Professional Biologists in Europe

Position and Perspectives in Employment

European Communities Biologists Association

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PROFESSIONAL BIOLOGISTS IN EUROPE
Position and Perspectives in Employment

**Report of the Workshop «Biologists in New Fields»
organised by the European Communities Biologists Association
at Kollekolle, Denmark, December 13 - 17, 1984.**

Edited

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Aims of ECBA

1. **To represent the professional interests of biologists to the European Communities.**
2. **To ensure the professional competence of biologists within the European Communities.**
3. **To facilitate the exchange of information of professional matters relating to the work of biologists within the European Communities.**
4. **To facilitate free movement of biologists within the European Communities.**
5. **To promote exchange of those teaching biology in all classes of educational establishment.**
6. **To promote co-operation and exchange of information between the natjonal biological societies about their activities throughout Europe.**
7. **To advice the EEC and the public in general of biological matters having implications for society.**

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I. INTRODUCTION

The changing employment pattern

The pattern of employment of biologists is changing. It contains the same elements as it has done for many years but the proportions of occupational types are changing at a, rapid rate. This change is such that in a few years time a very different impression of occupations typical of biologists will be created.

The major traditional fields of employment have been, for biologists as for several other groups of academically trained people, in education and research, the latter mainly in universities and public research institutes. These fields still employ the majority of European biologists. However, a notable change has taken place in many European countries in the last 10-15 years.

A consequence of a general increase in educational level, of technological development, and of political pressures led to the well-documented increase in student intake into universities from the late nineteen fifties onwards. In some countries this increase was explosive in character, and was accompanied by a buoyant demand for teachers in secondary schools and universities. The growth did not level off until the mid — and late seventies when the change was abrupt and the market for teachers in schools, colleges and universities became saturated. At that time the number of students in universities in most community nations was large, in some cases even when compared with the number of candidates. This fact, in combination with economic recession, led to cuts (in some cases drastic) in the intakes of students and in the number of teachers' posts and caused fears for high unemployment of, among other groups, biologists.

Up to this point, the development had been of broadly similar character in most countries and the fear that universities were producing graduates for unemployment was also common to most countries. The actual development in the occupational situation thereafter followed slightly, but significantly different trends, probably dependent upon the economic climate and the type of developments in society and especially the industrial bases in the respective countries.

Table 2, p. 32 illustrates the approximate employment situation for European biologists in 1984.

Development of «new» fields

It is generally known that technological development has led to increased use of biological processes in a variety of industrial areas. Production of enzymes (detergents) or by enzymes (beer, cheese) is well established, but the level of sophistication is increasing. Other fermentation processes have found uses for the production of new substances, e.g. in the pharmaceutical industry, or in the new

exploitation of classical substrates, like the nutritious waste products of beer and sugar manufacturing. In other areas a knowledge of biological interactions became important. Thus in pest control it is important to concentrate the deleterious effects on a specific pest species while in the production of fungal resistant paint enhancement of toxic effects on fungi is sought while at the same time minimizing toxic effects on painters.

Population increase and the intensification of industrial production have caused problems of wastes and have depleted natural resources sufficiently to demonstrate that the collective activities of mankind threaten the entire biosphere, unless their immediate and, more importantly, their long term effects are controlled. It is increasingly, though not generally, understood that lasting solutions to environmental deterioration must be based on a thorough knowledge of the processes which take place between living organisms and of their dependence on (and influence upon) their physical surroundings.

Thus, at the same time as the demand for biologists in more theoretical fields, such as teaching, has tended to decrease, there has been an increasing demand for biologists in fields of more immediate application. The resulting employment patterns in European countries are then to a considerable extent determined by the academic courses taken, the level reached by biologically based industry and the attitude of society towards nature and the environment.

Favourable developments in the coming years will require a proper balance between the number and specializations of biological graduates produced and development in new and redirected organisations depending upon biological expertise. The ends served will be to increase production in agriculture, aquaculture, fisheries, biotechnology and pharmacotechnology, to improve pest control, tropical and other disease control and general health, and to harmonize past and future developments in society and industry with nature and environment. It is ECBA's concern that

— the number of biologists produced and the types of their qualifications are adapted to the needs of society

— that advice in matters with biological consequence or content is taken from qualified persons, and

— that employers who might benefit from biological competence are made aware of the expertise biologists have to offer.

The Council of ECBA resolved to arrange a workshop to discuss these important issues and the booklet to which this forms an introduction is the printed summary of a workshop to which representatives of almost all of the member countries of the EEC and of several other European countries contributed. The specific aims of the workshop were as follows:

1. To summarize the present pattern of employment of biologists.

2. To analyse developments in basic and applied biology with their impact on the opportunities for employment of professional biologists.

3. To examine society's future needs from the biological profession.

II. EMPLOYMENT PATTERNS OF BIOLOGISTS: THE PRESENT, IMMEDIATE POSSIBILITIES AND FUTURE TRENDS

1. Universities

The number of biologists employed in universities has been decreasing in some member countries during the last few years, but seems at present generally to be stable. The numbers of students have decreased naturally or have been reduced in many countries with a reduction in the number of university teachers required as a logical consequence. As university teachers in general are also researchers, a decrease in teaching capacity will consequently also be a decrease in the capacity for university research. This fact has led to concern among industrial leaders who find that the level and amount of basic research in universities depends upon the level and amount of national know-how in the respective field, the quality of the graduates produced, and the level of professional interaction between researchers in universities and industrial laboratories. Further, industry generally wishes to maintain and develop a reciprocal interplay in which university research forms a base for the applied research and development taking place in companies, especially those of larger and medium size. University scientists, aware of the fact that university research must prove its indispcnsability more directly than was previously considered necessary, have in latter years demonstrated a trend towards placing basic research in fields where it is likely to have application (strategic research). A proportion of university people who find this intellectually attractive, may also become involved in commitments outside the university, where their work may be developed commercially. They may, thus, become advisors or directors of companies.

2. Teaching

The teaching of biology in schools is tending to decrease in large areas of Europe. The main reason is a decrease in the number of children attending school, but in some countries this is accompanied.by a reduction in the amount of time allotted to biology in the school curriculum. The latter fact is in peculiar contrast to the increasing

awareness in the media and in the general population of significant biological dimensions in many important community problems (local and global waste deposition, nitrate leakage, intensive agriculture, nature conservation, landscape planning, energy from wind and water, health care, nutrition policy). Requests to increase the modest amount of time dedicated to biology in both primary and secondary schools are met with reluctance by educational planners, who are bombarded with demands for increased time for many of the subjects taught in school, all of them considered important for trade, society or individual development by different groups. The special need for biological education is based on the fact that the large number of political decisions which have to be taken on topical problems such as agricultural methods, public health, or landscape development, will have extremely long-lasting effects on matters vital to whole populations.

3. Adult education

This field may show more immediate promise for employment. Professional introduction and guidance to nature trails are much appreciated in the places where they have been established. Courses of this type should prove a good investment, increasing public awareness of the need for a nature conservation policy, and supporting behaviour in nature areas used for recreational purposes, which prevents the «wearing-out» of popular localities.

A popular subject in adult education is health in all its many aspects, with an emphasis on the less traditional approaches. An increasing awareness of the importance of protecting health rather than curing disease has created great interest in exotic health strategies but also an appreciation of optimal nutrition and physical fitness. The latter type of interest could be supported by a range of courses in aspects of health, as separate subjects or integrated into the field of human biology.

4. Advisory and control functions in public and private administration

In most countries, biologists have been rare in public administration until recently. Increasing population, increasing industrial and agricultural production, and dwindling nature resources, have, however, created problems of increasing complexity. It is now impossible to imagine that these problems can be solved solely by the traditional, mainly technical approaches used in pollution control and other problems based upon imbalance of life processes which traditionally were handled by non-biologists, mainly engineers.

Problems of sewage, smoke, ash, and other waste, agricultural fertilizers, pesticides and fish farm effluents, have reached a stage where purely technical solutions will only make the problems reappear in an aggravated form within a short time and possibly elsewhere (e.g. acid rain). The only way to obtain lasting solutions to this

kind of problem is by reestablishment of the perturbed balance betwen the organisms involved — or establishment of a new type of balance. The problems are primarily biological, and lasting solutions rely upon biological competence. They must be analyzed by a systems approach, and account must be taken of the requirements for normal function and the interplay between the species involved, i.e. on a solid knowledge of systematics, physiology, ecology and other relevant areas of biology.

Following the recognition of the biological basis of environmental problems, biologists have been employed in increasing numbers in governmental and local administration. So many problems are still unsolved and new ones brought forward, that the employment of biologists in this area can reasonably be predicted to increase for some time to come. Some countries are closer to saturation of the field than others. Attempts to avoid overadministration may tend to delay increases in the numbers of biologists in public advice and control functions. However, the human impact on the environment is continuously increasing, and some further increase in this field is to be expected anywhere. Due to the increasing complexity of problems arising, public advice and recommendations should be taken at the highest level.

Generally, biologists in governmental administration are concerned with the development and implementation of laws, while those in local administration are more concerned with control and advice. The balance between central and local administration and control differs between countries, as does the public use of private counselling.

Biologists in consulting practice tend to have rather varied types of advisory work in microbiological and biotechnical fields, environmental matters and landscape planning. New laws, e.g. from the European Commission, require biological expertise on items like patenting microbiological organisms for biotechnological use.

Private advisory work takes place as direct biological counselling by individuals or small firms, or as part of more extended counselling by consultant engineer firms, where biologists work in teams with other academic specialists, such as engineers and architects. In such firms the role of the biologist may be to assess the impact on the environment of large constructions, such as harbours, bridges, and highways.

5. Industry

Industry has traditionally employed a proportion of biologists in areas such as brewery, medical industry, and in some types of chemical industry. The increasing number of biologists occupied in these and other industries is related partly to an increase in technological possibilities, and partly to an increased concern over some developments within technology.

The pace of biotechnology is accelerating, as in the production of enzymes and other bulk protein by fermentation, and in the much discussed DNA technology. Biological production in a classical sense flourishes in fish farming and other types of

aquaculture.
Rising concern has led to a search for biologically based solutions in several fields. Unfavourable experience with chemical pest control has inspired methods aiming much more specifically at the pest species, based on predators or parasites, or on perturbing their natural behaviour by pheromones. Ethologists are called upon by fur farmers and meat producers with the expectation that changes in housing and transport conditions leading to less stress in life and death of the animals will diminish criticism from animal protectionists and the general public, and at the same time provide a better product.
Biologists in industry (especially chemical and related industry) often work in teams with engineers, chemists and other professions. The biologist's role is typically to retrieve research knowledge in literature etc. and to suggest fields for future production. In some countries, biologists have mainly found employment in larger firms, but in other countries, firms of medium and smaller size, together representing a substantial amount of research and development, have taken advantage of the broad education and science training of biological candidates. With technological development, new research fields have become applied in industry and public institutions. Demands from consumers for flavours and other food additives of natural origin has caused some manufacturers in human nutrition to turn towards biologists. Likewise, as an awareness of human ecology becomes more widespread, the need for specialists in toxicology and immunology is increasing.

6. Agriculture

Agricultural organizations recognise the problems of nitrate released from fertilizers. They want the help of biologists to solve the problem by recycling the nitrogen, and also to mediate the problems in a way that will make them understood by both agriculturists and the public in general. Biologists are also wanted for work on problems such as recycling of waste, e.g. biogas production, methods by which leakage of waste materials is avoided and energy is conserved or reused. DNA technology is likely to be of special significance in relation to agriculture, e.g. by making the type of nitrogen fixation known from leguminous plants available also to other species. Geneticists are required to introduce new qualities or remove old defects, e.g. yellow tips in chives. New methods are also needed to change production away from fields, of overproduction.

7. General management

This feature in the employment pattern of biologists has interest with the fear of an overproduction of biological candidates, felt in some countries. Biologists have to

some extent entered general management (tables 4 and 5, p. 34 & 35), usually after qualifying further by a special management course. This tendency has been strongest in the U.K. but appears to be increasing in other countries as well, as biologists change from biologically specialized positions to positions with an increasing content of general management. Biologists should, by the nature of their studies, be well qualified for this kind of work. They are used to dealing with complex situations, they are nowadays numerate as well as literate and aware of human variability. Outside the U.K. this fact seems not to be fully recognised by employers nor, often, by biologists and teaching institutions who fail to stress aspects relevant to the direct use of these qualifications.

8. The study of biology: Adaptation to employment in new fields

The change in the employment pattern of biologists has revealed or underlined advantages and weaknesses in university curricula and general attitudes. These will necessarily show variations dependent upon nation or even university. However, certain apparently general features are repeatedly emphasized by employers and biologists working outside the classical teaching and university fields. The overall character of the biology curriculum is a major asset and is the basis of **the** almost general ubuquitousness of biologists. Qualities repeatedly referred to are the broad biological training with knowledge of systematics, morphology, physiology, genetics, and ecology, and the solid research training. It should be noted that emphasizing some subjects does not make others superfluous. On the contrary, taxonomy, for example, cannot be meaningful without an understanding of evolution, genetics, comparative anatomy and physiology, and (for animals:) ethology. Likewise, ecology depends upon physiology, microbiology and population biology, including genetics and taxonomy.
Biologists should have a knowledge of organisms and life processes from the molecular and cellular level through organs and organisms to populations and ecosystems. A supporting knowledge of chemistry, physics and mathematics, including statistics and computer training, is essential in most areas. Broadness of the base of the curriculum is a prerequisite for cooperation with other academic groups. For a biotechnology career, special adaptation of the curriculum is necessary, and science training should include work with advanced laboratory methods. Generally, the area of specialization is more relevant than any particular skill. For employment in some areas, supplementary studies are necessary, e.g. some aspects of law in environmental management. Qualifications in general management are specially mentioned by industrial people, but are an advantage anywhere. Qualities which are generally appreciated are versatility, openmindedness, willingness to cooperate, self-confidence, ability to think logically, and a readiness to take up new problems. Students should also be trained in team work. Biologists are

often expected to present considerable amounts of data in a short, precise and directly understandable form. In many areas, the biologist's job is to reveal biological implication. Data should be retrieved within a restricted time-limit, and discussion is often expected to take place at more than one level. A specially important aspect for work with farmers, in agriculture-related fields or environmental control, is that the biologist should have a similarity in background to ("speak the same language as") the farmers. Therefore persons of rural origin are often preferred in these fields. One criticism is often repeated in some countries and might be taken into account in other countries as well, namely that biologists have inadequate training in handling industrial, large-scale processes. Further, they appear to be insufficiently trained in completing a piece of work (with the quality allowed by the amount of time given) within a limited time. Rather they are apt to improve upon their work for too long a time. They should be capable of quantitative thinking, and they should be aware of economic pressures, e.g. understand if a manager wants to stop a project which is too slow in showing promise.

Young graduates often show a critical attitude which is negative rather than constructive. This may be the case even when a firm or an organization hires the biologist to develop new methods to solve problems of objectionable additives or waste.

The adaptation of biologists to the new market —and vice versa —can be helped by adjustments in university training and attitude.

Students should be made aware of the possibilities and the special demands for qualifications in these occupational fields. Some university courses should include training in work outside the university and teaching fields. They might include training in team work and effective communication, written as well as oral, in marketing and counselling, and give some experience in outside organization, thus preparing students for new roles in trade and society. Practical periods in industry are, in principle, desirable for both industry and university. Industry's wish to protect know-how is an obstacle, but in the U.K. the experience of such practical periods has been good. Apart from the immediate benefit gained by the student, the knowledge of the applicability of biologists is spread in the outside world. Students should be informed about the employment situation and receive instruction in how to apply for jobs or possibly start their own private enterprise. Universities should inform employers about the qualifications of biologists. On the whole, they should (create and) keep a broad surface of contact with employers and society in general. An industrial leader has said about biologists: "Universities are sometimes accused of producing graduates for unemployment. Rather, they produce a very good product without marketing it». This may be true also for other types of graduates.

III. PERSPECTIVES I: ADVANCES IN BIOLOGICAL KNOW HOW'

1. Introduction

Biology, as an academic discipline, has traditionally been primarily a basic science which investigated the variety of forms of living organisms in universities and research institutions, in departments of microbiology, botany, zoology and human biology (anthropology).

These classical pillars within biology have broadened notably in the last twenty or thirty years. The introduction of advanced laboratory equipment and of elaborate techniques in cooperation with physicists, chemists and engineers has led to a dynamic development of research in all levels of complexity: subcellular, cellular, organ, populations and ecosystems within each discipline. This diversification of traditional biological disciplines into multiple sub-disciplines («bio-sciences») has not taken place solely as remote and esoteric research. Increases in funding for technological advancements have led to extensions of research activity into different applied fields of biology, such as agriculture, nutrition, pharmacy, and medicine.

A more recent development in biological knowledge and biological methodology has been a new view on bio-systems conceived through the use of bio-systems for practical purposes and commercial use: the process of diversification of biological research into very specialized fields of different complexity in the analysis of biological systems, has concurrently led to a process of unification between disciplines hitherto recognized as being distinctly disparate. The discipline responsible for this unification is cell biology. Cell biology together with the advances of molecular genetics now offers an exceedingly powerful analytical tool which revolutionizes the attitude towards and the use of biological resources. All three developments, the diversification into specialized fields, the orientation towards applied fields, and the unification of thinking and handling of the biosphere in terms of cell biology, will impinge strongly upon the professional contributions biologists can make to the every day life of mankind.

2. Diversification of fundamental bioscience

Within the classical four pillars of biology, botany, zoology, microbiology and human biology, an expanded area of research has been introduced by the use of new methodological approaches towards different levels of complexity of particular biological systems. This has created a variety of singular, defined and specialized fields of research. Table 1 summarizes these different biosciences which evolved within the classical disciplines.

Table 1

BOTANY	ZOOLOGY	MICROBIOLOGY	MEDICINE
Genetics	Genetics	Genetics	Genetics
Biochemistry	Biochemistry	Biochemistry	Biochemistry
Biophysics	Biophysics	Biophysics	Biophysics
Ultrastructure	Ultrastructure	Ultrastructure	Ultrastructure
Physiology	Physiology	Physiology	Physiology
	Embryology		Embryology
Developmental	Developmental		Developmental
Biology	Biology		Biology
Pathology	Pathology	(Pathology)	Pathology
Cytology	Cytology	Cytology	Cytology
Histology	Histology		Histology
Anatomy	Anatomy		Anatomy
Systematics	Systematics	Systematics	
Autecology	Autecology	Autecology	Autecology

They are defined mainly by the level of complexity of the biological system under investigation:

— the level of ecosystems, where the interaction and the interrelation of organisms with each other and with their surroundings is analysed (ecology)

the level of populations (systematics)

the level of organisms (morphology)

-~ the level of organs and tissues (anatomy, physiology, histology)

- the level of cells (cell biology, microbiology)

— the level of molecules (cellular metabolism, molecular biology, biochemistry, biophysics)

Some biological disciplines such as genetics span all levels of complexity. Within all these levels dynamic research fields for biologists have developed which are regarded as autonomous: biophysics, biochemistry, metabolism, cytology, histology, neurophysiology, genetics etc.. etc. These have all developed from classical biology and the diversification process is still going on. More than SOsubdisciplincs could easily be named which have reached an acknowledged status within the scientific community, in research institutions, industrial laboratories and universities. Many biologists have been quick to respond to new developments by their use of instrumentation, modern mathematical, physical, chemical or other techniques. However, some have not wanted to adopt these techniques and have continued to pursue traditional research. The optimum blend of both pathways is desirable for the advancement of biological knowledge.

Old areas of research once thought to be finalized (or «wrapped up») have re-opened for investigation through the availability of new technology from other disciplines. Previous crude enzyme studies now involve the use of chemical and biochemical techniques, e.g. electrophoresis, iso-electric focusing, animo-acid analysis, radioactive or fluorescent labelling, etc.

The application of these techniques to biological research has led and will lead further to the impingement of previously isolated biosciences on each other and also on other fundamental and applied sciences: old biological disciplines and, by diversification, emerging new fields in basic bio-sciences will continue to offer professional biologists good opportunities in all kinds of research institutions, when governments will realize that massive support of basic or fundamental sciences is the key for future survival of mankind. A society cannot afford not to support basic research and development on a large scale.

3.The Orientation of fundamental bioscience towards applications

There is an increased tendency to make use of biological processes of many kinds in a wide range of industrial activities. Governmental funding supports the trend to orientate fundamental research towards product development, quality control, consumer research and so on.

In all cases the end is achieved only as a result of processes of research and development involving biological «know-how» and biologists with a broad range of skills.

Figure 1 summarizes some of the traditional and actual uses of biological processes as biological «know-how», that is to say the thinking, techniques, methodologies, processes and results, presently able to contribute to areas, in which biologists find employment; the area of medicine and pharmacy, the area of food and agriculture (animal production and plant production), the area of environment and the steadily expanding area of industrial use.

3.i Medicine and Pharmacy

Pharmaceutical firms employ an increasing number of biologists. This relies upon the many and varied aspects of biological «know-how» involved: new diagnostics (genome-analysis, monoclonal antibodies), new treatment methods (immune-regulation, plasminogen-activation), new medicals (interferon), alternative methods for testing (screening methods, toxicity measures) and the complex area of /"/i-v/'/ro-fertilization.

3.H Animal and Plant Production

The nutrition of man and of all domestic animals has always been of vital interest, and. even with the advances of «civilization»> more people arc still employed in agriculture than in any other industry, even in some of the most developed countries. Agriculture is a technology depending on many sciences, of which biology, in the widest sense, is the most important. The specialization of agriculture into animal production or plant production has widened the influence of biological background. Growth hormones, feed stuffs, vaccines, veterinarian drugs and the technique of superovulation are entirely biological developments.

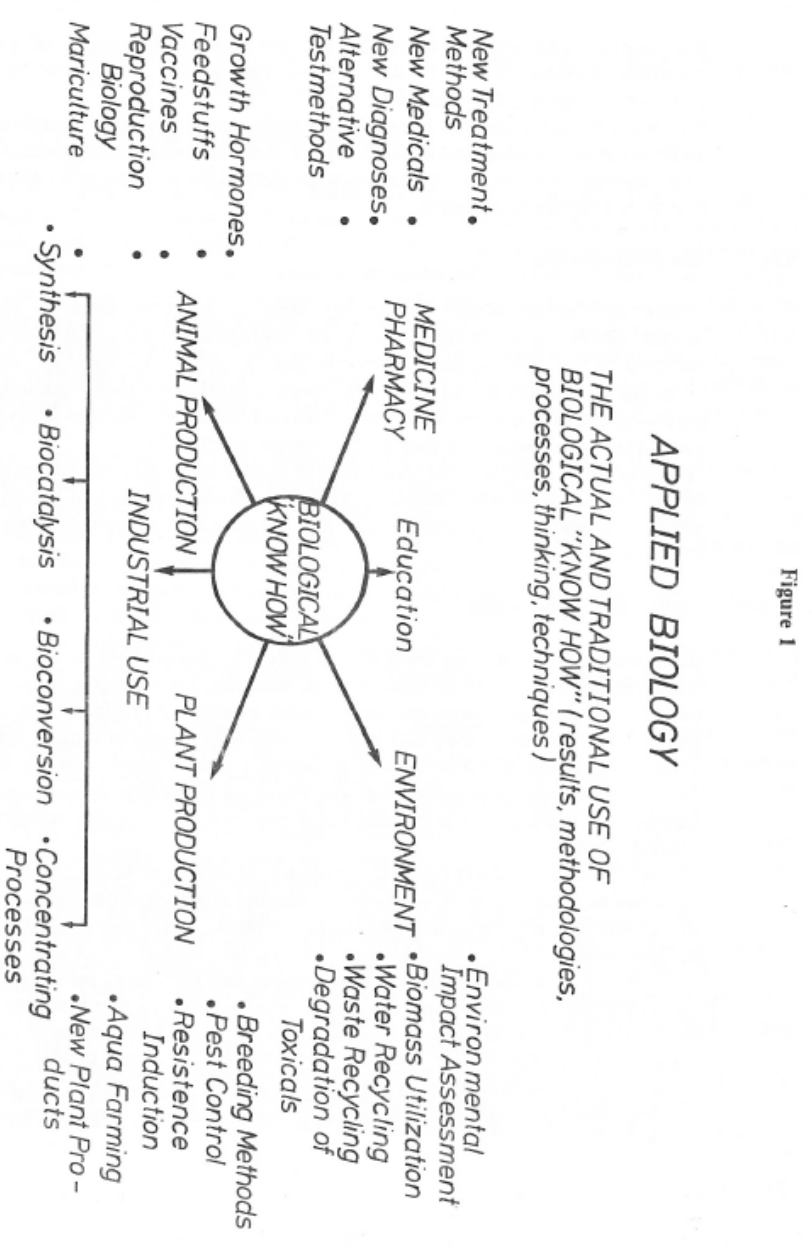

Figure 1

Fertilization and embryo-manipulation are new technologies of yet unsettled importance which will involve biological I know-how and will offer positions for biologists.
For plant production new breeding methods, the transfer of symbiotic abilities for NVfixation and of resistance to diseases, pests and high soil salt concentration will involve biologists with their skills in plant cell culture and gene transfer techniques.

The Environment

Many of the problems concerning man at present relate to the «environment» and obviously rely on biological expertise for their solution. Pure and applied research into problems of ecology, the planning, organization and managements of natural assets such as national parks, conservation areas, water resources and forests are obvious areas of employment for biologists (see ECBA report no. 5,1984). However there are also problems with the degradation of toxic chemicals, the development of new toxicological test methods, processes of biomass utilization, water and rubbish recycling, all of which require biological solutions.

Industrial applications

Biotechnology has a long tradition in industry. Several old established industries have a biotcchnological basis. Brewing, for example, relies on two living organisms, barley and yeast, and one botanical product, hops. As demand for industrial products has increased **and** scince, **especially bio**-sciences, augment the possibilities of product development and quality control, breweries, pharmaceutical and chemical firms employ increasing numbers of biologists for fundamental research and routine scientific control work.
The synthesis of products (alcohols, proteins, single cell proteins), the use of enzymes as biocatalysts (L-aminoacids, slucose-isomerization, **hydrolysis** of antibiotics), bioconversion processes (cellulose, agricultural products, detoxification) and concentrating treatments (metal leaching) will increasingly be based on biological resources and biological principles. As biological knowledge and biological «know-how» (a combination of methodologies, techniques, processes, results and thinking) gradually acquire new aspects for use in agriculture, in food production, processing and preservation, in pest control, and in the health services, new developments in fundamental research of biosciencccs will mature towards

application and will lead to the appointment of biologists in such specialized applied fields.

4. The unification of dissimilar biosciences

As mentioned on p. IS, the diversification into many specialized subdisciplines of biology has not in general led to single isolated working fields. The fear seems to be unfounded that the training of biologists in specialized «micro»-areas will make the graduates unable to bridge the gap between the micro-level and the necessary macro-level. On the contrary, the specialization in micro-disciplines has resulted in the development of a higher level of specialized expertise, conferring greater versatility in the researcher and allowing him/her to work in a number of other bio-sciences. This is especially evident with regard to the complexity level of cells within each of the classical biological disciplines botany, zoology, microbiology and human biology (Fig. 2).
The development of technologies at the cellular level offers the potential for knowledge acquired e.g. in protoplast technology of plant cells to be applied to pure and applied fields of research in animal, microbial or human biology by the same researcher. This acquisition enables him to move to work on other fundamental areas. To be a botanist or a zoologist is nowadays not decisive. Specialized and advanced techniques developed at the cell culture level lead to a unifying concept of generally applicable biological principles.
The consequences for the professional situation of biologists, for the development of the biosciences and for the biosphere and for mankind could be manifold and arc not to be foreseen.
There is already a tradition for use of biological "know-how" based on cell technology in the fields of medicine *(in-viiro* fertilization), plant production (protoplast-fusion and breeding) and animal production (embryo-transfer and sexing; cell dissociation from embryos to produce genetically identical triplets). With the further use of technologies developed at the gene level it will in the longer term be possible to introduce new genes into plant, animal and microbial cells opening completely new areas of biological manipulation. The fusion of methodologies, techniques and biological processes furthermore creates and develops its own new technology. Typical examples include the radio-immuno-assay-technique and the production of monoclonal antibodies. The latter emerges from biological observations that B-cells matured from lymphocytes produce only one antibody when attacked by an antigen, and that the cells resulting from fusion of different cells behave like both cell lines.
This biological know-how was used by Georges Kohler and Cesar Milstein, two of the Nobel prize winners for medicine 1984, to produce hybridoma cells by fusion of lymphocytes from normal B-cclls and tumours (with unlimited growth) which

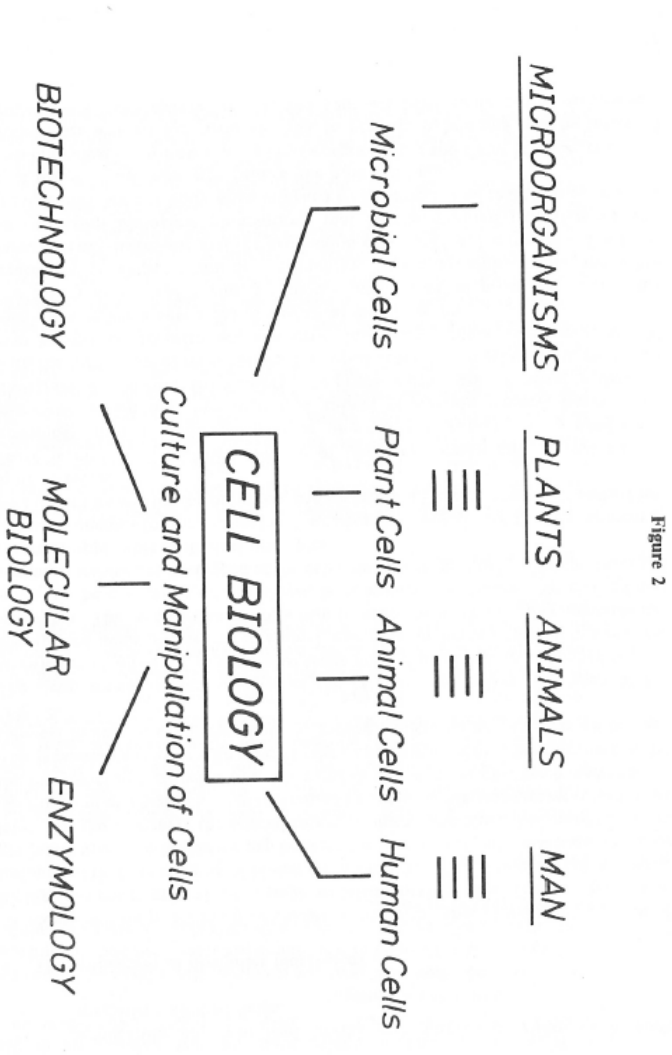

Figure 2

produced the monoclonal antibody of the original B-cells.
Future use of biological know-how will also include less obviously related disciplines like psychology, sociology, psychiatry e{c. Ethology and animal behaviour are beginning to be used as basis for comparable studies of brain research, gerontology, neurobiology with the aim of asking what functions underlie human behaviour and how human mentality is working.
However, such developments in biological know-how need to be put into a wider context by competent biologists.
All biologists should be able and encouraged to discuss with industrial, governmental and political representatives within and outside the parliament, where such developments are likely to go and what impact they might have on society.

IV. PERSPECTIVES 2 : THE NEEDS OF SOCIETY

1. Introduction

The demands likely to be made on biologists by society seem likely to increase rather than decrease for some considerable time to come. This will be true for both developed and developing areas of the world though not necessarily for the same reasons.
The considerations which will play a part in shaping these demands range from pressures to reduce energy requirements through better environmental monitoring and control and the generation of new industry to enlarged horizons of knowledge and decision making at a personal level.

2. Education and Communication

Biology is already a major component of the courses in secondary schools in many European countries. The importance of the place it occupies in the curriculum is still, however, in the view of ECBA, under-rated in some countries and it is to be expected that some expansion of the teaching of biology might take place in such countries. There are considerable pressures to place human biology and basic ecology squarely in the central part of the school biology curriculum and such pressures are expected to increase with increasing recognition of the need to consider human societies as complex systems in which both biological and cultural factors operate. It follows from this that biological education in schools will need to be directed towards those for whom school biology is the only or major source of biological information. The training of biology teachers will rest soundly upon the type of foundation already supported by ECBA (1976) for the foreseeable future. However, the rapidly changing state of knowledge of many fundamental areas of biology will impose considerable demands for updating and refresher courses of an in-service nature.

The role of the media and particularly that of television is increasingly important in the dissemination of knowledge of all kinds. Programmes featuring wildlife, human biology and environmental issues are increasingly common in most member countries. However, in too many cases the presentation is made without the assistance of biologists leading to the transmission of misleading or indeed, in some cases, totally untrue information. It is in the interest of government and of the individual that information be accurately and simply conveyed and to this end ECBA recommends that appropriate agencies in the member states be informed of the position and asked to take steps to ensure that qualified biologists are engaged to assist in the production of media features.
As TV films are frequently used in schools the engagement of a biologist will not only ensure accuracy but also allow for his participation in discussion before or after the presentation.

3. Community considerations

One of the areas where expert advice is likely to be needed more and more in the future is that of consumer groups which are already fairly well established in some countries but still rudimentary or non-existent in others. Many of the issues with which such groups concern themselves are matters on which biologists can, and should, give expert advice and help.
Environmental considerations especially where they relate immediately to the quality of life of particular groups of people arc not new. However with increasing realisation of the extent to which chemicals such as fertiliser nitrate, insecticides and many substances resulting from industrial products permeate water, soil and air, the pressure for proper monitoring and control of the levels of such substances and for work on the effects of these substances on living systems seems certain to increase. Biologists will be needed in significant numbers to assist with this work. Hopefully too in the future the planning of new industrial processes and units will involve, from an early stage, an input from environmental biologists (ECBA no. 5). Biological systems are frequently both cheaper and more effective than purely chemical systems in dealing with disposal of wastes and effluents. Here too an increase in the input from biologists should be seen.
There are many aspects of reclamation to which biologists can contribute. The reclamation of derelict land, quarries and spoil heaps represents one such area and much work needs to be done here. Successful reclamation based on sound biological advice has been undertaken in some countries and the demand for work of this sort is expected to increase in future. Less obvious examples of reclamation based on biological knowledge are seen in the legal requirement in Italy for restoration of works of art to include microbiological expertise. Other related areas of work in which biological competence is required include landscape architecture and the

control of plant and animal species causing deterioration to human habitation.

4. Economic aspects

In Chapter III Figure 1 (p. 19) illustrates the very large number of applications of new biological knowledge of economic interest. It is too soon to try to assess the scale on which these new applications will provide jobs and revenue for society. However some at least are likely to be used very widely indeed and to require significant numbers of biologists particularly in microbiology and molecular genetics. Some of these new technologies offer great opportunities for the establishment of small companies by individual entrepreneurs. ECBA takes the view that enterprises of this sort should be strongly encouraged and urges the Community and the European Parliament to provide a legal framework by which small companies based on new biological techniques («biotcchnology» in the broad sense) can be encouraged.

5. Health

A number of aspects of health in which biologists are involved are likely to develop considerably in the next few decades. Of these one of the most important is concerned with the causes and prevention of neoplastic diseases. Considerable advances in knowledge of oncogenes coupled with the concern about known or suspected carcinogens especially, though not exclusively those in the work place, and in foodstuffs, together suggest that a considerable amount of new research by biologists on fundamental aspects of carcinogenesis is to be expected. There is already general and considerable need for a systematic programme of Health Education (see ECBA publication no. 4 Health Education and School Biology 1984).

6. Food and Agriculture

Within the Community production of some important agricultural products is in excess. Thus some of the pressure for biological improvement will be directed towards lower inputs rather than higher outputs. Likely developments in this connection could be lower fertiliser requirement, greater photosynthetic efficiency and better cycling of agricultural wastes. New biological techniques which will be increasingly valuable are genetic engineering, cell fusion, *in vitro* fertilisation, and biological pest control. Application of these techniques could also provide great advances in Third World agriculture.
Among other activities which would be of value, both for food production and in social terms, are the breeding of strains suited to marginal land conditions and the development of aquacultural systems both for intensive production and for other

purposes.
Other areas requiring large efforts in research and routine laboratory work are allergies, toxicology (where the development of cell culture test systems is an important goal), development and use of diagnostic systems, neurobiology, gerontology, and the diagnosis and treatment of genetic disease.
It is still the case in some areas within the Community that water quality is less than it should be. ECBA is of the view that appropriately trained biologists should be available everywhere to carry out microbiological and ecotoxicological checks of water quality.
In the field of parasitology there are many problems of large magnitude in countries of the developing world. As qualified personnel are still scarce in such countries the need for biological assistance in dealing with these large health problems will be considerable for many years to come.
ECBA urges the EEC to support strategic biological research on the major parasites and their vectors of developing countries.
It is thus evident that over a wide range of problems in many different types of society considerable demands will be made of the community of professional biologists.
Resolution of the problems will require the application of many different types of biological expertise which will need to be underpinned by a healthy level of ongoing fundamental research.

V. CONCLUSIONS

The spread of the fields of expertise which are the proper province of the professional biologist has always been broad extending as it does over many different geographic areas, ecosystems and grades of complexity. The emphasis is changing, however, with more and more biologists moving into non traditional avenues of employment and relatively fewer entering the traditionally numerically important sectors of education (at all levels) and academic research.
The modern biologist is, generally speaking, equipped with a battery of analytical skills which can be deployed in a variety of contexts ranging from aquaculture through forensic science to genetic engineering. The modern biologist is also skilled in the use of computers for a variety of purposes and typically will also be proficient in the preparation of succinct, clear and informative reports. When training in basic management skills is allied to these qualities a biologist is very well kitted out for an industrial or commercial career both as a practising biologist or taking a route through the management side of the company which employs him. The rate of change in the way western societies order their activities is now formidably great. Many of the changes have profound implications which may be social, economic or scientific in nature and for the resolution of which calls on biological knowledge and practical skills will increasingly be made. The "quality of life" is a phrase which has, to some extent, been devalued by careless use but in its best sense signifies something of great importance. In the next few decades technological change will produce needs for maintenance of the quality of life (in the fullest sense) for the resolution of which biologists in considerable numbers will need to be engaged.

VI. RECOMMENDATIONS

1. ECBA *recommends* that the EEC and the European Parliament take steps to provide a framework encouraging the establishment of modern small companies based on modern techniques.
2. ECBA ***recommends*** that the EEC develop a programme of research on the major parasites (and their vectors) of developing countries.
3. A steadily larger proportion of the European industrial product is likely to arise from biologically based industry in future. ECBA ***recommends*** that all efforts be made to secure adequate finance for a high level of the basic research which underlies industrial application and that the EEC and member bodies be so advised.
4. ECBA ***recommends*** that the national professional bodies take steps to increase the awareness among young biologists of the need to maintain an open attitude towards industrial employers of biologists, including the economic management and research aspects.
5. ECBA ***recommends*** that member bodies should ensure that attention is drawn to the fact that, by their training, biologists are well suited to deal with complex situations. They are thus generally very capable in management positions and the majority have desirable numerical skills.
6. It is evident that some industrial concerns would welcome the availability of biological graduates with some experience in economics. ECBA therefore ***recommends*** that where suitable conditions exist some courses combining these two areas of knowledge should be established.

STATISTICAL DATA

The data material that formed basis for the workshop was compiled in the member countries. For reasons of economy it was necessary to rely extensively on material which had originally been made available for other purposes. Therefore, not all desirable data have been obtained from all countries but, as Table 2 shows, an appreciable amount of information is nevertheless at hand. Even though uniformity in the material and a simple grouping are attained, at least one national difference has influenced the material in a way which must be borne in mind at the interpretation, namely the length of the curricula. Table 2 shows data on the employment pattern in the participating countries. The biologists reported upon in the table fall in two groups with respect to the length of their curricula. All European countries offer a biology training of around five years, and biologists with the corresponding degree have equivalent qualifications all over Europe (ECBA Report no. 1, 1977). However, some countries also offer a shorter version with a 3-4 year curriculum with about the same amount of factual learning, but without a final 1-2 years of individual research training. The figures for Sweden, UK, and Ireland concern candidates with the shorter curricula. Candidates with this ••First degree» may supplement their education with the above-mentioned research training. (The number of candidates choosing this opportunity in the UK appears from table 4, which further allows a comparison of the employment patterns for the two types of candidates).

The pattern of employment in the nine European countries surveyed in table 2shows both similarities and differences, as could be expected. The number of biologists relative to the whole population is of the same size of order, 3-500 per million inhabitants, in most countries. Greece differs somewhat from the other countries listed in the table in this and some other points. A more detailed description of the Greek employment pattern is shown in table 3. The percentage of unemployment shows some variation. The general trend has been some increase during the later years, depending upon the general tendency to reduce the recruitment to the traditional fields of employment, schools and universities, which began at comparable times over most of Europe. However, there are significant variations in extent and duration, depending upon the general attitude of government towards public versus private initiatives, squeezing of public economy, and state of developing interest in the industry in hiring university trained biologists. The number of candidates to be expected in the near future is, of course, of great interest for the changes in the employment/unemployment numbers. However, these figures should be taken cautiously. The expected number of graduating biologists per year is estimated from the yearly intakes of biology students and the usual percentage of dropouts or study changes in the respective countries, plus an estimate of the trend to increased or decreased recruitment of students to biology. The lower half of the table shows the distribution of candidates in employment

sectors. Here considerable differences exist, partly explainable on background of tradition, degree of industrialization, and rates of decrease in student numbers, numbers of teachers, positions, and public expenditure. The entry «Research» comprises universities and public research institutions. It is an appreciable percentage in all countries, lowest in Sweden and Germany. The higher figures for recently graduated biologists in Sweden and UK are caused by first degree candidates in training positions for their second degree.

The number of biologists allotted to education is distributed differently from the number allotted to research. There are relatively many, especially in Austria. Germany, and Sweden, but fewer in Denmark and the Netherlands. In Greece, the number is low compared to the number of inhabitants. This may delay the evolution of a general understanding of the biological basis for environmental protection and development, general hygiene, and a healthy life style.

Governmental employment will to some extent reflect political attitude with respect to nature conservation, pollution control, and landscape planning, but this sector also comprises persons occupied with e.g. fisheries' control and development. Private employment is increasing in all countries, but it is seen that the number is as yet modest in most countries.

When comparing the employment pattern for young candidates (where such information has been available) with the pattern for biologists as a whole, it is seen that the trend towards employment in private industry is stronger among the young, another indication of an increasing trend. In countries with an appreciable number of biologists going to industry, there may be a higher employment level for young than for older biologists, because this market prefers young persons, or because recent graduates may have chosen curricula especially fit for an employment in industry, thus making them better qualified for this field than their older colleagues. The number of unemployed biologists reflects both the general level of unemployment /employment in the respective countries and the education policy, the general economic situation, and the specific interest in private and public institutions to hire biologists. Important is also the initiative among biologists themselves to seek untraditional occupations and to make their qualifications known and appreciated. The hesitation of industry in the Netherlands to hire biologists is reflected in the numbers unemployed (especially for young candidates) and further in the low numbers employed in the private sector.

It might be expected that the unemployment percentage generally should be higher among young candidates than among biologists as a whole, due to the fact that it takes some time to find a job, especially when jobs are sought where there is no tradition of employing biologists. On the other hand, young candidates are often willing to take short-term jobs and odd jobs.' Further, a number of young candidates will be in educational positions or under further education, e.g. for teaching in secondary schools. On this background no clear relations between the employment

levels of young and older biologists is to be expected.

Some national surveys provided material additional to that which was obtained from other countries. Part of this material was especially well suited to illustrate important points in the report and is therefore given in the following.

Greece (Table 3)

Greece differs from the other participating European countries by a lower number of biologists relative to the population and by high unemployment. The small number of biologists is to some extent due to the fact that the first candidates with a biology curriculum from a Greek university graduated as recently as 1971. The I'anhellenic Union of Biologists has provided a breakdown of the employment pattern for 722out of 995 members (1984). It is seen that a major part of those with employment are working in the teaching and research fields. One reason for the rather modest number working in private industry is the general shortage of capital for investment in new industry in Greece. This will affect employment of biologists so much more as the new industries, e.g. in biotechnology would be expected to be apt to employ biologists. It is noteworthy that only 1 biologist was stated to work in aquaculturc in 1984. On the other hand it is also noteworthy that Greek biologists have found occupation within a very wide spectrum of public and private enterprise, underlining the versatility of modern biologists.

United Kingdom

The material provided from the UK allows a comparison of the employment for candidates with the shorter curriculum (first degree) and those with a higher degree. The number of biologists in UK had grown by 7% between 1980 and 1983, and the percentage of unemployed had risen from 12 to 17 for those with a first decree, and from 2 to 4 for those with a higher degree. In the same period, the number continuing with a teacher training had decreased from 9 *<;<Ao* 6 %**.** It can be deducted from table 4 that about 30 % of those with first degree go on and take a higher degree. Candidates with this specialization arc almost sure to get a job.
An appreciable number of candidates graduating with a first degree, and even of those with a higher degree, are occupied with non-biological work, using their broad training as a qualification of a general nature (Table 5).

Ireland
Although there was a decrease in the number of graduates in the biological sciences that were employed directly on qualifying with a primary degree in the period 1977-82, only 2-7 % of graduates in any one year were seeking employment (or considered unemployed) at the time of completing questionnaires (Table 6). There was.'an

increasing interest among the Biology graduates in pursuing careers in vocational training unrelated to the discipline in their primary degrees. Accountancy, business and law arc included among the vocational areas of most interest to biology graduates. As Table 7 shows, there is a decrease in the employment of teachers in (secondary) schools and third level colleges. There is a marked increase in the number securing employment in industry over the 5 year period investigated and with a possible increase in those gaining employment in the business sector.

Denmark

Tables 8a.b and 9 show data from investigations on two groups of varying width. Table 8 comprising Danish biologists who graduated over an II -year period 1970 - 81. and "Table 9 graduates from 1978 - 80. The number becoming employed in secondary schools decreased in the period. This decrease has continued in the ensuing years. A large proportion of university biologists are in training positions. Therefore the percentage is high for new graduates in spite of an almost complete stop for appointments in fixed positions in the years 1978-80. Employment in the private sector is increasing. The unemployment percentage is undesirably high, but it was constant in this period in spite of a yearly 6-8 % increase in the number of biologists and a nearby stop for employment in traditional fields as research and teaching. The new fields of employment are public administration and private industry. Table 8b shows how biologists who graduated in 1970 - 81 are distributed between types of industry. ••Counselling" covers mainly biologists in consultant engineering firms (landscape planning etc.) or self-employed. The number of biologists in aquaculture has shown a sharp increase since this survey was made. It is in
1985 estimated to be about 20 persons and is still increasing

Table 2

EMPLOYMENT PATTERN FOR BIOLOGISTS IN EUROPEAN COUNTRIES IN 1984 [1]

		Austria	West Germany	Denmark	Greece	Nether-lands	Norway	Sweden	United Kingdom	Ireland
Population, mill.		7.5	60	5	9.5	14.4	4	8	52	3.5
Number of biologists		2300	25000	1813	1500	7200	1500-2000	3000	30000	2000
Number biol./mill. inhabitants		307	417	363	158	500	375- 500	375	577	571
Number unemployed biol.		0	1854	239	405	1160	50- 200	150	1500	140
Number biol. students entering/yr		410 ↓	5000	300	250	800	100- 150 ↓	600 ↓	5500	220
Number graduating biol./yr		120 ↓	4500	150	220	650	170 ↓	400	5000	200
Distribution of all biologists, per cent	Research	30 ↑	20 ↑	36	20	40-45	30-40	25	28	25
	Teaching	60 ↓	60 ↓	39 ↓	24 ↓	30-35 ↓	40-50 ↓	50 ↓	23	45
	Public admin.	5 ↑	10 ↑	5 ↑	7	4 ↑	5-15 ↑	13	8	6
	Private industry	5 ↑	10 ↑	7 ↑	8 ↑	3 ↑	2- 5 ↑	5 ↑	11	10
	Unemployed	0	7	13	27	16	2-10	5	5	7
	Other	0				4		2	25[2]	
Distribution of recently graduated biologists, per cent	Research	40		26		32		45	30	45
	Teaching	20		31		24		20	8	17
	Public admin.	20		8		5		6	16	7
	Private industry	20		14		4		6	17	24
	Unemployed	0		12		30		13	17	7
	Other			9		5		10	14	

1) Denmark and United Kingdom: Figures are from 1983
2) «Non-biological» work
↑ Increasing ↓ Decreasing (Only where information on trend was available)

Table 3

EMPLOYMENT PATTERN FOR 995 BIOLOGISTS IN GREECE

	Number	Per cent
TEACHING	175	24.2
High school	140	
Technical school	7	
Teacher Training College	1	
Adult Education	1	
Private schools	26	
RESEARCH AND TEACHING	141	19.5
Universities (permanent)	65	
» (temporary)	33	
Research Institutions	43	
GOVERNMENT	50	6.9
Min Agriculture (fisheries)	35	
» » (agr. developm.)	2	
» Environment	8	
» Public Health	2	
» Economy	2	
» Research	1	
HOSPITALS	58	8.0
Biochemistry laboratories	51	
Centres of Thalassaemia	7	
SEMI PUBLIC	2	0.3
Water Authorities	1	
Museums	1	
PRIVATE INDUSTRY	46	6.4
Food	9	
Cosmetics	4	
Pharmaceuticals (Q.C)	11	
» (marketing)	14	
Fish-farming	1	
Environment	2	
Biomedical lab.	5	
ABROAD	12	1.7
Research	11	
Job	1	
OTHERS	43	6.0
Different profession	30	
Military Service	6	
Housewives	4	
Dead	3	
UNEMPLOYED	195	27.0
UNKNOWN OCCUPATION	273	

Table 4

THE FIRST EMPLOYMENT OF BIOLOGY GRADUATES FROM UK UNIVERSITIES IN 1983

The following figures come from information collected by Appointments Officers of UK Universities for people obtaining degrees in : Agricultural Biology; Biology; Botany; Zoology; Physiology; Biochemistry; Combined biological sciences.

Of the 5294 first degree graduates 90 % replied and 86 % of the 1624 higher degree graduates returned the questionnaire.

The posts obtained by the graduates of known destination were:

	First **degree**	**Higher de|**
Teaching in schools	369[1]	-
Research and teaching in universities & polytechnics	1272[2]	500
Research assistants at universities	182	-
Government research and administration	119	167
Semi-public institutions	344	-
Private industry		
a) as biologists (est)	290	70
b) non-biological (est)	500	70
Abroad	62	68
«Culture»	20	3
Various		
Short term employment	204	-
Not available for employment	222	27
Further education	209	-
Miscellaneous employment	109	53
Overseas students returning home	-	383
Unemployed at 31.1283.	879	58
Total :	4781	1399

1) These take a one year training for teaching
2) These spend three years of research training to obtain a PhD

Table 5

THE TYPES OF PRIVATE INDUSTRIES EMPLOYING BIOLOGISTS, BOTH IN «BIOLOGICAL» AND «NON-BIOLOGICAL» WORK IN THE UK

	First degree	**Higher degree**
Agriculture and forestry	**41**	**11**
Chemical industry	173	**64**
Engineering /building	38	**9**
Accountancy	110	**2**
Banking/insurance	67	**3**
General manufacturing	139	**35**
Public utilities /transport	28	**3**
Commerce /general	194	**13**
Total :	790	**140**

Table 6

EMPLOYMENT OF BIOLOGY GRADUATES (FIRST DEGREES) FROM IRISH UNIVERSITIES 1977 - 1980 and 1982

	Employed	Seeking Employment	Research and further study	Teacher Training	Vocational/ Professional Training
1977	27	4	56	9	-
1978	20	5	51	18	-
1979	24	2	47	18	3
1980	17	4	53	14	5
1982	14	7	51	17	4

Results expressed as a percentage of total Honours Biologists graduating each year.

Data concerns the National University of Ireland. The information was extracted by Mr. D. Montgomery, Trinity College, Dublin, from questionnaires completed by science graduates 3-6 months following graduation.

Table 7

TYPES OF EMPLOYMENT [1]) FOR BIOLOGY GRADUATES (FIRST DEGREE) IN IRELAND FOLLOWING GRADUATION 1977-80 and 1982

Employed in:.	1977	1978	1979	1980	1982
Civil Service & Local Government	14	5			7
Health Boards & Hospitals	19	15	27	38	18
Education (Schools & Colleges)	31	23	10	24	18
State Sponsored Bodies	5	10	12		7
Industry	5	28	29	38	32
Commerce	7	8	4	-	11
Professions	-	8	2	.	4
Other work (incl. temporary)	7	3	16		4

Results expressed as a percentage of total biologists employed 3-6 months following graduation.

Table 8a

EMPLOYMENT PATTERN FOR 1061 BIOLOGISTS IN DENMARK

91.8 % of those graduating from Danish universities during the years 1970 - 1981

	Number	Per cei
University etc	177	16.7
Teaching (sec. school)	400	37.7
Public administration and research (mainly central)	103	9.7
Public administration (mainly peripheral)	68	6.4
Semi-public institutions	18	1.7
Private industry	98	9.2
Abroad	35	3.3
Culture	27	25
Unemployed -)	82	7.7
Other	53	5.0

') Science training positions: 76 = 7.2 %

[2]) The number of persons with less than full employment (partly employed + unemployed) was 261 = 14 %. The deficit in employment has been recalculated to the corresponding number of fully unemployed persons / "lacking positions".

Table 8b

EMPLOYMENT FIELDS FOR 98 BIOLOGISTS IN PRIVATE INDUSTRY, IN DEMARK

Counselling	9
Medical industry	23
Chemical industry	8
Aquaculture	3
	2
Brewery	4
Privately funded research institutions	6
Professional and public organizations	14
Other private industry	23
Electronic data processing (after re-training)	6

Table 9

EMPLOYMENT PATTERN FOR BIOLOGISTS GRADUATED FROM DANISH UNIVERSITIES 1978-80'

	Number	Per cent
University etc.	**104**	**26 >)**
Teaching	**120**	**31**
Public administration	**33**	**8**
Private industry	**43**	**11**
Dan. State Radio + abroad	**12**	**3**
Unemployed [J])	**46**	**12**
Other	**34**	**9**
Total	**392**	**100**

') Survey by the Employment Secretariat 1982

■) Including training positions

[J]) All less-than-full employment, converted to full-time unemployment

VIII. ACKNOWLEDGEMENTS

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Annex 1

Published Reports of ECBA

1. Biology Curricula at Universities (1977).
2. Biologists in European Society (1979).
3. School Biology for Child and Society (1981).
4. Health Education and School Biology (1984).
5. Biologists and the Environment The Role of the Professional in a Changing World (1984).
6. Professional Biologists in Europe: Position and Perspectives in Employment (1985).

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