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Come see the flowers - it may be your last chance

SCIENCE

Every spring, busloads of tourists stream north from Cape Town to witness an annual miracle: the transformation of arid semi-desert into a carpet of Namaqualand daisies. But the daisies are under threat from the hole in the ozone layer. By RUBEN MOWSZOWSKI

Each year during spring, just after the rains, busloads of tourists stream up the N7 in the Western Cape towards Namaqualand. The attraction? A previously arid landscape suddenly carpeted as far as the eye can see with daisies.

It's a sight that can bring the most hardened traveller to tears and it has made a visit to Namaqualand one of the great experiences in South Africa.

Enjoy it while you can: it might not be there for ever. There are indications, says scientist Charles Musil, that depletion of the ozone layer will cause the northern areas to lose their flowers and that these won't come back again if and when the depletions are reversed.

And you thought that it was the hole in the ozone layer way down there in the Antarctic that was the problem. Not so, says Musil. The problem actually gets more critical as you approach the tropics, because the sun's elevation is higher and the ozone layer thinner as you move away from the poles.

Small reductions in the thickness of the ozone layer in these latitudes therefore cause relatively greater increases in ultraviolet radiation. What's more, the plants that are closest to the equator are already experiencing the highest level of ultraviolet radiation ever experienced by

plants in this species. We know that the daisies can accommodate levels lower than this because they do. We do not know if they can withstand higher levels because they've never experienced such levels.

The cause of it all is pretty much common knowledge. The sun's rays hitting our atmosphere split the oxygen atoms into ozone which in turn is turned back into oxygen when the sun impacts on it.

The blanket of ozone shields the earth from much of the ultraviolet rays of the sun. CFC's (chloro-fluoro-carbons, the stuff you no longer get in your aerosol can) react with the ozone layer as it is formed, reducing its absorbance capacity so more ultraviolet radiation is getting through.

How much more? About 5% right now. This is estimated to increase to 10% in five years' time and, according to a worst-case scenario, 20% by the middle of the century. After that, it should start declining.

If, through an extraordinary feat of international co-operation, we stabilise our planetary CFC output by the end of the century, it will take about 100 years for the ozone layer to get back to its 1970 condition.

But, says Musil, while those of us with sensitive skins might need to put off going to beach for a century or so there's no need to panic. Our fynbos has survived under pretty hard conditions for millions of years so it's obviously pretty resilient.

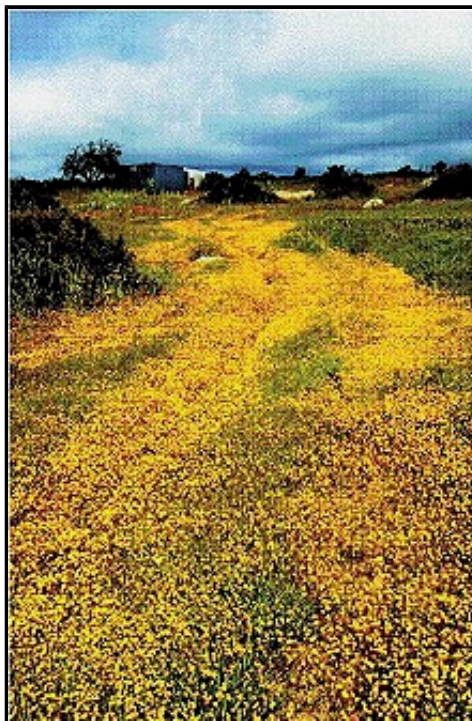
Southern Namaqualand should be fine, thinks Musil, but in Nababeep, come the middle of the next century, the few tourists who still pass that way might have to make do with floral wallpaper and plastic flowers.

Musil's research station is surrounded by real flowers, lots of them. Its location is at Kirstenbosch, one of the best-known botanical gardens in the world drawing on an ecology with a greater plant diversity per square metre than any place on earth.

The plants appear to be perfectly happy and thriving under our strong Cape light. Why should a little more concern them?

It's not the visible light that is the problem, says Musil. That simply passes through the plant. It is the short-wave part of the light spectrum, the invisible ultraviolet light, that is absorbed by the plant and does the damage - if it exceeds the levels that the plant is adapted to deal with.

Plants have inbuilt mechanisms to protect themselves against their version of what, as humans, we would call sunburn. They produce compounds that act



like a sunscreen and they conduct their own repair using the direct energy from light to power these inbuilt repair mechanisms.

The current understanding, says Musil, is that the effects produced by ultraviolet radiation, a change of leaf shape, leaf thickness, earlier flowering, are not permanent. That is, they do not effect the genetic cells and are, therefore, not passed on to the next generation. The plant, using its repair mechanisms, returns to its former state when the ultraviolet light is reduced.

Musil's research has shown, however, that over a long period involving a number of generations, even very small increases in radiation have a cumulative effect.

When you take the progeny of plants exposed to increased ultraviolet radiation and grow them without any ultraviolet radiation you can see persistent changes. Many of these changes deal with the plant's capacity to defend itself against further increases in ultraviolet radiation and there is a concomitant decrease in seed production.

The time where the damage occurs, believes Musil, is when the pollen is dispersed from the male to the female flower. The reason is that DNA during that stage is in a dehydrated form and as such is most sensitive to ultraviolet radiation.

Musil has tested Namaqualand daisies through four generations under the levels of ultraviolet radiation we might expect during the middle of the next century, that is, 20% ozone depletion.

He found that there were significant changes in the physiology of the plants and in their processes. Changes to leaf symmetry in particular are regarded as indications of genetic change and these were increasing with each generation.

These observable changes in the plants were carried on to new generations even though the conditions were returned to normal. This indicated to him that changes had indeed taken place in the DNA of the plant.

If Musil's findings are confirmed, the information will be of particular relevance to Africa. In many sub-Saharan countries subsistence farmers customarily dry cereal-crop seeds in the sun. One of the outcomes of Musil's test with increased ultraviolet exposure over four generations is a decline in seed production.

Since, in subsistence farming practice, that seed stock provides the pool out of which the subsequent crop is selected, such a cycle of diminishing yield could end in crop failure.

Musil speculates that genetic damage leading to lower seed yields might already be playing a part in some of the disastrous crop failures that have occurred on this continent. Apparently these are not always accompanied by drought or changed rainfall patterns.

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However, Musil's tests provided only circumstantial evidence of genetic damage. What he needed was proof. So Musil asked microbiologist Jennifer Thomson of the University of Cape Town (UCT) if she could involve her department in the study.

Thomson and geneticist Val Abratt set up a test programme to search for evidence of changes to the genetic structure of the seeds of the daisies that Musil has tested through four generations of raised ultraviolet levels.

The laboratory research is being carried out by doctoral student Wata Mpoloka, from Botswana, under a programme going by the unwieldy name of Ushepia (University Science, Humanities and Engineering Partnerships in Africa).

Funded by the Rockefeller and Carnegie Institutes, the programme seeks to foster cultural and intellectual exchange between UCT and graduates from other African countries.

Abratt says the effects of genetic changes are often easier to see than the changes themselves. They are therefore looking for the results of gene mutations rather than the actual mutations.

These are likely to be found in the fine-tuning of the regulation of the gene. They are looking for changes in the products being produced by the gene - the proteins and the various plant components - which regulate the way the gene is switched on and off.

And what exactly is the nature of the damage cause to the DNA by ultraviolet radiation? During stages when the DNA is in a dried state, such as in pollen and seeds, certain compounds get linked together in an abnormal way.

When the damage is within the limits of self-repair, visible light will provide a photon of energy at exactly the right level to break the incorrect linkage.

But when the particular linkage cannot be repaired in visible light it needs to be repaired by mechanisms that take place much more slowly and in the dark. If the damage is still there when fertilisation takes place, it will be incorporated into the DNA structure of the progeny and become an inherited trait.

This means that instead of the plants reverting to their normal state when the ultraviolet levels are decreased, as some earlier studies by Oxford University have indicated, plant damage will have been shown to be cumulative and persistent.

This ties in with the anticipated doubling of the present level of carbon dioxide in our atmosphere by the middle of the next century and the estimated 20 to 30C rise in global temperature.

Current perceptions are that increases in carbon dioxide (caused by the burning of fossil fuels) negate or reduce the effects on the plant of increases in ultraviolet radiation.

For instance, it stimulates growth and photosynthesis, both processes which ultraviolet radiation reduces.

Musil's findings were that residual damage to his daisies caused by exposure to ultraviolet radiation was intensified, not reduced, in conditions of elevated carbon dioxide.

Even if we only have two or three decades of high ultraviolet radiation levels, says Musil, these effects could persist long after the ozone layer has been restored.

With the amplification of the higher carbon dioxide levels, we could see all sorts of damaging effects which would reflect both the current and previous environmental conditions.

Do the geneticists have any indications as to which way the tests are going? Good scientists, it seems, don't engage in guesswork. We'll just have to wait and see.

In the meantime, don't postpone your trip too long. See the daisies while you can.

-- *Mail&Guardian, January 06, 1998.*

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