

COMMUNICATION

Temperature, salinity, oxygen, and nutrient profiles at a 200 m deep station in Golfo Dulce, Pacific coast of Costa Rica

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Abstract: On January 12, 1994, a vertical profile for physical (salinity, temperature) and chemical (dissolved oxygen, nutrients) parameters was conducted at a 200 m deep station in the inner region of Golfo Dulce, Pacific coast of Costa Rica. The profile was part of the R.V. Victor Hensen cruises. Water samples were taken every 10 m with a Niskin bottle. Temperature ranged from 31.5 C at the surface to 17.0 C at 200 m. Salinity varied from 29.5‰ at the surface to near 35‰ at 200 m. The maximum dissolved oxygen concentration was 425.0 $\mu\text{mol/L}$ at 10 m, and decreased to non-detectable concentrations at 200 m. Maximum nutrient concentrations ($\mu\text{mol/L}$) were: 31.5 for nitrate, 1.3 for nitrite, 42.8 for silicate, and 7.9 for phosphate. The vertical profiles were similar to those reported 26 years ago, and bring support to the hypothesis of intermittent inflows, at sill depth, of offshore water into Golfo Dulce.

Key words: Oxygen, inorganic nutrients, temperature, salinity, Golfo Dulce, Costa Rica.

Research on the vertical distribution of physical and chemical parameters in coastal embayments of Costa Rica has focused intensively in the Gulf of Nicoya, the most important estuary on the Pacific coast of the country (Vargas 1995). Golfo Dulce is also an embayment on the Pacific coast of Costa Rica; however, it has received less attention. It differs from the Gulf of Nicoya in that the Golfo resembles a temperate fjord because of its depth (200 m) and the presence of a sill (60 m) near its mouth. (Fig. 1) The sill restricts water circulation, leading to low oxygen concentrations in the deep waters of Golfo Dulce. The publication by Richards *et al.* (1971) of the results of the survey conducted in March, 1969, provided a description of the physical and chemical parameters at five stations within the Golfo. They reported that the inner gulf was characterized by the rapid vertical decrease in dissolved oxygen, the disappearance of nitrate with increasing depth, and the appearance of a secondary nitrite max-

imum at 100 m. They also found small concentrations of hydrogen sulfide near the bottom. No additional studies have been conducted after the Richards *et al.* (1971) survey. Thus, as part of the RV Victor Hensen expedition it was given priority to the conduction of vertical sampling for nutrients, dissolved oxygen, salinity and temperature, and to compare the results with those obtained 26 years ago.

The present study was carried out on January 12, 1994, at a station located at 8°41'N-83°23'W, with a maximum depth of 200 m, (Fig. 1). The site was located close to Richards *et al.*, (1971) station 5 (8°41'N-83°24'W). Samples for nutrients, salinity, and dissolved oxygen were taken, with a 5 L Niskin bottle, at 10 m depth intervals. Water temperature was measured directly in the Niskin bottle. Salinity was measured with an optical refractometer. Nutrient samples were stored frozen in 1 L plastic bottles. Samples for dissolved oxygen were taken using 350 ml BOD bottles, fixed, and analyzed immediately on board following

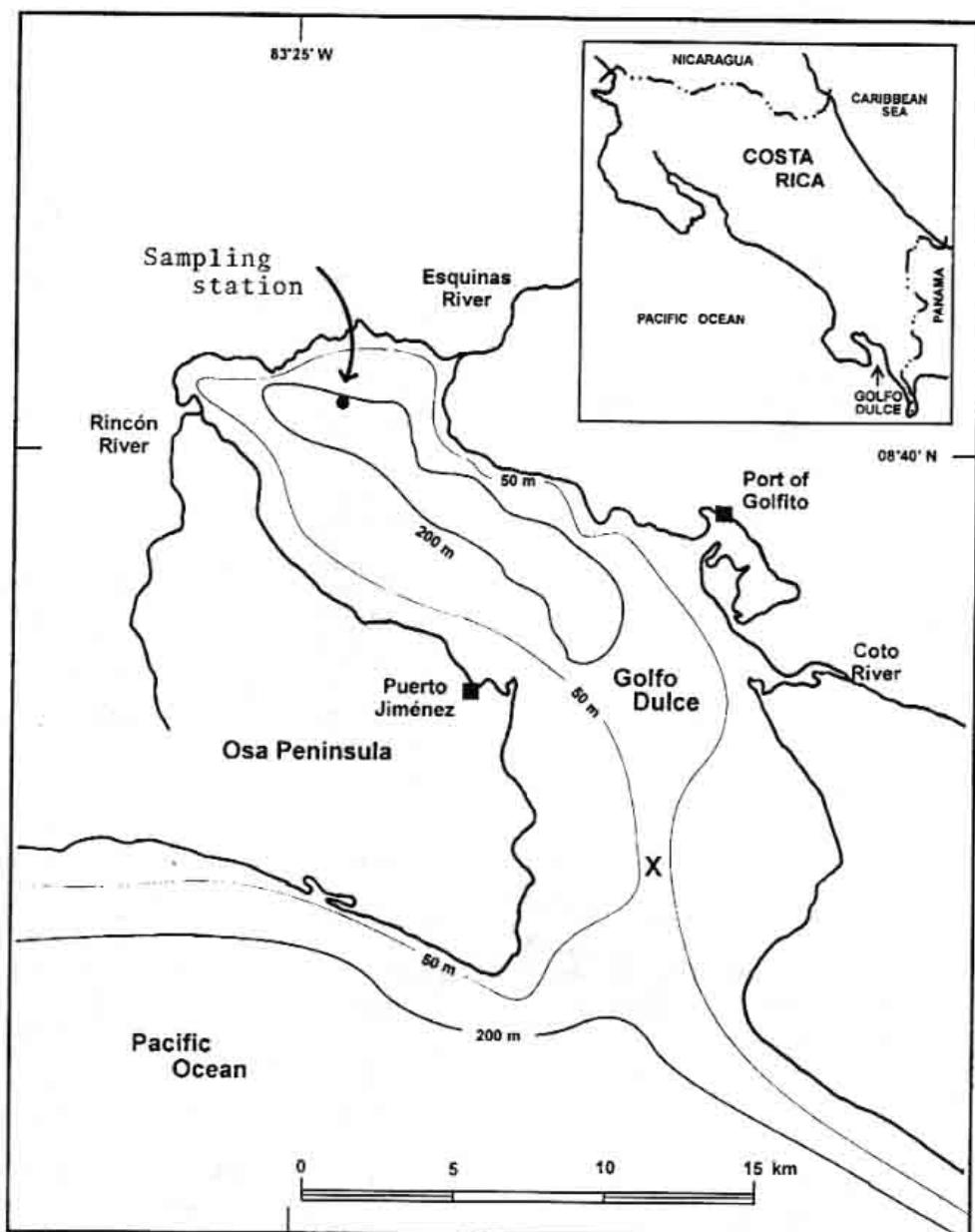


Fig. 1. Location of the sampling station in the inner Golfo Dulce, Pacific coast of Costa Rica. X: sill depth.

the Winkler method (Strickland & Parsons, 1972). Analyses for reactive nitrate, nitrite, silicate, and phosphate were conducted at the laboratories of the University of Costa Rica (CIMAR), and also following the methods outlined in Strickland & Parsons (1972).

Temperature ranged from 31.5°C at 10 m, to 17.0°C at 200 m., and a thermocline was evident between 20 and 50 m (Fig. 2). Salinity

ranged from 29.5‰ at the surface to near 35.0‰ at the bottom (Fig. 2). Dissolved oxygen concentrations varied between 425.0 µmol/L at 10 m, to non-detected at 200 m (Fig. 2). Values below 72.0 µmol/L were typical of waters deeper than 40 m, and a sharp decrease in concentration was observed in the interval from 10 to 40 m, where it dropped from 425.0 µmol/L to 72.0 µmol/L. The minimum value measured

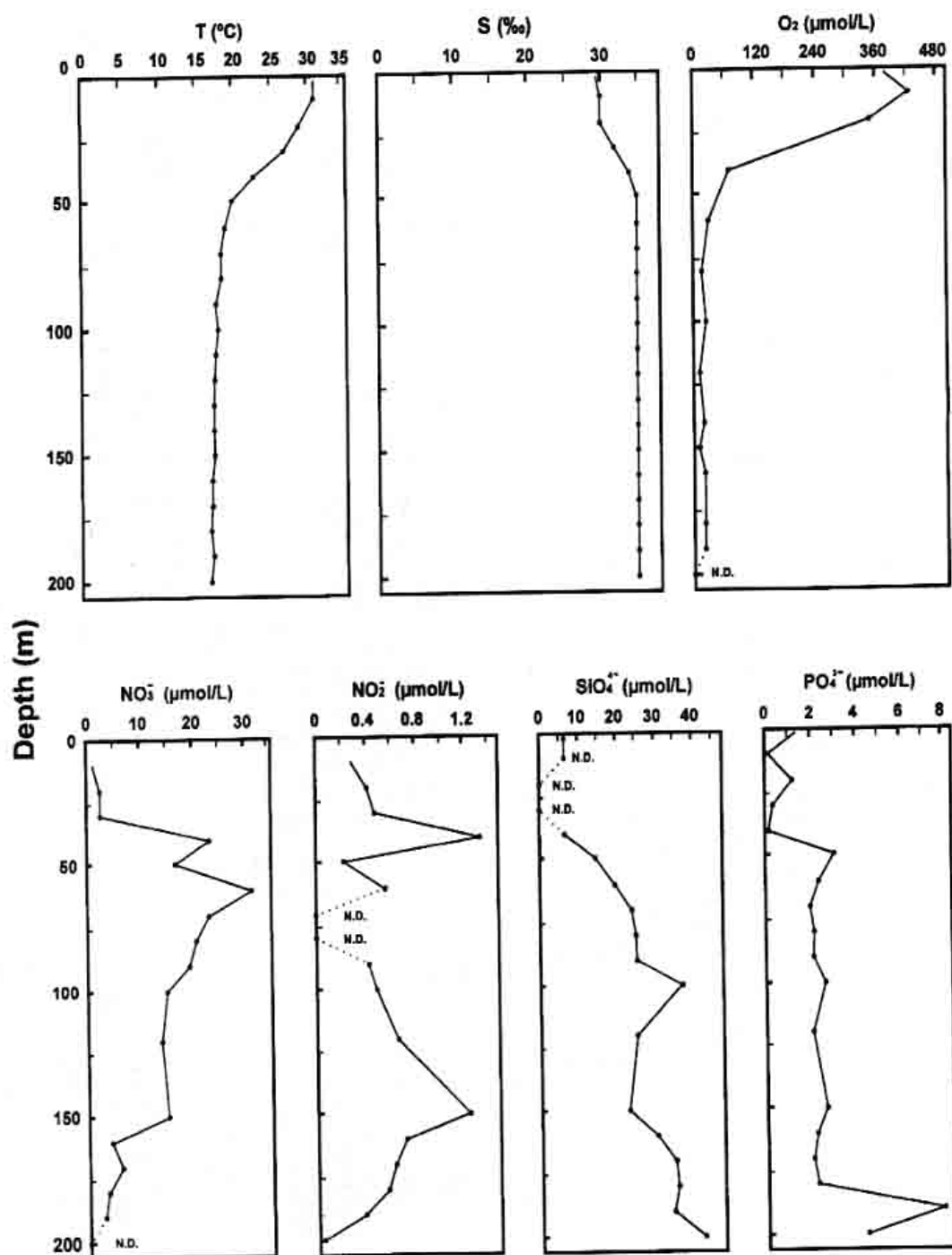


Fig. 2. Vertical distribution of temperature (°C), salinity (‰), dissolved oxygen, reactive nitrate, nitrite, silicate, and phosphate (μmol/L), at a 200 m deep station in the inner Golfo Dulce, Pacific coast of Costa Rica, January 12, 1994. Nutrient samples collected at 110 m, 130 m, and 140 m were not analyzed. Surface samples for nitrate and nitrite were not included because of low cadmium column efficiencies. N.D.: Not detected.

in the water column was 10.0 $\mu\text{mol/L}$ at 150 m. (Fig.2). The vertical nitrate concentration distribution observed at this station showed a decrement with depth beginning around 60 m, which is concurrent with an increase in nitrite concentration towards a second maximum at 150 m. Reactive nitrite varied from non-detected at 70 m and 80 m, to 1.3 $\mu\text{mol/L}$ at 40 m, near the base of the thermocline (Fig.2). Reactive silicate ranged from non-detected at 20 m and 30 m, to 42.8 $\mu\text{mol/L}$ at 200 m, with a high value of 37.4 $\mu\text{mol/L}$ found at 100 m (Fig.2). The concentrations of reactive phosphate fluctuated from 0.15 $\mu\text{mol/L}$ at 40 m to 7.0 $\mu\text{mol/L}$ at 190 m. A concentration of 3.1 $\mu\text{mol/L}$ was measured at 50 m (Fig.2).

The results obtained during the RV Victor Hensen cruise agree, in general, with those reported by Richards *et al.* (1971): a thermocline was present at a depth of about 40 m, the salinity range from surface to bottom was similar, and oxygen concentrations also decreased with depth from values close to 400 $\mu\text{mol/L}$ near the surface, but no anoxic conditions were found below 100 m, except near the bottom (Fig.2). Sampling conducted five days before (Thamdrup *et al.* 1996); however, found no oxygen below 100 m. The presence of nitrate between 40 m and 150 m, at concentrations around 20.0 $\mu\text{mol/L}$ (Fig.2) is important. On January 7, 1994, Thamdrup *et al.* (1996) found a maximum nitrate concentration of only 10 $\mu\text{mol/L}$ at the bottom of the thermocline. Moreover, on January 8, nitrate concentrations as high as 29.2 $\mu\text{mol/L}$ were measured, near the mouth of Golfo Dulce, at 55 m deep (Wolff and Vargas 1994). Such variability of environmental parameters within a few days was also noticed by Richards *et al.* (1971). These observations provide evidence in support of the hypothesis for an influx, at sill depth, of off-shore waters into the basin as originally proposed by Richards *et al.* (1971).

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RESUMEN

El 12 de enero de 1994, como parte de la expedición a bordo del buque oceanográfico Víctor Hensen, se realizó un muestreo vertical de parámetros físicos (salinidad, temperatura), y químicos (oxígeno disuelto y nutrientes), en una localidad de 200 m de profundidad, en la región interna del Golfo Dulce, Costa Pacífica de Costa Rica. El muestreo se realizó cada 10 m de profundidad con una botella Niskin. La temperatura osciló de 31.5 °C en la superficie hasta 17.0 °C a 200 m. La salinidad varió de 29.5 g/kg en la superficie, hasta cerca de 35 g/kg a los 200 m. La máxima concentración de oxígeno (425.0 $\mu\text{mol/L}$) fue a 10 m, decreciendo con la profundidad hasta valores no detectables a 200 m. Las concentraciones ($\mu\text{mol/L}$) máximas de nutrientes fueron: 31.5 para nitrato, 1.3 para nitrito, 42.8 para silicato, y 7.0 para fosfato. Los perfiles verticales son similares a los observados hace 26 años y proveen apoyo a la hipótesis de entradas intermitentes al Golfo Dulce de agua proveniente de mar afuera.

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