Introduction

For the past 20 years or so, nitrogen has been recognized as a primary limiting nutrient for algal productivity in coastal waters. The discharge of nitrogen from terrestrial sources has increased dramatically during this period, however, and many coastal environments have suffered from accelerated eutrofication.

From its meetings and publications on element cycling and environmental change, the Scientific Committee on Problems of the Environment (SCOPE) has been a valuable catalyst for presentation and synthesis of new, environmental research information. The present volume is therefore in accordance with a tradition, but is also a response to the increasing concern about marine eutrofication.

The book contains a number of invited contributions on productivity, regeneration of nutrients, and flow of nitrogen in coastal ecosystems. Emphasis has been placed on including the recent improvements in methodologies and current understanding of process regulation. More integrated research on nitrogen cycling in whole ecosystems has yet to be done, but we have incorporated a couple of such studies. We obviously take the full responsibility for selection of topics, although each chapter is clearly unique in terms of emphasis and style. It has been our general policy to be generous with space and if necessary, to accept some inevitable overlaps.

On basis of the manuscripts, and from experiences in our own work, the following represents a brief summary on some of the recent achievements and their perspectives for the research on nitrogen cycling in coastal environments.

Primary production

Algal nitrogen uptake in the sea is typically approached by ^{15}N methodology, but has been difficult to measure due to very small pool sizes of the nutrients. Measured uptake rates are generally too high as the nutrient pools are increased to concentrations over the K_m for uptake. By comparison, the ^{15}N methodology seems well suited to describe the 'nutritional status' of the algal community (Chapters 1 and 2). It would be interesting to introduce radioactive ^{13}N methodology into studies of nitrogen uptake and primary production, since only this approach may allow the pool sizes to remain low. Algal productivity measured by ^{14}C methodology may alternatively be converted into nitrogen uptake from Redfield's C:N ratio (Chapter 2). Finally, the rate of nitrogen mineralization (ammonium release) which is readily determined by ^{15}N methodology, may also give a measure of total uptake, at least when the nutrient concentrations are constant and low.

Pelagic mineralization

Although pelagic mineralization can be determined by the ^{15}N technique, there are serious gaps in our understanding of organic matter decomposition and the coupling between carbon and nitrogen mineralization in the sea. This is primarily because the nitrogen flow diverges from the carbon flow as the latter is being respired. Another complication is the apparent significance of carbon and nitrogen flow via excretion of dissolved organic matter from the phytoplankton. These organic compounds have a higher C:N ratio than the algae and are primarily decomposed by bacteria and microzooplankton in the 'microbial loop'. Bacterial biomass in turn has a lower C:N ratio than both the algae and their excretion products and may therefore increase the nutritional value of the detritus utilized at higher trophic levels. Chapters 3, 8, 9 and 15 discuss the significance of C:N ratios in dissolved and particulate component of marine foodwebs and elaborate on the production and mineralization at different trophic levels. Until the complicated relationships between carbon and nitrogen mineralization are better understood it may be recommended to double-check and, wherever possible, to measure both of them simultaneously.

Mineralization in the sediment

In relation to nutrient loading and pelagic productivity, the role of sediments is primarily that of detritus decomposition and release of nutrients to the overlying waters. Although benthic primary production and nitrogen fixation may be significant in shallow waters (Chapters 4 and 5), the sedimentation of pelagic production is generally the major nitrogen input to the sediments. Chapters 8 and 9 present the current methodologies for benthic mineralization (ammonium release, etc.) and discuss the relationships between carbon and nitrogen flow in the benthos. Large contents of nitrogen-containing, osmoregulatory compounds (alkylamines) present a new and interesting aspect of microbial degradation and cycling of non-proteinaceous nitrogen in the coastal sediments (Chapters 6 and 7).

Nitrification and denitrification processes at the sediment–water interface strongly affect the release of regenerated ammonium to the overlying waters, and the formation of atmospheric nitrogen gas by denitrification may represent a significant nutrient sink in coastal ecosystems. The activities have often been difficult to measure *in situ*, but new methodologies have recently demonstrated both a temporal and spatial variation of these processes (Chapters 10 and 11).

Recent attention to the benthic macrofauna has further demonstrated that both the decomposition, release of nutrients and loss via nitrification–denitrification can be markedly enhanced in bioturbated sediments (Chapters 10, 12 and 13).

Ecosystem studies and N models

Because of the important role of nitrogen in coastal algal production, there is considerable interest in the significance of terrestrial nitrogen inputs relative to the nutrient regeneration within the coastal ecosystems. As judged from the recent improvements in methodology, there should soon be answers to the important question: What is the impact of continued nitrogen loading on the productivity and water quality of coastal seas? In this context, there is an urgent need for integrated studies of whole ecosystems, specifically on the role of terrestrial inputs versus the local nutrient recycling and on the role of nutrient release and denitrification in the sediments. For instance, only if the significance of nitrogen recycling is determined can the predictive models on algal production and water quality be really useful. Chapters 14, 15 and 16 present some new models of nitrogen cycling in coastal environments which may be useful in relation to management practices.

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