

Elementary errors about entropy

SIR — We wish to correct a number of gross if elementary errors in John Maddox's article "When entropy does not seem extensive"¹.

First, entropy increases with increasing disorder, and does not decrease, as he claims. Second, it is the Helmholtz free energy and not the entropy difference that is proportional to $-\log Z^n$, where Z is the molecular partition function and n the number of molecules.

Maddox is also wrong to claim that the entropy of a black hole can be "equated with the calculable entropy of that radiation [from the black hole], whence the result that the entropy is proportional to the surface area". Even black-hole specialists allow that the radiation is black-body radiation, for which the entropy is proportional to the volume and the cube of the temperature. We know of no radiation whose entropy is proportional to the surface area.

That is one reason why it seems to us bizarre that the entropy of a black hole should be taken to be proportional to its surface area. The fact that the heat capacity of a black hole is negative is also a reason why such an object can never come into equilibrium with its radiation (among other things this suggests the Carnot rule does not apply, as Maddox asserts).

In our opinion, the extensivity property of the entropy is a red herring. The characterizing property of any entropy is its concavity^{2,3}, which ensures that heat should not spontaneously flow from cold to hot, that pressure should not increase with volume and that the chemical potential should not decrease as the particle number increases. The Beckenstein-Hawking entropy lacks concavity and so violates the second law.

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1. *Nature* **356**, 103 (1993).

2. Lavenda, B. H. & Dunning-Davies, J. (*Found. Phys. Lett.* **3**, 435–441 (1990)).

3. Lavenda, B. H. *Statistical Physics* (Wiley, New York, 1991).

Baha'i religion

SIR — Readers of *Nature* may be interested to know about the Baha'i religion, founded by Baha'u'llah in the mid-nineteenth century, which advocates science and religion as the two

potent forces in human life.

Baha'u'llah's teachings place great emphasis on spiritual principles as major contributors to all human achievements and hold religion to be the most effective means of establishing order in society. They call for recognition of the oneness of the human race as the prerequisite for the establishment of a world civilization. As incidentals to this central principle, Baha'u'llah teaches the abandonment of prejudices and blind imitations and calls for independent investigation of truth, universal education, equality of the sexes, essential harmony of science and religion and the need for a universal language. He also lays the blueprint for the future world civilization.

Commenting on some features of this world civilization envisaged by Baha'u'llah, Shoghi Effendi, the Guardian of the Baha'i religion, wrote in 1938:

"National rivalries, hatreds, and intrigues will cease, and racial animosity and prejudice will be replaced by racial amity, understanding and cooperation. The causes of religious strife will be permanently removed, economic barriers and restrictions will be completely abolished, and inordinate distinction between classes will be obliterated. Destitution on the one hand, and gross accumulation of ownership on the other, will disappear. The enormous energy dissipated and wasted on war, whether economic or political, will be consecrated to such ends as will extend the range of human inventions, and technical development, to the increase of the productivity of mankind, to the extermination of disease, to the extension of scientific research, to the raising of standard of physical health, the sharpening and refinement of human brain, to the exploitation of the unused and unsuspected resources of the planet, to the prolongation of human life, and to the furtherance of any other agency that can stimulate the intellectual, the moral and spiritual life of the entire human race."¹

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1. Shoghi Effendi, *World Order of Baha'u'llah*, 204 (Baha'i Publishing Trust, Wilmette, Illinois, 1982).

Epidemiology

SIR — Williams *et al.*¹ propose that terms applied to human disease should not be used for animal diseases. We dispute the suggestion that the terms describing the occurrence of diseases in populations should be distinguished by their hosts of principal significance.

We recognize that *-dem-* derives from the Greek *demos* (people) but we are sure that the authors of the letter would be comfortable with the term 'population dynamics' despite the fact that 'population' derives from the Latin '*populus*'.

Thus the only justification for the use of 'epizootic' seems to be that it is more specific than the generally accepted term 'epidemic'. The logical extension of this is that the authors of the letter in question (many involved in fisheries research) should be promoting the term epichthyotic while the study of disease in populations of birds should become epiornithology. This would lead to a ridiculous and confusing proliferation of unnecessary terms.

Many diseases are common to humans and nonhuman animals. Epidemiology, as a holistic discipline, should not create artificial distinctions. Would the authors prefer an individual investigating the natural history of toxoplasmosis to describe the study of its transmission among cats and sheep as epizootiology, that of its behaviour in humans as epidemiology and perhaps the transmission from animals to man as epizootodemiology?

The fact that the term epidemiology is both preferred and accepted for the study of diseases in populations in animals can be seen from the fact that the four major general textbooks published in the discipline^{2–5} all have the term epidemiology in the title. The primary journal for veterinary epidemiological studies (*Preventive Veterinary Medicine*) also encourages the use of epidemiology. We suggest that the terms epizootic and epizootiology be completely removed from the scientific literature.

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2. Schwabe, C. W., Riemann, H. P. & Franti, C. E. *Epidemiology in Veterinary Practice* (Lea & Febiger, Philadelphia, 1977).

3. Thrusfield, M. *Veterinary Epidemiology* (Butterworth, London, 1986).

4. Martin, S. W., Meek, A. H. & Willeberg, P. *Veterinary Epidemiology: Principles and Methods* (Iowa State Press, Ames, 1987).

5. Smith, R. *Veterinary Clinical Epidemiology. A Problem-Oriented Approach* (Butterworth-Heinemann, Boston, 1991).