in urban India and only 3% in rural India[10]. That urban concentration of diabetes has also been reported in many other Asian countries.

The likely explanation for these paradoxes is twofold. First, in the West, poor rural people are better able to afford fast foods than their Indian counterparts. Second, educated Westerners with access to fast foods and with sedentary jobs are by now often well aware that fast foods are unhealthy and that one should exercise, whereas that advice has not yet made wide inroads among educated Indians (Fig. 1). Nearly 25% of Indian city dwellers (the subpopulation most at risk) haven't even heard of diabetes[9].

In India, as in the West, diabetes is ultimately due to chronically high levels of blood glucose, and some of the clinical consequences are similar. But whereas Westerners think of type 2 diabetes as an adult-onset disease appearing especially after the age of 50, Indians (and Chinese, Japanese and Aboriginal Australians) with diabetes exhibit symptoms at an age one or two decades younger than that. The age of onset in India has been shifting towards ever-younger people even within the past decade[9] — among Indians in their late teens, 'adult-onset' diabetes already manifests itself more often than does 'juvenile-onset' diabetes. In Britain, the prevalence of type 2 diabetes is 14 times higher in Asian than European children. And although obesity is a risk factor for diabetes both in India and in the West, the disease appears at a lower threshold of obesity in India, as is also the case in China, Japan and other Asian countries[10].

Symptoms also differ between Indians and Westerners: Indians with diabetes are less likely to develop blindness and kidney disease, but much more likely to suffer coronary artery disease at a relatively young age[9,12]. Just as Indians can't be lumped in with people of European ancestry, differences also appear among Asians: some, but not all, distinctive features of Indian diabetes apply to other Asian populations. For example, by worldwide standards, Chinese people with diabetes experience a low prevalence of coronary artery disease but a high prevalence of retinal and kidney damage. The relative roles of genetic and lifestyle factors in these ethnic differences remain to be teased out.

Although poor Indians are currently at lower risk than affluent Indians, the rapid spread of fast food exposes even urban Indian slum-dwellers to the risk of diabetes. Sandeep and colleagues of the Madras Diabetes Research Foundation[13] summarize the situation as follows: "diabetes [in India] is no longer a disease of the affluent or a rich man's disease. It is becoming a problem even among the middle income and poorer sections of the society. Studies have shown that poor diabetic subjects are more prone to complications as they have less access to quality health care. This presents an alarming picture…" Alas, that's true. ■

Jared Diamond *is in the Geography Department, University of California, Los Angeles, California 90095-1524, USA.*
e-mail: jdiamond@geog.ucla.edu

1. Shaw, J. E., Sicree, R. A. & Zimmet, P. Z. *Diabetes Res. Clin. Practice* **87,** 4–14 (2010).
2. Magliano, D. J. *et al. Diabetes Care* **33,** 1983–1989 (2010).
3. Jowett, J. B. *et al. Twin Res. Hum. Genet.* **12,** 44–52 (2009).
4. Ramachandran, A., Ma, R. C. W. & Snehalatha, C. *Lancet* **375,** 408–418 (2010).
5. Mohan, V. *et al. Indian J. Med. Res.* **131,** 369–372 (2010).
6. Pradeepa, R. *et al. Diabetes Technol. Therapeutics* **12,** 755–761 (2010).
7. Dowse, G. K. *et al. Diabetes* **39,** 390–396 (1990).
8. Zimmet, P. *IDF Bull.* **36,** 29–32 (1996).
9. Mohan, V. *et al. Indian J. Med. Res.* **125,** 217–230 (2007).
10. Mohan, V. *et al. Diabetes Res. Clin. Practice* **80,** 159–168 (2008).
11. Dunstan, D. W. *et al. Circulation* **121,** 384–391 (2010).
12. Unnikrishnan, R. *et al. Diabetes Care* **30,** 2019–2024 (2007).
13. Sandeep, S., Ganesan, A. & Mohan, V. *Development and Updation of the Diabetes Atlas of India* www.whoindia.org/LinkFiles/NMH_Resources_Diabeletes_atlas.pdf (2010).

COSMOLOGY

A glimpse of the first galaxies

The recently refurbished Hubble Space Telescope reveals a galaxy from a time when the Universe was just 500 million years old, providing insights into the first throes of galaxy formation and the reionization of the Universe. SEE LETTER P.504

NAVEEN A. REDDY

A central focus of cosmology is to understand how the primordial density fluctuations imprinted by the Big Bang gave rise to the galaxies and larger structures we observe today. Just as archaeologists sift through deeper layers of sand to uncover the past, cosmologists use large telescopes and sensitive detectors to study galaxies at ever greater distances from Earth and, because of the finite speed of light, to peer farther back in time. On page 504 of this issue, Bouwens *et al.*[1] take another step in this direction by exploiting the deepest near-infrared images of the sky, which were obtained with the reserviced Hubble Space Telescope and its new Wide Field Camera[2]. On the basis of these data, the authors report the plausible detection of the most distant galaxy yet discovered. The galaxy would have existed when the Universe was just 4% of its current age and when one of the most important phase transitions of gas in the Universe occurred.

Building on previous studies, Bouwens and colleagues used the well-established Lyman break technique[3] to select galaxies at the largest distances, or redshifts. The method relies on the absorption, by neutral hydrogen within a galaxy or by intervening hydrogen clouds, of photons that are more energetic than Lyman-α photons (10.2 eV, corresponding to a wavelength of 1,216 ångströms). The resulting decrease in flux bluewards of the Lyman-α wavelength results in a characteristic 'break' in the spectrum of a galaxy. Galaxies at different redshifts can then be located by searching for objects that are detected in one filter but that disappear, or are very faint, in a bluer filter.

Until now, the primary obstacle to identifying galaxies beyond redshift 6 — when the Universe was less than 1 billion years old — has been that the Lyman break shifts to the observed near-infrared, where the emission from the sky background is several hundred times higher than it is in the visible range of the spectrum. This higher background inhibits the ability to obtain deep imaging, and has motivated observations from above Earth's atmosphere. A breakthrough came with the installation of the Wide Field Camera on Hubble; the camera's increased field of view and sensitivity over the previous near-infrared instrument on Hubble results in an increase by a factor of more than 30 in its capacity for finding faint galaxies at high redshift.

Using multi-filter imaging from Hubble and the Lyman break technique, Bouwens and collaborators[1] report the discovery of one candidate galaxy at a redshift of about 10 (Fig. 1). Comparing the number density of galaxies at redshift 10, inferred from their observations, with that determined at lower redshifts, they find that the average galaxy increases in luminosity by more than a factor of 10 during the first 2 billion years of galaxy formation. Taken one step further, this finding suggests a close connection between galaxy formation and the assembly of dark matter in the early Universe.

In contrast to the prevailing theory of cold dark matter and its relative success in reproducing the large-scale structure of the Universe, the physics of the development and evolution of visible matter is difficult to model:

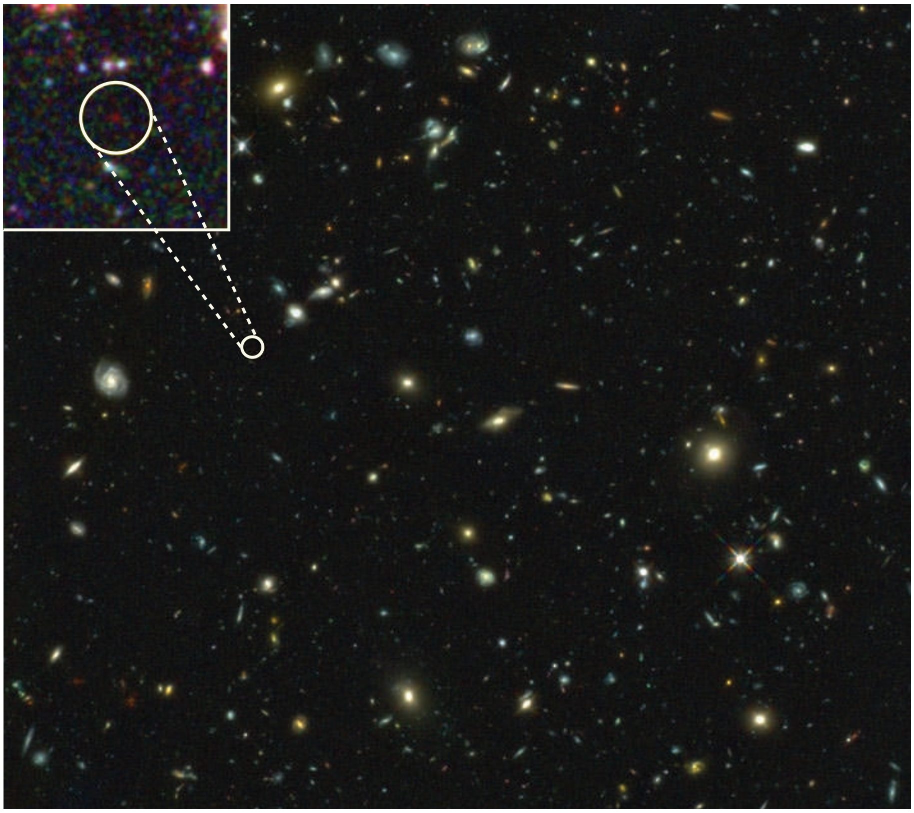
NATURE

50 Years Ago

The report of an enquiry into the employment of qualified women scientists and engineers in private manufacturing industry shows clearly that, in general, industry in Britain is a man-dominated world and is likely to remain so for many years to come … From the survey one conclusion is inescapable. Employers are reluctant to employ educated women scientists and engineers mainly because, on economic grounds, they are a bad risk … From the employer's point of view, their years of useful service before beginning full-time duties in their homes is very limited. All the well-meaning protestations by women's organizations will not make young women scientists and engineers anything but a bad industrial investment compared with their male counterparts. Most educated women know this and accept this.
From *Nature* 28 January 1961

100 Years Ago

In his article on "Sex Relationship", Dr. R. J. Ewart said, in commenting on the present excess of females over males:—"The result of this is to produce in a community a section of women who cannot possibly perform that function for which they were fashioned. Their energies are naturally directed into other spheres, as evidence of which we see the revival of movement for political recognition." … Dr. Ewart errs in attributing to a purely physical cause a movement which really arises from a mental and moral awakening — and, indeed, his whole article is full of unsupported assertions and loose reasoning; but I should not have ventured to criticise it had he not so clearly allowed his judgment to be warped by his political bias.
Hertha Ayrton
From *Nature* 26 January 1911



NASA/ESA/G. ILLINGWORTH (UCO/LICK OBS. & UNIV. CALIFORNIA, SANTA CRUZ)/ R. BOUWENS (UCO/LICK OBS. & LEIDEN UNIV.)/HUDF09 TEAM

Figure 1 | A galaxy at redshift 10. Bouwens and colleagues' search[1] for galaxies in the Hubble Ultra Deep Field has resulted in the plausible discovery of the most distant galaxy yet detected. The circle marks the location of the galaxy (red blob in inset).

it depends on complex processes that govern the cooling of gas to form stars, the evolution of the stars themselves, and the feedback of energy and matter from stars and black holes. It is perhaps remarkable, therefore, that at early cosmic times the growth of galaxies seems to mirror that of the dark-matter haloes in which the galaxies reside[4]. This similarity suggests that, despite the seemingly complex physics of star formation, simple gravitational theory — combined with a factor that parametrizes the efficiency of star formation (the fraction of gas that is converted to stars) — can provide a first-order prediction of the luminosity of a galaxy.

Aside from probing the earliest stages of galaxy formation, a topical area of interest in cosmology is to identify the sources responsible for the transition between a neutral state of hydrogen in the Universe (roughly 300,000 years after the Big Bang) to a mostly ionized state at redshift about 6 (950 million years after the Big Bang). Bouwens and colleagues' study[1] probes galaxies at the heart of this 'reionization' epoch. Given some — albeit very uncertain — assumptions of the clumpiness of gas in the Universe and the fraction of ionizing photons that can escape galaxies, they argue that galaxies at redshift 10 may not provide enough ultraviolet flux to reionize the Universe. The dominant contributor to the ionizing flux at early cosmic epochs remains a mystery. Nonetheless, the plausible detection of a galaxy at redshift 10 suggests an onset of star formation at redshift beyond 12 (about 100 million years earlier), potentially increasing the role of galaxies in the early ionization of the Universe.

Although these results[1] provide a glimpse of the earliest stages of galaxy formation, substantial uncertainties remain and more work is needed. Sample variance remains the dominant uncertainty, as a result of the small number of objects and the small field of view surveyed (equivalent to an area of about 0.6% the size of the Moon). Even more crucial, however, is the need to confirm the redshifts of these objects. The best confirmation of distance would be the detection of a strong emission line in the spectrum, such as the Lyman-α line. Detecting this line may be challenging for these 'primordial' galaxies because they are expected to be gas-rich (having not had enough time to convert a significant fraction of their gas into stars) and to be surrounded by a mostly neutral medium that resonantly scatters Lyman-α photons.

The best hope is the James Webb Space Telescope (JWST). With its larger mirror and near-infrared-sensitive detectors, this facility will dramatically improve the situation: imaging and spectroscopy across a larger swathe of the spectrum will enable the confirmation of a spectral break or the detection of a strong emission line. Scheduled for launch in 2014, the JWST will also have the sensitivity to detect galaxies at redshift 10 that are even fainter than the one reported by Bouwens and collaborators. Studying this faint population will yield a more complete picture of their role in reionizing the Universe. The authors' preliminary foray in studying the first galaxies underscores the important role of facilities such as the JWST in revolutionizing our understanding of galaxy formation at the earliest cosmic epochs, and paves the way for a bright future in studying faint and distant galaxies. ■

Naveen A. Reddy *is at the National Optical Astronomy Observatory, Tucson, Arizona 85719, USA.*
e-mail: nar@noao.edu

1. Bouwens, R. J. *et al. Nature* **469,** 504–507 (2011).
2. Kimble, R. A. *et al. Proc. SPIE* **7010,** 1–12 (2008).
3. Steidel, C. C. & Hamilton, D. *Astron. J.* **104,** 941–949 (1992).
4. Bouwens, R. J. *et al. Astrophys. J.* **686,** 230–250 (2008).

ZOOLOGY

Why are whales big?

Different groups of diving vertebrates vary greatly in size, with whales being by far the largest. A comparative investigation of the links between swimming speed, size and metabolism provides clues to the reasons.

GRAEME D. RUXTON

Animals that breathe air but forage under water are highly adapted to the challenges of their extreme lifestyle. The oxygen collected at the surface must be husbanded carefully under water to maximize foraging efficiency. Because the energetic cost of swimming increases rapidly with speed, such divers have long been predicted to ascend and descend at the speed that minimizes the energetic cost (and thus the oxygen burned in aerobic metabolism) for the distance travelled.

In a paper in *Journal of Animal Ecology*, Watanabe *et al.*[1] present the strongest evidence yet in support of such fine-tuned adaptation. Key to their study is the consideration of how we might expect both size and metabolic rate to influence a diver's swimming speed. On the basis of established biomechanical and energetic principles[2], the authors predicted that larger divers should swim faster (specifically, that swimming speed should increase with mass to the power 0.05). They also predicted that low-metabolism ectotherms (animals, such as turtles, whose temperature is strongly influenced by their environment) should swim more slowly than same-sized, high-metabolism endotherms (which maintain a constant temperature; for example, birds and mammals).

Telemetry studies of free-living animals are becoming increasingly common, making it possible for the researchers[1] to assemble dive-speed data for 37 species encompassing mammals, birds and turtles, and ranging in size from a 500-gram rhinoceros auklet (*Cerorhinca monocerata*) to a 90-tonne blue whale (*Balaenoptera musculus*). They found that dive speed does indeed increase with size, and that the mass exponent of the increase (mean 0.09, 95% confidence interval 0.04–0.14) provided a good match to their theoretical predictions. They also found that the three turtle species in the data set all had slower swimming speeds than expected on the basis of their mass: just as the authors' theory predicted for ectotherms.

Although fish are the oldest and most diverse group of diving organisms, they do not reach the gigantic size attained by some other marine divers. The largest-known extant fish is the 6-metre-long whale shark *(Rhincodon typus*) and the largest extinct fish the 9-metre-long *Leedsichthys*[3]. Compare these species with the two groups of whales: baleen and toothed. Among the 15 extant baleen whales, only the pygmy right whale (*Caperea marginata*) is as small as the whale shark, and only this species and the common minke (*Balaenoptera acutorostrata*) are smaller than *Leedsichthys*. Among the toothed whales, meanwhile, there are at least five species larger than any extant fish. Turning to extinct marine reptiles[4], mosasaurs ranged up to 17 m in length, pliosaurs and plesiosaurs were at least 15 m and 20 m, respectively, and ichthyosaurs were perhaps as large as 21 m.

From these figures, then, explanation is required for the different maximum sizes of the three groups: ectotherms that draw their oxygen from the water (fish); air-breathing endothermic divers (whales); and air-breathing ectothermic divers, both extant and extinct (turtles and species such as mosasaurs). That explanation might run as follows. First, larger divers can stay submerged for longer because oxygen stores increase more rapidly with size than do metabolic rate or the cost of swimming[5]. Second, as Watanabe *et al.*[1] demonstrate, larger divers swim faster.

Taken together, these considerations mean that larger breath-holding divers can exploit deeper waters and search for food more efficiently. However, these selection pressures do not act on fish size. The effect of size on swimming speed is less drastic in modern-day turtles, probably because their ectothermic metabolism constrains swimming speed. Thus the prediction is that ectothermic breath-holding divers should still face selection for large size, but that this selection will not be as strong as in endotherms such as whales. In agreement with this prediction, the largest extinct marine reptiles were larger than any fish, but not as large as the biggest whales.

This is a thought-provoking study[1], and there are clear ways in which it could be built upon. Further data on diving ectotherms would be helpful, along with development of the theory to give quantitative predictions for the influence of metabolism. Particularly valuable data would be those that allowed assessment of variation in both resting metabolic rate and dive speed in a given species of turtle across waters of different temperatures (and thus functioning across a range of metabolic rates).

Perhaps the least satisfying aspect of the current theory is that it cannot explain the trend in the empirical data for avian divers to swim faster than mammals of the same mass. Watanabe *et al.*[1] suggest that their assumption that metabolism does not increase to cope with thermoregulation in water may be more valid for mammals than birds. Expansion of the species available for the comparative analyses would help in evaluating such theories: the largest bird considered was the 25-kg Emperor penguin (*Aptenodytes forsteri*) and the smallest mammal was the 33-kg Antarctic fur seal (*Arctocephalus gazella*). Measurements of small diving mammals, such as otters, might be particularly instructive for comparison with those of same-sized birds.

A final puzzle is why gigantic species have not evolved in two groups of extant vertebrate divers (birds and turtles). Perhaps the difference between these and the other vertebrate divers is that birds and turtles must return to land to reproduce, and it is this phase of their existence (in which they lack the buoyancy of water to support much of their weight) that limits their sizes.

Clearly, diving animals still pose many fascinating questions. As Watanabe *et al.*[1] show, however, modern data-collection technologies, combined with biomechanical modelling and comparative approaches, can bring the answers closer to our reach. ■

Graeme D. Ruxton *is in the College of Medical, Veterinary and Life Sciences, University of Glasgow, Glasgow G12 8QQ, UK.*
e-mail: graeme.ruxton@glasgow.ac.uk

1. Watanabe, Y. Y. *et al. J. Anim. Ecol.* **80,** 57–68 (2011).
2. Hansen, E. S. & Ricklefs, R. E. *Am. Nat.* **163,** 358–374 (2004).
3. Friedman, M. *et al. Science* **327,** 990–993 (2010).
4. Nicholls, E. L. & Manabe, M. *J. Vert. Paleontol.* **24,** 838–849 (2004).
5. Halsey, L. G., Butler, P. J. & Blackburn, T. M. *Am. Nat.* **167,** 276–287 (2006).