

**Baseline investigations of the Lichens and Bryophytes at  
Grand Canyon-Parashant National Monument, Part II**

**A Cooperative Proposal between  
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**and the**

**U.S. National Park Service  
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## BACKGROUND

Grand Canyon-Parashant National Monument (PARA) was created in 2000, and includes more than 1 million acres of complex and often remote landforms. Situated at the junction of two major biomes, each with unique and diverse floras, PARA contains elements of both the Colorado Plateau and the Mojave Desert. Geologic materials ranging from deeply dissected sandstones, characteristic of the Grand Canyon, to coarse volcanic intrusions, and these produce a spectacular array of landforms and habitats. Because of its highly variable climatic conditions across its major ecological regions and of its heterogeneous landscape, PARA supports a diverse flora, with vascular plant vegetation ranging from Ponderosa pine forests on Mt. Trumbull to Giant Mohave Yucca at lower elevations.

Within the context of this extensive, heterogeneous landscape, PARA probably contains some of the most remote and least surveyed lands in the American Southwest. This complex and relatively inaccessible landscape likely contains very diverse lichen and bryophyte vegetation types. First year surveys conducted in 1993 yielded 173 species in 58 lichen genera from seventeen sites visited during approximately 5 days in the field. 38 species were new to this region, and the second record of *Letharia vulpina* for the State of Arizona was found. The potential exists for many more species to be added to the lists, and for many more significant finds. Knowledge of these floras, though intrinsically valuable to land managers charged with documenting the important resources of PARA, will also be important for planning biomonitoring of ecological trends related to past and future human activities.

For example, PARA lies downwind from the former atomic testing site in southern Nevada. Radionuclide emissions in the 1940's and 1950's resulted in subsequent well documented human health degradation in southern Utah immediately north of PARA. Because the half life of many radionuclides extends from years to millions of years, it is likely that radioactive signals are still detectable, particularly in long-lived vegetation, such as lichens. The utility of using lichens to monitor radioactive deposition is well established (e.g. Palmer et al. 1965, Seaward et al. 1988, Biazrov 1994).

Today PARA lies downwind from Las Vegas, one of the most rapidly growing urban regions in North America. The proximity of this large city will result in many visitors coming to the park and their physical impact on the monument, such as the potential degradation of the cryptogamic crusts, largely formed by lichens and bryophytes (Belnap and Lange 2001), will be a management issue for PARA. Similarly, PARA is likely to be impacted by increasing air pollutant emissions from the Las Vegas region as well as coal-fired power plants that are situated in remote areas of the Southwest. Both lichens and bryophytes are excellent surrogate receptors of atmospheric deposition (Garty 2001, Nash 1989, Puckett 1988, Zschau et al. 2003), and spatial and historical variation in deposition patterns can readily be monitored.

Accordingly the goal of this research to initiate documenting the range and variability of lichens and bryophytes across different vascular plant vegetation types, selected in collaboration with PARA personnel, who plan to join us in the field.

## **OBJECTIVES**

1. Survey the lichen species occurring in a range of habitats and microhabitats, as are readily accessible over a 3-5 day field excursion.
2. Identify species of lichens and bryophytes, which due to their widespread distribution and local abundance would be suitable for future biomonitoring of radionuclides and/or metal deposition.
3. Based on preliminary observations of the communities visited and information about past land practices provided by PARA personnel, provide a preliminary, non-quantitative assessment, on whether relatively undisturbed cyptogamic communities are present.
4. If additional monies become available in FY05, the objectives and scope of work may be modified to start some of the biomonitoring identified, or to start other experiments. If this occurs, a new Scope of Work will be prepared

## **STUDY AREAS**

The Grand Canyon-Parashant National Monument is jointly managed by the Bureau of Land Management (BLM) and the NPS. Preliminary inspection of the maps available indicates that the more remote, lower elevation sections of PARA are the NPS-managed lands on the southern portion of the landbase. We anticipate investigating a range of sites across an elevational gradient from NPS to BLM portions of the monument.

## **PROCEDURES**

In order to maximize the chances of locating diverse lichen and bryophyte communities within PARA and to minimize the cost associated with field travel, these investigations will rely on the PI's knowledge of cryptogamic microhabitat variability together with pre-survey investigations by PARA personnel into potential sites as well as the initial investigations of Leila Shultz, who will precede us in her investigations of relic vascular plant communities. Monument personnel can often give information on areas that could be missed through other methods. In conjunction with monument staff interviews and examination of existing topographic, land-use and geological maps, potential sampling sites will be identified. It is anticipated that this methodology will minimize costs associated with locating these usually isolated areas within large, heterogeneous landscapes.

At each site a range of potential lichen and bryophyte substrates will be surveyed, including soils, litter, rocks (including the range of basic and acidic types available), bark

(recorded by vascular plant species or genus) and wood. Longitude and latitude for each site will be measured with a GPS device and recorded.

Lichen and bryophyte specimens will be prepared according to standard herbarium practices (Nash et al. 1993) and deposited in the Arizona State University lichen herbarium (ASU). A representative collection of duplicate specimens will be deposited in the monument. We will follow Esslinger and Egan (1995) for nomenclature of the lichens.. These are an integral part of the USDA Integrated Taxonomic Information System (ITIS) used in our respective herbarium management systems as well as by the NPSpecies and ANCS+ Databases used by the NPS.

In the case of lichens identification frequently requires microscopic examination, both with stereomicroscopes and compound microscopes, both of which will be provided by Arizona State University. For lichens, knowledge of secondary metabolites occurring in them is frequently essential for accurate determinations. These will be identified with standard thin layer chromatographic procedures (e.g. Culberson 1972).

## **DELIVERABLES**

For FY 2004-05

- By September 30, 200, a draft final report with a list of sites sampled and a preliminary list of species found will be provided.
- A final report due December 30, 2005 listing all species found by site and including a preliminary assessment of the cryptogamic crusts as well as recommendations on potential species to be used in future biomonitoring investigations. Information on lichens will be available at <http://ces.asu.edu/collections/> and may be searched at Southwestern Environmental Information Network through the same web site at any point in the future to provide updates as identifications are inevitably revised by subsequent systematic investigations. Hard copies (two each) and electronic copies of the final report will be provided to Kari Yanskey and CPCESU.

For FY 2006

- to be negotiated pending available funding.

## **TO BE PROVIDED BY COOPERATOR**

- Motorized vehicle travel (ATVs, other vehicles as appropriate)
- Lodging in government bunkhouses or otherwise as appropriate
- Existing maps, imagery, photographs, GIS layers as described above for site selection

## **P.I. AND CONTRACTOR JUSTIFICATION & INSTITUTIONAL COLLABORATION**

Dr. Thomas H. Nash III will (1) be responsible for the verification of lichen names in the NPSpecies Database, (2) participate in the field excursion, and (3) provide full use of the Arizona State University Lichen Herbarium facilities. Dr. Nash is the PI on a National Science Foundation supported greater Sonoran Desert Lichen Flora project, which includes the PARA region, is a past president of the American Bryological and Lichenological Society. He has international collaborations with colleagues in Europe and Australasia and has published approximately 150 research papers and 3 books. A short curriculum vitae for Dr. Nash is attached. The Department of Plant Biology at Arizona State University will be the cost center for the project.

#### **PROJECT SUMMARY AND SCHEDULE.**

This is a one-year project, within the context of a multi-year proposal. This research consists of the following tasks:

1. Field work at PARA, including all collections in collaboration with PARA staff.  
Dates to be determined
2. Curation of collected material – after field work
3. Identification of curated material –June to December, 2005
4. Final report compilation –September to December, 2005

#### **Literature Cited**

- Anderson, L. E., H. A. Crum, and W. R. Buck. 1990. List of the mosses of North America north of Mexico. *Bryologist*, 93: 448-499.
- Belnap, J. and Lange, O.L. 2001. *Biological Soil Crusts: Structure, Function, and Management*. Ecological Studies 150. Springer Verlag: Berlin & Heidelberg.
- Biazrov, L.G., 1994. The radionuclides in lichen thalli in Chernobyl and east Urals areas after nuclear accidents. *Phyton [Austria]* 34, 85-94.
- Culberson, C.F. 1972. Improved conditions and new data for the identification of lichen products by a standardized thin-layer chromatographic method. *J. Chromatogr.* 72: 113-125.
- Esslinger, T.L. and Egan, R.S. 1995. A sixth checklist of the lichen-forming, lichenicolous and allied fungi of the continental United States and Canada. *Bryologist* 98: 467-549.
- Garty, J., 2001. Biomonitoring atmospheric heavy metals with lichens: theory and application. *Critical Review in Plant Sciences* 20, 309-371.
- Nash, III, T. H., 1989. Metal tolerance in lichens. In: J. Shaw (ed.) *Metal Tolerance in Plants: Evolutionary Aspects*. CRC Press, Boca Raton, Florida, pp. 119-131.

Nash III, T.H., Wetmore, C., Anderson, W., Bratt, C., Denison, W. Eversman, S., Murray, B. and St. Clair, L. 1993. Floristics. Chapter 1, pp 6 – 15. In Huckaby, L.S. (ed.) Lichens as Bioindicators of Air Quality. Ft. Collins: USDA Forest Service General Technical Report RM-224.

Palmer, H.E., Hanson, W.C., Griffin, B.I., Braby, L.A., 1965. Radioactivity measured in Alaskan natives, 1962-1964. *Science* 147, 620-621.

Puckett, K.J., 1988, Bryophytes and lichens as monitors of metal deposition. *Bibliotheca Lichenologica* 30, 231-267.

Seaward, M.R.D., Heslop, J.A., Green, D., Bylinska, E.A., 1988. Recent levels of radionuclides in lichens from southwest Poland with particular reference to <sup>134</sup>Cs and <sup>137</sup>Cs. *Journal of Environmental Radioactivity* 7, 123-129.

Zander, R. H. 1993. Genera of the Pottiaceae: Mosses of Harsh Environments. *Bulletin of the Buffalo Society of Natural Sciences* Vol. 32. Buffalo, NY. 378p.

Zschau, T., Getty, S., Gries, C., Asmeron, Y., Zambrano, A. and Nash III, T.H. 2003. Historical and current atmospheric deposition to the epilithic lichen *Xanthoparmelia* in Maricopa County, Arizona. *Environmental Pollution* (in press).

**Budget, FY 2004-05**  
**for the “Continuation of Survey of the Lichens and Bryophytes of**  
**Grand Canyon – Parashant National Monument”**

|                            |            |
|----------------------------|------------|
| Salaries and Benefits      |            |
| Salaries                   |            |
| PI – Dr. Nash              | \$4944     |
| Student/K. Sweat           | \$4091.50  |
| Grad Student               | \$900      |
| Undergrad –hourly          | \$770      |
| Total Salaries             | \$10705.50 |
| Fringe Benefits (12.25%)   | \$1494.50  |
| Total Salaries & Fringe    | \$12,200   |
| Travel                     | \$600      |
| Materials & Supplies       |            |
| Supplies                   | \$300      |
| Publication                | \$100      |
| Total Mater. & Suppl.      | \$400      |
| Total Project Direct Costs | \$13,200   |
| Indirect Costs (17.5%)     | \$2800     |
| Total Costs                | \$16,000   |

**Budget Justification – Grand Canyon – Parashant**

**A. Salaries**

Dr. Nash will devote \_\_\_ months to the project, traveling to the field with students, and working with the students in the lab to certify proper identifications. Mr. Ken Sweat, a Ph.D. candidate under Dr. Nash and lecturer at ASU West, will assume primary responsibility for collecting lichens in the field, curating them and identifying them using the facilities at Arizona State University. A different graduate student will assist in the field collecting (ca. one week) and assist with sectioning of the crustose lichen material (anticipated to be most of what is collected) for approximately one week in the laboratory. The undergraduate, working on an hourly basis, will assist with thin layer chromatography of the

specimens to determine their secondary metabolites and with data entry into the Arizona State University lichen herbarium system.

**B. Fringe Benefits**

Both Dr. Nash and Mr. Sweat's summer salary carry a 15% fringe benefit rate, as their medical insurance was paid during the academic year. The graduate student is calculated at 7%, as no tuition contribution is anticipated during the semester. The hourly undergraduate is figured at 4%.

**C. Travel – Dr. Nash and Mr. Sweat will be reimbursed for driving their personal vehicles to the research sites from Phoenix.**

**D. Materials and Supplies – This budget of \$300. will allow purchase of one box of TLC plates for chemical analyses and minor herbarium supplies (paper, etc.). The publication cost (\$100.) will support printing costs, such as the purchase of a laser cartridge**

Indirect Costs – Due to agency limitation (e.g. National Park Service negotiation with Northern Arizona University; C. Redman as the Arizona State University representative), indirect is calculated as 17.5% (see <http://jan.ucc.nau.edu/~envsus-p/new/index.htm>).

**Arizona State University Sponsored Projects Officer:**

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## VITAE AND PUBLICATIONS

**Name:** Thomas H. Nash III                      **Citizen:** U.S.

**Birth:** November 13, 1945 in Arlington, Virginia

**Education:**

**Major:**

|                         |         |             |                     |
|-------------------------|---------|-------------|---------------------|
| Duke University         | B.S.    | 1967        | Botany              |
| University of Minnesota | Summers | 1967 & 1969 | Biology             |
| Rutgers University      | M.S.    | 1969        | Botany              |
| Rutgers University      | Ph.D.   | 1971        | Botany & Statistics |

**Honors:** 1978 & 1985/6 Alexander von Humboldt Fellowship (Germany); 1986 Fellow, Arizona-Nevada Academy of Science; 1992/93 Fulbright Fellowship (Austria); 1999/2000/2001 senior Alexander von Humboldt Research Prize (Germany)

**Societies:** American Bryological and Lichenological Society, The British Lichenological Society, The Biometric Society, Ecological Society of America, American Association for the Advancement of Science, American Institute of Biological Sciences, Organization for Tropical Studies, Arizona-Nevada Academy of Science (fellow), Sigma Xi (life member)

**Professional Experience:**

2001 – 5 weeks with Dr. G. Rambold, University of Bayreuth, Bayreuth, Germany  
2000 – 3 months research with Dr. H. Hertel, Staatssammlung, Munich, Germany  
2000 – 2 months research with Dr. B. Buedel, University of Kaiserslautern, Germany  
1993 & 95 & 99 - 11 months of research with Dr.J. Kesselmeier, Max Planck Institute for Chemistry, Dept. of Biogeochemistry, Mainz, Germany  
1986 & 1987 - five months of research with Prof. O.L. Lange, University of Würzburg, Germany  
1985 & 1986 – five months of research with Dr. J.A. Elix, Dept. of Chemistry, Australian National University, Canberra  
1985 - five months of research with Prof. L. Kappen, University of Kiel, Germany  
1978 - twelve months of research with Prof. O.L. Lange, University of Würzburg, Germany  
1981-present Professor of Botany, Arizona State University  
1976-1981 Associate Professor of Botany, Arizona State University  
1971-76 Assistant Professor of Botany, Arizona State University

**Principal Professional Service:**

1975-81 Secretary, International Association for Lichenology  
1979-81 Vice-President, American Bryological and Lichenological Society  
1981-83 President, American Bryological and Lichenological Society

1995-present – Associate Editor, Bibliotheca Lichenologica  
1997 Host, XXIX Air Pollution Workshop

### **Principal Research Interests**

Systematics, floristics, and ecology of the lichenized fungi. Currently bringing to conclusion the Greater Sonoran Desert lichen flora project and a monograph for Hypotrachyna for Flora Neotropica.

### **Five Publications relevant to this proposal**

Nash III, T.H., Ryan, B.D., Gries, C., and Bungartz, F. (eds.). 2002. Lichen Flora of the Greater Sonoran Desert Region. Vol. I. Tempe, Lichens Unlimited. 532 pp.

Lumbsch, H.T., Nash III, T.H. and Messuti, M.I. 1999. A revision of Pertusaria species with hyaline ascospores in southwestern North America (Pertusariales, Ascomycotina). Bryologist 102: 215-239.

Moberg, R. and Nash III, T.H. 1999. The genus Heterodermia in the Sonoran Desert area. Bryologist 102: 1-14.

Elix, J.A. and Nash III, T.H. 1997. A monograph of the lichen genus Pseudoparmelia (Ascomycotina, Parmeliaceae). Bryologist 100: 482-498.

Nash III, T.H., J.A. Elix and C. Gries. 1995. A Monograph of the South American Xanthoparmeliae. Bibliotheca Lichenologica 56: 1-157. J. Cramer: Berlin & Stuttgart.

### **Five Other Publications**

Herrera, M. de los A., Clerc, P. and Nash III, T.H. 1998. Pendulous Usneae from the temperate forests in Mexico. Bryologist 101: 303-329.

Ryan, B.D. and Nash III, T.H. 1997. Placodioid taxa of Lecanoraceae sensu Zahlbr. (lichenized Ascomycotina) in North America: Taxa excluded from Lecanora subg. Placodium. Nova Hedwigia 64: 393-420.

Ryan, B.D. and Nash III, T.H. 1997. Systematics of Lecanora subgenus Placodium (Lichenized Ascomycotina) in North America: an overview with keys. Nova Hedwigia 64: 111-127.

Nash III, T.H. (ed.) 1996. Lichen Biology. Cambridge: Cambridge University Press.

Elix, J.A. and T.H. Nash III. 1992. A synopsis of the lichen genus Psiloparmelia (Ascomycotina, Parmeliaceae). Bryologist 95: 377-391.