Marine Ecosystem
Enclosed Experiments

Proceedings of a symposium held
in Beijing, People's Republic
of China, 9–14 May 1987
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Editor: C.S. Wong and P.J. Harrison
Abstract

This symposium on marine ecosystem enclosed experiments (MEEE) consists of nine review papers that describe various types of ecosystem enclosures and a series of papers resulting from enclosure experiments in Xiamen, People’s Republic of China, and Saanich Inlet, BC, Canada. The reviews on types of enclosures include benthic enclosures for rocky and sandy shores and the effects of pollutants (primarily hydrocarbons) on bacteria, macroalgae, and invertebrates. The pelagic enclosures were used to study the control of phytoplankton blooms, the uptake and release of dissolved organic substances, and the effects of pesticides on freshwater ecosystems.

Six enclosure experiments were conducted in China and Canada from 1986–87. Some of these experiments examined the effects of contaminated sediments, primarily heavy metals, on bacteria, phytoplankton, and zooplankton and the pathways and fates of these heavy metals in the seawater. Other experiments studied the chemistry and biological effects of chemically dispersed oil.

Résumé

Ce compte rendu du symposium sur les expériences faites en écosystèmes marins comprend neuf communications qui décrivent les écosystèmes retenus et les expériences faites à Xiamen en République populaire de Chine et à Saanich Inlet, C.-B., au Canada. Les communications portent, notamment, sur les écosystèmes benthiques des littoraux rocheux et sablonneux et sur les effets des polluants (surtout les hydrocarbures) sur les bactéries, les grandes algues et les invertébrés. Les expériences sur le contrôle des brutales pullulations (“blooms”) du phytoplancton furent menées dans les écosystèmes pelagiques, ainsi que l’absorption et le dégagement des substances organiques dissoutes et les effets des pesticides sur les écosystèmes d’eau douce.


Resumen

Este simposio sobre Experimentos Marinos en Ecosistemas Cerrados (MEEE) consistió en nueve trabajos de análisis que describen varios tipos de enclaustramientos ecosistémicos y una serie de trabajos derivados de experimentos con estos enclaustramientos en Xiamen, República Popular de China, y en Saanich Inlet, Canadá. Los estudios incluyen enclaustramientos bentónicos para costas rocosas y arenosas, y los efectos de los contaminantes (fundamentalmente hidrocarburos) sobre bacterias, macroalgas e invertebrados. Los enclaustramientos pelágicos se utilizaron para estudiar el control de la reproducción del fitoplancton, la ingestión y expulsión de substancias orgánicas disueltas y los efectos de pesticidas en los ecosistemas de agua dulce.

Se realizaron seis experimentos en ecosistemas cerrados en China y Canadá, de 1983 a 1987. Algunos de estos experimentos examinaron los efectos que ejercen los sedimentos contaminados, fundamentalmente los metales pesados, sobre bacterias, fitoplancton y zooplancton, y el ciclo y destino final de estos metales pesados en el agua de mar. Otros experimentos estudiaron los efectos químicos y biológicos de los aceites crudos dispersados por medios químicos.
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Benthic Mesocosms in the Netherlands

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In the mid-1970s, two indoor mesocosms, mimicking an intertidal mudflat environment, were built. Ten years of observations and experimentation in these facilities showed that the structure and major functions of the present experimental ecosystems behaved in a very realistic way. The systems were largely self-maintaining and had a long lifespan. Consequently, eight similar mesocosms were built in the open air and used in applied studies into the ecological effects of oil spills and harbour sludge in coastal areas on mudflat ecosystems. The results contributed in a significant way to methods of dealing with such perturbations and, moreover, provided better insight into the functioning of ecosystems in general.

Research on marine mesocosms in the Netherlands dates back to the early 1970s, wooden enclosures were erected around natural mussel beds in the western Wadden Sea and were used in pollution studies (de Wolf et al. 1972).

In 1975, both the introduction of large plastic bags for pollution studies in coastal waters (Kuiper 1977) and the construction of two large indoor mesocosms (de Wilde and Kuipers 1977) for fundamental research in intertidal mudflats followed. The indoor systems were used with changing time intervals for a period of almost 10 years. From the results obtained, it was concluded that benthic mesocosms were a new and promising tool for ecological studies.

In 1980, four model tidal flats (MOTIFs) were established in the open air (Kuiper et al. 1983, 1984). Three years later, another four MOTIFs were built. From 1981 until 1987, under the umbrella of OPEX1, applied research has been carried out on the short- and long-term effects of oil pollution on intertidal mudflat areas and on oil-combatting techniques in the Dutch Wadden Sea. In 1987, under the acronym SEDEX (Sediment Experiment), experiments on the effects of dumping harbour sludge were started. An overview of mesocosm research in the Netherlands is shown in Fig. 1. As the marine enclosure experiments with plankton communities in plastic bags have already been described by Kuiper (1982), only

1 OPEX (Oil Pollution Experiment) is a cooperative research program of the Netherlands Organization for Applied Scientific Research (TNO), Division of Technology for Society in the Netherlands, the Netherlands Institute for Sea Research (NIOZ), the Research Institute for Nature Management (RIN), and the Department of Tidal Waters (DGW) of the Ministry of Public Works and Waterways.
Fig. 1. Overview of mesocosm research in the Netherlands. Two indoor mesocosms were used over a period of 10 years for fundamental research and eight outdoor model tidal flats were used over a period of 7 years for applied studies dealing with oil pollution and dumping harbour sludge. Subtidal North Sea mesocosms are under construction. Acronyms: TNO, Netherlands Organization for Applied Scientific Research; NIOZ, Netherlands Institute for Sea Research; RIN, Research Institute for Nature Management; DGW, Department of Tidal Waters of the Ministry of Public Works and Waterways; CEPEX, Controlled Ecosystem Pollution Experiment; OPEX, Oil Pollution Experiment; and SEDEX, Sediment Experiment.
the results from the indoor benthic systems are discussed here. Some results from the OPEX experiments are also referred to.

What is a benthic mesocosm?

A benthic mesocosm is an artificial benthic ecosystem on a mesoscale (cf., Banse 1982; Grice and Reeve 1982). It contains a variety of primarily benthic organisms belonging to various trophic levels, showing mutual relations, comparable to those found in nature (Ringelberg 1976). Basic ecological functions, i.e., primary and secondary production and mineralization, must occur in a realistic way. A benthic mesocosm must exhibit an unchanging or predictable state for relatively long periods of time. Human interference must be kept to a minimum.

Indoor mesocosms

The two indoor mudflat ecosystems, each with a surface area of 25 m², provided fully controlled systems with regard to energy input, tidal regime, and temperature (for a detailed description, see de Wilde and Kuipers (1977)). One of these mesocosms (I) was used to accommodate a number of divergent experiments pertaining to scientific problems of current interest. The other mesocosm (II), after it was set up with sediment and organisms, was left undisturbed for almost 10 years. The evolution of the benthic structure and the energy flow through the latter system were monitored. Some of the results from both the indoor mesocosms and the outdoor MOTIFs are now used to illustrate the variety of applications and potential of artificial benthic ecosystems.

Growth of the lugworm

During the last few decades, an increasing phosphate load, originating from river discharges, has caused eutrophication and phytoplankton bloom formation in the coastal waters of the North Sea. A considerable part of the organic matter produced here ultimately entered the Wadden Sea and gave rise to enhanced food availability on the tidal mudflats. The effect of extra food on this intertidal ecosystem, with a macrofauna biomass of ±27 g ash-free dry weight (AFDW) (Beukema 1976), was unknown. Laboratory and mesocosm experiments showed that growth in selected faunal elements of the mudflats could easily cope with the extra supply of food by speeding up growth (de Wilde and Berghuis 1979).

Based on the growth curves for the lugworm Arenicola marina (Fig. 2), it was concluded that growth of Arenicola in its natural habitats was far below its potential. The macrofauna biomass in the mesocosm reached a value of ±50 g AFDW·m⁻². Ten years later, macrofauna biomass in the Wadden Sea had increased from 27 to 40 g AFDW·m⁻² (de Wilde and Beukema 1984). This led to the striking conclusion that the intertidal ecosystem of the Wadden Sea is apparently not predator controlled (Reise 1977), but seriously food limited.

Formation of the stratified layer

The bioturbation activity of lugworms is well known. Subterraneous sediment uptake, downward transport of sediment particles in the feeding shaft, upward particle transport by the animal itself, and deposition of the feces at the sediment
Fig. 2. Food limitation in macrobenthic organisms in natural mudflat systems in the Dutch Wadden Sea. Growth curves (solid curves) obtained from laboratory experiments for fed Arenicola marina (Polychaeta) at different temperatures and for nonfed animals (shaded bar) are compared with the growth of juvenile Arenicola under field conditions at a nursery area at Mok Bay, Texel (open squares) and at the Balgzand area (dotted line) (Beukema and de Vlas 1979); at the Whitstable flats, UK (Newell 1948); and in two indoor mudflats (open and solid circles) (de Wilde and Berghuis 1979).
surface causes stratification in the sediment (Straaten 1952), with a layer of coarse particles (shell fragments, peat lumps, etc.) at the living depth of Arenicola. Natural flats are exposed to tidal currents and wave action, and the time scale within which such layers are formed in the sediment is poorly understood.

In the indoor mesocosm, filled with homogenized mudflat sediment, the number and size of the lugworms was known exactly. The formation of stratified layers in the sediment generated by lugworms was monitored for 400 days. Figure 3 shows the development of heterogeneity in the sediment (Baumfalk 1979).

Mineralization in the sediment

In July 1976, the vertical distribution of mineralization processes in the sediment of the mesocosm was studied (Vosjan and Olanczuk-Neyman 1977). The values for the profiles of the organic carbon content, the sulphate-chlorinity ratio and the sulphide content of the interstitial water, oxygen utilization, and electron transport system (ETS) activity all appear to be sufficiently realistic when compared with certain parts of natural mudflat sediments (Fig. 4).

Effect of the larger predators

Toward the end of November 1977, 12 small flatfish (Solea solea), averaging 13 cm in length, were released into the mesocosm. Within a couple of weeks, the rich polychaete stocks of the mesocosm were completely exterminated by the sole, a notorious predator of worms. The numbers of Arenicola had decreased from 60 to <10 specimens m\(^{-2}\); those of Nereis diversicolor from about 5 000 to <1 000 specimens m\(^{-2}\). It is concluded that introducing larger predators into mesocosms should be considered very carefully. In most cases, the scale of the mesocosm may be insufficient to sustain the needs of the predator, depending on the size of the mesocosm.

**Fig. 3.** Development of heterogeneity (%) of median particle size in an indoor tidal-flat mesocosm (Baumfalk 1979).
Fig. 4. Vertical profiles in an artificial tidal flat system: (a) organic carbon content (% of dry sediment); (b) sulphate-chlorinity ratio in the interstitial water; (c) sulphide content (µg S²⁻·g⁻¹ wet weight sediment); (d) oxygen utilization (µL O₂·g⁻¹·h⁻¹ wet weight sediment); and (e) electron transport system (ETS) activity (µL O₂·g⁻¹·h⁻¹). Lines connect mean values (Vosjan and Olanczuk-Neyman 1977).

Algal-mat formation

The occurrence of algal-mat structures on the tidal flats in the Wadden Sea during the summer is a common phenomenon. Suddenly, the mudflats become covered with dense layers of filamentous and thallus, green and blue-green algae, which asphyxiate the infauna. An explanation for the edaphic and sudden appearance of the algal mats is lacking. In an attempt to understand the development of these mats, a series of experiments and observations was carried out (B. Kuipers, unpublished data). To this end, the mesocosm was rearranged in the summer of 1978. The existing system was removed and the basin was subdivided into eight compartments. Each compartment was filled with sterilized sandy sediment, low in
silt content and poor in organic matter and nutrients. Initially, the system was kept in the dark. On 15 September 1978, a 2-L sample of the upper sediment layer, scraped from a natural mudflat, was spread over the mesocosm. Previously, this sample was treated with an organic phosphorus compound (parathion), which killed the higher organisms but spared the plant material. Key nutrients in the 40 m² of seawater belonging to the system were brought up to concentrations representative of the Wadden Sea in summer: 47 μM NO₃, 21 μM SiO₄, and 7 μM PO₄.

Changes in nutrient concentrations in the mesocosm were recorded weekly. Later, on two other occasions, nutrient concentrations were raised again to the starting level. The experiment started when the lights over the mesocosms were turned on.

The developing vegetation consisted predominantly of *Enteromorpha* and *Chaetomorpha* species, which soon covered most of the sediment. The biomass of the algae was measured weekly in random collections of algae from 400 cm² surface areas. The material was dried (65°C) and combusted (2 h at 520°C).

The phytobiomass production in this ungrazed experimental situation had an exponential increase during the first 45 days (Fig. 5). The biomass doubled every 4–5 days, i.e., a daily increase of 18–20%. Of the nutrients in the mesocosm, nitrogen showed an almost reciprocal trend to that of the algae biomass, decreasing from the initial value of 47 μM to a value between 15 and 20 μM after 45 days, at which point it obviously started to limit the growth of the dominating algal population. After this first outburst, the threadlike algae became covered with diatoms, causing the colour of the algal mat to change to yellow. The increase in biomass between 50 and 60 days is attributed to these diatoms. Ultimately, a total biomass of about 11 g C·m⁻² was reached (Fig. 6). On day 67, nutrient concentrations were again brought up to the initial values. Nine days later, this had led to a total biomass of 25.4 g C·m⁻², after which the same nutrient treatment once again raised the biomass to 45 g C·m⁻² over the next 40 days. During the later blooms, however, a considerable population of the grazing isopod *Jaera albifrons* had developed in the mesocosm; hence, only the first 40 days of the experiment can be considered to have provided a production estimate through a biomass increase. Thus, over a period of about 4 months, a total phytobiomass of 45 g C·m⁻² had been produced. In light of the grazing activities of *Jaera*, this value clearly represents an underestimate. Unfortunately, the biomass that was grazed could not be measured.

Fate of organic matter in ecosystems

The structure and composition of organic matter determines whether this food can be utilized for maintenance, growth, and reproduction of organisms. Commonly, organic matter in ecological studies is evaluated in terms of organic carbon or organic nitrogen, but this presents a very rough indication and largely ignores the molecular structure and quality of the available food (Boon and Haverkamp 1979). Pyrolysis mass spectrometry (Meuzelaar et al. 1977) presents a technique by which organic matter is degraded and the fragments obtained are “fingerprinted” by mass spectrometry.

Studying the fate of newly produced organic matter in a mesocosm offers a unique opportunity to follow the pathways of food particles in marine ecosystems.
Fig. 5. Production of algal-mat biomass (g ash-free dry weight (AFDW) per 20 m²) following the supply of nutrients (NO₃, SiO₄, and PO₄) to an intertidal mudflat mesocosm (B. Kuipers, unpublished data).

In a similar study, Boon and Haverkamp (1979) studied the degradation and mineralization of organic matter, both aerobic and anaerobic, mediated by polychaete worms in the mesocosm. Mass pyrograms were obtained from fresh algae, fecal pellets, and aerobic and anaerobic sediments (Fig. 7).
Development of an experimental mudflat ecosystem

As already mentioned, the second indoor mesocosm was left almost undisturbed for about 10 years.

Faunal assemblage

In 1975, the system, with 200 lugworms m⁻², was initially completely dominated by the polychaete worm *Arenicola marina*. The growth of this species in the mesocosm was discussed earlier. Notwithstanding the complicated larval and juvenile development of *Arenicola* (Farke and Berghuis 1979), the species was able to complete its reproductive cycle in the mesocosm. However, a steady decline in population density was observed, with values of 85 lugworms m⁻² in 1976 and 20 lugworms m⁻² in 1980 (Fig. 8). In 1985, lugworms had almost vanished, with numbers decreasing to <5 lugworms m⁻². This reduction was due to a rapidly increasing population of a more opportunistic worm species, *Nereis diversicolor*. *Nereis* was introduced in error into the mesocosm, probably with the juvenile lugworms. In the mesocosm, *Nereis* was able to reproduce several times a year (F. Witte, unpublished data; W. Wiersinga, unpublished data). The species proved to be a competitor for algae. In addition, the adult *Nereis* is a serious predator of juvenile lugworms (Witte and de Wilde 1979).
Fig. 7. Curie-point pyrolysis mass spectra of surface sediment layers from an experimental laboratory-scale marine ecosystem. (a) Aerobic upper-surface sediment (algal mat) at 0–3 mm depth. (b) Anaerobic upper surface sediment (black mud) at 3–10 mm depth. The height of the peaks is expressed in arbitrary units, i.e., as a percentage of the total count intensity (t.i.) (Boon and Haverkamp 1979).
Fig. 8. Development of macrobenthic worm populations in an intertidal mudflat mesocosm. More opportunistic species (Nereis, Caulteriella, and Peloscolex) take over, which is detrimental to Arenicola. Bars indicate the spread in the estimated numbers. Shaded area presents the estimated limits in which the population of Nereis fluctuated. Caulteriella and Peloscolex were only studied in 1982.

During further development of the mesocosm, the Nereis population maintained a very high density, ranging from 3 000 to more than 10 000 specimens m\(^{-2}\). Finally, during the last years of the existence of the mesocosm, large numbers (1 000–4 200 specimens m\(^{-2}\)) of the small polychaete worm Caulteriella species and of the oligochaete worm Peloscolex benedeni were present. Meiofauna organisms, mainly nematodes, numbered between 1 and 2 million organisms m\(^{-2}\) over the period in which the mesocosm existed.

Biomass

During the 1st year, the total macrofauna biomass in the mesocosm reached about 50 g AFDW m\(^{-2}\) of which 80% was contributed by Arenicola (Fig. 9). Four years later, the biomass measured only 32 g AFDW m\(^{-2}\) and, in 1982, it measured
30 g AFDW m$^{-2}$. Apparently, the biomass had adjusted to a level related to the amount of food available in the mesocosm. The share of *Arenicola* with respect to the total biomass had decreased gradually, that of *Nereis* remained unchanged, and other opportunistic species increased. The growth of opportunistic species provides evidence of the disturbed character of the mesocosm.

### Energy flow

To obtain insight into the relationship between the standing stocks of macrofauna organisms and the availability of food, energy flow budgets were developed. The input of light energy into the system was well documented. Irradiance, 12 h d$^{-1}$ produced by ten 400-W sodium bulbs, was periodically measured at the sediment surface during both low and high tide. Initially, during the 1st year, the irradiance amounted to $\pm 1.4 \times 10^{9}$ J m$^{-2}$ a$^{-1}$. Then, to obtain a more homogeneous light distribution, the light sources were suspended at a higher level, and the irradiance decreased to $\pm 0.4 \times 10^{9}$ J m$^{-2}$ a$^{-1}$ (Fig. 10). The light input in the mesocosm was low.

On three occasions, the rates of primary production and mineralization, both in the water and in the sediment, were measured (Table 1). Some comparable data are also included from the outdoor mesocosms and from the natural flats. Most obvious is the extremely high level of primary productivity in the mesocosm, particularly when the low light levels are taken into account. The rather uniform ambient factors must have facilitated the selection of algae that can grow efficiently under

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*Fig. 9.* Development of macrobenthic biomass (g ash-free dry weight (AFDW) per m$^2$) in an intertidal mudflat mesocosm, stabilizing at 30 g AFDW m$^{-2}$. Apparently, the biomass had adjusted to a level related to the amount of food available in the mesocosm. The share of *Arenicola* with respect to the total biomass had decreased gradually, that of *Nereis* remained unchanged, and other opportunistic species increased. The growth of opportunistic species provides evidence of the disturbed character of the mesocosm.
Fig. 10. Light irradiance (microamperes, µA) at the sediment surface of the indoor mesocosm: (a) during low water, mudflat exposed, the interval between isolines is 10 µA; (b) during high water, 50-cm water depth, the interval between isolines is 7 µA (Hofstede and Stelder 1980).

such low-light conditions. Moreover, it is known that for diatoms, light saturation values may be as low as 10% of natural sunlight.

A second remarkable feature is the relatively high biomass in the mesocosms. A gradual shift was expected to a system dominated by microorganisms and small food-web organisms (meiofauna and protozoans); instead, the macrofauna, with a total biomass ranging from 30 to 50 g AFDW·m⁻², maintained high densities. In the outdoor mesocosms (discussed below), and in the natural environment of the Wadden Sea, equally high biomass is found (Dekker and van Moorsel 1987).

Some information on mineralization activity in the mesocosm (derived from oxygen demand in both sediment and water) was obtained on two occasions. In 1979, only 10% of the available carbon was aerobically mineralized in the water column and 30% in the sediment. Apparently, the rest was degraded anaerobically or was buried in the sediment. In 1983, much higher mineralization, i.e., 50% of the organic carbon, occurred in the water, and about the same percentage in the sediment. The notable increase of mineralization in the water is related to the gradual enhancement of particulate and dissolved organic carbon in this part of the system. In contrast to the relatively small residence times of the water in the outdoor mesocosms and in the Wadden Sea, i.e., 5–7 days, no exchange of water occurs in the indoor mesocosm.
### Table 1. Tentative energy flow in the intertidal mesocosms and in the western Wadden Sea (de Wilde and Beukema 1984).

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<tr>
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<tbody>
<tr>
<td>Energy input (MJ m⁻² a⁻¹)</td>
<td>1400</td>
<td>400</td>
<td>400</td>
</tr>
<tr>
<td>Primary production (g C m⁻² a⁻¹)</td>
<td>200</td>
<td>400</td>
<td>300</td>
</tr>
<tr>
<td>Extra supply (g C m⁻² a⁻¹)</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>Total &quot;food&quot; available (g C m⁻² a⁻¹)</td>
<td>200</td>
<td>400</td>
<td>300</td>
</tr>
<tr>
<td>Macrobenthic biomass (g AFDW m⁻²)</td>
<td>50</td>
<td>30</td>
<td>35</td>
</tr>
<tr>
<td>Mineralization (g C m⁻² a⁻¹)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pelagic</td>
<td>?</td>
<td>40</td>
<td>165</td>
</tr>
<tr>
<td>Benthic aerobic</td>
<td>?</td>
<td>120</td>
<td>165</td>
</tr>
</tbody>
</table>

Notes: Macrobenthic biomass in the various systems tends toward a comparable value of 30–40 g ash-free dry weight (AFDW) per m². The natural mudflats of the Wadden Sea have an extra supply of organic matter from the North Sea. Food available means available for pelagic and benthic food-chain organisms and for mineralization by microorganisms. Question marks indicate a lack of observation; dashes indicate negligible amounts.

### Outdoor benthic mesocosms

Model tidal flats were used successfully during the last 5 years in applied research dealing with the effects of oil pollution and with oil-combating techniques in the Wadden Sea (Kuiper et al. 1986). As a direct effect of (dispersed) oil or dispersant, or both, and in relation to their concentrations, distinct changes in behavioural activities and also (mass) mortalities in certain susceptible mudflat organisms in the mesocosms were observed. Moreover, it could be demonstrated that a considerable part of the oil stranded on the mudflats is buried in the sediment, mainly by the bioturbative activities of lugworms.

Buried oil can seriously disturb normal development and regeneration of the mudflat ecosystem over extended periods. Thus, the model tidal flat experiments showed not only the short-term effects (mortality) but also some unexpected long-term effects. The results of the experiments contributed significantly to oil-combating strategy in the Wadden Sea.

The experiments also led to the identification of indicator species. The behaviour of these species is indicative of the effect of pollution on the entire ecosystem. *Corophium volutator*, a small amphipod, was considered to be a good indicator. Its numbers and population development reflected very well, and in a dose-dependent way, the extent of the artificial oil spills in the mesocosms.
It is emphasized here that mesocosms used in applied studies will also provide fundamental knowledge of the functioning of ecosystems in general; in this case, in terms of larval settling, species interaction, and growth. Controls, running together with the contaminated systems, fulfill a key function. The more or less comparable total biomass, observed in differently treated mesocosms, indicated that other species easily compensate for reduced secondary production by speeding up growth in case certain susceptible species are reduced in numbers.

Conclusions

The main objective of this paper was to document the usefulness of benthic mesocosms. The investigator must decide on the proper mesoscale of the marine ecosystem to be tested. The design, intended structure of the benthic ecosystem, and expected lifespan of the mesocosm are primarily dictated by the kind of scientific questions that are asked.

In general, mesocosm experiments are thought to provide, and facilitate, a special type of research, such as ecotoxicology and selected management problems, and to combat pollution, in which they will bridge the gaps between laboratory and field experiments. Mesocosm experiments are certainly not intended as a substitute for marine research in the field.

The dimensions of most mesocosms are set pragmatically, rather than being based on sound arguments. Benthic mesocosms mimicking the intertidal mudflat environment do not offer special problems. The associated organisms are hardy and able to resist large variations in ambient conditions. Mesocosms that will properly mimic the benthic system of shelf seas, or the even more difficult open ocean, still pose a great challenge.

It is a misunderstanding that budgets associated with mesocosm research are much smaller than those associated with similar research in nature. Indeed, logistics are sometimes easier in mesocosms, and disturbances and calamities caused by external factors, such as the weather, may be reduced or excluded. On the other hand, the various relationships and processes taking place in a well-developed mesocosm are as complicated as those occurring in nature. Adequate monitoring of the dynamics of the dominant species or groups in the mesocosm and of the key functions of the system is laborious and will require the attention of a multidisciplinary team of scientists.

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