

water extraction and penetration of compacted soil layers⁸. Once identified and mapped, these genes (which are extremely difficult to score in the field) could be readily tracked in a breeding programme via the associated molecular markers.

(4) Advances in basic knowledge of stress responses could come first from using the RFLP map in an analytical way to dissect major components of drought resistance, and second by creating novel variation by genetic transformation. An example of the former would be the identification of independent sets of genes controlling the same complex trait, such as genes regulating embryo abortion or pollen infertility⁹, both of which cause drought stress-induced sterility. More knowledge is needed to design and produce agronomically useful genotypes by transformation techniques, but some valuable experimental approaches, such as transfer of genes for betaine synthesis¹⁰ into rice can be imagined.

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Scientific Correspondence

Scientific Correspondence is intended to provide a forum in which readers may raise points of a scientific character. They need not arise out of anything published in *Nature*. In any case, priority will be given to letters of fewer than 500 words and five references. □

Gaian test

SIR—Lovelock (*Nature* **344**, 100; 1990) is unhappy at the lack of acceptance of his Gaian hypothesis but adds nothing that would help to answer any of the legitimate questions which arise. Instead, he ignores most of the wisdom of the past 300 years while shooting himself in the foot.

His first error is his table of 'successful predictions'. Long ago, David Hume pointed out that no number of positive instances 'prove' anything; the homely instance is that of a child dropping a soft toy from its pram a hundred times; this provides no guidance whatsoever for the experience of heaving a rubber ball overboard.

Popper expresses the idea explicitly. The essential property of a scientific theory is not verifiability, but falsifiability. The problem of Gaia is that it is a 'theory of everything'. As such, it is capable only of self-fulfilling prophecies. But Lovelock provides us in his article with a strong testable assertion. "Among the insights that come from a Gaian approach are that planetary life can never be sparse. A planet with a sparse life can never be self-regulating."

But the geological record indicates a number of catastrophes, each involving the disappearance of fossilizable species to at least 90 per cent. Clearly 10 per cent survival is not 'sparse'. Should a geological horizon be discovered tomorrow involving 99 per cent extinction, then 1 per cent is not sparse.

The assertion, which looked like a good test, merely demonstrates non-falsifiability, and hypotheses which are as resistant as this to contradiction are not scientific or philosophic, they are religious. No wonder Lovelock can boast that he is "moved by the interest taken by theologians and philosophers", while deploring the "rubbish" which the theory has accreted.

Lovelock's second error is to try to extract value and purpose from the theory, that is to derive a value from a fact (even if we agreed about the facts), a valuation from a description, or an 'ought' from an 'is'. As Hume put it, "In every system of morality, which I have hitherto met with I have always remarked, that the author proceeds for some time in the ordinary way of reasoning, and establishes the being of a God, or makes observation concerning human affairs; when of a sudden I am surprised to find that instead of the usual copulations of propositions is and is not, I meet with no proposition which is not connected with ought and ought not . . .".

Lovelock insists that Gaia (his replacement of one God by another would have made Hume smile), provides guidance for "understanding the consequences of pollution and environmental disturbance".

This idea is again testable. From the evidence or facts of the geological record we can see that repeated extinctions over the last 500 million years have eliminated 90 per cent of species without disruption to long term gaian self-regulation.

We conclude that we may proceed likewise, and proceed with extinctions, exploitations and pollution up to the 90 per cent level, without either physical or moral danger, and since we are not to be treated as special, we may be included in the 90 per cent. This is the logical conclusion. Is it acceptable to Lovelock or his theological, philosophical or green adherents? I think not.

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Ischaemic injury mediator

SIR—Feigl has suggested¹ that nitric oxide ($\cdot\text{NO}$), derived from endothelium, may be an important detoxifying mechanism for superoxide (O_2^-). Although O_2^- and $\cdot\text{NO}$ are known² to form rapidly the peroxynitrite anion, ONOO^- , our results suggest that ONOO^- is toxic and that preventing its formation may explain the therapeutic efficacy of circulating superoxide dismutase in many diverse insults³.

Peroxyntirite has a pK_a of 6.8 at 37 °C and when protonated decomposes to generate highly reactive agents: apparently hydroxyl radical ($\text{HO}\cdot$) and nitrogen dioxide (NO_2). Moreover, ONOO^- has a half-life of under 1 second at pH 7.4, allowing it to diffuse to critical cellular targets before decomposing. We have shown that classical $\cdot\text{OH}$ scavengers competitively inhibit oxidation initiated by ONOO^- decomposition, while the iron chelator desferrioxamine is a potent scavenger because of its direct reaction with ONOO^- , independently of its ability to bind iron.

Macrophages and neutrophils produce both O_2^- and $\cdot\text{NO}$ when activated^{4,5}, suggesting that ONOO^- may be an additional cytotoxic agent formed by these cell types. In endothelium and brain, Ca^{2+} is the intracellular messenger initiating the NADPH-dependent oxidation of arginine to produce $\cdot\text{NO}$ (ref. 5). Pathophysiological processes such as ischaemia, excessive activation of the *N*-methyl-D-aspartic acid receptor in brain, and sepsis allow the influx of Ca^{2+} into cells, which may stimulate the simultaneous production of $\cdot\text{NO}$ and O_2^- . Injurious amounts of ONOO^- could result, because every tenfold increase in the concentrations of $\cdot\text{NO}$ and O_2^- will increase ONOO^- formation 100-fold.

Such a mechanism may be important for reperfusion injury to ischaemic tissue, as ischaemic endothelium will accumu-