Helgoländer wiss. Meeresunters. 30, 1–7 (1977)

International Helgoland Symposium "Ecosystem research": Opening address

O. KINNE

Biologische Anstalt Helgoland (Zentrale); Hamburg 50, Federal Republic of Germany

Ladies and gentlemen! Colleagues and friends!

Welcome to the island of Helgoland and welcome to the Meeresstation of the Biologische Anstalt Helgoland! My associates and I are happy to note that some 250 scientists from 30 countries have accepted our invitation and have come here to join this scientific meeting.

Before I deliver my opening address, the Minister for Research and Technology of the Federal Republic of Germany would like to welcome you through his representative Dr. Hohendorf*.

We have come together here to present and to discuss new information obtained on ecosystems and other multispecies assemblages in the sea and in the laboratory. The symposium is also intended to celebrate the completion and the formal opening of a new building – the Helgoland Multipurpose Environmental System, known in German as "Experimentell Ökologisches Laboratorium".

In this opening address I would like to

(1) briefly refer to some essential features of the new building;
(2) outline some of the research activities which we plan to conduct in the new facility;
(3) make some comments regarding the topic of our symposium on ecosystem research.

The Multipurpose Environmental System (MES) has been designed for research cultivation and small-scale experiments on commercial cultivation (aquaculture). Major planning goals were: maximum flexibility, maximum control of environmental factors, and the simultaneous availability of several, independent and modifiable bodies of sea-water. The MES accommodates 9 major sea-water systems. Of these, 8 can be operated as open-, semi-open or closed culture units; the ninth is an open

* The Minister's welcome address is available upon request from Biologische Anstalt Helgoland, Administration Office, Palmaille 9, D-2000 Hamburg 50, Federal Republic of Germany.

sea-water system. The MES contains facilities for some 7 scientists. The present research team represents the following research disciplines: microbiology, protozoology, phytoplanktology, zooplanktology, invertebrate and fishery biology.

The Helgoland MES (Figs 1–4) consists of 6 basic units: (1) An outdoor test area of about 330 m^2; (2) an indoor test area of the same size; (3) a laboratory building with rooms to accommodate the different research disciplines mentioned, as well as 22 temperature-controlled rooms and several special laboratories; (4) a sea-water tower sectioned into 9 header tanks (one of which is separated into two subsections); (5) eight underground sedimentation tanks and filters; (6) a library building with a conference room, study rooms and related services.

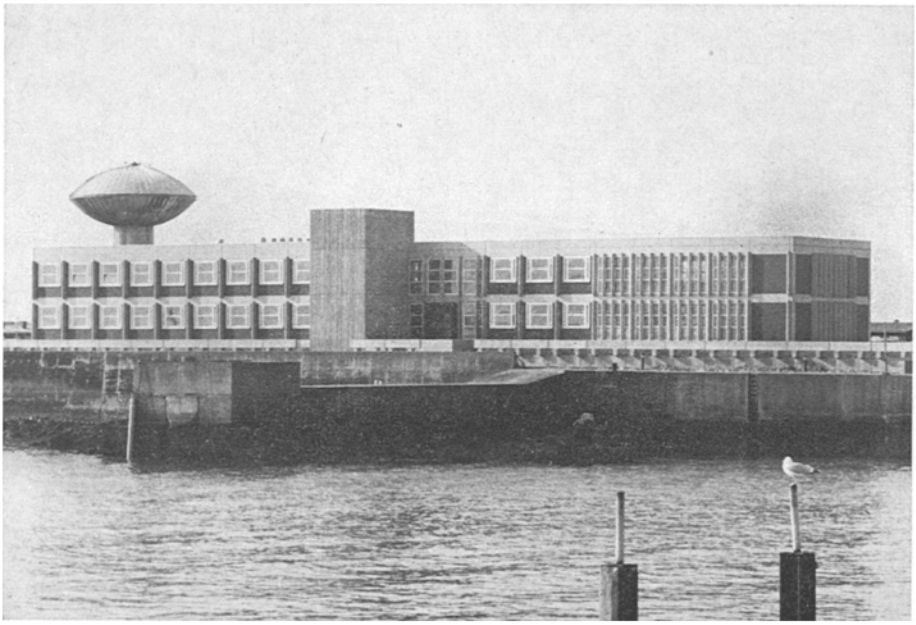

Fig. 1: Multipurpose environmental system ('Experimentell Ökologisches Laboratorium') of the Biologische Anstalt Helgoland. (Photo: J. K. Holtmann)

Each sea-water circuit has a capacity of 45 m^3; the total system contains more than 700 m^3 of sea water. Part of the sea-water can be pretreated, e.g. by zentriklones, cartridge filters or diatom-retaining filters. Routine water treatment involves running-sea-water temperature control, aeration with filtered air, as well as optional installation of disinfection procedures such as micro-filtration, ozonation, or ultraviolet irradiation. Drawn at a water depth of 2.5 m, the sea-water enters the building via pumps P_1 and P_2; it may also be pumped up (P_3) from a well (Fig. 4). From the sea-water receiver tank, the water flows into (1) 4 sedimentation tanks (9_1 to 9_4), each with a total capacity of 95 m^3; these tanks deliver unfiltered sea-water; (2) filter tanks (1 to 8), each with a filter surface of 8 m^2, a maximum depth of 2.5 m, and a reservoir of 16 m^3 which delivers filtered sea water. Unfiltered sea-water is pumped (P_{12}) into section 9a of the sea-water tower; filtered sea water is pumped into sections 1a to 8a (each with a total capacity of 5.5 m^3) of the tower. From the sea-water tower, unfiltered or filtered sea water flows to the culture tanks located in the indoor or outdoor test areas (1b to 8b and 9b) or in the laboratory building (9b only). The maximum height difference between water levels in tower and culture containers is about 10 m.

Next to the elaborate sea-water treatment and circulation facilities, the indoor test area is the most important feature. It allows a maximum of versatility of

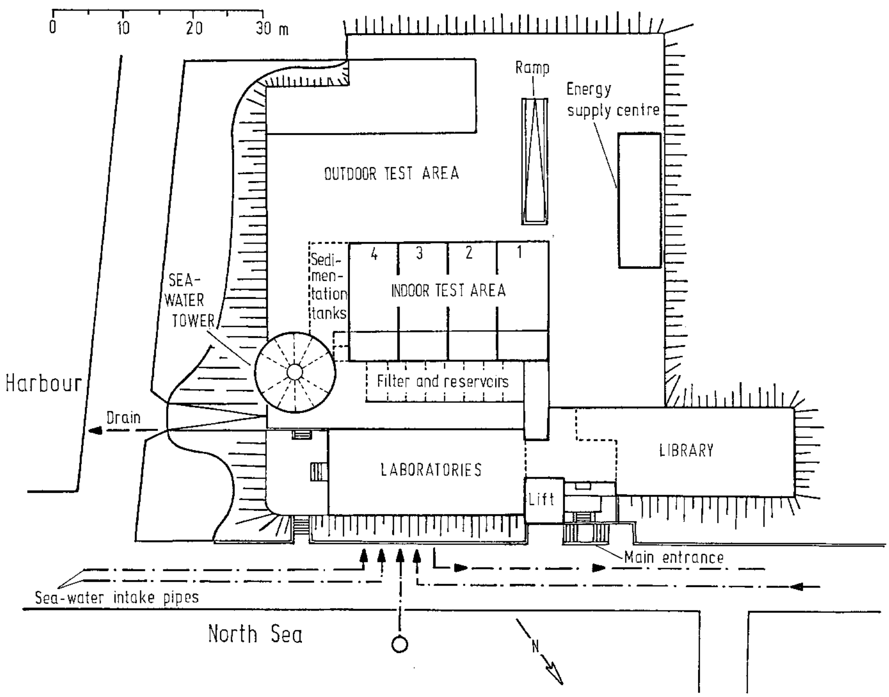

Fig. 2: Multipurpose environmental system of the Biologische Anstalt Helgoland. Schematic top view; general plan. (After Kinne, 1976*; modified)

experimental design, and work under close-to-natural light conditions. Comparison of the effects of indoor and outdoor light conditions is facilitated by the possibility of shifting the cultures from the indoor to the outdoor test area. Indoor and outdoor areas are supplied with 42 service points – each providing sea water, air, electricity and drains.

We hope that the new building will significantly enlarge our capacity for cultivating stenoplastic marine organisms and for working with artificial ecosystems.

* Cultivation of marine organisms: Water-quality management and technology. In: Marine Ecology. Ed. by O. Kinne. Wiley-Interscience, London, **3** (1), 19–300.

However, we realize that the relationship between facility improvement and scientific productivity does not tend to be a straight-line function.

It is planned to publish a detailed description of the new building in "Helgoländer wissenschaftliche Meeresuntersuchungen" as soon as our description can be combined with an adequate report on the system's performance.

What do we want to do in the MES? Our present research programme is based on two interrelated projects. The first project focuses on the cultivation of ecologically important North Sea organisms. This programme part includes the management of water quality, the development of mass-culture techniques for food organisms; the control and measurement of important abiotic and biotic parameters of culture systems; the development of culture methods and of culture-control techniques; and the determination of autecological data for typical North-Sea ecosystem representatives. The second project concentrates on experimental ecosystem research and includes such aspects as the construction of simulation models; adaptive

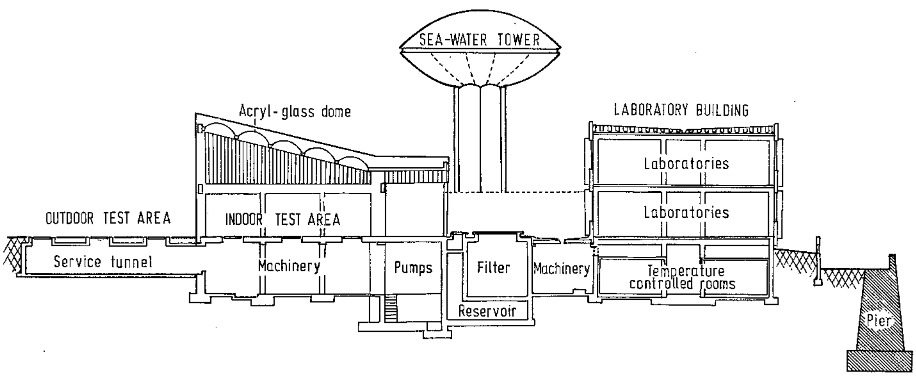

Fig. 3: Multipurpose environmental system. Schematic side view. (After Kinne, 1976*; modified)

experimental design, i. e. systematic selection of parameters and problems to be tackled; experiments on population dynamics; the determination of ecological key criteria – such as rates of reproduction, growth, food uptake, and food conversion; the systematic analysis of essential functions – such as prey/predator dynamics, competition and food selection. Finally, the research programme includes modern methodological efforts in documentation and result analysis.

Let us now turn to the topic of this symposium. Ecosystem research is an important and timely topic. In fact, I cannot conceive of any topic which would be more important to mankind's long-term survival; more challenging to natural science; or more relevant to solving today's most essential problem – to sustain billions of people and, at the same time, to avoid critical deformation of the earth's life-supporting environmental properties.

Natural ecosystems of normal complexity are very difficult to analyse and to comprehend. This fact is primarily responsible for our presently very limited know-how of ecosystem dynamics. There is much "soft ware", and hard facts have remained a rarity. Vagueness and uncertainty prevail in concepts, in the criteria to be employed and in the functions or factors to be studied. A few biologists even insist that ecosystems do not exist – except in the brains of ecologists. I would not go that far, but I would admit that there is much need to focus the picture. We need a more solid basis of indisputable facts, better methods for analyzing essential functions and structures of multispecific living systems, as well as world-wide applicable concepts of measurement and interpretation.

What then is, according to current knowledge, an ecosystem? An ecosystem is an integrated spatial entity, made up of interacting and interdependent biotic and abiotic components which are linked by energy flow and material cycling, by exchange processes – between biotic and abiotic and among biotic constituents – as well as by

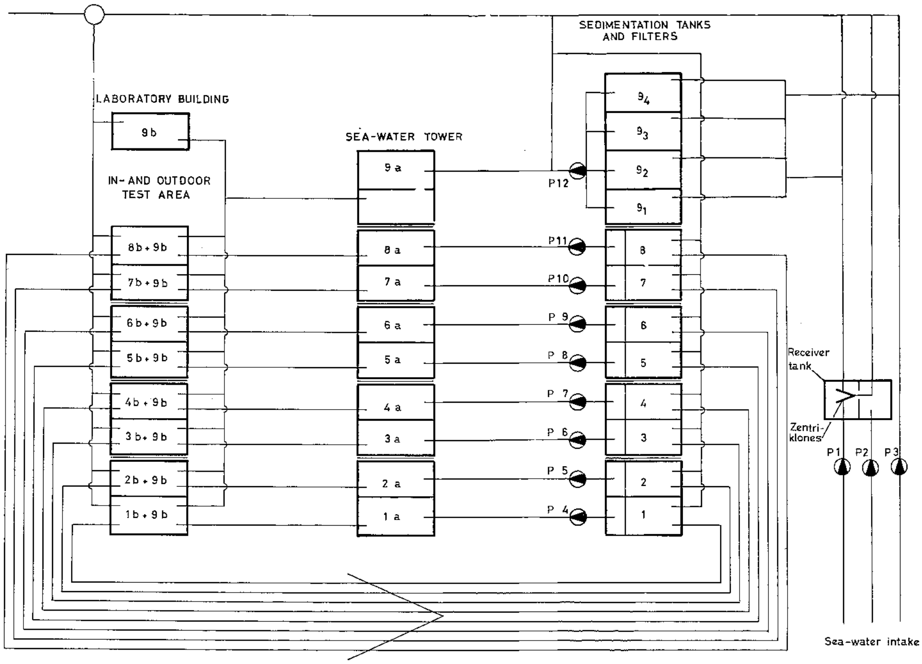

Fig. 4: Multipurpose environmental system. Schematic seawater-flow diagram. For explanation see text. (After Kinne, 1976*; modified)

homeostatic control mechanisms. An ecosystem consists of different forms of living organisms plus their non-living environment. Although conceptual differentiation between these two basic parts is necessary for analysis, in nature, organisms and environment are often so closely interrelated as to defy exact, detailed separation. Similarly, the boundaries of adjacent ecosystems are usually difficult to define in objective terms. They depend on the specificity of the system's functions and structures, the perspective of the investigator, as well as on convenience or the research methods employed. In the course of opportunistic evolution, the pathways, mechanisms and the organisms involved in an ecosystem and in the material cycling processes driven by solar energy have become adjusted, modified, diversified and specialized into an overwhelming multiplicity of interacting and interrelated phenomena. In most cases, the resulting situation is very complex and extremely difficult to study, to analyze and to comprehend.

Man himself is a result of ecosystem dynamics – possibly an accident, a malheur: He represents the only species which has critically escaped the system's control mechanisms and which is capable of destroying the system. In terms of hundreds or thousands of years, man can survive only if he succeeds in reintroducing controls and in reharmonizing his technology and his other manifold activities with the system's natural dynamics. In essence, controls involve (i) self-restriction in terms of numbers and impact per capita; and (ii) system management based on ecological knowledge. Will we be able to produce the enormous amount of information necessary for this new role of man? Will we be able to do this in time? And will we be able to apply the knowledge gained when its application requires rigid self-restriction? There is no reason to be optimistic. Unfortunately!

In ecosystem research, some investigators have attempted to correlate each and every abiotic and biotic factor in the system recognizable to them. This seems a Sisyphean task. Even in limnic ecosystems, which are often less complex and presumably easier to comprehend than marine ones, such attempts have resulted in disappointment and failure. Several factors cannot be measured accurately, others may not even have been recognized yet. Usually, the attention of the investigator has been focussed on conventional factors that are easy to measure and to record. However, some of these factors are not clearly definable units required for system analysis but a combination of 2, 3 or more separable vectors, each with specific biological consequences. Salinity, for example, may affect organismic responses through changes in total osmoconcentration, relative proportions of solutes, coefficients of absorption and saturation of dissolved gases, density and viscosity, and related properties (Kinne, 1971)*.

Obviously, we must be selective and concentrate on ecologically meaningful factors as well as on those functions and structures which determine the ecosystem's essential characteristics. Essential ecosystem functions are rates and routes of energy flow, and of material recycling, as well as homeostatic control; essential structures are the ecologically most influential species and their substratum.

Only if we are able to recognize the ecosystem's essential functions and structures and their roles in the system's dynamics can we gain maximum benefit from an ecosystem in terms of utilizable productivity (human food and other resources); can we hope to be able to protect it from critical stress due to man's activities; can we attain capacities for managing the system, and thus attempt to control the prerequisites for long-term human life on earth.

It is our sincere hope that this symposium will help to bring more light into the functions and structures and into the basic dynamics of marine ecosystems.

---

* Salinity: Animals – Invertebrates. In: Marine Ecology. Ed. by O. Kinne. Wiley-Interscience, London, **1** (2), 821–995.

We have subdivided the formal programme into 6 sections concerned with: general aspects, experimental ecosystems, tidal ecosystems, coral-reef ecosystems, benthic ecosystems and pelagic ecosystems, as well as a section on pollution effects on ecosystems.

In addition to formal paper presentations, we will have 3 informal events: An Evening Discussion convened by Dr. W. Greve (Helgoland), devoted to a topic of immediate concern to many European countries: 'North Sea Management – Science or Science Fiction?' An Informal Session convened by Dr. Joel W. Hedgpeth (Santa Rosa, California, USA), focusing on marine ecosystem research and man's dependence on the sea; and a second Informal Session convened by Dr. John McN. Sieburth (Kingston, Rhode Island, USA) on biomass and productivity of microorganisms in planktonic ecosystems. All informal discussions will be recorded. Provided the discussions yield adequate substance and the respective convener is willing to transform this substance into a publishable account, we are prepared to print the conveners' reports in "Helgoländer wissenschaftliche Meeresuntersuchungen".

I look forward to an interesting symposium and to challenging exchanges and discussions of facts, problems and concepts. Please accept my best wishes for a rewarding and pleasant time on Helgoland!

I hereby open the International Helgoland Symposium 1976 on "Ecosystem Research"!