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Lemon Tire, Very Pretty... Discover, pg. 16.

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scientists," he says. "A small in-house group defined what assumptions were going to be made." So Lutz assembled a panel of 20 experts in the fields of fertility, mortality, and migration—the three factors that immediately affect populations—to discuss future trends.

In the panel's most likely scenario, population will peak at 10.6 billion in the latter half of the next century and then will start to fall. Though life expectancy is predicted to increase in industrialized countries, less developed countries may suffer increased mortality due to infectious diseases. But the driving factor in the panel's prediction is declining fertility rates.

In the past five years, fertility rates have fallen even in countries where they have been constantly high. Lutz and his colleagues interpret this as the start of a long-term downward trend in fertility rates worldwide, due to an increase in educated women. Also, as more people leave rural areas for cities, family size is expected to drop because large families are not assets for urban dwellers. Fertility rates will eventually drop below replacement level, the panel predicts, to around 1.7 children per woman, resulting in a shrinking population.

But the end of population growth brings its share of troubles. China's one-child-per-family policy, Lutz points out, will bring about an abrupt aging of the population, a prospect many other countries also face. "In China, it had been lots of children and grandchildren looking after parents," he says. "Now if you have two generations of one-child families, it would mean that a single person is in charge of four grandparents. That's going to be a big issue."

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Birdie Work Steve Johnson, a botanist at the University of Natal in South Africa, was puzzled and amused when he came across this double-collared sunbird, *Nectarinia chalybea*. The bird had a clump of pollen stuck to its bill, which Johnson soon identified as orchid pollen. Unlike the loose and powdery pollen found in most plants, orchid pollen is attached to a sticky pad in the flower that breaks away when a bird pokes its beak into the flower for a sip of nectar. Until Johnson's observation, most botanists had assumed that South African orchids relied on insects for pollination. Sunbirds have been known to pollinate plants such as proteas, aloes, and ericas but not orchids. Later that day, Johnson found a dune filled with the orchid *Satyrium carneum*; fluttering among the flowers were a number of sunbirds, many carrying the trademark sticky pad on their beaks. Unfortunately, the pad seems to annoy the birds—Johnson has seen them scraping their beaks against tree stumps and branches to no avail.

TECHNOLOGY

Lemon Tire Very Pretty...

AMERICANS discard about 250 million tires every year. Researchers have tried, with varying degrees of success, to break down old tires and recycle them into new ones, and they've tried adding ground-up tires to asphalt. Still, most tires end up in landfills. Now Kirk Manfredi, a chemist at the University of Northern Iowa, has come up with yet another way to dent this mountain of worn-out rubber: he produces lemon oil from it. Specifically, Manfredi produces limonene, the main ingredient in the oil of lemons and other citrus fruits.

When Manfredi feeds shredded tires into an airless reactor set at about 725 degrees, a thick, dark oil containing a chemical called polyisoprene seeps out. He then heats and vaporizes the polyisoprene, breaking it into individual isoprene molecules. The vaporized isoprenes, rather than reforming into the long, complex polyisoprene chains, naturally tend to bond together in simple pairs to form limonene. The chemical structure matches the oil from lemons, although the source is decidedly artificial.

Manfredi now gets about 2 percent of the weight of the tire as limonene, but he's working on tweaking the procedure to up the yield. "Temperature and pressure are really critical," he says. "The size of the tire piece is very important as well; if the piece is too big, stuff that's in the middle can't get out into the gas phase as quickly." Manfredi thinks he will ultimately be able to convert about 10 percent of a tire into lemon oil.

He still has to work on the purification process—trace components, for example, now make the limonene smell pretty foul. Once he solves these problems, his tire juice may find its way into lemon-scented soaps and cleaners, and even as a flavoring in sodas. And Manfredi thinks he can isolate other useful compounds from tires as well, such as the main ingredient in bug-repelling citronella candles. He also hopes to find oils that could be used in chewing gum and mouthwash. Says Manfredi, "You have to think big."

RECIPE FOR LEMON OIL: SHRED TIRES, BAKE AT 725 DEGREES UNTIL BLACK AND OILY . . .