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ON THE DISCOVERY OF A LARGE MICROBIAL COMMUNITY LIVING IN THE SOFT BOTTOMS OF THE CONTINENTAL SHELF OFF CHILE AND PERU[1]

POR:
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[1] See, too: GALLARDO, V.A., 1977: Large benthic microbial communities in sulphide biota under Peru-Chile subsurface countercurrent. Nature (Lond.) 268: 331-332.

In a benthic macrofaunal survey of the continental shelf of northern Chile a peculiar filamentous material was collected in grab and dredge samples of greenish, foul smelling sediment from depths of 50 to 280 m (ref. 1). In reporting the results emphasis was placed, however, on the fact that a virtually 'azoic' bottom had been found between depths of 50 to 400 m. Average biomass was only 0.17 g (wet weight) /m^2, with 6.6 individuals /m^2*. The distribution of the azoic sediments coincided with low oxygen concentrations in the water above (ref. 2). The author again found white filamentous material while sampling the benthos off the Bay of Concepcion and the Gulf of Arauco, in central Chile. These findings together with the casual observation of filaments in the mouth parts of the commercially important galatheid shrimp **Pleuroncodes mondon**, initiated new efforts to learn about this material and its possible ecological significance.

* Samples washed through a 1.00 mm^2 sieve.

Recent quantitative bottom-grab samples taken off Concepcion (Petersen 0.1 m^2) have consistently disclosed the presence of the filamentous material dominating the total benthic biomass. One sample (Sta. 1: 36° 35.3'S, 73° 04.2'W) taken from a depth of 65 m had 54 g (wet weight) of filaments and 24.7 g of animal wet weight. A second sample (Sta. 4: 36°41. 8'S, 73°01. 4'W) from 50 m depth had 106.55 (wet weight) of filaments and only 11.55 g of animal wet weight.** The peculiar benthic infauna associated with the filaments is characteristically composed of small polychaetes and dominated in numbers by a few of them, i.e. **Mediomastus** sp., **Aricidea (Aricidea)** sp. and **Cossura chilensis**. **Paraprionospio pinnata** dominates the deeper sample but there are reasons to suspect that this is a seasonal response. Diversity is low with individuals totalling about 4.000 distributed among some 40 or so species.

The substratum off the Bay of Concepcion consists of a yellowish-brown layer of a few mm thick, an intermediate layer of black, H_2S-smelling sediment about 8 cm thick an a lower dark-brown layer of sticky compacted mud. The filaments ocurr in the upper two layers giving the whole mass a soft, spongy texture. The sediments also contain a large proportion of assorted organic debris such as fish scales, fish bones, empty polychaete tubes, fecal pellets, a few shells and some terrestrial vegetal remains. The diatom frustules in the mud belong to the genus **Coscinodiscus**. Again, one of the striking concurrent oceanographic features at these sites is the low oxygen content of the water above the bottom (0.3 ml $0_2/1$)

Although the identification is still tentative, it now seems likely that the filaments consist mainly of an assemblage of species of **Thioploca**, a genus of gliding bacteria not previously recorded in the sea, possibly including two underscribed species. These sheathed forms fall clearly into three groups according to their cell diameter: 1) 30-40 μm, 2) 15-20 μm, and 3) 2.5-5 μm, possibly **T. ingrica** (Dr. S. Maier, personal communication).

Little is known about the nutrition of **Thioploca** species but it has been suggested that this is presumably chemolithotrophic (ref. 3). It has also been pointed out that for the known species of **Thioploca** their

** Samples washed through a 0.25 mm^2 sieve.

gliding movements would permit transport of hydrogen sulfide from the "lower to the higher horizon where oxygen is available for oxidation" (ref. 3).

The presence of a low-oxygen water mass flowing south from northern Peru to about 40°S is well established (refs 4, 5, 6). Although possibly pervading most of the marine ecosystem of the south-western coast of South America, the latitudinal and bathymetric fluctuations throughout the year and the biological implications of the undercurrent have seldom been considered (ref. 7). Because it supplies nutrients that reach the surface through upwelling, it is greatly responsible for the high productivity of the region (ref. 8), and because of its low oxygen content it creates an extensive dysaerobic*** environment on the shelf (ref. 9), favorable to procaryot development. Along this region the findings of the filamentous bacteria are widespread (Fig. 1) (ref. 10). Whether or not their distribution is continuous along a narrow band of continental shelf and upper slope, associated throughout with the poorly oxygenated waters of the Peru - Chile Sub - Surface Current, remains to be seen. Equally important is the determination of the bathymetric pattern of distribution of the procaryotic assemblage. Seasonal fluctuations of the Subsurface Current's upper boundary have been described which show that off central Chile this boundary may be found in the summer shallower than 50 m and in the winter deeper than 100 m (ref. 11). While the macrofauna would probably be more depauperate in the bottoms under the permanent influence of the Subsurface Current (ref. 12), no quantitative data is available for the filamentous bacteria for depths greater than 65 m.

Azoic regions have also been described elsewhere, particularly in basins such as the Black Sea, the Gulf of California, and the basins off California (ref. 8). Open-sea azoic conditions have been reported more rarely although they apparently are common but restricted to particular areas in the world oceans (ref. 13). Walvis Bay's adjacent shelf (south-western South Africa) area is probably the best known open-sea azoic zone (refs. 14,15). The low diversity of its benthic communities has been described by Sanders (ref. 16). Similar zones exist in the Gulf of Aden, the Gulf of Oman and the Arabian Sea (refs. 17,18,19,20). The

***Describes conditions of reduced oxygen in the range 1.0-0.1 ml. O_2/l.

explanation for the Walvis Bay azoic zone has been sought in a chain of events that lead from upwelling and phytoplankton blooms to catastrophic fish mortalities, anoxic bottoms and thus azoism (refs. 21, 22). However, there are now reports on the existence of a south flowing sub-surface oxygen-poor current off south-west Africa, similar to that found off Peru and Chile (refs 23,24,25) . Conditions off Walvis Bay also seem favorable for the existence of benthic filamentous bacteria. In fact, several records have been found under the cryptic designation of 'slimy grass' in the local literature (ref. 26). Considering the depths involved (90-165 m) 'slimy grass' may indeed be a procaryotic assemblage similar to that described herein. As this paper was under preparation a single filament of a bacterium $30\mu m$ in diameter was observed in a sample recently taken off Walvis Bay by Cruise No. 93 of the ATLANTIS II (courtesy of Dr. John Farrington).

In the report of the DISCOVERY Expedition's passage off the coast of Chile and Peru (ref. 27), numerous references were made to a mysterious 'flocculent material', which ' generally resembles organic debris', forming 'dense aggregates'.These descriptions fit the appearance of the filamentous bacteria collected off Chile after preservation, particulary in alcohol. This fact added to a limited distribution which may generally coincide with rather narrow shelf bands would explain their elusiveness to expeditions throughout time. As pointed out above, filamentous bacteria can be expected in other coastal upwelling ecosystems of the world as long as a lowoxygen water mass is also present impinging against the shelf, thus creating the appropiate physico-chemical and biological (depauperate benthic macrofauna) conditions necessary for their development. Because procaryots originally evolved under the anaerobic or low-oxygen environments of primitive earth (ref.28), it would seem indeed reasonable to expect similar biological systems as the one here described for the shelf of south-western South America in other parts of the world exhibiting similar oceanographic conditions. Dysaerobic zones may thus be considered primitive environments in a sense, where one might also expect primitive biological systems (ref. 10).

How do these procaryots function in the sea? What is their productivity? Which is their role in the ecosystem? Answers to these questions are important in understanding the coastal marine ecosystem. The

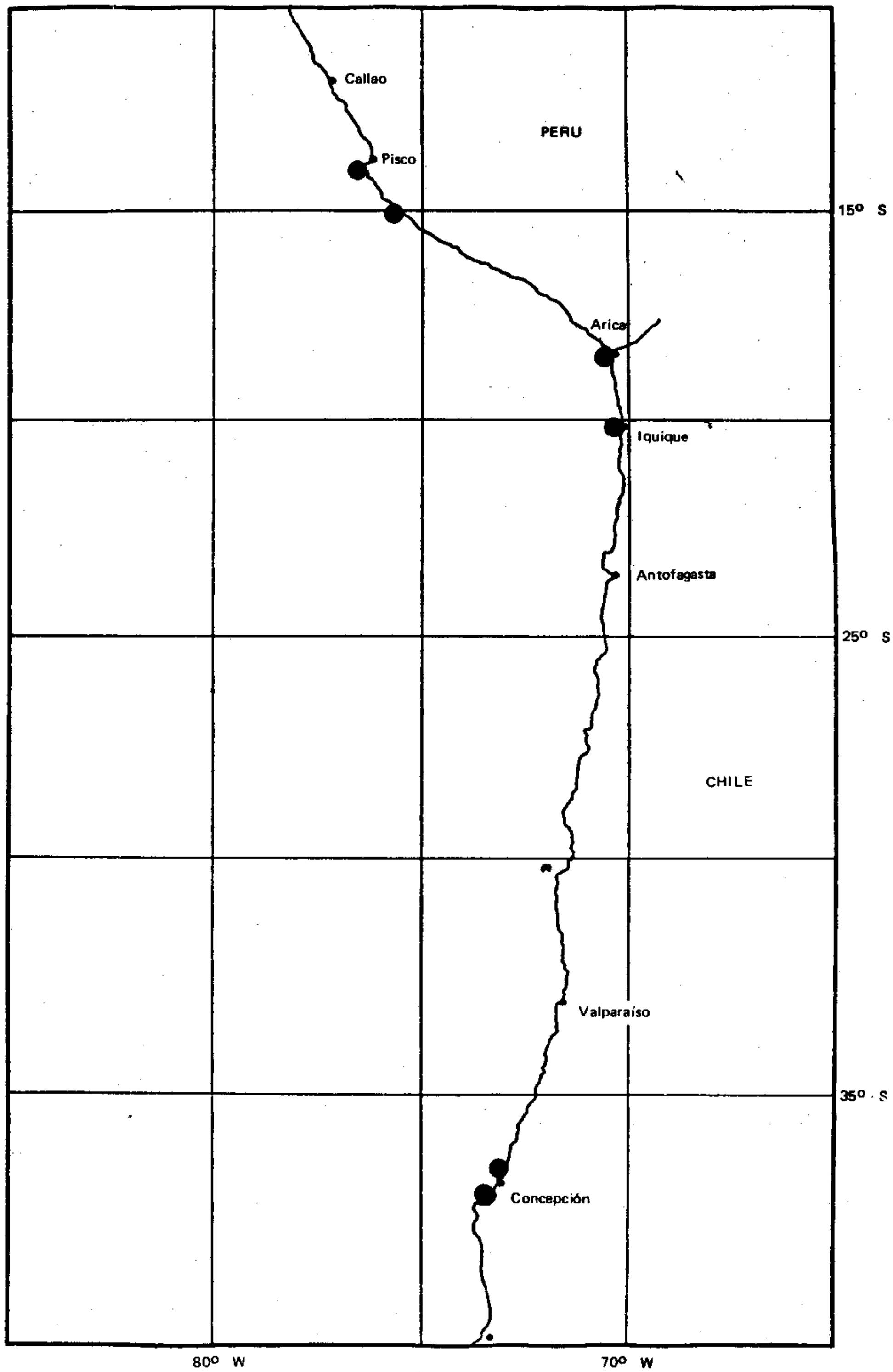

FIGURA 1. Localities off the west coast of South America at which filamentous bacteria have been found. Records off Peru are due to Dr. Gilbert T. Rowe.

significance of these quantitatively important bacterial assemblages in the food chain off south-western South America is strongly suggested by the coincidence of their distribution and the location of the main shrimp and hake fishing grounds off Chile (refs. 29,30,31,31). In fact, shrimp and hake trawling fishermen have long geen familiar whit the filaments which tangle on their nets an have a popular name for them, i.e., **'estopa'**.**** Whatever their importance may be off Chile or in other parts of the world, it would seem necessary to adjust present conceptions about the primary production of organic matter in the coastal seas in these regions to account for the benthic production of important procaryotic populations. It would also seem appropriate to examine the possible relationship between the same populations and the genesis of phosphorite deposits which off south-western South America share the same environment (refs. 33,34), and their significance in the formation of bituminous sediments and stromatolites.

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****Uncleansed wool or flax, unworked fibres of thread

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