The American Association for the Advancement of Science

And now here is the virus forecast

The first of four reports from the American Association for the Advancement of Science looks at predicting plagues

ON FEBRUARY 18th a glimmer of hope died. The Population Council, a big international charity, announced the results of one of the largest trials yet undertaken of a vaginal microbicide intended to protect the user from infection with HIV, the virus that causes AIDS. It failed. Carraguard, whose principal ingredient is a gel derived from seaweed, proved no more effective than a placebo in an experiment involving 6,000 South African women.

AIDS kills over 2m people a year. A way of stopping it spreading is urgently required. Yet according to Nathan Wolfe, a virologist at the University of California, Los Angeles, things need never have got this bad. If there had been, in the 1970s, a programme searching for unrecognised diseases in Africa then AIDS would have been noticed long before so many people had started dying from it. Microbicides and other interventions could have been tested when only hundreds of thousands were infected, rather than tens of millions. AIDS would still have been horrible, but not nearly as horrible as it has become.

To try to stop this happening again, Dr Wolfe is attempting to create what he calls the

Global Viral Forecasting Initiative (GVFI). This is still a pilot project, with only half a dozen sites in Africa and Asia. But he hopes, if he can raise the $50m he needs, to build it into a planet-wide network that can forecast epidemics before they happen, and thus let people prepare their defences well in advance.

Dr Wolfe outlined his ideas, and the research that has led him to believe they are feasible, to this year's meeting of the American Association for the Advancement of Science (AAAS) in Boston. He began his work nearly a decade ago in Cameroon, in a project reminiscent of the 19th-century animal-collecting expeditions that pushed into the forest to look for new species. Except that his quarry is viruses, not butterflies and birds.

Small-game hunter

Almost all human viruses whose origins are known have come from animals. But it is not simply a matter of an animal virus suddenly finding humans to be a congenial host, and flourishing as a result. With AIDS, for example, the global epidemic is caused by what was originally a chimpanzee virus. There is, however, a second form of AIDS, caused by a monkey virus. This has not become global. It is pretty much restricted to West Africa. Moreover, there are a further two very rare forms caused by different versions of the chimpanzee virus. These rare forms are examples of what Dr Wolfe calls viral chatter, a term borrowed from intelligence agencies which monitor telephones for the use of certain words or unusual patterns of communication.

His thesis is that there is continual low-level interchange of viruses between species. That is particularly so for people, such as hunters and farmers, who are in constant and often bloody proximity to animals. His hope is that by monitoring this viral chatter he will be able to spot pathogens before they take the second, crucial evolutionary step of being able to transmit themselves from one human to another.

So far, he has concentrated his efforts on a group known as retroviruses, of which HIV is one. He has already found three examples of “foamy viruses” jumping from wild apes and monkeys to Cameroonian hunters. At the moment, no known foamy virus can spread between people. But until the 20th century that was true of the simian equivalents of HIV.

He has also found two new members of a group called HTLV that have moved from monkeys to men. Since HTLV-1, an example of the group discovered several decades ago, has already spread around the world, these cases are particularly noteworthy. HTLV-1 is not as common as HIV, and causes symptoms in only 5-10% of those it infects. But those symptoms can include a fatal leukaemia. And a different type of HTLV might not be so choosy about whom it kills.

Even more worryingly, Dr Wolfe has found many examples of viruses recombining in his Cameroonian hunters. Recombined viruses often have properties present in neither parent. Sometimes these include the ability to jump from human to human. The pandemic version of HIV is the result of such a recombination.

The next stage of the project is to try to gather as complete an inventory as possible of animal viruses, and Dr Wolfe has enlisted his hunters to take blood samples from whatever they catch. He is collaborating with Eric Delwart and Joe DeRisi of the University of California, San Francisco, to screen this blood for unknown viral genes that indicate new species. The GVFI will also look at people, monitoring symptoms of ill health of unknown cause and trying to match these with unusual viruses.

Nor, if Dr Wolfe can raise the money, will the project be confined to tropical forests. Animal markets are next in line. Dr Wolfe is working with Peter Daszak, of the Consortium for Conservation Medicine, to study the so-called wet markets of China where SARS began in 2002. They will inspect the animals sold in them, and test the stallholders and customers for signs of dodgy viruses. Dr Daszak is a co-author of a study published in this week's Nature that maps the global “hot spots” of emerging diseases and concludes, as Dr Wolfe has, that the real threat lies in the tropics. That is despite the fact that most new diseases are (as with AIDS) first noticed in rich countries.

If and when the GVFI is running smoothly, Dr Wolfe hopes to see not only what is threatening, but also to identify the general characteristics (if any) that threatening viruses share. If some features are regularly associated with a propensity to become pandemic, then forecasting outbreaks of new viral diseases will become easier and more scientific. At that point, this branch of medicine will be able to make the most important leap of all—from cure to prevention. And then a catastrophe like AIDS will need never happen again.

Human evolution

Moral thinking

Biology invades a field philosophers thought was safely theirs

WHENCE morality? That is a question which has troubled philosophers since their subject was invented. Two and a half millennia of debate have, however, failed to produce a satisfactory answer. So now it is time for someone else to have a go. And at a panel discussion at the American Association for the Advancement of Science meeting, a group of biologists did just that.

Mark Hauser, of Harvard University, opened the batting by asking whether morality is more than just the refined application of the emotions. He thinks that it is. Human brains, he believes, have a separate morality module. Brain-scanning experiments show that when a volunteer is faced with a moral dilemma (such as a runaway railway trolley approaching a set of points, with dire consequences whichever way he throws those points) his emotional centres are not involved in the decision. Such "trolleyology", as it has waggishly been dubbed, also suggests that reason is not part of the process. Different ways of killing the same number of people with a runaway trolley produce systematically different answers.

That does not mean all moral decisions have to be the same in everyone (though in trolleyology they often are). Instead, Dr Hauser uses the analogy of language. All healthy humans have, in the words of his Harvard colleague Steven Pinker, a "language instinct" which incorporates the idea of nouns, verbs, adjectives and how these all fit together. Exactly which language you learn, though, depends on your upbringing.

David Sloan Wilson, of Binghamton University, in New York state, agrees with that point, but reckons the actual moral sense an individual acquires is not arbitrary, as a language is, but is functionally adapted to circumstances. He and his colleague Ingrid Storm looked at liberals and conservatives (in the American senses of the words). Each group has a package of values it sees as moral, while viewing many of the beliefs of the other side as immoral. Dr Wilson and Dr Storm restricted their study to white, Protestant teenagers, in order to eliminate confounding variables. However, their volunteers came from two different traditions—Pentecostal, which tends to the conservative, and Episcopalian, which tends to the liberal.

The researchers conducted the study by giving each volunteer a beeper that went off every two hours or so. When it beeped, the volunteer answered a questionnaire about what he was doing at that moment, and how he felt about it.

Dr Wilson and Dr Storm found several unexpected differences between the groups. Liberal teenagers always felt more stress than conservatives, but were particularly stressed if they could not decide for themselves whom they spent time with. Such choice, or the lack of it, did not change conservative stress levels. Liberals were also loners, spending a quarter of their time on their own. Conservatives were alone for a sixth of the time. That may have been related to the fact that liberals were equally bored by their own company and that of others. Conservatives were far less bored when with other people. They also preferred the company of relatives to non-relatives. Liberals were indifferent. Perhaps most intriguingly, the more religious a liberal teenager claimed to be, the more he was willing to confront his parents with dissenting beliefs. The opposite was true for conservatives.

Dr Wilson suspects that the liberal package of individualism and confrontation is the appropriate response to survival in a stable environment in which there is leisure for learning and reflection, and the consequences for a group's stability of such dissent are low. The conservative package of collectivism and conformity, by contrast, works in an unstable environment where joint action, and thus obedience to their group, are at a premium. It is an interesting suggestion, and it is one that plays into the question of how morality actually evolved.

That was addressed by Samuel Bowles, of the Santa Fe Institute in New Mexico. An important feature of moral behaviour is altruism. Normally, biologists explain this as being either nepotism or you-scratch-my-back-and-I'll-scratch-yours. But Dr Bowles believes people do perform acts which cost them more than they gain. To explain this, he invokes an idea that went out of fashion in the 1960s: group selection. This says that the winnowing of the gene pool, which drives evolution, can favour or destroy entire social groups as single entities, as well as working at the level of individual organisms.

No one ever claimed group selection is impossible, but it looks mathematically unlikely. Dr Bowles, however, thinks that the virtues of human collaboration are so great that groups composed of genuine, self-sacrificing altruists would outcompete others.

His best example of such self-sacrifice is warfare, an activity in which morality and immorality intersect in ways that have always been puzzling—and where liberals and conservatives often draw opposite conclusions about what is right and wrong. Paradoxically, that clash of views suggests that Dr Bowles and Dr Wilson really are on to something with the idea of functional morality. Perhaps they and their colleagues can eventually do what philosophers have never managed, and explain moral behaviour in an intellectually satisfying way.

Climate change

Sour times

The sea is becoming more acidic. That is not good news if you live in it

EVERY silver lining has its cloud. At the moment, the world's oceans absorb a million tonnes of carbon dioxide an hour. Admittedly that is only a third of the rate at which humanity dumps the stuff into the atmosphere by burning fossil fuels, but it certainly helps to slow down global warming. However, what is a blessing for the atmosphere turns out to be a curse for the oceans. When carbon dioxide dissolves in water it forms carbonic acid. At the moment, seawater is naturally alkaline—but it is becoming less so all the time.

The biological significance of this acidification was a topic of debate at the American Association for the Advancement of Science meeting in Boston. Many species of invertebrate have shells or skeletons made of calcium carbonate. It is these, fossilised, that form rocks such as chalk and limestone. And, as anyone who has studied chemistry at school knows, if you drop chalk into acid it fizzes away to nothing. Many marine biologists therefore worry that some species will soon be unable to make their protective homes. According to Andrew Knoll, of Harvard University, many of the species most at risk are corals.

The acid test

Dr Knoll drew this conclusion by studying the fossil record. The end of the Permian period, 252m years ago, was marked by the biggest extinction of life known to have happened on Earth. At least part of the cause of this extinction seems to have been huge volcanic eruptions that poured carbon dioxide into the atmosphere. But some groups of animals became more extinct than others. Sponges, corals and brachiopods (a once-widespread group that look a bit like bivalve molluscs) were particularly badly hit.

Rather than counting individual species of fossils, which vary over time, palaeontologists who study extinction usually count entire groups of related species, called genera. More than 90% of Permian genera of sponges, corals and brachiopods vanished in the extinction. By contrast, only half of the genera of molluscs (the real ones) and arthropods disappeared.

Dr Knoll reckons this is because molluscs and arthropods are able to buffer the chemistry of the internal fluids from which they create their shells. This keeps the acidity of those fluids constant. Sponges, corals and brachiopods, however, cannot do this.

The situation at the moment is not as bad as it was at the end of the Permian. Nevertheless, calculations suggest that if today's trends continue, the alkalinity of the ocean will have fallen by half a pH unit by 2100. That would make some places, such as the Southern Ocean, uninhabitable for corals. Since corals provide habitat and food sources for many other denizens of the deep, this could have a profound effect on the marine food web.

Gretchen Hofmann of the University of California, Santa Barbara, has brought some experimental evidence to bear on the question. She is investigating the effects of changing acidity and temperature in the sea on a creature called the purple sea urchin. This animal is a scientists' favourite for embryological experiments, and has thus had its genome sequenced (in part by Dr Hofmann, as it happens), so it is well understood. Dr Hofmann's work suggests that a combination of heat and acidity is more deadly than either alone. When she and her team reproduced the conditions which are predicted to prevail in 2100 if carbon-dioxide emissions are not curbed, they found that the genes of larval sea urchins had to work up to three times harder than normal to form the animals' skeletons. On top of that, those skeletons were often deformed.

No corals, no sea urchins and no who-knows-what-else would be bad news indeed for the sea. Those who blithely factor oceanic uptake into the equations of what people can get away with when it comes to greenhouse-gas pollution should, perhaps, have second thoughts.

Pollution

A poison Pill

Human contraceptives are bad for fish

ONE thing Canada is not short of is lakes. It has so many that it can afford to set some aside to experiment on. And that is what Karen Kidd, an ecotoxicologist at the University of New Brunswick, has just done to a small lake in north-west Ontario. She has poisoned it in the name of science.

Her chosen poison was oestrogen, one of the hormones that make women women and help to control the menstrual cycle. People flush a lot of oestrogen down the toilet. Some is natural. Some is the synthetic stuff used in oral contraceptives. There is a strong suspicion that if this oestrogen is not removed during sewage treatment (some works do, some do not), it causes serious damage to rivers and lakes. Until now, however, proof has been lacking. Dr Kidd wanted to find out if the suspicion was correct. As she told a session of the American Association for the Advancement of Science meeting in Boston, it is.

The lake's algae, bacteria and invertebrates appeared unfazed by the extra hormone which she dumped in the lake at regular intervals. Presumably, its chemistry was not similar enough to their own biochemicals for them to notice. But the population plunged in the smallest fish species, the fathead minnow. Male minnows became feminised: their sperm production was delayed and they started producing eggs. After two years of treatment, the fathead minnow population collapsed.

Other changes took longer. Pearl dace mature more slowly than minnows and can outlive them by several years. The dace therefore managed to hold out for three years before the lack of male potency brought about a population crash.

There was damage even to the lake's largest fish, its trout. Here the cause was less that boys were turning into girls than that the trout were on short rations—since the minnows had disappeared. But the upshot was the same: fewer trout, and confirmation that oestrogens are very bad news for fish, even at low concentrations.

The better news was that things quickly returned to normal once the hormone treatment stopped. Fixing sewage works to prevent them from spewing out oestrogen should therefore help fairly rapidly. Controlling the sale of contraceptive pills will not be necessary, and fishermen will once again be able to use their rods and tackle with impunity.