

## Large benthic microbial communities in sulphide biota under Peru–Chile Subsurface Countercurrent

BENTHIC observations off the coast of Chile have consistently disclosed the presence of large coherent microbial communities living at depths of about 50–280 m in the H<sub>2</sub>S-containing sediments of the shelf in contact with the deoxygenated waters of the Peru–Chile Subsurface Countercurrent (SCC). Similar observations were also made off Peru in 1969 by Gilbert T. Rowe, and in 1976 by G. T. Rowe and John Waterbury of Woods Hole Oceanographic Institution. The microflora, which has only been reported once before in the literature<sup>1</sup>, has been known for years by the local fishermen who call them *estopa* (Spanish for uncleaned wool or fiax) due to the filamentous appearance of its main components. In this report I describe this massive microbial community which includes organisms typical for sulphide biota, and may have unsuspected importance in the ecology and economy of the sea off western South America.

Repetitive quantitative grab sampling off Concepcion, Chile (36°35'30"S, 73°04'20"W) at 60-m depth, indicated biomass of 106 g (wet weight) per 0.1 m<sup>2</sup> for the microbial component, while the benthic infaunal biomass in the same sample attained only 11.5 g (wet weight) per 0.1 m<sup>2</sup> (Peterson 0.1-m<sup>2</sup> sample washed through a 0.25-mm<sup>2</sup> sieve). Preliminary examination of the community has shown that it consists of many kinds of prokaryotes. The main constituent, however, is typically large filaments of *Thioploca* spp. This genus of gliding bacteria has not been previously recorded in open oceans. The *Thioploca* spp. fall clearly into three groups according to their cell diameter: (1) 30–40 μm, (2) 15–20 μm, and (3) 2.5–5 μm, (Dr Maier, Ohio University, personal communication). Other members of the community are *Oscillatoria*-type blue-green algae (cyanobacteria), flexibacteria (probably of the genus *Chlorophlexis*) and various other forms of bacteria.

The *Thioploca*-like forms appear as many individual filaments within a common sheath (Fig. 1, inset) forming large, whitish-yellow, twine-like structures that attain 100–500 μm in diameter and several cm in length, therefore perfectly visible to the naked eye (Fig. 1). Off the Bay of Concepcion, where most of the recent observations have been carried out, the sediments consist of a loose superficial yellowish-brown layer of a few mm thick, an intermediate layer of black H<sub>2</sub>S-containing sediment about 8 cm thick, and a lower dark-brown layer of sticky compacted mud<sup>1</sup>. The filamentous microbial material occurs in the upper two layers, giving the sediment a soft, spongy texture. The sediment, a diatomaceous mud, also contains large quantities of assorted organic debris such as fish scales, fish bones, faecal pellets, few shell fragments, empty polychaete tubes and some terrestrial vegetal remains.

Although the genus *Thioploca* is classified among the colourless Beggiatoaceae<sup>2</sup>, some species of the genus contain a greenish blue pigment and have therefore an uncertain taxonomic relationship to the *Beggiatoa*<sup>3</sup>. Ethanol extracts from seawater-washed filaments have given absorption spectra typical for chlorophyll *a*, with major peaks at about 410 nm and 670 nm; however, it is probable that this pigment is associated with oscillotorian cyanobacteria known to be components of this community. The gliding of independent filaments occurs within their common sheath at speeds of up to 12.5–25 μm min<sup>-1</sup>.

Whatever the taxonomic position of these *Thioploca*-like forms, their large standing-crop suggests an important role in the ecology of the upwelling biome off southwestern South America.

The SCC, a wedge-shaped water mass distributed between northern Peru and southern Chile (to about 41°S), is characterised

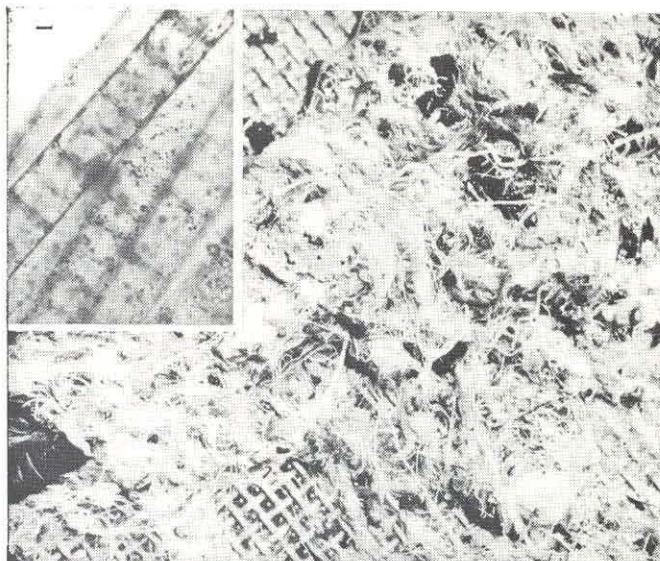


Fig. 1 Filamentous microflora deposited on a 1-mm<sup>2</sup> mesh 12-inch diameter geological sieve after washing a 0.1 m<sup>2</sup> Petersen grab sediment sample collected at 100-m depth off the Bay of Concepcion, central Chile, October 7 1975. At 90 m salinity was 34.54‰, temperature 9.71 °C, and dissolved oxygen 0.54 ml l<sup>-1</sup>. Inset, photomicrograph of portion of *Thioploca*-like form no. 1. The common sheath and four cell-chains containing intracellular sulphur granules are visible. Cell dimensions are 2436 μm diameter and 3036 μm length. Bar represents 10 μm.

by relatively high salinity and temperature, and extremely low oxygen content, typically under 0.1 ml O<sub>2</sub> per l. Nutrient concentrations are high<sup>4–6</sup>.

The presence of filamentous microbial associations should be looked for in other parts of the world where similar oceanographic conditions exist. Recently a single *Thioploca*-like filament was observed in a small sediment sample collected off Walvis Bay in south-western Africa (J. W. Farrington). In this upwelling region a mysterious benthic 'slimy grass' has been reported at depths of about 90–130 m (ref. 7), occurring with a low-oxygenated subsurface countercurrent impinging against the shelf<sup>8</sup>.

The coincidence of the depth distribution of the microbial community off Chile and that of the principal shrimp (both penaeid and galatheid) and hake fishing grounds<sup>9</sup>, strongly suggests a possible trophic relationship in view of the fact that most of the standing-crop therein seems to be made up of filamentous bacteria.

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VICTOR A. GALLARDO

Woods Hole Oceanographic Institution,  
Woods Hole, Massachusetts 02543, and  
Departamento de Biología Marina y Oceanografía,  
Universidad de Concepcion,  
Concepcion, Chile

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<sup>1</sup> Gallardo, V. A. *Gayana (Zool.)* **10**, 3–15 (1963).

<sup>2</sup> Leadbetter, E. R. in *Bergey's Manual of Determinative Bacteriology* (eds Cowan, S. T. et al.), 112–113 (Williams and Wilkins, Baltimore, 1974).

<sup>3</sup> Maier, S. *Ibid.*, 115–116.

<sup>4</sup> Brandhorst, W. *Ber. Landw. Hamburg* **43**, 148–187 (1967).

<sup>5</sup> Hartmann-Schroeder, G. & Hartmann, G. *Mit. Hamb. zool. Mus. Inst.* **62**, 1–384 (1954).

<sup>6</sup> Wooster, W. S. & Gilmartin, J. J. *Mar. Res.* **19**, 97–100 (1961).

<sup>7</sup> Bonde, C. von *Rep. Fish. Mar. Biol. Surv. Un. S. Afr.* **5**, 10–85 (1928).

<sup>8</sup> Decker, A. H. B. de *Invest. Rep. Div. Fish. Un. S. Afr.* **84**, 1–24 (1970).

<sup>9</sup> Ledermann, J. *Infimes. Pesq. Inst. Fom. Pesq. Santiago, Chile.* **57**, 1–10 (1975).

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by

Víctor A. Gallardo

Paragraph 1, line 11 should read "wool or  
flax" instead of "wool or fiax"

Paragraph 2, line 5 should read "Petersen"  
instead of "Peterson"

Paragraph 4, line 1 should read "genus"  
instead of "genius"

Paragraph 4, line 7 should read "oscilla-  
torian" instead of "oscillotorian"

Paragraph 6, line 4 should read "1 ml O<sub>2</sub>"  
instead of "0.1 ml O<sub>2</sub>"

Fig. 1, line 8 should read "24-36 um"  
instead of "2436 um"

Fig. 1, line 9 should read "30-36 um"  
instead of "3036 um".