that it is not a precise moment, but a gradation of human worth. With this model, a fetus at 3 months is somewhat of a human being, but a newborn is more of a human being. So is a 10-year-old more of a human being than a 1-year-old? Is a politician or athlete more of a human being than a wheelchair-bound paraplegic? Can we really stratify intrinsic human dignity and worth? Is human equality a myth? This sort of thinking forms the basis for demeaning entire classes of people, ultimately denying them their humanity. The 20th century has not been without ample evidence of the depravity of such thinking. Some history surely should not be repeated.

"To say that an embryo has the 'potential' to become a human being is dangerous."

Furthermore, it is an error to contend, as Feldbaum does, that it is a "faith-based belief that the cloned embryo's potential to become a person entitles it to legal and moral status as a person." No, the intrinsic dignity of a human person is not "faith-based"; it is a truth grounded in natural law, not theological exegesis. It is not a faith-based belief that a human embryo's potential to become a person entitles it to legal and moral status. It is a part of the fabric of natural law that the human embryo's actuality of being human entitles him or her to legal and moral status.

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Response

ULTIMATELY, SCIENCE CANNOT WIN AN argument with those who look at a sick person and a microscopic cluster of undifferentiated cells side by side and see the same thing: two human beings. But most people, regardless of religious or scientific background, intuitively recognize a difference between the two, as well as the gradations in development that Baumgartner finds so disturbing.

Baumgartner asks, "If a human embryo only has the potential to become a human being, then when precisely does the the embryo become a human being?" I cannot answer that question, although some scientists have suggested that the appearance of the primitive streak is an important demarcation. Implantation in the uterus is an important step as well, and that is where federal legislation that the biotechnology industry supports would draw the line.

The accusations of eugenics—particularly against the disabled—are inappropriate, given that the scientists engaged in this research are dedicated to helping patients with debilitating and deadly diseases.

"...science cannot win an argument with those who look at a sick person and a microscopic cluster of undifferentiated cells side by side and see the same thing..."

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Letters to the Editor

Letters (~300 words) discuss material published in *Science* in the previous 6 months or issues of general interest. They can be submitted by e-mail (science_letters@aaas.org), the Web (www.letter2science.org), or regular mail (1200 New York Ave., NW, Washington, DC 20005, USA). Letters are not acknowledged upon receipt, nor are authors generally consulted before publication. Whether published in full or in part, letters are subject to editing for clarity and space.

Human Appropriation of Net Primary Production

THE FRACTION OF TOTAL PLANT GROWTH OR net primary production (NPP) appropriated by humans, often referred to as human appropriation of net primary production (HANPP), is among the most widely used measures to assess the "human domination of Earth's ecosystems" (*1*). S. Rojstaczer *et al.* ("Human appropriation of photosynthesis products," Reports, 21 Dec., p. 2549) find large margins of error associated with many parameters needed to estimate HANPP, resulting in a HANPP range from 10 to 55% of global terrestrial NPP.

According to Rojstaczer *et al.*, one of the parameters adding the most uncertainty to HANPP estimates is productivity of agricultural land. The database (*2*) used to estimate these error ranges, however, contains studies of very different quality that unduly inflate uncertainty (*3*). Error ranges on agricultural productivity could be reduced by using harvest indices (*4*, *5*) that relate NPP on agricultural land to commercial harvest. Data on commercial harvest are readily available in Food and Agriculture Organization (FAO) statistics (*6*). These data are available on the national level, which makes them a good starting point for spatially more explicit analyses (*3*).

Agricultural land is also a useful example to discuss problems in defining HANPP (*7*–*9*). The decision by Rojstaczer *et al.* not to consider land-use–induced changes in NPP as part of HANPP can yield problematic results. For example, aboveground productivity on Austria's agricultural land increased by a factor of 2.6 from 1830 to 1995 and by a factor of 1.8 from 1950 to 1995 (*10*, *11*) because of changes in agricultural technology (fertilization, irrigation, and so forth). If one were to use the definition used by Rojstaczer *et al.*, one would find considerable increases in HANPP expressed in absolute values (e.g., tons of dry matter or carbon).

Increased agricultural productivity, however, allowed for a reduction of Austria's agricultural area by 25%, whereas forests grew by 22% from 1830 to 1995. This meant that about 23% more aboveground NPP remained in ecosystems, despite an increase in harvest of 73% during the same period (*10*). If we define HANPP as the difference between potential NPP and NPP remaining in ecosystems after harvest (*9*, *11*), we find that aboveground HANPP fell from about 60% of potential aboveground NPP in 1830 to about 50% in 1995 (*10*). We find this latter definition more useful than the convention proposed by Vitousek *et al.* (*7*), and also used by Rojstaczer *et al.*, which regards all NPP of forest plantations and human-managed grasslands as appropriated: Even in forest plantations, a considerable fraction of the NPP remains in the ecosystem and supports food chains not directly controlled by humans. Such inaccuracies should be avoided because they have already been used to question the HANPP concept altogether (*12*).

By using methods such as those suggested here and elsewhere (*3*), uncertainty of HANPP appraisals can be considerably reduced. This would improve the usefulness of HANPP for studying human-environment interaction.

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Response

IN CONTRAST TO MATURE SCIENTIFIC FIELDS, understanding of the global environmental impact of humans is still in its infancy. Haberl *et al.* note the need to develop a means to reduce uncertainty in estimates of human appropriation of NPP. We concur and stated this in our report. As they note, some reduction in uncertainty is possible by making changes in the model we used. In our report, we explicitly borrowed and did not modify the model of Vitousek *et al.* (*1*) because it is well known and we feel that it is a good starting point for attempting a worldwide assessment of NPP using more contemporary data.

As noted by Haberl *et al.*, this model can and should be improved. We agree, but significant reductions in uncertainty will not come about through modifications of this globally averaged model. Rather, major reductions in uncertainty will only be realized with more accurate estimates of the basic parameters governing human appropriation of NPP.

Haberl *et al.* suggest that by using Food and Agriculture Organization (FAO) data, we can get accurate estimates on the productivity of agricultural lands. It should be noted, however, that our estimate of uncertainty in productivity of agricultural land is less than the estimate of mean uncertainty of all the parameters in the model. We disagree with Haberl *et al.* that our estimates of uncertainty in this parameter are inflated.

FAO data sets are useful for estimating components of human appropriation of NPP, and we used them extensively in our analysis. FAO estimates, as noted by Haberl *et al.*, depend on data supplied by individual countries. With regard to developed, democratic nations (such as Austria), FAO data are of high quality. But the preponderance of the world's population lives in countries where government-based estimates of agriculture are poor or are modified for political purposes. Also, FAO data describe the edible mass produced and not the productivity of the land itself. Given these limitations, an FAO-based estimate of global agricultural productivity cannot be expected to provide an improvement over our estimate. Shortcomings like these point to the difficulty of measuring the human footprint on biological resources with current data sets.

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Fungal Diversity and Plant Roots

PHILIPPE VANDENKOORNHUYSE *ET AL.* ("Extensive fungal diversity in plant roots," Brevia, 15 March, p. 2051) report on various new and unusual fungi from roots of the grass plant *Arrhenatherum elatius*. I won't quibble about the putative identification and taxonomic grouping of the fungi involved, but the authors strongly suggest a necessary relationship between the fungi recovered and the plants themselves. I contend that it is just as likely that these fungi were associated with the plants simply by accident. Root sampling and cleaning techniques were not well described, but plant roots commonly have wounds associated with them even before sampling. Many organisms may become passively associated with such wounds or may even be drawn up into the nonliving root xylem if this is exposed to soil and soil water. Polymerase chain reaction techniques are so powerful that even traces of accidental associations would be detected. Thus, I contend that many of the novel organisms detected by the authors could simply be passive associations of soil organisms that have no necessary involvement directly with the roots of these plants. On the basis of DNA extractions from soil directly, we are all aware that most soil microorganisms have yet to be identified because they fail to culture easily on common growth media. The ones described by Vandenkoornhuyse *et al.* could simply be from that great array.

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Response

IN OUR BREVIA, WE CHARACTERIZE FUNGAL diversity in a mundane ecological niche, the roots of a plant. Sequences from roots of *Arrhenatherum elatius* revealed an unexpected diversity, with all known fungal phyla represented. The diversity within these phyla is very high, with a large proportion of fungi that could not be related to any known SSU rRNA gene sequence. The cleaning procedure of the root surface was designed to remove the mineral and organic particles. With this strategy, it is impossible to clean the inner root structures such as xylem. However, observations of stained roots under microscope showed only arbuscular mycorrhiza (Glomales) and septate endophytic fungal structures within or between the root cortical cells and a network of septate fungal filaments on the root surface. These external hyphae did not form the typical structures of ectomycorrhiza, nor did we observe any symptoms of plant pathology.

Crowe addresses, in part, the question of the ecological functions of these fungi associated with roots. One fungal group that we certainly did expect to find represented in roots was the arbuscular mycorrhizal (AM) fungi (*1*, *2*). These ubiquitous biotrophic zygomycetes in the order Glomales form symbioses with more than 80% of land plants (*3*). The co-occurrence of different symbiotic AM fungal phylotypes within the roots of a plant species is in agreement with previous work (*1*, *2*). However, our results show clearly that the Glomales correspond only to a small fraction of the fungal diversity in these roots.

We can only speculate on the possible roles of the other 94% of the root fungal diversity found here. Further studies are required to know which part of root fungal diversity interacts actively with host plant. A better knowledge of the diversity of the fungal world and a better understanding of fungal ecological functions in ecological niches and ecosystems are likely to become important issues.

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CORRECTIONS AND CLARIFICATIONS

SPECIAL ISSUE ON SUPRAMOLECULAR CHEMISTRY AND SELF-ASSEMBLY—NEWS: "Chemists look to follow biology lead" by J. Alper (29 Mar., p. 2396). The name in the photo credit for organic molecules appearing on page 2397 should have appeared as Sone *et al.*

PERSPECTIVES: "Of predators, prey, and power laws" by P. A. Marquet (22 March, p. 2229). In the figure, the *y* axis should have been labeled as "Log density/km^2."