

10-10-2006

Yeast in the Antarctic Dry Valleys: Biological Role, Distribution, and Evolution

Laurie B. Connell

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Recommended Citation

Connell, Laurie B., "Yeast in the Antarctic Dry Valleys: Biological Role, Distribution, and Evolution" (2006). *University of Maine Office of Research and Sponsored Programs: Grant Reports*. 198.

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Final Report for Period: 06/2002 - 05/2006

Submitted on: 10/10/2006

Principal Investigator: Connell, Laurie B.

Award ID: 0125611

Organization: University of Maine

Title:

Yeast in the Antarctic Dry Valleys: Biological role, distribution, and evolution

Project Participants

Senior Personnel

Name: Connell, Laurie

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Rodriguez, Russell

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Redman, Regina

Worked for more than 160 Hours: Yes

Contribution to Project:

Dr. Redman worked during the Antarctic deployed portion of this project to set up the laboratory in Crary and helped to culture micro-organisms from soils. This position was funded through the grant.

Post-doc

Graduate Student

Undergraduate Student

Technician, Programmer

Name: Craig, Scott

Worked for more than 160 Hours: Yes

Contribution to Project:

Mr. Craig is our GIS and mapping specialist. He also developed and maintains our database and provides any role that must be filled during field operations. This position was funded through the grant

Other Participant

Research Experience for Undergraduates

Organizational Partners

University of Miami Rosenstiel School of Marine&Atmospheric Sci

We collected samples and sent them to Dr. Fell's lab where they screened them for undescribed organisms

Other Collaborators or Contacts

Jack Fell- RSMAS screening isolated DNA for undescribed organisms

Alvaro Fonseca- Portugal further identification of new species that we isolated

Activities and Findings

Research and Education Activities: (See PDF version submitted by PI at the end of the report)

Please see attached file

Findings:

Major findings are these

- (1) we have identified a number of new species
- (2) we have determined a much greater distribution and abundance of yeast and yeast like fungi than previously reported in the literature
- (3) Fungi have been isolated from soils with high pH and very low moisture (below 0.1%)
- (4) abundant yeast and other fungi have been isolated from regions above the ancient lake leve (300m above valley floor)
- (5) Sterol analysis shows that potentially unique sterols are produced by a number of yeast isolated from Taylor Valley
- (6) there is seasonal variability in the abundance of specific taxa, and this abundance is associated with soil temperature.

Training and Development:

Beyond those training and development items listed in previous report we have additional reports

- (1) GIS specialist Scott Craig developed databases and more GIS training
- (2) TEA Amy Stoyles participated in both the field season and made 2 trips to Maine to talk with other teachers and students.
- (3) The group participated in a video made by M. Comberi for the museum kiosk in Christchurch NZ
- (4) We had 2 writers from the Writers and Artists program join our group for several field trips. One included our team in an article.
- (5) 2 undergraduate students have been working on sequencing isolated brought back from our field season. They are using the information they collect to identify these isolates
- (6) we collaborated with a middle school in Seattle Washington (Greenlake) on a project-organized by B. Schulz.
- (7) An undergraduate student has been developing a website with student and teacher information as well as field information.
- (8) Two undergraduate students have worked to identify several new species and will participate in publications.
- (9) One graduate student has developed a profile of sterols from yeast at several growth temperatures and is developing a manuscript from those results.
- (9) Three highschool students from the Upward Bound program for Science and Math participated in DNA identification of new yeast species.

Outreach Activities:

Dr. Connell has given a seminar on preliminary findings at The University of Maine
 Mr. Craig has given a talk at the Craig Brook National Fish Hatchery to a small group of community members
 Mr. Craig has presented his findings at a meeting with collaborators in FL.
 Ms. Schulz has posted her web based journal
 a general laboratory website has been initiated for this project
 Ms. Stoyles has given over 30 talks to student and teachers groups- including 6 in Maine.
 We participated in a video for the Antarctic museum kiosk in Christchurch NZ
 We have associated with a school in Seattle WA
 We have initiated a web site for both researcher and the general public (<http://www.umaine.edu/nunatak/antarcticwhole.html>)
 We have participated in Science and Math Upward Bound Program

Journal Publications

Connell, L. B., R. Redman, S. D. Craig and R. Rodriguez, "Distribution and abundance of fungi in the soils of Taylor Valley, Antarctica", *Soil Biology & Biochemistry*, p. 3083, vol. 38, (2006). Published

Fell, J. W., G. Scorzetti, L. B. Connell and S. D. Craig, "Biodiversity of micro-eukaryotes in Antarctic Dry Valley soils with less than 5% soil moisture", *Soil Biology & Biochemistry*, p. 3107, vol. 38, (2006). Published

Adams, B., R. Bardgett, J. Aislabie, E. Ayres, S. Bamforth, R. Bargagli, C. Cary, P. Cavacini, L. B. Connell, P. Convey, J. W. Fell, F. Frati, I. Hogg, K. Newsham, T. O'Donnell, N. Russell, R. Seppeldt, M. Stevens and D. Wall, "Diversity and Distribution of Victoria Land Biota.", *Soil Biology & Biochemistry*, p. 3003, vol. 38, (2006). Published

Connell, L. B., R. Redman, S. D. Craig and R. Rodriguez, "Seasonal variation of fungal communities in the soils of Taylor Valley, Antarctica", *Polar Biology*, p. , vol. , (2006). Submitted

Books or Other One-time Publications

Web/Internet Site

URL(s):

<http://www.umaine.edu/nunatak/antarcticwhole.html>

Description:

Other Specific Products

Contributions

Contributions within Discipline:

This project focused on micro-fungi from the soils of Taylor Valley in southern Victoria Land, Ross Desert region (see Fig. 1 for map of sites) and has established an initial database, a baseline collection of yeast and yeast-like fungi, as well as identified potential sampling locations in each of the three major regions (coastal, central, and interior).

Transects established in each of these three regions of Taylor Valley spanned elevations from above to below the proposed ancient Lake Washburn (a potential source of relic nutrients). Our database for both biotic and abiotic parameters has been established and transferred to ArcGIS for incorporation into the LTER database. Over 150 different isolates of fungi (dominated by yeast and yeast-like fungi) originating from a variety of habitats have already been identified from the first two field seasons. Exploration of DNA extracted directly from soils, with collaborator Dr. J Fell, has yielded previously uncultured and unidentified lineages (Fell, Scorzetti et al. 2006).

During our first field season we developed a protocol for extraction of DNA from Antarctic desert soils and refined a protocol for culturing yeast from soil with extremely low organic matter and biomass. Protocols for site selection, site layout, and sample collection have been refined. We established broad landscape ranges for yeast vs. filamentous fungal distributions (Connell, Redman et al. 2006) as well as baseline data for temporal changes in selected soil communities.

A major finding was that soil pH was strongly correlated with abundance and distribution of filamentous fungi, but not yeast and yeast-like fungi- demonstrating that yeast are able to compete in a much broader range of habitats. Yeast were found in ground rock on top of blue ice as well as extremely dry powdered soils of the Lake Bonnie basin. Nutrient

utilization analysis for selected isolates is currently being carried out to help determine potential roles these organisms have in the environment.

Contributions to Other Disciplines:

Our work has been useful for others working with soils in that our techniques for DNA extraction have been highly successful in these desert soils. Also, our initial sterol analysis have shown that egersterol can not be used as a marker for total fungal abundance since several of these yeast do not produce significant amounts of egersterol, but do produce otehr sterols.

Contributions to Human Resource Development:

This project has been instrumental for the generation of scientific interest in Three highschool students (Upward Bound), Two Undergardauate students and one Graduate student, all women (and other minorities).

The highschool students participated in determining the species of several yeast by isolation of DNA, PCR and DNA sequence analysis. These studes came from rural areas of Maine and from Nigeria.

Contributions to Resources for Research and Education:

We have generated a database in GIS format for inclusion into the Taylor Valley LTER. Additioanlly we have developed a website (<http://www.umaine.edu/nunatak/antarcticwhole.html>) principally for the general public.

We have a collection of yeast and fungi in storage for distribution to other researchers who may wish to investigate species colleted from Antarctica.

Contributions Beyond Science and Engineering:

There was no direct specific contribution to public welfare beyond science and engineering.

Categories for which nothing is reported:

Any Book
Any Product

Antarctic project (OPP-0125611 Yeast in the Antarctic Dry Valleys: Biological role, distribution and evolution. \$333,968; ended 31 May 2006).

Understanding the links between soil biodiversity and ecosystem functioning is essential to assessing the effects of ecosystem changes on soil processes. The complexities of soil systems in temperate regions pose difficulties in studying the relationships between biotic and abiotic parameters in ecosystem function. Thus, factors controlling populations of soil microbiota remain poorly understood. In contrast, the soil community of the Antarctic polar desert of Southern Victoria Land is comprised of few endemic species of bacteria, fungi, and, invertebrates, offering the opportunity to identify many more “players” in these communities. This project focused on yeast and yeast-like fungi in the Ross Desert of Antarctica. Both filamentous and single cellular fungi have been isolated from a diversity of Antarctic soil types, but only yeast appear to be endemic to the drier polar desert soils. Although ecological roles of yeast in Antarctic soils is undefined, yeast may be involved in accumulation and mobilization of growth limiting nutrients into the polar desert food web and one of the principle sources of sterols for nematodes in some habitats.

This project focused on micro-fungi from the soils of Taylor Valley in southern Victoria Land, Ross Desert region (see Fig. 1 for map of sites) and has established an initial database, a baseline collection of yeast and yeast-like fungi, as well as identified potential sampling locations in each of the three major regions (coastal, central, and interior). Transects established in each of these three regions of Taylor Valley spanned elevations from above to below the proposed ancient Lake Washburn (a potential source of relic nutrients). Our database for both biotic and abiotic parameters has been established and transferred to ArcGIS for incorporation into the LTER database. Over 150 different isolates of fungi (dominated by yeast and yeast-like fungi) originating from a variety of habitats have already been identified from the first two field seasons. Exploration of DNA extracted directly from soils, with collaborator Dr. J Fell, has yielded previously uncultured and unidentified lineages (Fell, Scorzetti et al. 2006).

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This project enabled graduate through middle school students to participate in research at variety of levels, including participation though the Teachers Experience in Antarctic program (TEA). Two undergraduate students have been working in the Connell Laboratory learning how to identify isolates by both genetic and biochemical means. These students have been active in the identification of several new species and will participate as authors on manuscripts in preparation.

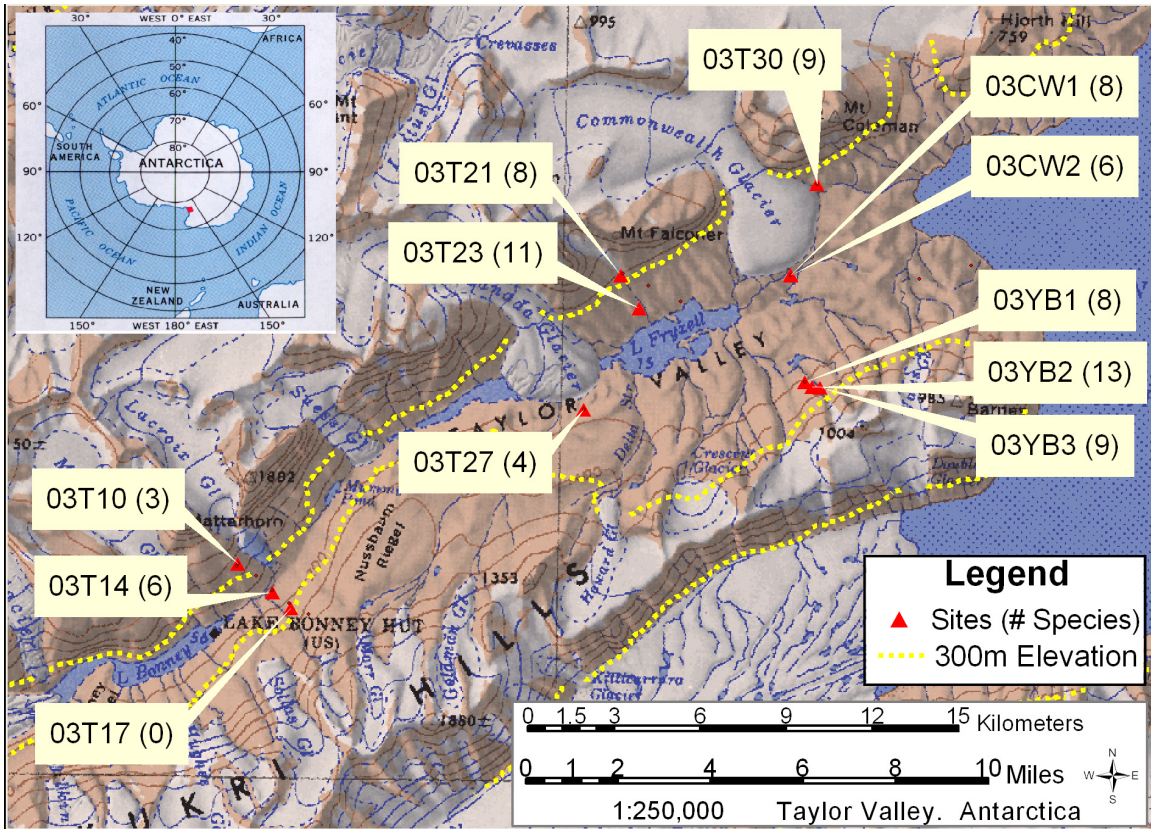
The data generated from the first two field seasons continues to be analyzed. Two peer reviewed manuscripts based on this work have been published (Connell, Redman et al. 2006; Fell, Scorzetti et al. 2006). One additional publication has been submitted. This manuscript comparing (1) temporal fungal diversity within central Taylor Valley at a few selected sites. In addition, a publication determining baseline data for sterol profiles in three Antarctic yeast is in preparation by a graduate student. At least five publications will result from new species descriptions, including the genera *Leucosporidium*, *Dioszegia*, *Acremonium*, and *Hyphozyma*.

Manuscripts published:

- Connell, L. B., R. Redman, et al. (2006). "Distribution and abundance of fungi in the soils of Taylor Valley, Antarctica." Soil Biology & Biochemistry **38**: 3083–3094.
- Fell, J. W., G. Scorzetti, et al. (2006). "Biodiversity of micro-eukaryotes in Antarctic Dry Valley soils with less than 5% soil moisture." Soil Biology & Biochemistry **38**: 3107–3119.

Figure 1

Sample site locations in Taylor Valley, Antarctica (2003–2004). Sites are identified by labels, 300m elevation level is denoted with a dotted line. The number of species isolated from each site (combining 4⁰C and 15⁰C culture incubation) is indicated in parenthesis. The dot on the inset indicates the location of Taylor Valley in Antarctica.



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