

Final project report

<i>Project ID</i>	2004/1.01
<i>Title</i>	Responses of Antarctic terrestrial and freshwater ecosystems to variations of climatic and environmental conditions.
<i>Principal investigator</i>	Roberto Bargagli
<i>Institution</i>	Dept. of Environmental Sciences "G. Sarfatti", University of Siena
<i>Email</i>	bargagli@unisi.it
<i>Duration</i>	3 years
<i>Assigned funding</i>	300.000,00 Euro

Activities and results

Trough the development of coordinated and integrated studies on the phylogeny of cryptogamic organisms and invertebrates and their adaptation mechanisms to the Antarctic environment, the project aimed at achieving a better understanding of the distribution and composition of the main biotic communities and the functioning of terrestrial and freshwater ecosystems in deglaciated areas of Victoria Land. Studies on interactions of Antarctic organisms with their environment, taxonomic revision, the creation of database, together with studies on genetic variability and differentiations of micro-invertebrates, cryptogams and cyanobacteria aimed at detecting/predicting the possible effects of climate and environmental change on Antarctic ecosystems. The project drew on the expertise of six Italian research groups (Prof. R. Bargagli, Dept. Environmental Sciences, Univ. of Siena; Prof. F. Frati, Dept. Evolutionary Biology, Univ. of Siena; Prof. C. Andreoli, Dept. Biology, Univ. of Padoa; Prof. G. Carchini, Dept. Biology, Univ. of Rome Tor Vergata; Prof. B. Fumanti, Dept. Plant Biology, Univ. of Rome "La Sapienza"; Prof. P.L. Nimis, Dept. Biology, Univ. of Trieste), acquired in over a decade of research within the international context of Antarctic biology and ecology. Several research activities were also performed in collaboration with some foreign Antarctic biologists and ecologists such as P.A. Broady, I.D. Hogg, A. Mc Gaughran, M.I. Stevens, M. Skotnicki, D.H. Wall and P. Convey. The results of the research activity have been reported in several scientific publications and communications at international workshops and symposia (see the section products); thanks to samples stored in our laboratories and some culture of Antarctic algae and cyanobacteria some research activities are still going on. Among the most important results:

- new record and genetic characterization of thermophilic bacteria and the moss *Pohlia nutans* from geothermal grounds of Mt. Rittmann and the northwest slope of Mt. Melbourne.
 - The biogeochemical cycle of Hg throughout the Victoria Land, the finding of an enhanced deposition in the Nansen Ice Sheet region with Hg accumulation on mosses, lichens and lacustrine sediments. We found that the coastal polynya at Terra Nova Bay is a source of marine aerosols and during the austral spring the photochemically driven Hg⁰ oxidation by reactive halogens determines "Hg depletion events" like those previously reported in some Arctic coastal ecosystems. These results raises concern about the possible environmental effects of changes in regional climate and sea ice coverage, and on the possible role of Antarctica as a sink in the global Hg cycle.
 - The development of algae, moss and lichen communities is affected by spatio-temporal variations in the availability of water and nutrients, which mostly arise from the marine environment.
 - ANTADATA: a database on biogeography of non-marine algae in continental Antarctica; new records of Antarctic algae, molecular phylogeny and ecophysiology of *Koliella antarctica*.
 - Differently from most cryptogamic organisms, the terrestrial microarthropods have limited dispersal capability, highly aggregated distribution and their diversity and genetic variability seem affected mainly by local factors (i.e. the geological and glaciological history) rather than latitudinal or altitudinal gradients.
 - VICTORIA: a database of Antarctic lichens and on-line identification key of all taxa recorded in the northern Victoria Land.
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Products

A – papers in scientific magazines (with IF)

2004

1. Barbarotto K., Zacchello C., Giacometti G.M., Andreoli C., Rascio N. (2004). Damage suffered by the green microalga *Koliella antarctica* exposed to cadmium. *Acta Physiol. Plant* 26:205-206.
2. Bargagli R., Skotnicki ML, Marri L, Pepi M, Mackenzie A, Agnorelli C (2004). New record of moss and thermophilic bacteria species and physico-chemical properties of geothermal soils on the northwest slope of Mt. Melbourne (Antarctica). *Polar Biol.* 27:423-431.
3. Borghini F, Bargagli R. (2004). Changes in major ion concentrations in melting snow and terrestrial waters from northern Victoria land, Antarctica. *Antarct. Sci.* 16:107-115.
4. Gambaro A., Moret I., Piazza R., Andreoli C., Da Rin E., Capodoglio G., Barbante C., Cescon P. (2004). Temporal evolution of DMS and DMSP in Antarctic coastal seawater. *Intern. J. Environ. Anal. Chem.* 84: 401-412.
5. Negrisolo E., Maistro S., Incarbone M., Moro I., Dalla Valle L., Broady P.A., Andreoli C. (2004). A high rate of morphological convergence characterizes the evolution of Xanthophyceae (Heterokontophyta): evidence from nuclear SSU rDNA and plastidial *rbcl* genes. *Mol. Phylogenet. Evol.* 33:156-167.

2005

1. Baldisserotto C., Ferroni L., Andreoli C., Fasulo M., Bonora A., Pancaldi S. (2005). Dark-acclimation of the chloroplast in *Koliella antarctica* exposed to a simulated austral night condition. *Arct. Antarct. Alp. Res.* 37:146-156.
2. Baldisserotto C., Ferroni L., Andreoli C., Fasulo M., Bonora A., Pancaldi S. (2005). Dark-acclimation of the chloroplast in *Koliella antarctica* (Klebsormidiales, Chlorophyta). *Eur. J. Phycol.* 41:213-222.
3. Allegrucci G., Carchini G., Todisco V., Paggi A., Convey P. (2005). A molecular phylogeny of Antarctic chironimidae and its implications for biogeographical history. *Polar Biol.* 10.00300-005-0056-7)
4. Bargagli R., Agnorelli C., Borghini F., Monaci F. (2005). Enhanced deposition and bioaccumulation of mercury in Antarctic terrestrial ecosystems facing a coastal polynya. *Environ. Sci. Technol.* 39:8150-8155.
5. Borghini F., Grimalt J.O., Sanchez-Hernandez J.C., Bargagli R. (2005). Organochlorine pollutants in soils and mosses from Victoria Land (Antarctica). *Chemosphere* 58:271-278.
6. Pepi M., Agnorelli C., Bargagli R. (2005). Iron demand by thermophilic and mesophilic bacteria isolated from an Antarctic geothermal soil. *BioMetals* 18:529-536.
7. Selbmann L., de Hoog G.S., Mazzaglia A., Friedmann E.I., Onofri S. (2005). Fungi at the edge of life: cryptoendolithic black fungi from Antarctic desert. *Stud. Mycol.* 51:1-32.

2006

1. Adams B.J., Bardgett R.D., Ayres E., Wall D.H., Aislabie J., Bamforth S., Bargagli R., Craig C., Cavacini P., Connell L., Convey P., Fell J.W., Frati F., Hogg I.D., Newsham K.K., O'Donnell A., Russell N., Seppelt R.D., Stevens M.I. (2006). Diversity and distribution of Victoria Land biota. *Soil Biol. Biochem.* 38:3003-3018.
2. Barrett J.E., Virginia R.A., Hopkins D.W., Aislabie J., Bargagli R., Bockheim J.G., Campbell I.B., Lyons W.B., Moorhead D.L., Nkem J.N., Sletten S., Steltzer H., Wall D.H., Wallenstein M.D. (2006). Terrestrial ecosystem processes of Victoria Land, Antarctica. *Soil Biol. Biochem.* 38:3019-3034.
3. Cavacini P., Tagliaventi N., Fumanti B. (2006). Morphology, ecology and distribution of an endemic Antarctic lacustrine diatom: *Chamaepinnularia cymatopleura* comb. Nov. *Diatom Res.* 21:57-60.
4. Castello M., Martellos S., Nimis P.L. (2006). VICTORIA – An on-line information system on the lichens of Victoria Land (continental Antarctica). *Polar Biol.* 29:604-608.
5. Lenucci M., Leucci M.R., Andreoli C., D'alessandro G., Piro G. (2006). Biosynthesis and characterization of glycoiproteins in *Koliella antarctica* (Klebsormidiales, Chlorophyta). *Eur. J. Phycol.* 41:213-222.
6. Hogg I.D., Cary C., Convey P., Newsham K.K., O'Donnell A.G., Adams B.J., Aislabie J., Frati F., Stevens M., Wall D.H. (2006). Biotic interactions in Antarctic terrestrial ecosystems. Are they a factor? *Soil Biol. Biochem.* 38:3035-3040.

2007

1. Bargagli R., Monaci F., Bucci C. (2007). Environmental biogeochemistry of mercury in Antarctic ecosystems. *Soil Biol. Biochem.*, 39:352-360.
2. Borghini F., Colacevich A., Bargagli R. (2007). Water geochemistry and sedimentary pigments in Antarctic lakes. *Polar Biol.* 30:1173-1182.
3. Caruso T, Bargagli R. (2007). Assessing abundance and diversity patterns of soil microarthropod assemblages in northern Victoria Land (Antarctica). *Polar Biol.* 30: 895-902.
4. Caruso T, Borghini F, Bucci C, Colacevich A, Bargagli R. (2007). Modelling local scale determinants and the probability of microarthropod species occurrence in Antarctic soils. *Soil Biol. Biochem.* 39: 2949-2956.
5. Imperio T, Bargagli R., Marri L. (2007). Detection of IncP replicon-specific regions in DNA from Antarctic microbiota. *Cent. Eur. J. Biol.* 2: 378-384.
6. Maistro S., Broady P.A., Andreoli C., Negrisolo E. (2007). Molecular phylogeny and evolution of the order Tribonematales (Heterokonta, Xanthophyceae) based on analysis of plastidial genes *rbcl* and *psaA*. *Mol.*

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Phylogenet. Evol. 43:407-417.

7. Onofri S., Selbmann L., de Hogg G.S., Grube M., Barreca D., Ruisi S., Zucconi L. (2007). Evolution of fungi at boundaries of life. *Adv. Space Res.* 40:1657-1664.
8. Ruisi S., Barreca D., Selbmann L., Zucconi L., Onofri S. (2007). Fungi in Antarctica. *Rev. Environ. Sci. Biotechnol.* 6:127-141.
9. Stevens M.I., Frati F., McGaughan A., Spinsanti G., Hogg I.D. (2007). Phylogeographic structure suggest multiple glacial refugia in northern Victoria land for the endemic Antarctic springtail *Desoria klovstadi* (Collembola, Isotomidae). *Zool. Scripta* 36:201-212.

2008

1. Bargagli R. (2008) - Environmental contamination in Antarctic ecosystems. *Sci. Total Environ.* 400: 212-226.
2. Borghini F., Colacevich A., Caruso T., Bargagli R. (2008). Temporal variations in the water chemistry of northern Victoria Land lakes (Antarctica). *Aquat. Sci.* 70:134-141.
3. Carapelli A., Comandi S., Convey P., Nardi F., Frati F. (2008). The complete mitochondrial genome of the Antarctic springtail *Cryptopygus antarcticus* (Hexapoda, Collembola). *BMC Genomics* 9: 315.

2009

1. Caruso T, Hogg I.D., Carapelli A, Frati F, Bargagli R (2009). Large-scale spatial patterns in the distribution of Collembola (Hexapoda) species in Antarctic terrestrial ecosystems. *J. Biogeogr.* 36:879-886.
2. Colacevich A., Caruso T., Borghini F., Bargagli R. (2009). Photosynthetic pigments in soils from northern Victoria Land (continental Antarctica) as proxies for soil algal community structure and function. *Soil Biol. Biochem.* 41:2105-2114.
3. La Rocca N., Andreoli C., Giacometti G.M., Rascio N., Moro I. (2009). Responses of the Antarctic microalga *Koliella antarctica* (Trebouxiophyceae, Chlorophyta) to cadmium contamination. *Photosynthetica* 47: 471-479.
4. Maistro S, Broady PA, Andreoli C, Negrisolo E (2009). Phylogeny and taxonomy of Xanthophyceae (Stramenopiles, Chromalveolata). *Protist* 160:412-426.

2010

1. Fogliano V., Andreoli C., Martello A., Caiazza M., Lobosco O., Formisano F., Carlino P.A., Meca G., Graziani G., Rigano V., Vona V., Carfagna S., Rignano C. (2010). Functional ingredients produced by culture of *Koliella antarctica*. *Aquaculture* 299:115-120.
2. Caruso T, Garlaschelli D., Bargagli R., Convey P. (2010). Testing the metabolic scaling theory: a comparison of methods for fitting allometric equations to metabolic rates of Antarctic microarthropods. *Oikos* 000:1-2.2009; doi:10.1111/J.1600-0706.2009.17915.x
3. McGaughan A., Torricelli G., Carapelli A., Frati F., Stevens M., Convey P., Hogg I. (2010) Contrasting phylogeographic patterns for springtails reflect different evolutionary histories between the Antarctic Peninsula and continental Antarctica. *J. Biogeogr.* 37:103-119
4. Torricelli G., Carapelli A., Convey P., Nardi F., Boore J.L., Frati F. (2010) High divergence across the whole mitochondrial genome in the "pan-Antarctic" springtail *Friesea grisea*: evidence for cryptic species? *Gene* 449: 30-40.

B – books and book chapters

1. Bargagli R. (2005). *Antarctic Ecosystems. Environmental Contamination, Climate Change, and Human Impact.* Ecological Studies, vol. 175; Springer-Verlag, Heidelberg, 395 pp.
2. Bargagli R. (2007) – Ecotoxicology. In: Riffenburgh B. (ed.) *Encyclopedia of the Antarctic.* Vol. I. Routledge, Taylor & Francis Group, Oxford, pp. 372-374.
3. Bargagli R.(2009) – Marine and terrestrial pollution. In: Turner J., Bindschadler R., Convey P., Di Prisco G., Fahrbach E., Gutt J., Hodgson D., Mayewski P., Summerhayes C. (eds.) "Antarctic Climate Changes and the Environment". *A contribution to the International Polar Year 2007-2008.* Scientific Committee on Antarctic Research (SCAR), Scott Polar Research Institute, Cambridge; pp. 283-288.

C - proceedings of international conferences

1. Allegrucci G., Carchini G., Todisco V., Convey P., Sbordoni V. (2004). Molecular phylogeny of Antarctic Chironimidae investigated by 28S rDNA sequencing. XXVIII SCAR Open Science Conf., Bremen, 25-31 July 2004.
2. Bargagli R., Agnorelli C. (2005). Moss colonization in geothermal soils of northern Victoria Land. Int. NSF-Workshop "Synthesis of soil biodiversity and ecosystem functioning in Victoria Land" Jekyll Island, GA, 21-23 April 2005, 13-14.
3. Bargagli R., Borghini F. (2005). Lakes as early warning indicators of climatic and environmental changes: preliminary data from freshwater ecosystems in northern Victoria Land, Antarctica. Int. NSF-Workshop "Synthesis of soil biodiversity and ecosystem functioning in Victoria Land" Jekyll Island, GA, 21-23 April 2005, 15.
4. Bargagli R., Agnorelli C., Borghini F., Monaci F. (2005). A coastal polynya enhances mercury bioaccumulation in terrestrial ecosystems around the Nansen ice Sheet (Victoria Land, Antarctica). IX SCAR Int. Biology Symp.

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- "Evolution and Biodiversity in Antarctica", Curitiba, Brazil, 25-29 July 2005, 3.
- Borghini F., Bargagli R. (2005). Water chemistry and pigments of phototrophic organisms in surficial sediments of Antarctic lakes. IX SCAR Int. Biology Symp. "Evolution and Biodiversity in Antarctica", Curitiba, Brazil, 25-29 July 2005, 141.
 - Carapelli A., Comandi S., Fanciulli P.P., Nardi F., Convey P., Frati F. (2007) - Description of the mitochondrial genome of *Cryptopygus antarcticus* (Hexapoda, Collembola) and the genetic variability observed among its populations in Maritime Antarctica. Int. Workshop "Critical issues and research priorities for the IPY and 2007-09" Follonica, 7-9 June 2007.
 - Carchini G. (2007) - Size structure of benthic communities of two streams at Edmonson Point. Int. Workshop "Critical issues and research priorities for the IPY and 2007-09" Follonica, 7-9 June 2007.
 - Borghini F., Colacevich A., Bargagli R. (2007) - Limnological investigation in northern Victoria Land (Antarctica). IPY-AMBIO Meeting, Università di Liegi, 6 dicembre 2007, 18-21.
 - Carchini G., Lecci S., Cattaneo A., Solimini A.G. (2007). Size structure in Antarctic streams. 30^o Congress of the International Association of Theoretical and Applied Limnology. August 12 – 18, 2007, Montreal, (abs.).
 - Caruso T., Bargagli R. (2007). Terrestrial biodiversity in Antarctic ecosystems: research priorities for the IPY 2007/08. VI^o PNRA Meeting on Antarctic Biology: critical issues and research priorities for the IPY and 2007-09. Follonica (GR), 7-9 June 2007, (abs) 11.
 - Caruso T., Bargagli R. (2007). Modelling the local probability of occurrence of the prostigmatic mite *Stereotydeus belli* in Antarctic ice-free areas. Proceed. Int. Conf. "Cryogenic Resources of Polar Regions", Salekhard City, West Siberia, 17-21 June 2007; vol. 1, pp- 308-310.
 - Caruso T., Bargagli R. (2007). Determinants of Antarctic epilithic lichen distribution in northern Victoria Land (Antarctica). Int. Conf. "Cryogenic Resources of Polar Regions", Salekhard City, West Siberia, 17-21 June 2007; vol. 1, pp.310-312.
 - Torricelli G., Carapelli A., Nardi F., Boore J.L., Frati F. (2007) .- High genetic divergence of the complete mitochondrial genome between populations of *Friesea grisea* (Hexapoda, Collembola) from the Antarctic Peninsula and Victoria Land. Int. Workshop "Critical issues and research priorities for the IPY and 2007-09" Follonica, 7-9 June 2007.
 - Torricelli G., Carapelli A., Frati F., Stevens M (2007) - Mitochondrial DNA divergence among continental Antarctic and sub-Antarctic *Friesea* species (Collembola, Neamuridae). Tenth Annual New Zealand Molecular Ecology Meeting, Kaikoura, New Zealand, 7-9 December 2007, 9.
 - Bargagli R. (2008). Environmental contamination in Antarctic ecosystems. Int. Antarctic Conf. IAC2008 "Ukraine in Antarctica-National Priorities and Global Integration", Kiev, Ucraina, 23-25 maggio 2008, 5-6..
 - Bargagli R. (2008). Environmental contamination in Antarctic ecosystems. Bilateral Conference "Biology of Antarctic", Varsavia, Polonia, 23 giugno 2008, abs.
 - Cattaneo A., Carchini G., Lecci S., Solimini A.G. (2008). From Roma to the Antarctic: Regularity in Size Spectra of Stream Communities Along a Latitudinal Gradient. 56th Annual Meeting of the North American Benthological Society (NABS 2008), Salt Lake City, Utah (USA), 25-30 May 2008 (abs.)
 - Caruso T., Garlaschelli D., Baragagli R. (2009) Research perspectives on soil food webs in Antarctic ecosystems: data from northern Victoria Land. Xth SCAR Biology Symposium, 27-31 July, Sapporo, Japan 2009.

D – proceedings of national meetings and conferences

- Cavacini P., Fumanti B. (2004) ANTADATA- a database on biogeography of non marine algae in continental Antarctica. *Terra Antarctica* 11: 455-458.
- Castello M., Martellos S., Nimis P.L. (2005). Licheni antartici: dall'erbario ad Internet. *Atti Mus. Civ. Stor. nat. Trieste*. 51:65-68.
- Selbmann L., de Hogg G.S., Onofri S. (2005). Ecologia, origine ed evoluzione di specie fungine endemiche delle Secche di McMurdo in Antartide. *Inform. Bot. It.*, 37:870-871.
- Onofri S., Selbmann L., Zucconi L., Tosi S., de Hogg G.S. (2005). The mycota of continental Antarctica. *Terra Antarctica* 11:37-42.
- Borghini F., Bargagli R. (2005). A preliminary survey on the biogeochemical cycle of C, N and S in lakes of northern Victorian Land. *Polarnet Tech. Rep.* 1/2005:1-5.
- Agnorelli C., Bargagli R. (2005). Physico-chemical properties of geothermal soils colonized by mosses in northern Victoria Land (Antarctica). *Polarnet Tech. Rep.* 1/2005:6-10.
- Cavacini P., Fumanti B. (2005). Cyanobacterial algal biodiversity at Edmonson Point (northern Victoria Land, Antarctica). *Polarnet Tech. Rep.* 1/2005:19-22.
- Andreoli C., Strozzi L., Moro I. (2005). Morphological, ultrastructural and molecular surveys on *Urospora* sp. (Chlorophyta, Ulvophyceae, Acrosiphoniales) from Antarctica (Terra Nova Bay, Ross Sea). *Polarnet Tech. Rep.* 1/2005:30-33
- Allegrucci G., Todisco V., Sbordoni V., Carchini G. (2005). Progress in molecular phylogeny of Antarctic Chironomidae. *Polarnet Tech. Rep.* 1/2005:58-62.

E – thematic maps

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F – patents, prototypes and data bases

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G – exhibits, organization of conferences, editing and similar

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H - formation (PhD thesis, research fellowships, etc.)

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Research units

R. Bargagli – Dept. Environmental Sciences, University of Siena (biogeochemistry and ecosystem functioning, Coordination of research activities)

C. Andreoli – Dept. Biology, University of Padoa (molecular biology and ecophysiology cyanobacteria and algae)

G. Carchini - Dept. Biology, University of Rome Tor Vergata (phylogeny of Antarctic Chironomidae)

F. Frati – Dept. Evolutionary Biology, University of Siena (phylogeny and genetic variability of Antarctic collembola)

B. Fumanti – Dept. Plant Biology, University of Rome "La Sapienza" (Taxonomy and biogeography Antarctic algae)

P.L. Nimis - Dept. Biology, University of Trieste (taxonomy and biodiversity of Antarctic lichens)

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Notes