Timothy Brian SHIREY
Lewis and Clark Fund for Exploration and Field Research in Astrobiology
awarded May 2011

The environmental determinants of soil microbial community activity, viability, and composition in the Atacama Desert, Chile

PROJECT REPORT

BACKGROUND

The unique geology and harsh environmental conditions of the Atacama Desert have affected pedogenic processes, producing some of the most inhospitable soils on the planet (Ewing 2006; Houston and Hartley 2003; Navarro-Gonzalez *et al.* 2003). The Atacama spans approximately 1000 km from central Chile to southern Peru, and holds the longest continuous record of semi-arid to arid conditions on Earth (Hartley *et al.* 2005). The driest region of the desert, where hyperarid conditions exist, lies north of latitude S 25°. Increased precipitation in the southern desert produces arid to semi-arid conditions that are capable of supporting large vascular plant communities (Warren-Rhodes *et al.* 2006). The precipitation of the southern Atacama is primarily attributable to inundation by coastal fog, known locally as *camanchaca*, which is advected from the sea to the coastal mountain range then penetrates inland through corridors and over peaks with elevations less than 1000 m (Cereceda *et al.* 2008; Warren-Rhodes *et al.* 2006). Although still extremely dry, soils of the southern Atacama Desert sustain plant and animal communities not found at lower latitudes. As a result, the Atacama provides an excellent backdrop to examine how soil microbial activity, viability, and composition are regulated under disparate desert conditions.

Historically, research into microbial communities in the Atacama has focused on specific locales within the hyperarid region of the desert (Connon *et al.* 2007; Drees *et al.* 2006; Navarro-Gonzalez *et al.* 2003; Nielson *et al.* 2012; Wierzchos *et al.* 2011, 2012), yet few studies have examined the soil microbial communities of the southern region. In contrast to the reduced microbial biomass and low activity common in hyperarid soils of the north, soils of the southern Atacama are expected to support more diverse, active, and abundant microbial communities. This greater microbial diversity, activity, and abundance help facilitate nutrient cycling and increase mineralization of organic compounds essential for desert plant communities (Goldstein *et al.* 1999; Puente *et al.* 2009).

The primary objective of this study was to investigate microbial activity, viability, and community composition in arid and hyperarid soils of the Atacama Desert, and to identify the environmental conditions impacting those communities. Measurements of soil carbon (C), nitrogen (N), soil organic matter (SOM), pH and eC were performed, as were analyses of microbial viability, composition, and activity. The results from this study will highlight the environmental conditions that impact microbial communities in arid and hyperarid soils of the Atacama Desert, and the effects those conditions have on the microbial communities within the two regions.

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Sampling.

Sampling was conducted from May 29 – June 12, 2012, along a north to south latitudinal transect in the Atacama Desert, Chile. Samples were obtained from 1 hyperarid site (KM40, S 22º 42') and 6 arid sites (AT-N01 to AT-N06) located at S 27º 02' to S 30° 05' respectively (Table 1). One sampling pit was randomly dug at each site and 3 replicate samples were collected at a depth of 20 cm from each pit. Consistency in sampling depth, elevation, and time were

maintained to minimize the effects of spatial and temporal heterogeneities. All samples were collected with an ethanol-sterilized sampling trowel, deposited into sterile Whirl-Pak bags (Nasco), and stored at room temperature until use.

Table 1.Geographical characteristics of study sites.

Site	Latitude	Longitude	Elevation (m)
KM40	S 20°43'59.6"	W 070°00'28.2"	757
AT-N01	S 27°02'42.7"	W 069°55'11.7"	1678
AT-N02	S 27°36'12.9"	W 070°26'49.5"	574
AT-N03	S 28°25'07.3"	W 070°42'42.5"	679
AT-N04	S 29°16'56.8"	W 071°02'12.4"	604
AT-N05	S 29°50'01.4"	W 070°49'58.3"	980
AT-N06	S 30°05'55.2"	W 070°43'01.0"	928

Pictures:

Fig. 1

Fig.2

Fig. 3

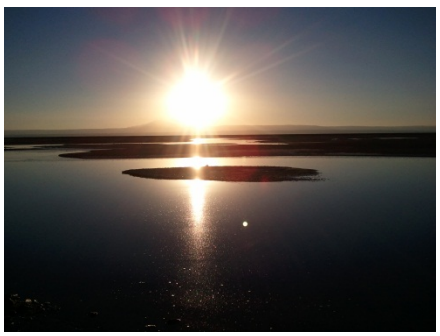

Fig. 4

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Fig. 5

Fig.6

Fig. 7

Fig. 8

Figure descriptions:

Fig. 1. Myself in front of a salt outcrop at Valle de Luna near San Pedro de Atacama, Chile.

Fig. 2. Myself at Valle de Luna near San Pedro de Atacama, Chile.

Fig. 3. Myself at Salar de Llamara, Chile.

Fig. 4. Sunset at Salar de Atacama, Chile.

Fig. 5. Moon and Andes at Salar de Atacama, Chile.

Fig. 6. Animal tracks near San Pedro de Atacama, Chile.

Fig. 7. Salt outcrop at Valle de Luna, Chile.

Fig. 8. Atacama Dese-rt near San Pedro de Atacama, Chile.

Publication:

The findings resulting from the sampling trip funding by the Lewis and Clark Fund is currently being prepared for publication in a peer reviewed scientific journal. The Lewis and Clark Fund for Exploration and Field Research in Astrobiology will be acknowledged as a funding source for this study.