

South Carolina: Charleston Co.: LSUMZ 36919, Jasper Co.: LSUMZ 74432

Tennessee: Lake Co.: LSUMZ 74856

Texas: Anderson Co.: TCWC 64992, TCWC 81207, Angelina Co.: SFA 654, Aransas Co.: TCWC 81205, Austin Co.: TCWC 4583, TCWC 6453, Burleson Co.: TCWC 18279, Brazoria Co.: TCWC 53155, Brazos Co.: TCWC 5164, TCWC 13838, TCWC 45620, Chambers Co.: TCWC 60707, Colorado Co.: TCWC 64322, Dewitt Co.: TCWC 82477, Fort Bend Co.: TCWC 81641, Galveston Co.: TCWC 27368, Grimes Co.: TCWC 64991, TNHC 36319, Hardin Co.: TNHC 4534, TNHC 19800, TNHC 21940, TNHC 28728, Harris Co.: TCWC 183, TCWC 8711, TCWC 18278, Harrison Co.: TCWC 79273, Houston Co.: TCWC 67299, Jackson Co.: TCWC 29467, Jasper Co.: SFA 2896, TCWC 48425, TCWC 78732, Jefferson Co.: TCWC 8710, TCWC 16178, Leon Co.: TCWC 2614, TCWC 5158, TCWC 5159, TCWC 5160, TCWC 5161, TCWC 5162, TCWC 5163, TCWC 5177, TCWC 8709, TCWC 8712, Liberty Co.: TNHC 21846, Madison Co.: TCWC 17389, TCWC 49322, Morris Co.: TCWC 78731, Montgomery Co.: TCWC 57916, TCWC 68233, TCWC 68237, TCWC 81209, TCWC 82476, Nacodoches Co.: SFA, SFA 1216, SFA 1233, SFA 2033, SFA 2291, SFA 2309, Newton Co.: TCWC 48426, Orange Co.: TCWC 33646, TNHC 21963, Refugio Co.: TNHC 20583, TNHC 32202, San Jacinto Co.: LSUMZ 34289, Tyler Co.: TCWC 78730, TCWC 81204, Victoria Co.: TCWC 70080, Walker Co.: TCWC 67234, TCWC 82818, Wharton Co.: TCWC 4757, TCWC 81206

Unknown Locality: SFA, SFA, TCWC 31956

offs, and possible extinctions (Berger et al. 1998; Bosch et al. 2001; Carey et al. 2003; Daszak et al. 1999; Green et al. 2002; Muths et al. 2003). *Batrachochytrium dendrobatidis* has been considered an aquatic pathogen because it requires water to transmit zoospores (Longcore et al. 1999) and cannot survive desiccation (Johnson et al. 2003). In wild populations of amphibians, chytridiomycosis has only been associated with aquatic habitats and surface water. We report here the first case of chytridiomycosis in a wild-caught, strictly terrestrial salamander. Our discovery expands the known ecological occurrence of this deadly pathogen into the terrestrial community, and indicates that many more amphibians, not just those associated with aquatic habitats, are potentially vulnerable to the disease.

We observed a *B. dendrobatidis* infection through histological examination in wild-caught terrestrial Jemez Mountains Salamander (*Plethodon neomexicanus*, Plethodontidae), a species endemic to the relatively dry slopes of the Jemez Mountains, New Mexico, USA. A single gravid adult female (specimen 18810; U.S. Geological Survey, National Wildlife Health Center, Madison, Wisconsin; mass: 2.57 g; SVL: 63.3 mm) was collected in a meadow with a few aspen trees (*Populus tremuloides*) (2950 m elev.). The infected salamander had typical foci of infection around the vent containing multiple zoosporangia of *B. dendrobatidis* and black flakes of unshed skin around the vent (Fig. 1A), characteristic of abnormal ecdysis (Berger et al. 1998). Cytological and histological examinations of the abnormal molt and epidermis revealed thalli and zoosporangia of *B. dendrobatidis* (Fig. 1B, 1C). In addition, a PCR-based assay, which amplifies the internal transcribed spacer regions of the rDNA cassette specific to *B. dendrobatidis* (Annis et al. 2004), confirmed the presence of DNA of *B. dendrobatidis* in skin of the ventrum and tail.

This first report of chytridiomycosis in a wild-caught, strictly terrestrial species suggests that *B. dendrobatidis* survives in terrestrial habitats. The persistence and transmission mechanisms of the pathogen in terrestrial communities remain largely unknown. It is possible that the fungus was transmitted to this salamander either by direct or indirect contact with sympatric infected aquatic amphibians. Other sympatric amphibians include Tiger Salamanders (*Ambystoma tigrinum*) and Boreal Chorus Frogs (*Pseudacris maculata*).

Although Stuart et al. (2004) concluded that enigmatic agents are primarily affecting Neotropical montane stream-associated species, it is generally accepted that surface water-associated amphibian species on all continents are at serious risk from *B. dendrobatidis*. Despite suspected declines in some terrestrial salamanders (Parra-Olea et al. 1999), and a report of chytridiomycosis in a captive terrestrial salamander (Pasmans et al. 2004), this pathogen has not been a major concern in strictly terrestrial frogs, salamanders, or caecilians because of their dissociation from surface water. The discovery of chytridiomycosis in a wild-caught terrestrial salamander significantly expands the potential host-range of *B. dendrobatidis*, suggesting that many more amphibians are at risk than previously thought.

Terrestrial communities might play a heretofore unrecognized, but important role, in the distribution, persistence, or dispersal of this epizootic pathogen. Whereas effective methods of control of *B. dendrobatidis* in sites of natural amphibian populations are unknown, attention should be directed towards limiting the spread

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Aquatic Chytrid Pathogen Detected in Terrestrial Plethodontid Salamander

MICHELLE R. CUMMER

Department of Biology, Utah State University
5305 Old Main Hill, Logan, Utah 84322-5305, USA
e-mail: mcummer@biology.usu.edu

D. EARL GREEN

U.S. Geological Survey, National Wildlife Health Center
6006 Schroeder Rd, Madison, Wisconsin 53711, USA
e-mail: david_green@usgs.gov

and

ERIC M. O'NEILL

Department of Biology, Utah State University
5305 Old Main Hill, Logan, Utah 84322-5305, USA
e-mail: eric@biology.usu.edu

A conservative estimate by Stuart et al. (2004) identified declines in 43% of all amphibian species worldwide. Three major causes were recognized as underlying these rapid global declines: overexploitation, habitat reduction, and enigmatic agents (Stuart et al. 2004). Enigmatic agents (mainly pathogens) may be responsible for driving nearly a quarter of the world's amphibian species towards rapid extinction (Stuart et al. 2004). The main relationship currently recognized between a pathogen and amphibian declines has been with the chytrid fungus *Batrachochytrium dendrobatidis* (Chytridiomycota) (Carey et al. 2003). This emerging fungal pathogen causes the disease chytridiomycosis and is responsible for amphibian declines, die-

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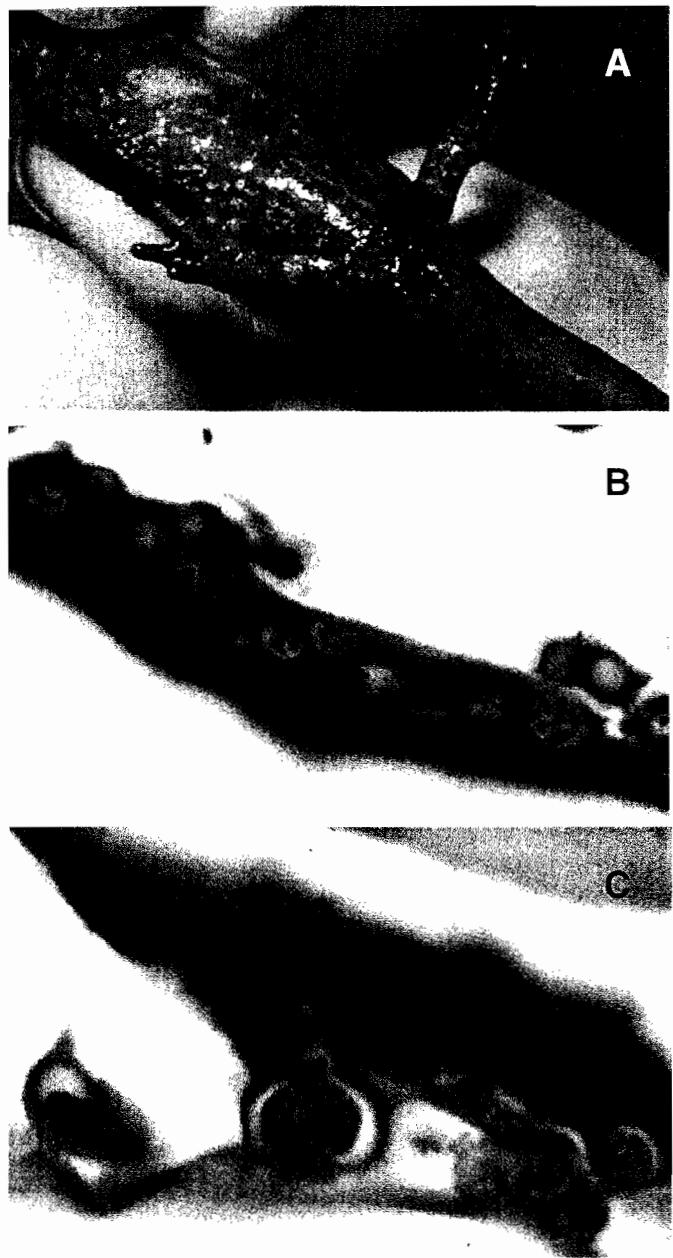


FIG. 1. Infection of *Batrachochytrium dendrobatidis* in terrestrial Jemez Mountains Salamander (*Plethodon neomexicanus*). A) Infected female with abnormal (black) spots around vent as it appeared after 11 days at 4°C. The black foci were limited to ventral skin and consisted of abnormally retained flakes of molt (dys-ecdysis). B) Histological section (hematoxylin and eosin [H&E] stain, 1000x) of abnormal molt showing numerous spherical zoosporangia of *B. dendrobatidis*. C) the larger flask-shaped chytrid thallus at bottom center is filled with zoospores and shows a characteristic discharge pore at the 12 o'clock position (H&E stain, 1000x).

of the agent by strict biosecurity measures in the field to prevent anthropogenic transmission and dispersal. Continued and expanded efforts to monitor the status of amphibian populations worldwide, to understand the biology of this pathogen, and to investigate the complex interactions of this host-pathogen system are urgently needed to reduce global losses of amphibian species.

- ANNIS, S. L., F. P. DASTOOR, H. ZIEL, P. DASZAK, AND J. E. LONGCORE. 2004. A DNA-based assay identifies *Batrachochytrium dendrobatidis* in amphibians. *J. Wildlife Dis.* 40:420–428.
- BERGER, L., R. SPEARE, P. DASZAK, D. E. GREEN, A. A. CUNNINGHAM, C. L. GOGGIN, R. SLOCOMBE, M. A. RAGAN, A. D. HYATT, K. R. McDONALD, H. B. HINES, K. R. LIPS, G. MARANTELLI, AND H. PARKES. 1998. Chytridiomycosis causes amphibian mortality associated with population declines in the rain forests of Australia and Central America. *Proc. Natl. Acad. Sci. USA* 95:9031–9036.
- BOSCH, J., I. MARTÍNEZ-SOLANO, M. GARCÍA-PARÍS. 2001. Evidence of chytrid fungus infection involved in the decline of the common midwife toad (*Alytes obstetricans*) in protected areas of central Spain. *Biol. Conserv.* 97:331–337.
- CAREY, C., D. F. BRADFORD, J. L. BRUNNER, J. P. COLINS, E. W. DAVIDSON, J. E. LONGCORE, M. OUELLET, A. P. PESSIER, AND D. M. SCHOCK. 2003. Biotic factors in amphibian population declines. In G. Linder, S. K. Krest, and D. W. Sparling (eds.), *Amphibian Decline: An Integrated Analysis of Multiple Stressor Effects*, pp. 153–207. Society of Environmental Toxicology and Chemistry, Pensacola, Florida.
- DASZAK, P., L. BERGER, A. A. CUNNINGHAM, A. D. HYATT, D. E. GREEN, AND R. SPEARE. 1999. Emerging infectious diseases and amphibian population declines. *Emerg. Infect. Dis.* 5:735–748.
- GREEN, D. E., K. A. CONVERSE, AND A. K. SCHRADER. 2002. Epizootiology of sixty-four amphibian morbidity and mortality events in the USA, 1996–2001. *Ann. New York Acad. Sci.* 969:323–339.
- JOHNSON, M. L., L. BERGER, L. PHILIPS, AND R. SPEARE. 2003. Fungicidal effects of chemical disinfectants, UV light, desiccation and heat on the amphibian chytrid *Batrachochytrium dendrobatidis*. *Dis. Aquat. Org.* 57:255–260.
- LONGCORE, J. E., A. P. PESSIER, AND D. K. NICHOLS. 1999. *Batrachochytrium dendrobatidis* gen. et sp. nov., a chytrid pathogenic to amphibians. *Mycologia* 91:219–227.
- MUTHS, E., P. S. CORN, A. P. PESSIER, AND D. E. GREEN. 2003. Evidence of disease-related amphibian decline in Colorado. *Biol. Conserv.* 110:357–365.
- PARRA-OLEA, G., M. GARCÍA-PARÍS, AND D. B. WAKE. 1999. Status of some populations of Mexican salamanders (Amphibia: Plethodontidae). *Rev. Biol. Trop.* 47:217–223.
- PASMANS F., P. ZWART, AND A. D. HYATT. 2004. Chytridiomycosis in the Central American bolitoglossine salamander (*Bolitoglossa doleini*). *Vet. Rec.* 154:153.
- STUART S. N., J. S. CHANSON, N. A. COX, B. E. YOUNG, A. S. L. RODRIGUES, D. L. FISCHMAN, AND R. W. WALLER. 2004. Status and trends of amphibian declines and extinctions worldwide. *Science* 306:1783–1786.