Metabolic Diversity Within the Eilat, Israel Saltern

Carol D. Litchfield[a], Army Orgy[a], Tamar Kis-Papo[b] , and Aharon Own[b]

[a] Department of Biology, George Mason University, Fairfax, Virginia, 22030, U.S.A.[1]*
[b] Division of Microbial and Molecular Ecology and The Moshe Shilo Minerva Center for Marine Biogeochemistry, The Hebrew University of Jerusalem, Jerusalem, 91904, Israel[2]

This paper describes the metabolic potential of several of the pans in the Israel Salt Company saltern in Eilat, Israel. The metabolic potential was evaluated over a three year period using BIOLOG GN plates and was remarkably consistent in pans of the same density.

1. INTRODUCTION

Since 1914 when Pierce isolated bacteria from brine (1), microbiologists have been culturing bacteria and algae from solar salterns. This continues today as new species and genera are still being discovered. While knowing what microorganisms can be cultured from an ecosystem is important, that is only a partial answer to the question of the role of microbes in that environment. Equally important is the answer to the question of the metabolic activities and potential of the microbial community. What are they capable of metabolizing or potentially metabolizing and how does this affect nutrient cycling? This information will not only provide insights into the ability of the consortium to metabolize a variety of nutrients, but it can also provide information on the role of microorganisms in hypersaline ecosystems.

Garland and Mills were the first to utilize BIOLOG GN plates to obtain an insight into the metabolic potential of an ecosystem (2). The plates contain 96 wells and each well, except the first one, has a carbon source. Also in each well are nutrients and a tetrazolium indicator which changes from clear to purple when it is reduced during the metabolism of the organism(s).

The microflora of solar salterns is generally considered to have limited metabolic capabilities as most of the isolation media have routinely included only casamino acids and citrate and occasionally sugars. Numerous halophilic Bacteria and Archaea with complex metabolic capabilities have recently been isolated from salterns worldwide. To test whether there was greater metabolic potential than expected, we applied the BIOLOG GN plate technique to a solar saltern in Eilat, Israel. The results of those experiments, the first for a saltern, are reported in this paper.

2. MATERIALS AND METHODS

2.1. Sample location and collection

The Israel Salt Company plant in Eilat was sampled in August 1996, January 1997, August 1997, and February 1998. Water samples were aseptically collected and transported to the laboratory for processing. Samples from throughout the saltern were tested with the following density ranges: inlet pond range of 1.026 to 1.045; ponds 200 (8/96) and 104 (l/97) 1.084 and 1.080, respectively; 202 (11/97), 200 (8/97), and 200 (2/98) 1.110, 1.100, and 1. 110, respectively; 305, 203 (8/96), 202 (8/97), 203 (8197), and 202 (2/98) ranged from 1.149 1.190. Numbers in parentheses are the sampling times.

2.2. Inoculation and incubation conditions

The samples were processed within two hours of collection, and each well in a BIOLOG GN plate inoculated with 145 µL of the whole community water sample. The plates were incubated at 350 C, examined daily for the first four days, and then weekly for four weeks. Any color change when

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[2] Present address: Institute of Evolution, University of Haifa, Mt. Carmel, Haifa 31905, Israel

compared to the control well was recorded as positive.

2.3. Data analysis

The data were entered into a computer as a 1 (positive color change) or 0 for no color change. The resulting data were analysed by the MVSP program using simple matching coefficient and nearest neighbor clustering to evaluate the similarities between the pans and the consistency of the results over time.

3. RESULTS AND DISCUSSION

Simple matching analysis revealed that the four salt pans with densities less than 1.080 density formed one tight cluster with the exception of the August 1997 inlet sample. Neither this sample nor the 1.084 density sample from August 1996 were similar to any other samples. In fact they clustered with the other samples only at the 60% level indicating very different metabolic potentials in these two samples compared with the other six samples. The two samples which had a density of 1. 110 (January 1997 and February 1998) while not from the same pond had a 90% similarity indicating essentially identical metabolic potentials. The remaining four samples clustered together at the 70% similarity level. Again this implies some affinity but a great deal of variability between the pans. The densities of these four samples ranged from 1.026 to 1.080.

The following compounds were routinely used by over 75% of the samples: α-ketoglutaric acid and D, L-lactic acid. The following were also not used by over 75% of the samples: α-cyclodextrin, N-acetyl-D-galactosamine, adonitol, i-erythritol, L-fucose, lactulose, Dmelibiose, L-rhamnose, mono-methyl succinate, acetic acid, formic acid, D-glucosamine, α-hydroxybutyric acid, itaconic acid, α-ketobutyric acid, α-ketovaleric acid, saccharic acid, alaninamide, and D, L-carnitine. However, 74 different compounds could be used by some members of the microbial community. Similar metabolic versatility has been found in other aquatic systems such as aquifers (3).

Thus, it appears that the metabolic potential in the salt pans in Eilat, Israel is fairly restricted. This confirms the previous conclusion that a restricted microbial population exists in the Eilat, Israel salt pans (4). These results also have implications for microbiological media to optimize recoveries of viable bacteria from solar salterns. In addition, the fact that 74 compounds can be used at various times by some portion of the population indicates that there is greater metabolic potential in the whole microbial community than generally assumed.

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