

## Nutrient budget of the lagoonal waters in an open central South Pacific atoll (Tikehau, Tuamotu, French Polynesia)

C. J. Charpy-Roubaud<sup>1</sup>, L. Charpy<sup>1</sup> and J. L. Cremoux<sup>2</sup>

<sup>1</sup> ORSTOM and Centre d'Océanologie de Marseille, Station Marine d'Endoume, Rue de la Batterie des Lions, F-13007 Marseille, France

<sup>2</sup> ORSTOM, P.O. Box 529, Papeete, French Polynesia

Date of final manuscript acceptance: June 29, 1990. Communicated by J. M. Pérès, Marseille

**Abstract.** Nutrient concentrations were measured in the lagoon and surrounding oceanic waters of Tikehau Atoll (Tuamotu Archipelago, French Polynesia) from 1984 to 1987. The "atoll-mass effect" alters the nutrient profiles: turbulent vertical mixing of the waters along the deeper slopes of the atoll induces nitrogen and phosphorus enrichment of the surface layer. Nutrient concentrations varied with year and month of sampling; except for ammonium, inorganic nutrient levels were lower inside the lagoon than in the surrounding oceanic waters. Nitrogen, phosphorus and silica budgets were calculated by mean differences in nutrient concentrations recorded between lagoon and oceanic surface waters and by the water-exchange rate through the passage linking the lagoon and oceanic waters and the reef-flat spillways. Particulate and dissolved organic nitrogen and ammonium are exported from the lagoon to the open ocean through the westward passage. The nitrogen budget is not balanced by the nitrate input from oceanic waters and the organic nitrogen and ammonium output from lagoonal waters. Nitrogen fixation would appear to constitute another source of nitrogen for lagoonal waters. The phosphorus budget is largely balanced by phosphate input from the oceanic waters and organic phosphorus output from the lagoon waters. The oceanic waters became impoverished in silicate during their crossing of the atoll reef edge and their residence in the lagoon. The atoll constitutes a source of nitrogen for the surrounding oceanic waters.

This paradox is very striking in the atolls of the Tuamotu Archipelago, since southern tropical waters, which pertain to a great anticyclonic gyre (Blackburn 1981), are poor in nutrients. In addition, the flat surfaces of the atolls and their remoteness from high islands (e.g. Tahiti) make terrestrial nutrient input zero.

We studied the biogeochemistry of the lagoon of Tikehau Atoll (Tuamotu Archipelago) between 1984 and 1987. The purpose of the study was to determine the nutrient fluxes between the lagoon and the surrounding oceanic waters with a view to answering the question: is an atoll a nutrient source or a nutrient sink?

Most coral-reef studies have focused on reef-flats rather than lagoons, and consequently have calculated nutrient fluxes between coral-reef communities and the overlying waters (Odum and Odum 1955, Johannes et al. 1972, 1983, Pilson and Betzer 1973, Pomeroy et al. 1974, Webb et al. 1975, Smith and Atkinson 1983). Lagoons are considered as subsystems of the atolls which receive nutrients and energy inputs from the reef-flat. However, during their residence time in the lagoon, oceanic waters can also exchange nutrients with the lagoon communities; thus, in Tikehau Atoll, Charpy-Roubaud (1988) calculated lagoonal primary production as  $0.69 \text{ mg C m}^{-2} \text{ d}^{-1}$ .

Nutrient budgets between lagoonal and surface oceanic waters must take into consideration not only reef-flat inputs, but also nutrient fluxes in the lagoon as a whole.

Tikehau Atoll is located in the north-west of the Tuamotu Archipelago. The lagoon surface is  $400 \text{ km}^2$ , average depth 25 m. The  $25 \text{ km}^2$  of islands are intersected