The end of the World is not nigh

Sir — My book *The End of the World: the Science and Ethics of Human Extinction*, reviewed by Freeman Dyson (*Nature* **380,** 296; 1996), joined Richard Gott (*Nature* **363,** 315; 1993) in developing a point originated by Brandon Carter. People have some grounds for distrusting any theory that makes them very unusually early among all humans who will ever have been born. Taking account of this, they can justifiably re-estimate the risk that humankind will soon be extinct. They can become less confident in Dyson's suggestion (*Reviews of Modern Physics* **51,** 246; 1979) that their descendants will continue onwards eternally.

Dyson calls it "typical" of the book to reason as follows: that if the number so far born is about a hundred billion then "our species has only a ten-per-cent chance of surviving as long as five hundred generations with our present size of population". In fact, however, the book follows Carter in arguing only for changes in the risk-estimates generated by examining various dangers. If Carter and I saw a gigantic asteroid rushing at us, or well funded plans for surviving asteroid impacts, then that would affect our probabilistic calculations. What Dyson calls typical bears scant resemblance to anything we have said. Further, we are innocent of the blunder he describes. We avoid assuming simultaneously (1) that, as he puts it, "we know nothing of our place in the history of our species", and (2) that we know we are placed "among the first hundred billion humans".

Consider the following story, told in the book. If fully funded, an experiment was sure to run as follows. Initially, three people would each receive an emerald. Several centuries later, emeralds would be given to 5,000 people. You yourself get an emerald. Imagine you are ignorant of your place in the population history of emerald-getters, but are certain the experiment was fully funded.

You should bet you are in the group of 5,000. However, suppose you instead know you are in the group of three, much as we could know we are in the first hundred billion humans. This fortifies any suspicions you may have that the experiment was poorly funded, so that few emeralds will be distributed later. No blunder here! For you need not be assuming, first, that you know absolutely nothing of your place among emerald-getters, so as to be able to ask in all seriousness whether you are in the group of three, and second, inconsistently, that you know you are in it. Instead, certain you are among the three, but unsure whether there will be 5,000 emerald-getters later, you can be rightly taking account of how likely you as an emerald-getter had been to find yourself among the three, against the background of competing theories about the funding.

Had the funding been so poor that only three emeralds would ever be distributed, then the likelihood was unity; with full funding, it was roughly 0.0006. Taking account of such likelihoods is not claiming to be ignorant of what, in the very next breath, you say you know.

Take a simpler case. Two urns each contain three black balls. In one, there is nothing else; in the other, an additional 5,000 white. Having no idea of which is which, you choose an urn by tossing a coin. A ball is drawn, and it is black. You conclude that there is little chance that the urn is the one with the 5,000 white, for the likelihood of drawing a black ball from that urn had been so small. This reasoning does not involve declaring first that you are ignorant that a black ball has been drawn, and second that you know it. Asking what the likelihood would have been, on various hypotheses, that you would observe what you actually did observe, is fundamental to all science.

Dyson adds that the book fails to "examine critically" the literature of the dangers confronting us. Can this be true? It evaluates lengthy arguments not only from doomsayers but also from their critics, concluding on page 146 that humankind's chances of avoiding extinction in the near future are "encouragingly high".

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There aren't plenty more fish in the sea

Sir — Six pages of Briefing on fisheries science (*Nature* **386**, 105–110; 1997) ably demonstrates why the fisheries sector is in crisis. The reality is that if fishermen meet the market demand for fish, fish stocks will be completely fished out within a very short time.

There is only one answer to the fisheries crisis: we must farm more fish. Every fish the market receives from farming means that one less fish needs to be caught from the sea. The problem is that there is no universal species or farming technique that will supply world needs. Appropriate requirements need to be identified on a local basis. Such limitations deter those looking at global solutions.

Unfortunately, this simple solution to the fisheries problem is unlikely to become a reality, for two reasons. The first is that traditional fisheries scientists have little knowledge of aquaculture and therefore do not perceive it to be a realistic solution. The second reason, and one that simply confirms the first, is that poor publicity from one or two examples of aquaculture where things have not gone quite right have damaged the potential for the aquaculture industry.

The example used in your Briefing is of shrimp farming, not fish production. There is no doubt that the commercial exploitation of farmed shrimp has led to problems. That is because previously extensive production units have simply been intensified beyond their capacity. While there is a clear focus on short-term rewards, there is also an increasing demand for these shrimp from the West, which has been met by this uncontrolled intensification.

Such over-exploitation of extensive farming techniques is the inevitable result of a fisheries sector that has marginalized aquaculture. This applies equally to Europe, where the European Commission has decided that aquaculture development should be determined by individual commercial ventures rather than by defined long-term strategic policies. Aquaculture features only as a structural policy, not as part of any grand plan.

In Europe, while ministers argue about whether they should cut fishing by 20% or 30%, they are missing the opportunity to develop large-scale low-cost fish production. This is not comparable to the coastal pond systems used to produce shrimp in Asia, but instead is a form of offshore open-sea farming on a huge scale. Not only would this supply much of our fish requirement, but it would also create many needed jobs for skilled fish handlers.

Fisheries policies, as outlined in the Briefing, do not seem to have worked. Maybe it is now time to go back to the drawing-board and re-evaluate our fisheries needs. If we drop all our preconceived ideas and start again with a clean sheet, maybe we could guarantee the survival of our fish stocks. The alternative is that fish will disappear from both the seas and our diet.

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