Foreword

"Who truly informs me? He who teaches me the improbable"
(Michel Serres: *Le Monde de l'Éducation, de la Culture et de la Formation*, January 1998)

The National Program on Determinism of Recruitment (PNDR) was launched in 1984. For the fourth time an account was given on the state of the Program during the restitution Symposium that took place on the 8 and 9 December 1998, at the IFREMER Centre in Nantes[1].

This colloquium was of considerable importance due to a number of circumstances. On the one hand, 1998 corresponded to the end of the 3rd phase, when an inventory of the program's achievements to date was due. On the other hand, the project to combine and reshape the various oceanographic programs, including the PNDR, into a new coastal oceanography program was facilitated by this transition.

After 15 years of activity centred on the life cycle of various marine animals, it is useful to assess what has changed. Have the concepts, linked to larval biology, to interannual variability of the adult biomass or more generally to the functioning of the life cycle, changed over this period? Can the 'success' of a life cycle be defined on the basis of a single objective? Can an indicator of success be identified, as the 1993 Evaluation Committee wished, that describes a species' capacity to traverse the different stages of its biological cycle? Do limited energy resources restrict individual fertility, which is fundamental to recruitment? What is the impact of habitat size on the strategy of reproductive adults? It is no simple task to answer all these questions, but a number of reliable pointers emerge from the various publications in this issue.

[1] The contents of previous colloquia may be found in the following works: 1984: Determinism of Recruitment, Nantes Seminar: 2–4 July 1984; IFREMER report published with the participation of PIROCEAN; Direction of living Resources, DRV-85-01/D: 152 p. 1987: Minutes of the Nantes Symposium, 27–30 October 1987. half-way evaluation of the PNDR. Information Bulletin on the PNDR, special edition, December 1987, 128 p.
1992: Third Colloquium of the National Program on the Determinism of Recruitment. Ann. Inst. Océanogr., Paris. 68 (1–2), 7–225.

The essential aims of the program are i) identifying the critical phases of each life cycle, in terms of mortality; ii) understanding the mechanisms that regulate marine populations, and the biological and physical processes that allow them to operate, and finally iii) identifying the environmental conditions that control these biological processes.

The methods used are based essentially on collecting data and on modelling. They have been amply described in previous reports[2]. On the other hand, the characteristics of the program may usefully be recapped here.

- Its aim is to study both processes and mechanisms. The processes are linked to the maintenance of or variation in the exploitable biomass; the mechanisms that intervene in maintaining these processes concern for example adaptation to retention by reducing dispersion; adaptation to detection of the right substrate by repeatedly returning to the water column after testing the substratum; adaptation to high population density by limiting inter-individual competition.
- It focuses both on the individual and on the population as a whole: how the animal develops its flotation system; its potential for upward displacement; how it attaches itself to the substrate on initial contact; how it detects that a medium will meet the requirements for a subsequent stage, and how it manages to cope with turbulence when it reaches the layer next to the bottom; how it captures its prey, and the influence of turbulence on this.
- It implies several scales of space and time; the time scales are linked to developmental constants; the spatial scales are linked to dispersal and retentive capacity and to the physical structures of the medium, such as eddies, meso-scale fronts, turbulence in the limiting layer on the bottom, implied turbulence in the micro-scale encounter of predator and prey. Transferring from one scale to another is another problem requiring special attention.

[2] Foreword-Avant-Propos. Ann. Inst. Océanogr., Paris 68 (1–2) (1992) 7–13.

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–It covers several disciplines, including physics and biology: biologists use circulatory models prepared by physicists; likewise a genetic approach may be used to test dispersion conditions and the geographic limits of a population may be defined. Practically all this symposium's papers involve several disciplines to some degree.

Given of the length of the program, an overview was required. As early as 1993, the Evaluation Committee regretted the lack of any true synthesis of all the work involving the three pilot species (Scallop, Sole and Pectinaria) that highlighted each ecophase's critical factors. A great effort was made, involving a number of round tables and joint publications, in preparing the colloquium held in December 1998 which focused on Sole, Polychaete Annelids and Molluscs[3]. This overview covers not only the work of the different teams, but also local data acquired by small groups. This effort brought to light a certain number of results that must be followed up.

It is now recognised that the identification of parts of the cycle, the windows, capable of responding to exterior biological or physical influences that vary from year to year is particularly important. In such a schema, modelling the cycle may well prove simpler than attempting to integrate all its consecutive parts in a set of closed boxes one inside the other, juxtaposed in several series. We have at our disposal enough data on the various model species to allow us to attempt to organise the cycle in two major sequences.

a) An average state is defined, characterized by one generation's fertility level and its degree of success. Defining these parameters comes down to determining the efficiency of the specific characters developed through evolution; this efficiency represents the average recruitment enabling the population dynamics model to create cycle.

b) There is a variation in the cycle around this average state, influenced by various external parameters acting through several biological windows; in this part, we identify the physical and biological processes through which the mechanisms that regulate the marine population act: for example, oocyte growth in the autumn and the liberation of larvae in the spring are both particularly receptive to climatic conditions.

Continuing with our reasoning on the life cycle as a whole, it can now be advanced that fertility probably does not reflect loss by predation during planktonic life. This mortality by predation is not sufficient; planktonic dispersion must also be introduced, linked to an element related to the degree of success of a given strategy. Is there a better element than the reproductive adults' area to indicate, by definition, the zone where the whole life cycle can take place? The success of reproductive strategies can be formalized by the size-ratio of two areas: that of the reproductive adults and that where the oldest stages, disseminated beyond the limits of the previous area, finally settle to create sterile areas.

Such lines of research should lead to the unification of invertebrate and vertebrate life cycles. In invertebrates, migration and transfer seem poorly defined; the simplest case corresponds to a migratory process towards the substrate, in the water column, without any geographic change. In marine vertebrates, e.g. sole, spatial differentiation occurs between the spawning zone and the area where juvenile stages are found. In both cases, it is a matter of transporting individuals to a particular place at the end of a particular developmental stage. It is important to understand the conditions of this transfer, and to define the life cycle in an essentially spatial context.

Some examples of the changing interpretation of certain elements of the life cycle during the course of the Program are given in the table below. In the case of the free planktonic stage, it is unlikely that a doubt about a part in the interannual variability of this fraction of the life cycle could have been raised in 1980. Once certain arguments were accepted, in particular the evidence in favour of one aspect of larval behaviour, the frequent failure of larval recruitment at the end of the dissemination period, it became necessary to follow this through at the risk of seeming scientifically incorrect, developing a research program against the tide. Planktonic larvae may indeed be a handicap against which selection acts, and if it is true that larval development still dominates, this may reflect the difficulty for a species to lose its dissemination stage (phyletic pressure) rather than its retention

[3] Refer to Information Bulletins nb 29 : Report by the Mollusc Group p. 25; Report by the Picolo working group, p. 31; and the reports on Anchovy recruitment, Sole recruitment, the Overview summarising work carried out on Polychaetes in the Mediterranean and the English Channel, 42 p.

Criterion	At the beginning of the program	At the end of the current stage
free planktonic stage	response to the need to discover a suitable substrate; a dissemination phase	the species develops mechanisms allowing it to free itself from or to control it
individual losses	through predation during the planktonic phase	through natural mortality and predation during the juvenile stage: larval recruitment not assured over a sufficiently wide area
models of variability	based on local fluctuations in larval arrivals in the right place (role of currents);	based on a global approach involving all the different parts of the life cycle.
influence of the reproductive strategy	indirect development always fluctuates more than direct development; however, many counter-examples are found	one cause among many, such as life span which transmits or reduces interannual recruitment variation to the level of the adult biomass
extent or organisation of adult habitat	no value	in certain cases this may condition reproductive strategy

through selection. Similar ideas are found in the literature[4], which confirms that the present program is progressing in the right direction.

This program has led to the development of strong international links and a number of notes in this issue testify to the interest shown by the international community. PNDR is the French component of the GLOBEC Program (Global Ocean Ecosystem Dynamics) and we played a particularly important part during the Paris Colloquium held on the 17th to 20th March 1998. Other links are maintained with the DEMA Program (Developmental Ecology of Marine Animals), supervised by the NERC in the UK. A French representative was present at the last annual meeting from the 8th to 10th July 1999 at St Andrews University.

The development of this National Program on Determinism of Recruitment over the past fifteen years has been facilitated by the various supervising bodies: INSU, IFREMER, ORSTOM, which support the Program financially. We are very grateful to these organisations and to the different personalities who have, over the years, been members of both the Scientific Council, in particular its president, and the Supervising Committee. The members of the Evaluation Committee who produced a report in 1993, still a reference today, must also be thanked. The IFREMER Centre in Nantes has hosted all the Program's Colloquia, putting at our disposal the ample facilities of its Centre, and merits our gratitude.

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[4] Pechenik J.A., On the advantages and disadvantages of larval stages in benthic marine invertebrate life cycles, Mar. Ecol. Prog. Ser. 177 (1999) 269–297.