8 January 1999

Science

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Pages 133–288 $8

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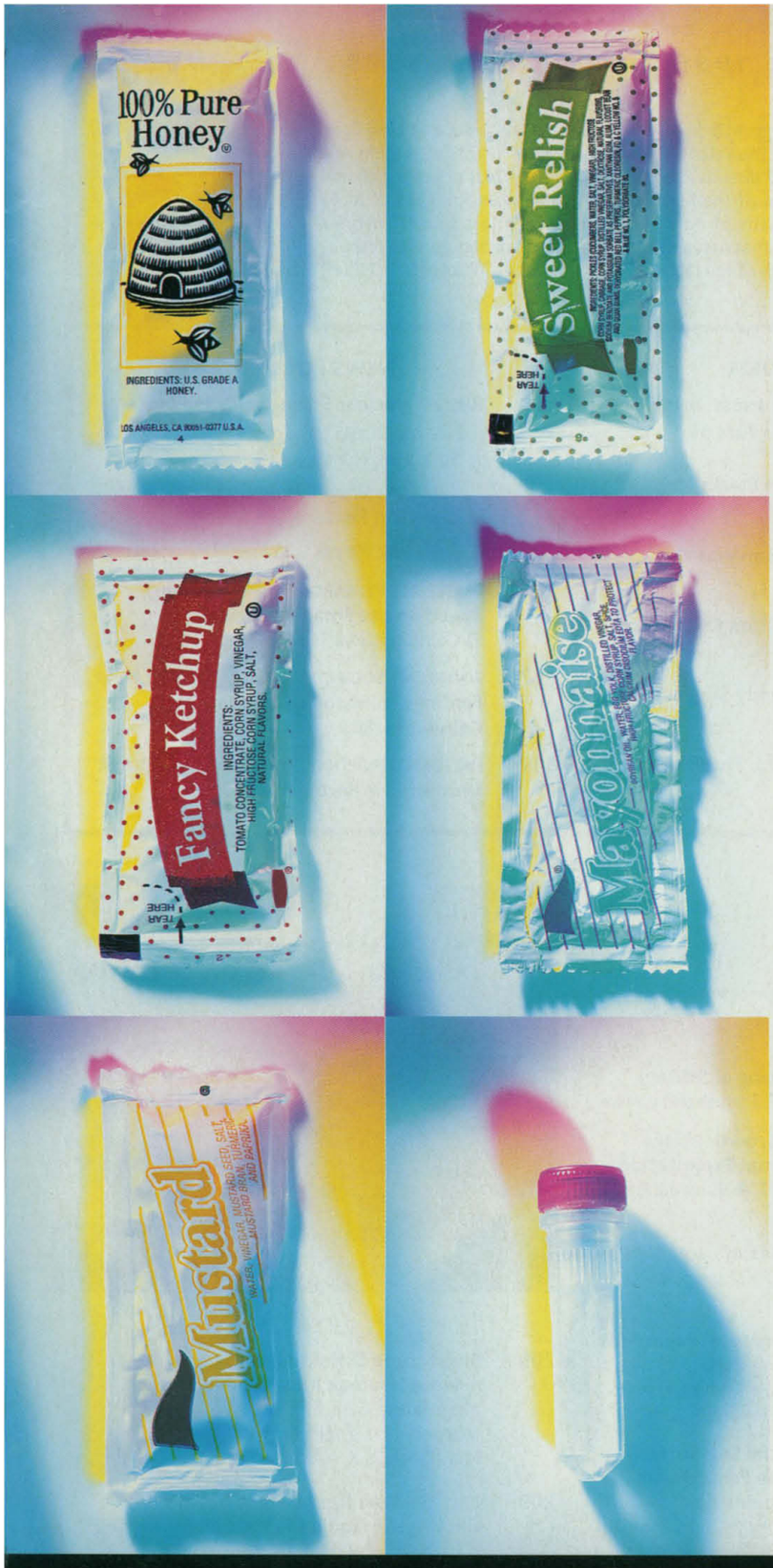

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Cover An emu eggshell discovered in a Pleistocene dune at Lake Eyre, central Australia. The calcite matrix of the shell resists alteration and thus can be dated directly (the one pictured is ~14,000 years old) and preserves a record of the bird's dietary preferences. Analyses of more than 1000 eggshells of emu and another flightless bird (*Genyornis newtoni*) suggest that human activity, rather than climate, was responsible for extinction of the latter ~50,000 years ago. [Photo: G. H. Miller]

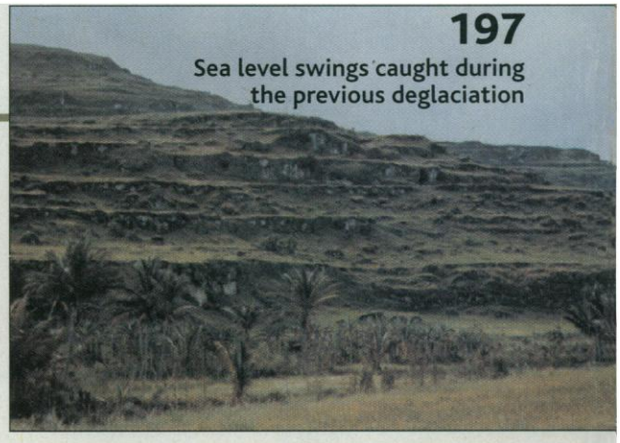
158
Inside Russia's nuclear cities

NEWS

NEWS OF THE WEEK

NEWS FOCUS

RESEARCH



197
Sea level swings caught during the previous deglaciation

REPORTS

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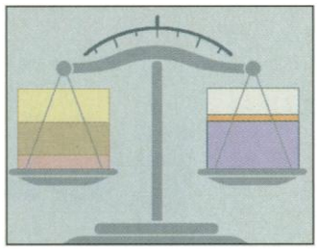

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CATCHING A WAVE

Solitary waves are common in many lakes and in the Earth's atmosphere and oceans, where they can enhance mixing. The origin of many of the waves, however, is uncertain. Farmer and Armi (p. 188) have used echo soundings and aerial photography to capture the formation and maintenance of these waves in Knight Inlet, British Columbia. Waves form well upstream of a sill in the inlet from instabilities that propagate upstream when the tidal current plunges over the sill and divides into two different flow patterns.

EARLY HUMAN IMPACTS

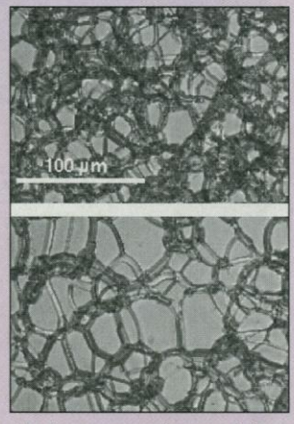
The interaction between early human populations and animal ecosytems is the subject of two reports. It can be difficult to trace the growth of early human populations. One means is to assess the impact of human predation on ecosystems and faunas. Stiner *et al.* (p. 190) examined the use of small animals as food by early humans in present-day Italy and Israel. Tortoises and marine shellfish, which are easily caught, were the dominant food until about 40,000 years ago when, increasingly, hares, partridges, and other hard-to-catch small animals were hunted. The size of the remaining tortoises also crashed. These data imply the human populations expanded rapidly then and depleted food resources; additional increases are seen later, after peak glacial times. In the beginning of the Pleistocene, Australia was populated with a wide variety of marsupials and other animals, including large flightless birds. Most of these medium-sized and large animals in Australia, however, became extinct in the last 100,000 years. The cause of this mass extinction—whether a climate change or the impact of humans on the ecosystem—has been uncertain, in large part because the age of the extinctions has been poorly dated. Through a wide variety of dates on bird eggshells and sediments in three diverse localities, Miller *et al.* (p. 205; see the cover and the Perspective by Flannery) now show that the extinctions of a major bird species happened about 50,000 years ago, when humans first arrived in Australia.

GLACIATION HISTORY REPEATING ITSELF

The most recent deglaciation was marked by sudden reversals in climate, including a marked cool period and pause in the melting of glaciers and sea level rise known as the Younger Dryas. In a pair of reports, Esat *et al.* (p. 197) and McCulloch *et al.* (p. 202) provide some provocative evidence that the previous interglacial began in a similar fashion about 130,000 years ago. They have studied corals on the Huon Peninsula in Papua New Guinea, which have experienced rapid uplift and thus leave a record of previous sea level changes as stranded and cut reefs. Corals in a wave-cut cave seem to record a sudden drop in sea level, by perhaps up to 60 to 80 meters, during the beginning of the previous deglaciation. Oxygen isotope records and strontium-calcium ratios on these corals also indicate that ocean temperatures dropped by several Celsius degrees at this time. This record may be consistent with and help explain the controversial Devil's Hole climate record.

STABILIZED THROUGH DEFECTS

Defects often weaken a material, but adding a small amount of solid particles to certain liquid crystalline materials can actually make them stiffer by stabilizing an internal defect network. Zapotocky *et al.* (p. 209) optically imaged defects in a cholesteric liquid



crystal that were formed by rapid cooling. Line defects in the material are connected at nodal points, and these line defects support the material when it placed under tension. The colloidal particles stabilize the nodes and hence the line defects when shear forces are applied.

CONTROLLING CHARGE

One of the main methods for producing charged ions for mass spectrometry of biomolecules, electrospray ionization (ESI), produces highly charged ions. These ions tend to fragment, which yields valuable information for composition analysis, but also produces highly complex spectra that limit the use of ESI for mixture analysis. Scalf *et al.* (p. 194) show how an α-particle source can be used to reduce the charge state of the ions so that spectra can be simplified.

COUNTING CALORIES

Why is it that some people can overeat and, in the absence of obvious exercise, still resist gaining weight? Levine *et al.* (p. 212; see the Perspective by Ravussin and Danforth) investigated the basis of this inter-individual variability by overfeeding 16 normal weight volunteers for 2 months and carefully monitoring the various components of energy expenditure. The only component that showed enough variability to explain a significant proportion of the variability in body fat gain was nonexercise activity thermogenesis (NEAT), defined as energy expended for fidgeting, maintenance of posture, and other activities of daily living. Thus, failure to increase NEAT after overeating could result in ease of fat gain and predisposition to obesity.

WARMER NIGHTS, ALTERED ECOLOGY

The increases in temperatures due to global warming are not felt uniformly over the diurnal cycle; Generally, nighttime minima have risen more than daytime maxima or average temeratures. The ecological significance of this difference was assessed by Alward *et al.* (p. 229; see the Perspective by Melillo) using a long-term dataset from a shortgrass steppe ecosystem in Colorado. Several correlations between climate measurements and the abundance and productivity of plant species were identified, including a pronounced decline in the dominant grass, which was negatively correlated with minimum spring temperatures. Other plant species showed gains in abundance, suggesting that the structure and dynamics of the ecosystem may be profoundly altered.

FIGHTING TO THE LAST TO FERTILIZE

When all's fair in love and war, both male and female compete for the reproductive advantage over their fellows. As Clark *et al.* (p. 217) show by analysis of mating in the fruitfly *Drosophila*, the competition is carried on even within the female's reproductive tract, where sperm from different males show different fertilization success

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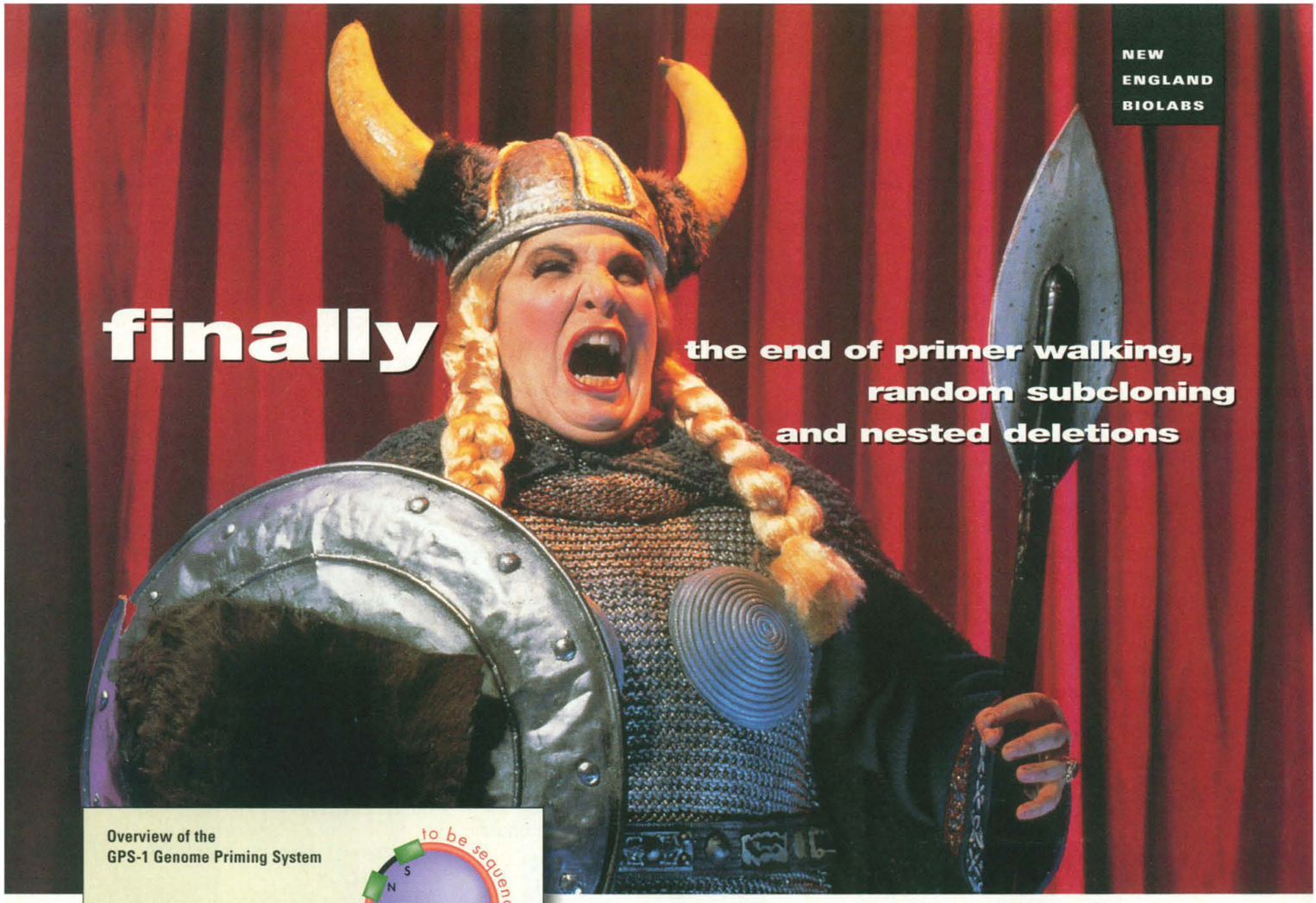

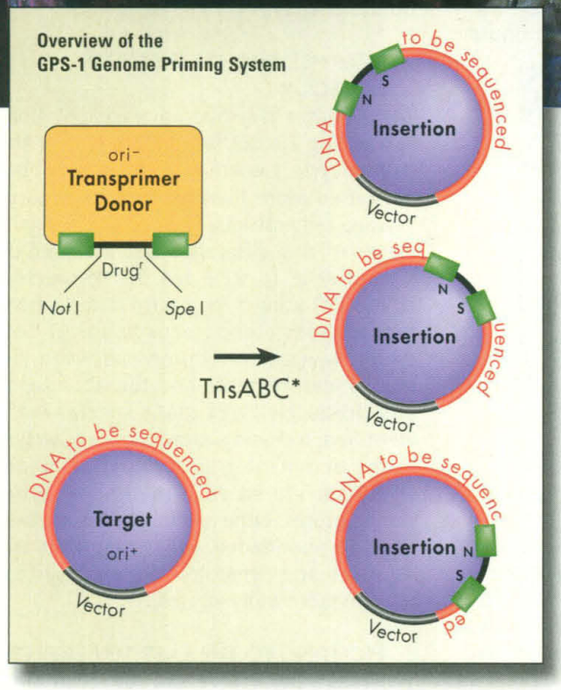

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CONTINUED FROM PAGE 141

rates. Caused by a complex interaction between the male's and female's genotype, this sort of cryptic selective force may constrain the outcomes of evolution.

COOLER ANCESTORS?

Existing phylogenetic trees place thermophilic organisms (those that live at temperatures near 100°C) at the deepest branch points, suggesting that the most recent common ancestor of eukaryotes, bacteria, and archaebacteria was a thermophile. Galtier *et al.* (p. 220; see the news story by Vogel), using a nonhomogeneous model of nucleotide substitution, propose that this ancestor actually contained ribosomal RNA (rRNA) of close to 50% G+C content. Because G-C base pairs contain three hydrogen bonds as compared to the two bonds used for A-T pairs, it is thought that a considerably higher G+C content (60 to 65%) would have been needed to stabilize the single-stranded rRNA at high temperatures. Thus, this analysis raises the possibility of a mesophilic (moderate temperature) origin of the most recent common ancestor.

THE STATS ON T CELL ACTIVATION

The STAT (signal transducer and activator of transcription) proteins are activated by phosphorylation in response to various cytokines that bind receptors on the cell surface. Welte *et al.* (p. 222) report that one such protein, STAT5, can also be activated in response to binding of antigen to the T cell receptor. STAT5 became physically associated with the activated T cell receptor, and subsequent tyrosine phosphorylation of STAT5 apparently required the tyrosine kinase Lck. Expression of a dominant negative mutant of STAT5 inhibited antigen-stimulated proliferation of T cells. Thus, STAT5 appears to be a component of the signaling machinery through which the T cell receptor induces changes in gene transcription and stimulates cell division.

TUNING THE EAR

The hair cells in the inner ear are the place where mechanical vibrations (sound) are coded as electrical signals. The resonant frequency of these hair cells depends on the gating kinetics of calcium-activated potassium (BK) channels. Ramanathan *et al.* (p. 215) show that the gating kinetics of BK channels can be slowed down by up to a factor of 50 when they are coexpressed with *slo*-β subunits. This additional subunit shows a gradual expression pattern in hair cells of the turtle cochlea. It is therefore possible that this expression gradient is used to electrically tune the hair cells in the inner ear.

SEEING MORE THAN PEPTIDES

When immunologists discuss "antigens," they are generally thinking about pieces of proteins, but natural killer T (NKT) cells take a broader approach toward antigen recognition. Schofield *et al.* (p. 225) found that the NKT cell induced "help" for antibody production against common surface proteins in the membrane of the *Plasmodium* or *Trypanosoma* parasites. The NKT cells recognized the glycosylphosphatidylinositol (GPI) lipid tail that hooks the proteins to the surface. Recognition is through presentation on the nonclassical CD1d protein, which can accommodate such ligands. Thus, a major function of these unusual cells may be in host defense to parasites.

TECHNICAL COMMENT SUMMARIES

The full text of these comments can be seen at www.sciencemag.org/cgi/content/full/283/5399/143a

Flowers and Insect Evolution

B. D. Farrell (24 July, p. 555) reconstructed the phylogeny of the Phytophaga, "the largest and oldest radiation of herbivorous beetles," with the use of DNA sequences and morphological characters. He concluded that the evolutionary success of beetles "seems to have been enabled by the rise of flowering plants."

B. N. Danforth and J. Ascher comment that the diversification of bees also supports the "hypothesis that insect diversity is intimately tied to the rise and diversification of angiosperms in the Cretaceous." R. S. Anderson discusses how a "'key innovation' ... the use of the snout (or rostrum) by adult female weevils in the preparation and excavation of oviposition sites" may have affected the diversity of that beetle family.

In response, Farrell agrees with Danforth and Ascher "that the angiosperm-based explanation for beetle diversity implies an extension to other herbivorous insect groups." He states that the "most serious difficulty" for Anderson's "ovipositional rostrum hypothesis lies in the absence of this structure in the weevil sister group, the Chrysomeloidea," which uses "an array of plant parts similar to that used by weevils."

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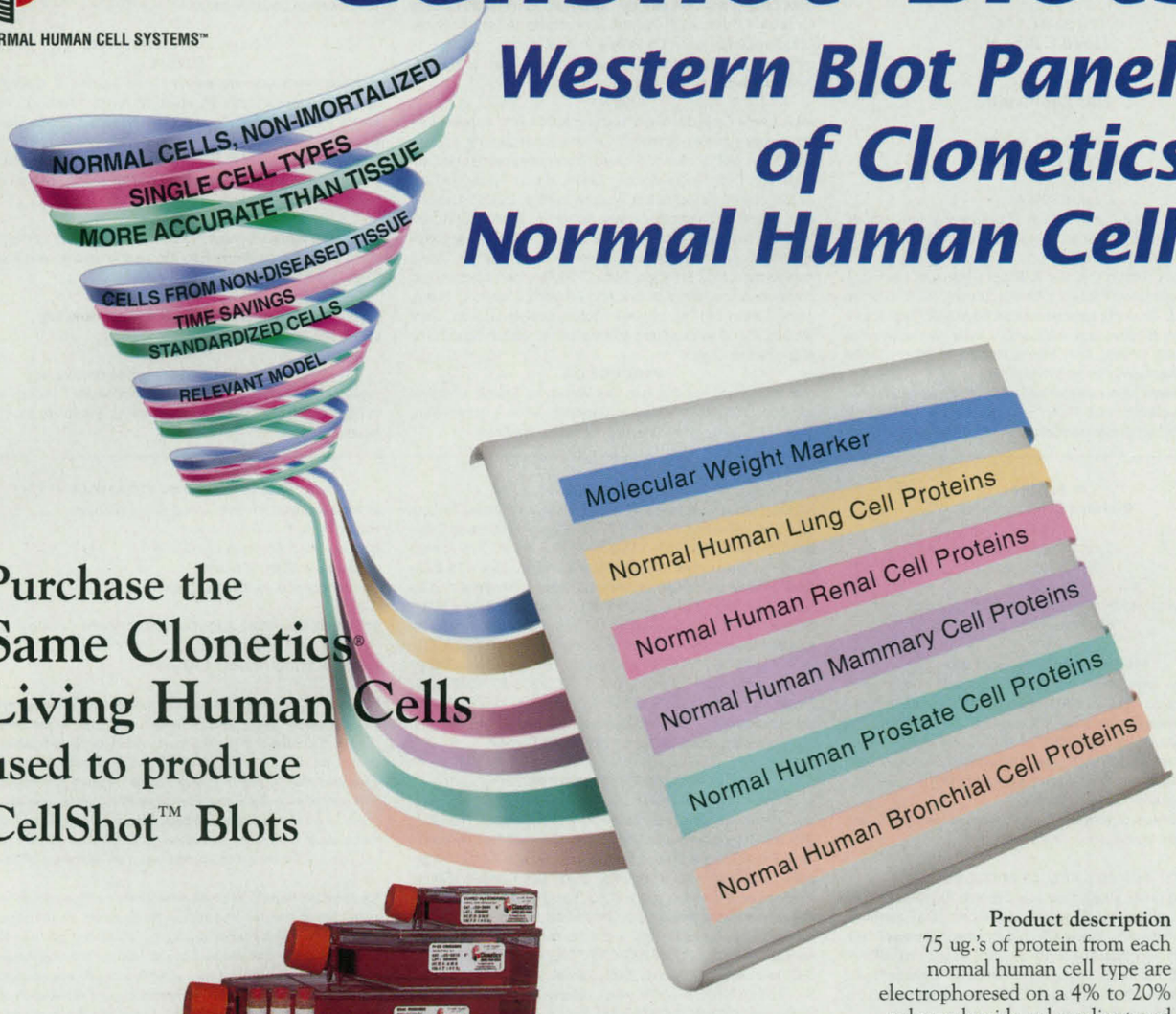

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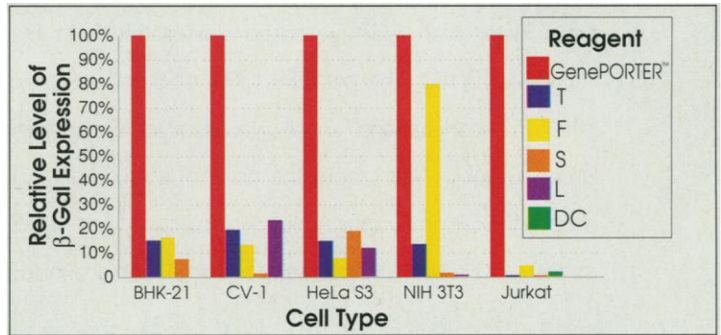

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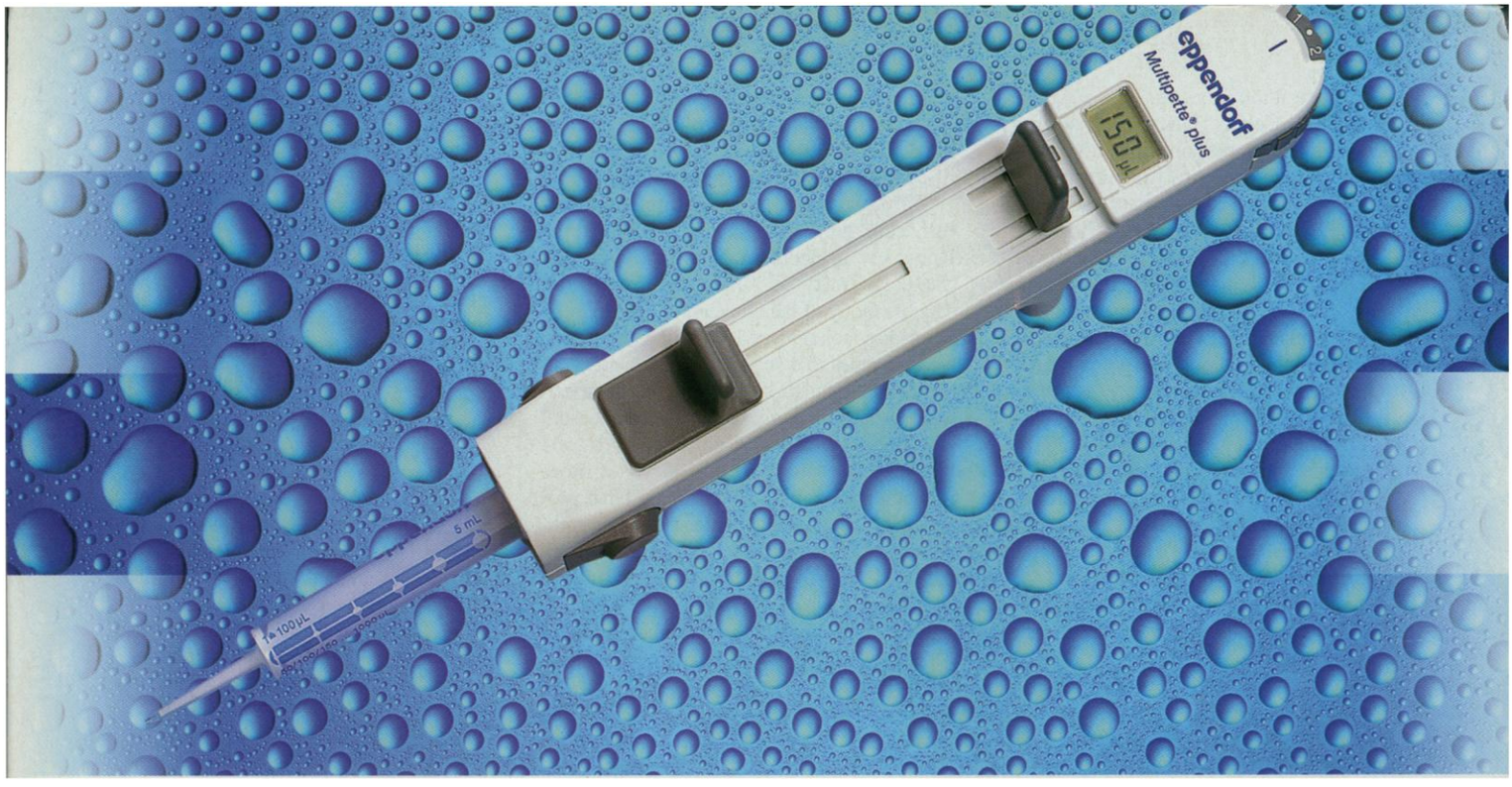

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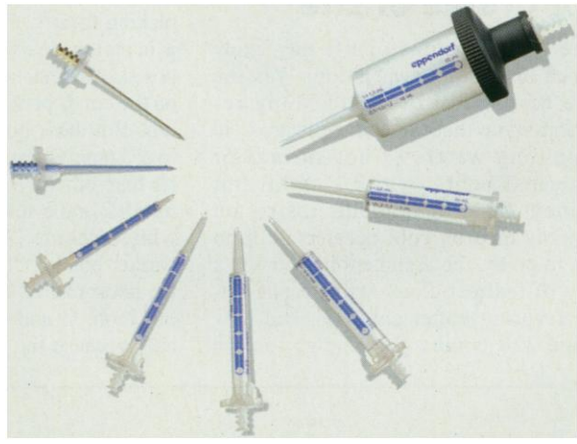

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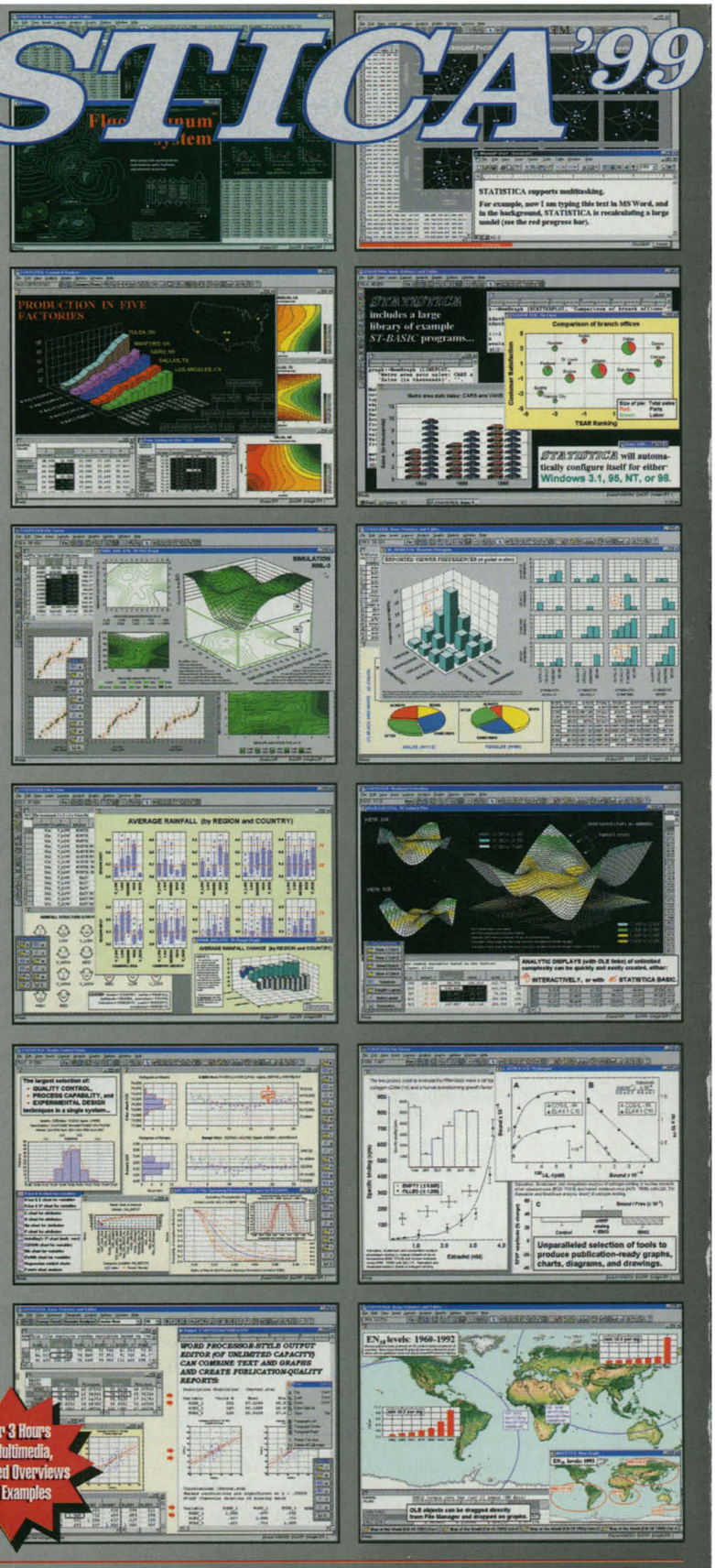

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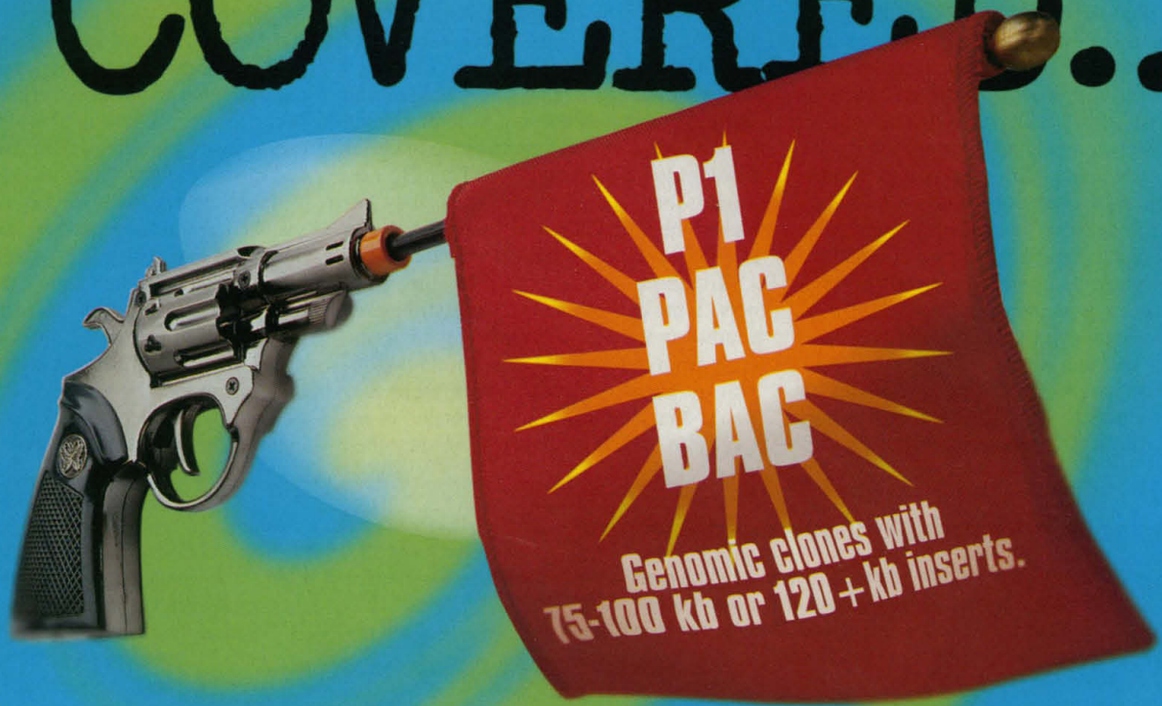

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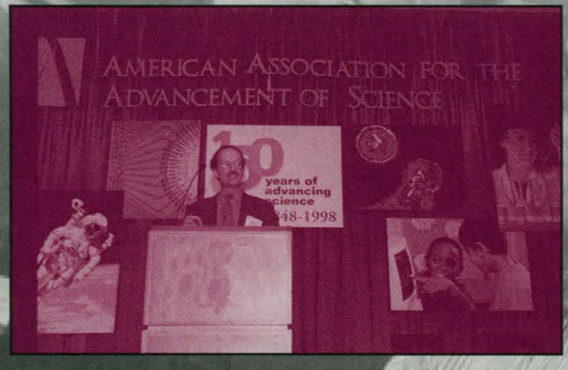

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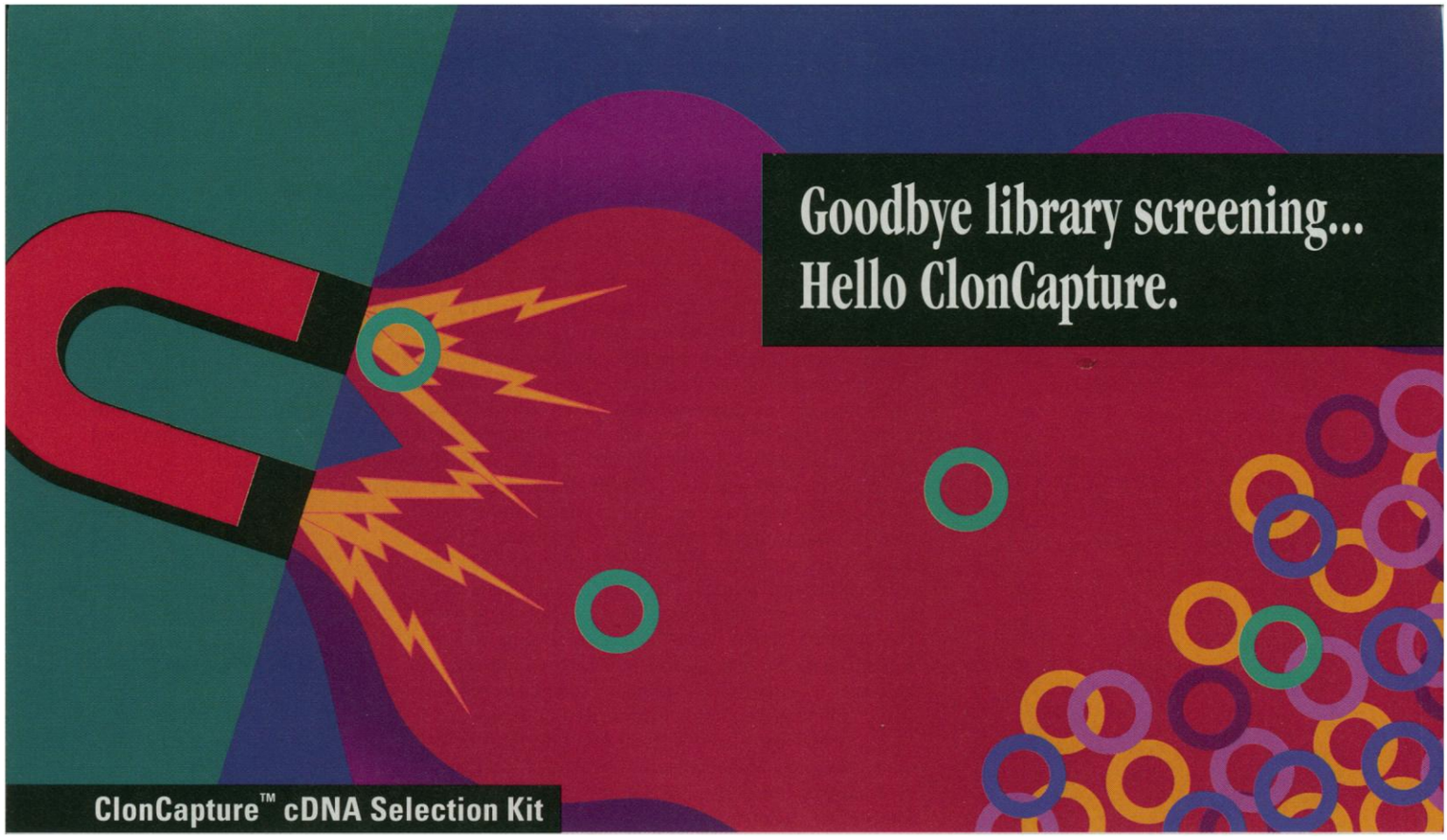

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