

## Letters to the Editor

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## Assisting, But Not Dictating

WHEN READING A JOURNAL SUCH AS *SCIENCE*, one is easily seduced into believing that empirical evidence can resolve moral disputes. In his Letter "Human being redux" (16 Apr., p. 388), M. S. Gazzaniga defends human embryonic stem cell research because of the vast discrepancy between a tiny ball of cells that can fit on the head of a pin and a live human being. J. T. Durkin ("The case against stem cell research," Letters, 3 Sept., p. 1402) minimizes this disparity by emphasizing that "[t]he embryo and the adult are different stages in the development of the human being." By referring to empirical information, they seem to think that the right (good) social policy for stem cell research can be justified. G. E. Moore's philosophical position, known as the naturalistic fallacy, argues that "goodness" is indefinable, and therefore its meaning cannot be logically derived by empirical means (1). That is, our biological underpinnings cannot prescribe what is good and right. However, facts in combination with a democratic ethic can assist in determining a policy decision. Although individuals will differ in their opinions, a democracy can decide whether the benefits of embryonic stem cell research outweigh any disadvantages. Science can assist in making this decision, but cannot dictate it (2).

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### References

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2. H. H. Kendler, *Amoral Thoughts About Morality: The Intersection of Science, Psychology, and Ethics* (Charles C. Thomas, Springfield, IL, 2000).

## Microbial Life in the Atacama Desert

IN THEIR REPORT "MARS-LIKE SOILS IN THE Atacama Desert, Chile, and the dry limit of microbial life," R. Navarro-González *et al.* found only very low levels of culturable bacteria in the Mars-like soils of the Atacama Desert, and they did not recover DNA

(Reports, 7 Nov. 2003, p. 1018). In contrast, we have found easily cultured, low numbers of bacteria and recoverable bacterial DNA from soils in the extreme arid core of the Atacama Desert in northern Chile.

Soil samples taken from a 4500-m elevational transect just south of the Tropic of Capricorn (−24°S) all yielded culturable bacteria on R2A agar (1, 2), including samples from elevations of absolute desert that have not harbored plant life for a million years or more. Four of our samples were taken in the vicinity of the dry Yungay region, in close proximity to those studied by Navarro-González *et al.* (elevation ~1000 m: S 24°4.16', W 69°51.98' and S 24°4.185', W 69°51.968'). Our three closest sites (987 m: S 24°4.517', W 70°12.555'; 1315 m: S 24°21.787', W 69°56.757'; and 1931 m: S 24°28.135', W 69°24.472') yielded counts of dry soil, respectively. A fourth site (703 m: S 23°57.417', W 70°17.157') yielded only 1 or 2 colonies per plate, which is a value too close to the detection limit of the spread plating method to quantify accurately but is still higher than that reported by Navarro-González *et al.* (<10 colonies found on 100 plates).

Image not available for online use.

### A rock formation in the extremely arid Atacama Desert in northern Chile.

Bacterial DNA was successfully extracted (3) from all of our samples (Navarro-González *et al.* report no recovery of DNA from the Yungay samples), and 16S rRNA genes were amplified (4, 5) and profiled by denaturing gradient gel electrophoresis (DGGE). Statistical analysis of DGGE profiles demonstrates a similar bacterial community structure in samples taken from soil profiles in the absolute desert portions of our Atacama transect. This community structure is quite different from that found in profiles from vegetated zones supported by fog or precipitation below (<500 m) and above (>2500 m) the absolute desert, respectively. Our results demonstrate the existence of life in one of the driest regions on Earth. We may have been able to demonstrate life

because we sampled at a depth of 20 to 30 cm, in comparison to Navarro-González *et al.*, who sampled the upper 10 cm of the soil. This only emphasizes the critical nature of the sampling protocol used in any extreme environment on Earth and particularly on Mars.

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### References

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3. Fast DNA Spin Kit for Soil, Qbiogene, Carlsbad, CA.
4. G. M. Colores, R. E. Macur, D. M. Ward, W. P. Inskeep, *Appl. Environ. Microbiol.* **66**, 2959 (2000).
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## Response

IN OUR PAPER, WE REPORTED EXTREMELY LOW levels of culturable organisms and no recoverable DNA in the surface soils of the extreme arid core of the Atacama Desert near the abandoned town of Yungay. We could not claim that there was no life in these soils on the basis of our results, and therefore we presented our data as indicating an upper limit of 100 culturable heterotrophic bacteria per gram of soil (see fig. 2E of our Report) for surface materials. This upper limit is orders of magnitude less than the concentrations of bacteria found in soils south of this Mars-like region of the Atacama. In more recent published work (1), we have reported that below the surface, there are discrete layers with higher numbers of culturable bacteria. For example, at a Yungay site, we have found negligible levels of bacteria at the surface (<100 CFU/g) but recovered less than  $1 \times 10^2$  to  $2.96 \times 10^5$  CFU/gram of soil in subsurface layers (1). In addition, we have conducted an extensive survey of surface and subsurface soils in the arid core of the Atacama (1–4). The data presented by Maier *et al.* for subsurface samples are consistent with our published work [our Report; (1–4)] and do not necessitate any reassessment or reevaluation of the conclusions of our Report. We agree with their conclusion regarding the critical nature of the sampling protocol used in any extreme environment on Earth and Mars.

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