

Finding food in changing climes

Climate change could negate the progress made with high yielding crop varieties, says ananthanarayanan

THE prospects of severe food shortages and global famine were staved by the development of varieties of wheat and rice with very high yield during the last century. With the rising population, adding acreage under cultivation became progressively more difficult and the only way was to get more grain from the same number of plants. According to UN Food and Agriculture Organisation figures, the increase in arable land, from 1961 to 1999, was 15 per cent but the increase in yield was 78 per cent and the two increases resulted in more than twice the production.

A factor that led to higher yields may have been the rising level of carbon dioxide in the



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atmosphere. As plants produce food by converting carbon dioxide in the air into oxygen and carbohydrates through photosynthesis, more carbon dioxide should and does lead to more grain. But the leaps in productivity came about through human directed genetic selection that led to varieties with hugely superior grain output even with the same level of CO₂ in the air. The rise in the level of CO₂ has been nearly 25 per cent to date, but this does not affect productivity to a similar extent. In fact, a study by Dimas M Ribeiro, Wagner L Araujo, Alsdair R Fernie, Jos HM Schippers and Bernd Müller-Röber, reported in *Plant Physiology Review*, says rising levels of CO₂ actually prevent high yielding varieties from being viable.

not much used. As nothing has changed in the genetic make-up of IR8, researchers working with Bernd Müller-Röber of the Max Planck Institute of Molecular Plant Physiology and at the University of Potsdam wondered if the rise in CO₂ during the last 50 years had brought about the decline.

The reason for the dwarf feature of the IR8 variety is that its capacity to produce an enzyme known as gibberellic acid is blocked. Gibberellic acid (GA) is a potent growth-regulating factor naturally found in plants. It was discovered in 1955 when scientists in Japan were investigating a fungus that affects rice plants and causes the plants to grow so tall that they cannot support their own weight. It was found that this was the effect of GA, a by-product of the growth of the fungus, and even a trace of GA could profoundly

Other effects

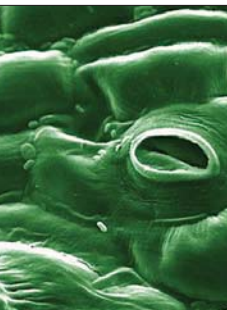
Quite apart from this effect on how high the plant will grow, higher levels of CO₂ certainly lead to more photosynthesis. Just how much and what other effects CO₂ has been studied in many laboratory and greenhouse experiments, where higher levels of CO₂ were maintained. The Free Air Carbon dioxide Enrichment trial is one where the natural or agricultural ecosystems were fumigated with higher levels of CO₂ without the use of enclosures and where conditions were more like in the real world.

While the rise in CO₂ was from 314 parts per million in 1959 to some 385 ppm in 2009, the studies have been made with CO₂ levels at 475-600 ppm, which levels we may reach by the end of the century. At this level, there is an increase of 40 per cent in leaf photosynthesis. Apart from allowing more photosynthesis, CO₂ exposure restricts the opening of stomata or pores in the surface of leaves. While these pores admit CO₂ into the leaf for photosynthesis, the pores are also the route for the plant to lose water through evaporation.

The plant naturally regulates the opening of stomata to optimise photosynthesis, given the water economy of the plant. In high CO₂ conditions, the plant can afford to keep the stomata less open and hence save on loss of water. The Face experiments have shown that there is an overall saving of water use of five to 20 per cent. The net results are an increase in the mass of the plant, above and below the ground, and increase in yield of 12-14 per cent.

There are other effects too, like the decrease in the nitrogen content of the plant material. This may also be because the plant draws less minerals from the soil, as a result of the lesser water use. These changes would affect the protein content of plant tissue and this would affect organisms that are at higher levels in the food chain. Insects feeding on plants may hence need to consume more plant tissue. Human nutrition would also be affected — protein content in wheat, rice, barley, potato, tubers has been found to be four to 14 per cent less when grown in high CO₂ conditions.

Biodiversity is also found to be affected. In enhanced CO₂ plants do better when grown alone. This is because different plants grab resources from the soil with differing levels of efficiency. The balance of soil composition is also lost. While some plants would die out, the others would lose parasite protection that the lost companions provided.



Stoma or pore in a leaf of the tomato plant. Electron micrograph.

affect the growth of plants.

While the discovery led to ways to control the fungus, or GA, to save plants from excessive growth, ways to block the action of GA also helped develop dwarf varieties, like IR8. Now, what the Max Planck Institute team has found in the case of IR8 is that atmospheric CO₂ has the effect of unblocking the blocked action of GA. With rising levels of CO₂, thus, IR8 plants have started growing just like other plants, and are not able to manage the heavy load of enhanced grain.

"Breeds now face the challenge of developing new plants that can continue to provide good yields under the altered climatic conditions," says Jos Schippers, one of the authors of the study. The team is now investigating the mechanism of the CO₂ action and to find ways to continue with dwarf varieties of high-yield strains.

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The writer can be contacted at simplescience@gmail.com

Survival of the smartest

When it comes to the mating game, our roadside romeros have a lot to learn from nature's naturals, writes debameeta bhattacharya

OUT in the wild, the mating game is often brutal and competing males cheat, sneak, steal and use every dirty trick to get the female of their choice. Sportsmanship is ignored, the modus operandi being... well, unscrupulous. If you thought clubbing was bad, imagine having to dance in front of potential mates for over an hour and a half, lest they make a meal of you — all while having to watch out for other dudes bent on exploiting your hard work.

Speciality matters, for example:

- Good vibrations: The male Australian Redback Spider, member of the Black Widow family, is much smaller than the female, so he warms her up by dancing on the web and plucking the threads and sending her good vibrations. A typical female demands 100 minutes of dancing; any less and he becomes the meal. But dance too long and a backstabbing male will sneak up and do the needful, without having had to do any dancing of his own.
- In drag: Not all males

are treated equal in the animal world. Some, like the Bluehead Wrasse, aren't quite up to snuff. But instead of giving up on the dating game, these fish use their undersized bodies to sabotage the mating of larger males. The sneaky primary males have the same colouring and size as the females, which makes it a lot easier to cozy up and slip them their sperm packets, leaving the dominant males clueless about how they lost out.

- Diced duel: Flatworms don't just backstab figuratively, they literally gore each other. Each flatworm has both male and female sex organs, so a mating pair settles down to decide who will be what.
- The first to pierce the other's skin with its penis is the male of the pair. The loser of this diced duel gets a consolation prize of sperm and the honour of birthing offspring.
- Love is... Male Monarch Butterflies have a unique sexual adaptation — their

penises double as dipsticks to detect how much sperm has already been deposited in a female. If her tank is on empty, the male will inject a diluted sperm mixture to fill her up and trick other males into thinking she's full of active sperm.

However, if a male determines

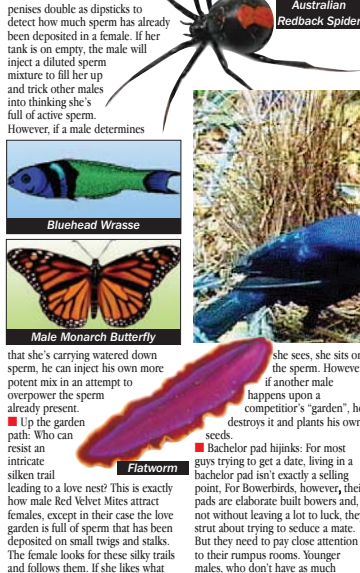
- Up the garden path: Who can resist an intricate silken trail leading to a love nest? This is exactly how male Red Velvet Mites attract females, except in their case the love garden is full of sperm that has been deposited on small twigs and stalks. The female looks for these silky trails and follows them. If she likes what

she sees, she sits on the sperm. However, if another male happens upon a competitor's "garden", he destroys it and plants his own seeds.

- Bachelor pad hijinks: For most guys trying to get a date, living in a bachelor pad isn't exactly a selling point. For Bowerbirds, however, their pads are elaborate built bowers and not without leaving a lot to luck, they strut about trying to seduce a mate. But they need to pay close attention to their rumpus rooms. Younger males, who don't have as much

home-decorating skills as the older ones, will sneak into other bowers and steal decorative items, like blue feathers and a lot more.

- Monkey business: There's no such thing as an unfair fight for Stump-tailed Macaques. If a smaller male has been picked on in the past, he'll attack the bully when he is most vulnerable — which is to say, halfway through the mating process. The attack doesn't prevent reproduction, however, since the mating male will already have ejaculated. The consolation? The old underworld maxim sums it up best: revenge is a dish best eaten cold.



The secret of true love

roger dobson reports on new research about our sensory systems that shows the nose is central to the way we form relationships

LOVE, according to romantics, can have a dramatic effect on the senses: striking lovers blind, deaf or rendering them tongue-tied. But the simple answer to the question of whether any relationship is "the one" seems to be that your ideal man or woman gets up your nose. New research suggests a sense of smell is vital for a good long-term relationship.

In the new study, reported in the journal *Biological Psychology*, researchers looked for the first time at the effect of being born without a sense of smell on men and women's relationships. The research involved analysing data on men and women aged 18 to 46 with no sense of smell and comparing it with information gleaned from a healthy control group. The results showed that men and women who were unable to smell had higher levels of social insecurity, although this manifested itself in different ways.

In men, but not in women, it led to fewer relationships. The men with a faulty sense of smell averaged two partners compared with 10 for healthy men.

One theory is that the lack of a sense of smell may make men less adventurous. They may have more problems assessing an opportunity for communicating with other people. They may also be concerned about how they are perceived



Al Pacino in a scene from Scent of a Woman.

by others, and worry about their own body odour.

The two groups of women had the same average number of sexual partners — four. But the women who couldn't smell well lacked confidence in their partners: they were around 20 per cent less secure in their relationship than the women in the control group. Lacking a sense of smell had no impact on their relationships with close friends, suggesting that smell plays a role for women specifically when it comes to their partners.

Research is increasingly showing that olfaction, one of the oldest sensory systems but probably the least understood, has an important role in a large number of areas. According to one study, women are more concerned about the smell than about the look of a potential mate, while men are the opposite. One study found that 13 per cent of men and 52 per cent of women have slept dressed in the clothing of another person, usually their partner, because of the smell.

"The sense of smell provides social information about others," say the researchers from the University of Dresden. "Its absence is related with reduced social security in men and women, and affects partnership. Men exhibit much less explorative sexual behaviour and women are affected in a way that they feel less secure about their partner. Our results show the importance of the sense of smell for social behaviour."

The role of smell as a trigger for arousal in men features widely in fiction, from Patrick Süskind's *Perfume: The Story of a Murderer* to Al Pacino's lead role in *Scent of a Woman*, where the blind Colonel Frank Slide can name or describe the appearance of women by their perfume alone.

Phillip Hodson, a psychotherapist and author of *How Perfect? Is Your Partner?*, described the new study as "a very astute piece of work... Instead of testing pheromones — which control moths but may not control humans — they've studied the smell-disabled to see how they differ from the rest. And both sexes with faulty noses appear to be less than sexually confident.

"We know the nose is a sexually interactive organ: it tends to run when we get aroused and often people sneeze when extremely excited," he said. "The French take the subject so seriously they even have a word for the scent of a woman when perfume is mingled with body oil: her *cassolette*."

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