “*Laboratoire Arago*”, although other names were used from time to time. The archives reveal that, in 1882, the name used was the *Laboratoire de zoologie expérimentale—station de Banyuls* (La Sorbonne and EPHE). After Henri de Lacaze Duthiers died and until WWII, the name *Laboratoire maritime Arago de Banyuls* was used. A few documents in the archives suggest that the Roscoff laboratory and the Banyuls laboratory were administratively clustered as the *Institut de Biologie Maritime*, which probably disappeared after WWII. The research conducted after WWII at the *Laboratoire Arago* is presented through a list of major research themes in *Vie et Milieu*. In 1968, research taking place at the lab was structured into teams and divisions.

### **1967**

Partnership with the CNRS (Centre National de la Recherche Scientifique)

### **1968-1971**

#### **Laboratoire Arago**

Division d’Océanographie

*Equipe Océanographie physique*

*Equipe Benthologie*

*Equipe Planctologie*

Division de Biologie marine

*Equipe Ecophysiologie et physiologie*

*Equipe Morphogenèse et développement*

*Equipe Algologie*

Division d’Ecologie terrestre

*Equipe Acarologie et entomologie*

*Equipe Vertébrés inférieurs*

### **1971**

#### **Laboratoire Arago**

Division d’Océanographie

Equipe Benthologie

*Equipe Planctologie*

*Equipe Milieux lagunaires*

Division de Biologie marine

*Equipe Morphogenèse et développement*

*Equipe Ecophysiologie et physiologie*

*Equipe Biologie végétale marine*

Division d’Ecologie terrestre

### **1972**

#### **Laboratoire Arago UA 117**

Division d’Océanographie

*Equipe planctologie*

*Equipe benthologie*

*Equipe biologie lagunaire*

Division de Biologie marine

*Equipe biologie cellulaire*

*Equipe carcinologie*

*Equipe teuthologie*

*Equipe phytobenthos*

Division d’Ecologie terrestre

### **1977-1979**

#### **Laboratoire Arago UA 117**

Equipe Production planctonique

Equipe Structure et fonctionnement de l’écosystème benthique

Equipe Biologie cellulaire  
 Equipe Biologie et développement des céphalopodes  
 Equipe Ecologie terrestre : acarologie et entomologie  
 Autres recherches

### 1983

#### **Laboratoire Arago UA 117**

Groupe 1 Production pélagique  
 Groupe 2 Structure et fonctionnement de l'écosystème benthique  
 Groupe 3 Biologie cellulaire et moléculaire (biologie des protistes et des Dinoflagellés)  
 Groupe 4 Biologie du développement et de la reproduction des Céphalopodes  
 Groupe 5 Structure et fonctionnement des écosystèmes terrestres  
 Autres recherches

### 1987

#### **Laboratoire Arago URA 117**

1989 Observatoire des Sciences de l'Univers / Ecole Interne de l'UPMC n° 938

Département d'Océanographie-Biologie Marine URA 2071

*Equipe Écosystème pélagique*

*Equipe Écosystème benthique*

Département de Biologie Moléculaire et Cellulaire

*Equipe Génome et cycle cellulaire des Eucaryotes primitifs*

*Equipe Cycle cellulaire et nucléaire des eucaryotes primitifs*

*Equipe Développement précoce des invertébrés marins (Échinodermes, Céphalopodes).*

*Equipe Phylogénie moléculaire*

*Equipe morphogénèse*

Département d'Ecologie terrestre

Thèmes transversaux :

*Processus biologiques et flux océaniques*

*Stratégies de reproduction et dispersion*

*Spéciation et phylogénie*

*Génome, cycle cellulaire et développement*

### 1992

#### **Laboratoire Arago URA 117, Ecole Interne de l'UPMC n° 938**

Département scientifique Océanographie et Biologie Marine

*Equipe Production primaire pélagique*

*Equipe Processus et production benthique*

*Equipe biologie des populations*

*Equipe Microbiologie*

Département de Biologie cellulaire et moléculaire

*Equipe Génome et cycle cellulaire des eucaryotes primitifs*

*Equipe contrôle moléculaire du cycle cellulaire*

*Equipe phylogénie moléculaire et évolution*

*Equipe Morphogénèse*

Département d'Ecologie terrestre

### 1994 Creation of Service d'Observation du Laboratoire Arago

#### **1996-1998-2000**

**Fédération de recherche Observatoire océanologique de Banyuls FR CNRS n° 639**

**Ecole interne UPMC n° 938, Service communs EP 129**

Laboratoire d'Océanographie Biologique de Banyuls UMR7621

*Equipe Processus et production biologique à l'interface eau-sédiment*

*Equipe Production et dégradation de la matière organique dans la colonne d'eau*

Modèles en Biologie Cellulaire et Evolutive UMR7628

*Equipe Ecologie évolutive*  
*Equipe Phylogénie moléculaire et évolution*  
*Equipe Génome et cycle cellulaire des eucaryotes primitifs*  
*Equipe Cycle cellulaire du développement précoce*  
*Equipe Morphogenèse des matrices extracellulaires*

#### **2001-2004**

**Observatoire Océanologique de Banyuls UMS2348**

**Ecole interne UPMC n° 938**

Laboratoire d'Océanographie Biologique de Banyuls UMR7621

*Equipe Processus et production biologique à l'interface eau-sédiment*

*Equipe Diversité et fonctionnement des écosystèmes pélagiques*

Laboratoire Modèles en Biologie Cellulaire et Evolutive UMR7628

*Equipe Physiologie environnementale et régulations neuroendocriniennes chez les poissons*

*Equipe Mécanismes cellulaires Cdk-dépendants*

*Equipe chromatine et expression génique*

*Equipe régulations cycline B dépendantes*

*Equipe dispersion, structuration des espèces et évolution*

#### **2005-2008**

**Observatoire Océanologique de Banyuls UMS2348**

**Ecole interne UPMC n°938**

Modèles en Biologie Cellulaire et Evolutive UMR7628

*Equipe Biologie évolutive et écologie parasitaire de populations de micro-mammifères insulaires*

*Equipe Physiologie environnementale et neuroendocrinologie chez les poissons*

*Equipe Mécanismes cellulaires CDK-dépendants*

*Equipe Régulation moléculaire de la traduction des messagers de cycline B au cours de l'embryogenèse précoce*

*Equipe Horloge circadienne et cycle cellulaire chez les végétaux*

*Equipe Génomique évolutive et environnementale du phytoplancton*

Laboratoire d'Océanographie Biologique de Banyuls UMR7621

*Equipe Processus et Productions biologiques à l'interface eau-sédiment*

*Equipe Diversité et fonctionnement des écosystèmes pélagiques*

#### **2009-2013**

**Observatoire Océanologique de Banyuls UMS2348**

**Ecole interne UPMC n° 938**

Laboratoire de Biocomplexité des écosystèmes coralliens de l'Indo-Pacifique

Laboratoire de Biologie Intégrative des Organismes Marins UMR 7232

2012

*Equipe Génomique évolutive et environnementale du phytoplancton*

*Equipe Facteurs du milieu et mécanismes adaptatifs*

*Equipe Régulation des mécanismes cellulaires au cours du développement*

*Equipe Evolution et développement des Chordés*

2013

*Equipe Evolution et développement des Chordés*

*Equipe Formation de la nageoire médiane chez les Chordés*

*Equipe Facteurs du milieu et mécanismes adaptatifs*

*Equipe Génomique évolutive et environnementale du phytoplancton*

Laboratoire d'Ecogéochimie des Environnements Benthiques UMR 8222

Axe Dynamique des couplages entre biodiversité benthique et environnement abiotique dans les habitats benthiques fragmentés

Axe Mécanismes de transformation de substrats organiques et de transfert d'énergie dans les écosystèmes benthiques

Laboratoire d'Océanographie Microbienne UMR 7621

*Equipe Réponse et fonctions des microorganismes en biogéochimie*

*Equipe Biodiversité et biotechnologies microbiennes*

*Equipe mixte de recherche Pierre Fabre/UPMC/CNRS*

*Equipe biologie systémique des réponses environnementales*

**2014-2018****Fédération de Recherche (FR 3724) – founded in 2016****Ecole interne de Sorbonne Université n° 938**

Laboratoire de Biocomplexité des écosystèmes coralliens de l'Indo-Pacifique

Laboratoire de Biologie Intégrative des Organismes Marins UMR 7232

*Equipe Evolution et développement des Chordés**Equipe Développement et évolution des ascidies**Equipe Facteurs du milieu et mécanismes adaptatifs**Equipe Génomique évolutive et environnementale du phytoplancton**Equipe Développement et Evolution des Vertébrés**Equipe Biologie intégrative de la métamorphose**Equipe Interactions Marines - Evolution et Adaptation*

Laboratoire d'Ecogéochimie des Environnements Benthiques UMR 8222

*Axe 1 Dynamique des communautés et de leurs fonctions : Mécanismes d'interaction entre propriétés abiotiques des habitats et relations biotiques.**Axe 2 Réponse des écosystèmes aux perturbations : Variabilité environnementale aux interfaces et connectivité à l'échelle régionale.*

Laboratoire d'Océanographie Microbienne UMR 7621

*Axe 1 Régulation des fonctions microbiennes par la lumière et les nutriments**Axe 2 Réactivité de la matière organique et diversité microbienne**Axe 3 Processus microbiens et biogéochimie des océans**Axe 4 Ecotoxicologie et ingénierie métabolique microbienne marine*

Laboratoire de Biodiversité et Biotechnologies Microbiennes UAR 3579

*Thème 1 Omique environnementale et mécanismes de régulation des communautés naturelles**Thème 2 Biodiversité et biomolécules**Thème 3 Contaminants émergents dans les environnements aquatiques et santé*

Thèmes fédérateurs

*Interactions biotiques marines**Rythmes et cycles en milieu marin méditerranéen**Toxicologie et Ecotoxicologie marine***2019-2023****Fédération de Recherche (FR 3724)**

Laboratoire de Biologie Intégrative des Organismes Marins

*Equipe Evolution et développement des Chordés**Equipe DEEVA (DEveloppement et EVolution des Ascidies)**Equipe Développement et Evolution des Vertébrés**Equipe Eco/Evo/Devo**Equipe Génomique évolutive et environnementale du phytoplancton**Equipe E6 Interactions Marines - Evolution et Adaptation**Equipe Cnidevo (2022)*

Laboratoire d'Ecogéochimie des Environnements Benthiques

*Axe Dynamique des assemblages benthiques marins**Axe Relations habitats-fonctions associées aux ingénieurs en écosystèmes**Axe Réponse au stress : des individus aux communautés*

Laboratoire d'Océanographie Microbienne

*Thème 1 – Régulation des fonctions microbiennes par les paramètres environnementaux**Thème 2 – Biogéochimie et diversité microbienne**Thème 3 – Ecotoxicologie microbienne marine et ingénierie métabolique*

Laboratoire de Biodiversité et Biotechnologies Microbiennes

*Thème 1 – Biodiversité et biomolécules**Thème 2 – Contaminants chimiques : Détection, impact et biodégradation**Thème 3 – Ecologie des Pathogènes*

Thèmes fédérateurs

*Interactions biotiques marines**Rythmes et cycles en milieu marin méditerranéen**Toxicologie et Ecotoxicologie marine*

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