NEWS & VIEWS

DEMOGRAPHY

Babies make a comeback

Shripad Tuljapurkar

The population of some wealthy countries is shrinking because of a declining birth rate. It comes as a surprise, and one with policy implications, that after a certain point of development that trend can reverse.

In many industrialized nations, including Japan, South Korea, Germany and Italy, and much of southern and eastern Europe, fertility is far below replacement — the level at which enough children are born to replace their parents. Many of these countries do not accept (or want) immigrants to make up this deficit, so their populations are projected to decline over the next 25–50 years, with potentially scary consequences[1]. Low fertility means that women delay and reduce childbearing[2], choices that typically follow improvements in education, wealth and health. Widespread fertility decline and its associated problems have seemed inevitable. But on page 741 of this issue[3], Myrskylä, Kohler and Billari brighten this prospect by presenting evidence that such declines may be expected to reverse.

For many years, environmental concerns have been used to argue that it would be a good thing if human populations became smaller. If that's true, should we not welcome low fertility and population decline wherever it occurs? The difficulty with this view is that although smaller populations may indeed be desirable in the long term, in the short term population decline poses challenges that we do not know how to manage. Low fertility means fewer babies, and eventually a smaller workforce that would have to pay higher per capita costs of infrastructure and social support systems. A consequence of low fertility and long lives is an ageing population with its attendant social and economic effects. National economic output would probably decline along with the size of the workforce. Political and military capability and influence would decline along with population. Thus, for many rich countries, population decline is a serious concern.

Myrskylä *et al.*[3] examine the relationship between fertility and the human development index (HDI), a measure of education, income and lifespan[4]. Fertility decreases with increasing HDI during early stages of development. But at high levels of development, fertility in many countries increases with HDI. This is the first evidence that fertility levels might move back towards the replacement level in such countries as Italy, Spain, the Netherlands, Germany and Sweden. Perhaps babies will be 'in' again in the richest countries.

B. HARRINGTON/PHOTOLIBRARY

Bundles of joy — and future taxpayers.

To understand the fuss about low fertility and population decline, consider how fertility affects population number. Annual fertility is measured as birth rate expected according to a woman's age, and it is summarized by the total fertility rate (TFR), the total number of children a woman could have at those age-specific rates. Replacement fertility in countries with long life expectancies is at a TFR of about 2.1. Many rich countries now have fertilities far below this replacement level, close to the record low fertilities of Spain, Japan and Italy, which had TFRs close to 1.3 in 2005. If fertility stayed at that level, the populations of these countries would eventually decline at about 1.5% per year. Annual immigration at that amount would just offset the decline, but would also lead to a rapid increase in the number of foreign-born residents. The latter factor comes with political concerns about the economic, social and cultural assimilation of immigrants, concerns that remain even in the United States, a country with a long history of immigration at or near such levels.

To obtain the HDI, education, income and length of life are evaluated relative to best-possible values and combined into a score on a scale of 0 to 1. Most low-fertility countries, including Spain and Italy, had HDI levels of more than 0.9 in 2005; more broadly, the HDI in most countries has been increasing over time. Myrskylä *et al.* discovered that in virtually all countries, the TFR falls as the HDI increases up to about 0.86. By contrast, when the HDI rises above that level, the TFR increases in many (but not all) countries.

The authors argue that high HDI levels (above 0.86) may result in changes that benefit women and make it easier for them to choose to have children. Increases in development in rich countries come about as a result of higher educational attainment for women, increases in the percentage of women in the labour force, and an increase in women's incomes. These changes make it likely that women, and couples, will find it easier to pay the high economic price of having children. In addition, women with more skills and work experience — important elements of what we call human capital — will probably find it easier to move out of jobs to have children and then to move back into jobs once the children are in school.

How far can these results go in alleviating concerns over population decline? An increase of 0.01 in the HDI can increase the TFR by 0.03

NATURE|Vol 460|6 August 2009

or more[3], or equivalently can increase the eventual annual growth rate by about 0.06%. This may seem like considerable leverage. But the HDI can't go above 1, and many low-fertility countries already have HDI levels of around 0.93. Therefore, the best one can expect is an increase in TFR of 0.2, which is equivalent to raising the growth rate by about 0.4% from its currently projected lows. Countries such as Spain or Italy would still be below replacement, although, setting the social and political considerations to one side, they would be able to maintain their populations with far fewer immigrants.

Myrskylä and colleagues[3] find important exceptions to the relationship between the TFR and HDI — in some countries, including Japan, South Korea and Canada, the TFR continued to fall even when the HDI rose above 0.86. What might be happening here? The authors suggest that the positive effects of increasing HDI on women's decisions to have children may not apply in Asian countries because of social or cultural characteristics. Perhaps so, but what about Canada? These puzzling findings may instead be due to use of the HDI, which does not directly tell us which aspects of human development affect women rather than men. A different measure, the gender development index (GDI)[4], describes the difference between male and female development. It would be useful to examine the relationship between the TFR and GDI, and to ask if countries such as Japan or Canada have a noticeable difference between trends in the HDI and GDI.

A final point worth stressing is that Myrskylä and colleagues[3] also show that fertility in developing countries, which have HDI levels much below 0.86, falls with increasing development. The social and environmental challenges of burgeoning populations in many developing countries, such as Bangladesh, Egypt, India and Pakistan, can only be addressed if these countries achieve and maintain low, below-replacement, fertility. Even in China, where low fertility was achieved by fiat, the maintenance of low fertility must eventually be driven by individual choice. In these and other developing countries, increased human development, especially development that benefits women, is still the most powerful and most democratic route to achieving and maintaining lower populations. ■

Shripad Tuljapurkar is in the Stanford Center for Population Research, and the Department of Biological Sciences, Stanford University, Stanford, California 94305-5020, USA.
e-mail: tulja@stanford.edu

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GALAXY FORMATION

Too small to ignore

Karl Glazebrook

A study of one galaxy's dynamics backs up previous claims that surprisingly compact galaxies existed in the early Universe. But how such objects blew up in size to form present-day galaxies remains a puzzle.

Giant red elliptical galaxies are the oldest and most massive assemblies of stars in the nearby Universe. Large optical telescopes have tracked their evolution back through 11 billion years — about 80% of the Universe's lifetime — by observing them at large cosmological redshifts[1–3]. Observations seemed to indicate that nothing much had happened to them over this time, except that they grew rarer in the more distant past. It was thus a surprise when astronomers discovered recently that these galaxies have grown in size by a factor of five over this period while barely changing in mass. This is like suddenly discovering that Roman Londinium had the same population as Greater London does today. This extreme size and density evolution was not predicted by theories of galaxy formation, and remains difficult to explain.

One possibility is that measurements of the galaxies' masses that are based on their luminosities are flawed, not only because they might be missing starlight but also because they are not sensitive to the galaxies' invisible dark-matter component (which does not contribute significantly to mass in the luminous regions, at least for nearby ellipticals). On page 717 of this issue, van Dokkum and colleagues[4] report the first 'dynamical' mass measurement — which is sensitive to both the visible and the dark-matter component — for an individual red compact galaxy, known as 1255–0, that is seen 10.7 billion years ago and is less than 1 kiloparsec (~3,000 light years) in size. This galaxy is about four times more massive and five to six times smaller than the Milky Way spiral. Distant red compact objects are widely considered to be ancestors of today's ellipticals owing to their similar stellar populations and morphologies. However, nearby ellipticals of similar mass have sizes of 3–10 kpc; none is of similar size and mass to 1255–0 (ref. 5).

A dynamical mass measurement is definitive but requires resolution of the internal velocity structure of the galaxy. If high-redshift ellipticals really are small but massive, it follows from Newton's law that their stars' velocities should be very high. Because stars in ellipticals generally move on eccentric orbits, this is measured using the stellar-velocity dispersion, which quantifies the average spread of velocities and can be determined from the subtle Doppler broadening of absorption lines in the galaxies' spectra.

Measuring the velocity dispersion for 1255–0 was a tour de force[4]. Most of the light

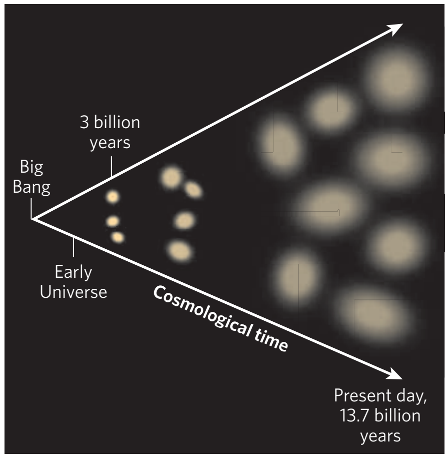

Figure 1 | Bloating galaxies. As the Universe evolves with time, elliptical galaxies, which are believed to be very compact at early epochs, maintain much the same mass but become bigger, more diffuse and more abundant. Newly produced ellipticals somehow have similar properties to the evolving, older ones. Van Dokkum and colleagues' spectroscopic analysis[4] of a galaxy seen when the Universe was about three billion years old gives clear-cut evidence of the compactness and high density of such a high-redshift object.

of such a high-redshift galaxy is redshifted into the near-infrared waveband (1–2 μm), where the airglow emission from the night sky contributes an enormous, noisy background. Van Dokkum *et al.*[4] sustained a heroic 29-hour exposure time using the 8-metre Gemini South Telescope's Near-Infrared Spectrograph. This was just enough to detect the absorption lines in the galaxy's spectrum — a feat in itself for such a high-redshift galaxy — and to measure the velocity dispersion. The measurement was partly helped by the large value of the final result: 510 km s^{-1}, the largest ever measured for any galaxy, but a value it had to have if it was as massive and as compact as previous measurements of its stellar mass had suggested[6].

Van Dokkum and colleagues' result[4] is especially surprising because an earlier velocity-dispersion measurement[7], based on a composite spectrum of several distant ellipticals (an interesting technique, albeit subject to its own problems), had measured a much lower value, sparking debate about the reliability of the stellar-mass measurements and the role of dark matter. The new measurement is significant because it is for a single object and so implies unequivocally that 1255–0 does have a density much higher than any nearby galaxy.