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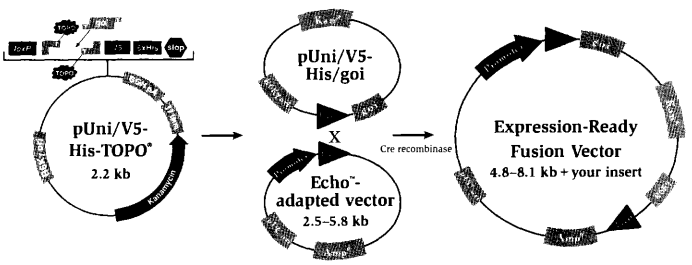

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Science

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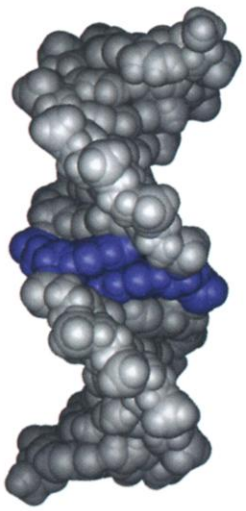
COVER A rolled-leaf hispine beetle (~5 mm long), *Cephaloleia dorsalis*, on a petiole of its host plant, *Costus* sp., in Chiriquí Province, Republic of Panama. *Costus* belongs to the order Zingiberales, consisting of gingers and related plants. Leaf damage inflicted on fossil gingers by ancient relatives of this beetle demonstrates that hispine beetles and their feeding associations with Zingiberales originated before the end of the Age of Dinosaurs. [Photo: D. M. Windsor]



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Loading the bases

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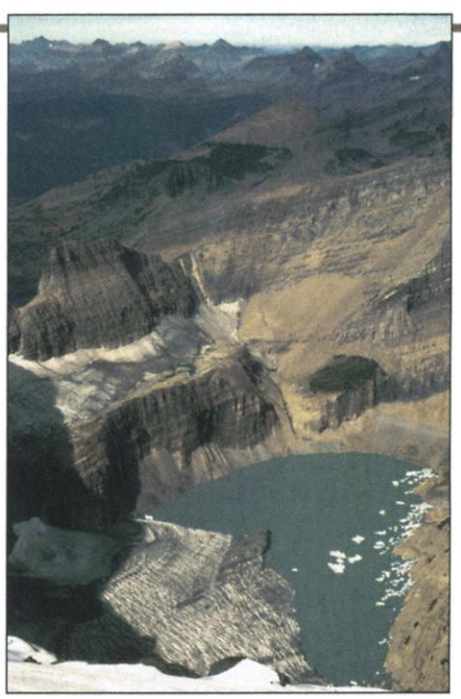

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Modern glacial retreat

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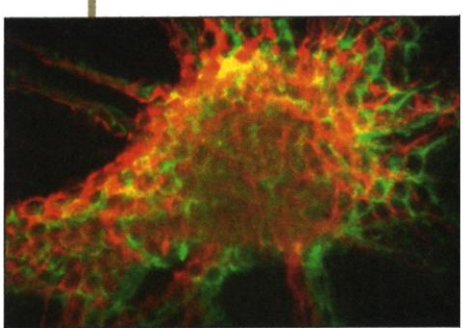
The what, how, and why

PERSPECTIVES

PATHWAYS OF DISCOVERY

The Quickening of Science Communication R. Lucky

In this month's essay, Robert Lucky examines the central sociological impacts that communications technologies have had on the way science is done as well as the critical influences that science has had in the evolution of communications technologies.



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Turning cells into cholinergic neurons

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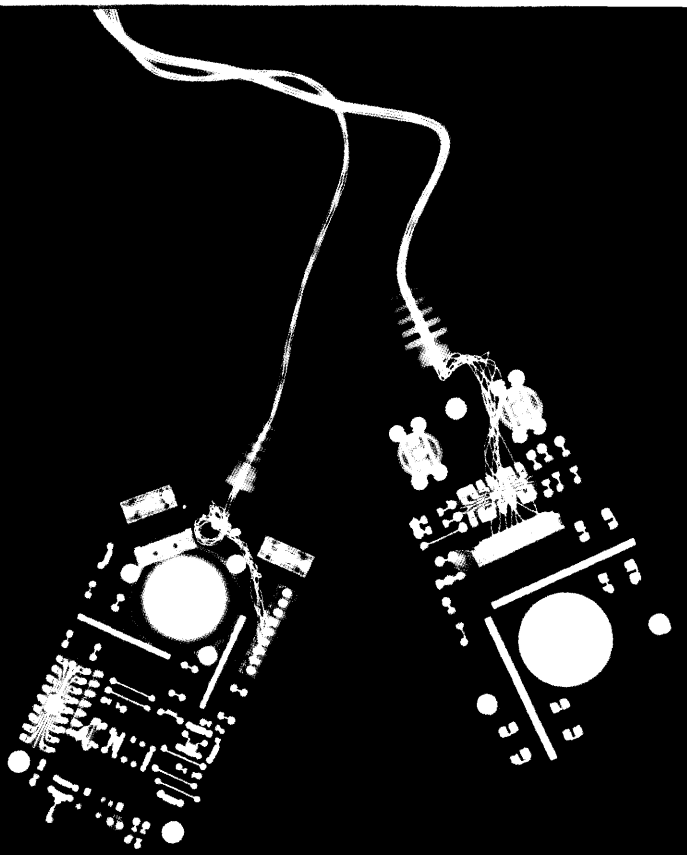

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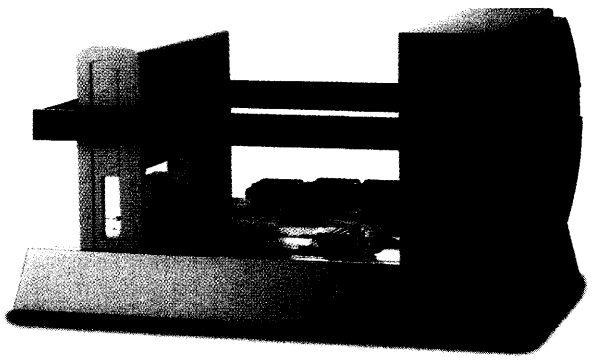

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A PARSIMONIOUS APPROACH TO CLIMATE CHANGE

Reconstructions of Northern Hemispheric climate for the last 1000 years show that warming and cooling occurred for extended intervals, such as during the Medieval Warm Period and the Little Ice Age, and that temperatures have risen to new highs in the past century. Why have these variations occurred? Crowley (p. 270; see the Perspective by Mann) has calculated how much changes in solar irradiance and volcanism should have affected global warmth during the last millennium. He finds that these two forcing factors can explain most of the variability before the Industrial Revolution. During the past half-century, however, the large rise in Northern Hemisphere temperatures cannot be accounted for without including the effect of anthropogenic greenhouse gases.

SUPERCONDUCTING STRENGTH OR COHERENCE?

In conventional superconductors, the phase coherence of the Cooper pairs and the strength of the pairing are essential but distinct features of the condensate that can be probed with different techniques. For example, photoemission measurements are used to determine the superconducting energy gap; that is, the strength of the coupling between electrons forming the Cooper pairs. Feng *et al.* (p. 277) present data for one of the high-temperature superconducting cuprates, $Bi_2Sr_2CaCu_2O_{8+\delta}$, and show that the dependence of the intensity of the photoemission peak on the doping and temperature resembles that of the superfluid density and is a measure of the phase coherence. Moreover, the peak intensity shows an abrupt behavior near the transition temperature, as opposed to near the higher pseudogap temperature, where pairing of the electrons is thought to occur without coherence. These results provide strong evidence against a Fermi liquid description of these superconductors.

BOOSTING INFORMATION CAPACITY

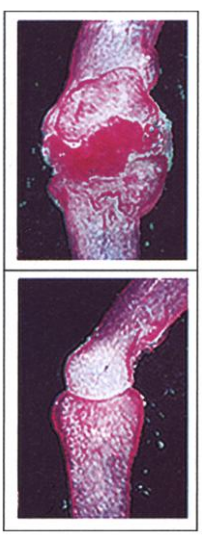
Recent theoretical work has shown that the introduction of scattering into a system can enhance rather than reduce the information capacity of a wireless communications network. Stuart (p. 281) now carries over those ideas to a real communications network and uses the spatial degrees of freedom of a mulitmode fiber (MMF) and dispersive scattering between the modes to enhance the information capacity of the fiber. In a proof of principle study, two laser inputs and two detectors connected through a single MMF boosted its carrier capacity. Such a technique should prove useful for direct optical links to computer networks.

LEAVING BITE MARKS

Beetles comprise the most abundant species of insects, and although many beetle species are associated with particular plant species, the evolutionary record is uncertain. For example, the hispine beetle fossils, a major group of beetles that feed on specific plants, have first been found in the Tertiary, long after the appearance of angiosperms. Wilf *et al.* (p. 291; see the cover and the news story by Pennisi) use the characteristic feeding pattern of hispine beetles to extend, using fossil leaves, the appearance of this group back into the Cretaceous.

NATURAL TARTAR CONTROL FOR JOINTS?

Little is known about the etiology of arthritis. In a study aimed at identifying genetic factors that contribute to the disease, Ho *et al.* (p. 265; see the news story by Hagmann) cloned the defective gene in mice with *progressive ankylosis* (*ank*), a spontaneously arising mutant strain that shows certain pathologic features of human arthritis (top). The *ank* gene encodes a multipass transmembrane protein that appears to regulate the transit of inorganic pyrophosphate (PP_i) into and out of the cell. The ability of PP_i to inhibit mineral deposition has been exploited in the formulation of tartar control toothpaste. Thus, when working properly, the ANK protein may prevent arthritis by inhibiting mineral deposition in articular cartilage and other tissues (bottom).



PRESSURIZING CONTINENTAL SLOPES

Continental slopes harbor sharply cut canyons and also ecosystems that gain their shape and energy, respectively, from fluids seeping out of the slopes. Measurements have indicated that these fluids are being expelled at high pressures near that of the lithostatic pressure of the sedimentary rock load. Dugan and Flemings (p. 288) have developed a two-dimensional model of lateral fluid flow that reproduced fluid overpressures consistent with observations. Their results highlight the importance of overpressurized lateral fluid flow for explaining slope failure and possibly for the health of slope ecosystems.

WATER FUTURES

One common concern raised regarding future climate change is that it could significantly alter precipitation patterns and thus water demands. Possibly compounding this effect is likely growth in population (and thus the demand for fresh water), particularly in many areas of the world that already have limited freshwater resources. Using climate and population models, Vörösmarty *et al.* (p. 284) examined how these effects could alter water resources globally. For most areas, the likely population pressures on water resources overwhelmed any changes (for better or worse) that may result from climate change.

AN INHERITED SENSE OF TIMING

Studies in zebrafish indicate that the circadian clock may be an intergenerational continuum. Delaunay *et al.* (p. 297) isolated and studied the zebrafish version of the clock gene *Per3*. The results show that some manifestations of circadian rhythm may be maternally inherited. Circadian *Per3* gene expression was not affected by the time of fertilization or the speed of development (which is adjustable by temperature in this poikilothermic species). A certain extent of development is required to fully assemble the clock, because a more downstream gene did not begin its circadian pattern of expression until development had progressed further.

BRING ON THE DEFENSES

When plants are subjected to stress, they bring out their chemical arsenal of secondary metabolites that are often harvested for their incidental value as pharmaceuticals, flavors, dyes, and insecticides. This biosynthetic response is medi-

CONTINUED ON PAGE 215

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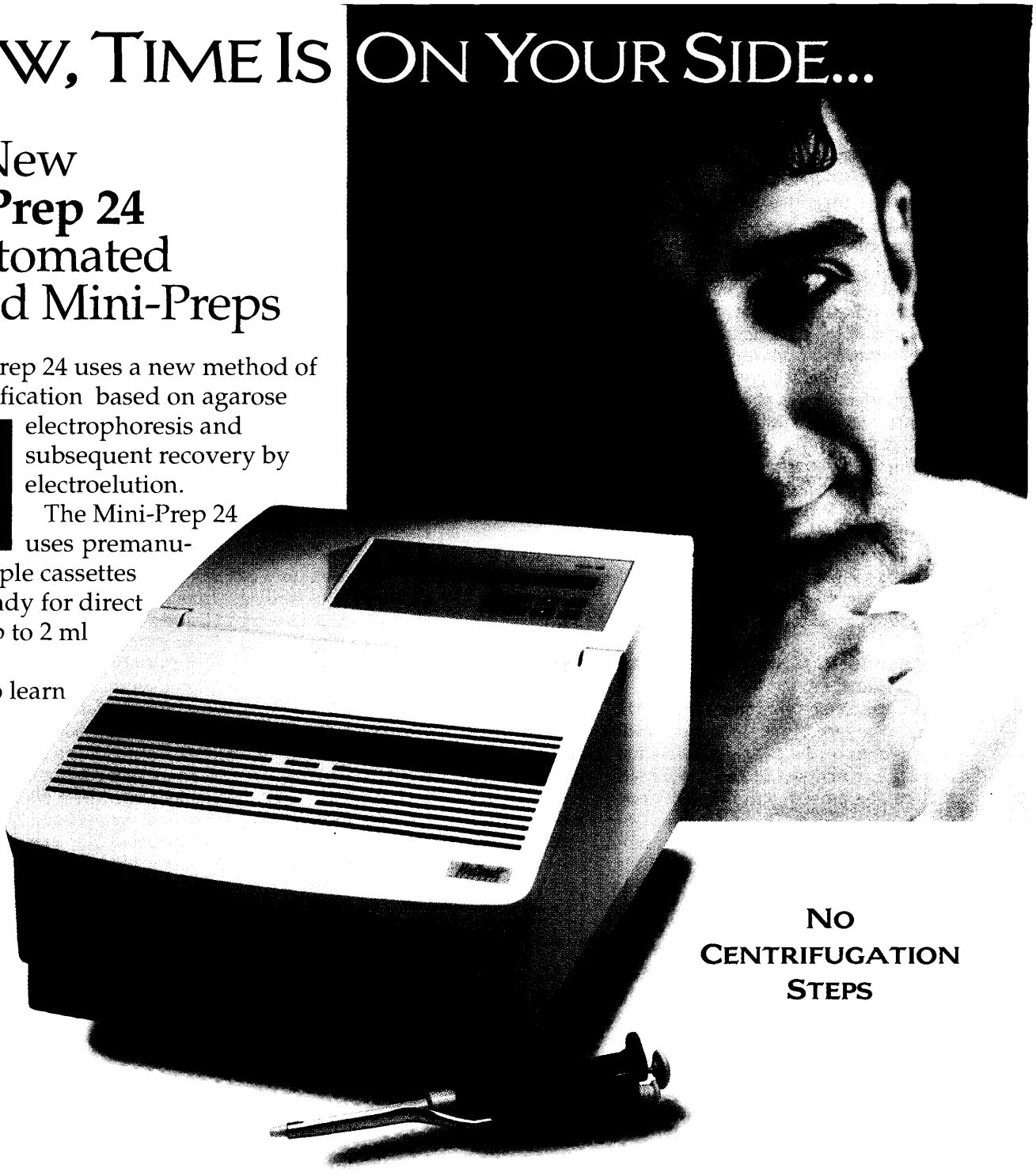

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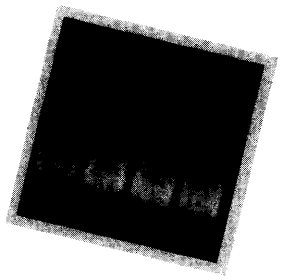

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CONTINUED FROM PAGE 213

ated in part by (methyl)jasmonate, a plant hormone produced in response to stress. Van der Fits and Memelink (p. 295) have now identified a transcription factor, ORCA3, which is regulated by (methyl)jasmonate and in turn regulates several genes in both primary and secondary metabolic pathways. Analysis of this gene leads to insights into how plants bring their chemical defense responses online without destructively disrupting their primary metabolic pathways, as well as into ways to produce secondary metabolites in vitro.

A KINDER CUT OF P73

In the brain of very young mammals, a vast oversupply of neurons is pruned back as the neuronal interconnections become increasingly refined. The pruning process relies on p53-promoted apoptosis. Pozniak *et al.* (p. 304; see the Perspective by Morrison and Kinoshita) now find that the actions of p53 are counterbalanced by the actions of a truncated form of p73 lacking its transactivation domain. In its full-length form, p73 also promotes apoptosis, but its truncated form blocks apoptosis. The decision to produce truncated or full-length p73 is made at the point of transcription, which suggests a potential mechanism for a very rapid response to changing cell-death or cell-survival needs. A healthy supply of truncated p73, and thus cell survival, is promoted by the presence of nerve growth factor (NGF). Thus, p73, whose function depends on the particular isoform produced, is a mediator of the NGF cell-survival signal.

ENSURING AN EVEN SPLIT

The spindle checkpoint provides a mechanism by which cells ensure that chomosomes are properly connected to the mitotic spindle before the cell begins anaphase. How is chromosome alignment and attachment monitored during meiosis I, when sister centromeres remain attached and homologous chomosomes are separated, one to each daughter cell? Shonn *et al.* (p. 300; see the Perspective by Sluder and McCollum) analyzed checkpoint mutants of budding yeast and found that components of the mitotic checkpoint have a key role in meiosis I. Whereas the checkpoint is dispensable for normal mitosis, less than half the checkpoint mutant cells underwent normal segregation of chromosomes in meiosis I. The checkpoint apparently delays the onset of anaphase in response to the lack of tension on the chromosomes. This process appears to allow time for reorientation before anaphase begins. The results suggest that abnormalities in the spindle checkpoint could contribute to Down syndrome, a birth defect caused by improper segregation of human chromosome 21 during meiosis I.

MATING IN *CANDIDA*

Candida albicans is a ubiquitous inhabitant of human beings, often as a nuisance, but increasingly as a serious pathogen. Its identity has been known for 80 years, but only very recently has it been suspected of having sex, despite the sexual nature of similar yeast-like organisms. Now two groups by two different routes have discovered mating in *C. albicans* (see the Perspective by Gow *et al.*). Hull and Johnson (p. 307) consolidate their recent observation of a mating locus by engineering a series of strains with deletions in components of the mating type–like locus (*MTL*) and identifying the progeny of pairs of various combinations of engineered strains that have mated during infection in mice. They only found progeny, with increased DNA content, from pairs of strains with appropriate genotypes—in this case, *MTLa* and *MTLα*. In contrast, Magee and Magee (p. 310) generated hemizygose strains by metabolic selection (something that could easily happen in nature) on sorbose-agar plates. This group also achieved mating between the resulting *MTLa* and *MTLα* strains and confirmed that these progeny were tetraploid. What both groups have yet to obtain are spores formed after meiosis.

CREATING CHOLINERGIC NEURONS

Much effort has been focused recently on the development of catecholaminergic properties in the central nervous system and on the induction cholinergic neurons in the peripheral autonomous nervous system. However, the factors that induce and maintain cholinergic function in the brain have largely remained unexplored. López-Coviella *et al.* (p. 313) show that bone morphogenesis protein–9 (BMP-9), a member of the transforming growth factor-β superfamily of growth and differentiation factors, is a differentiating factor for cholinergic properties in septal and spinal chord neurons.

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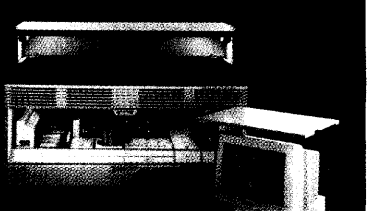

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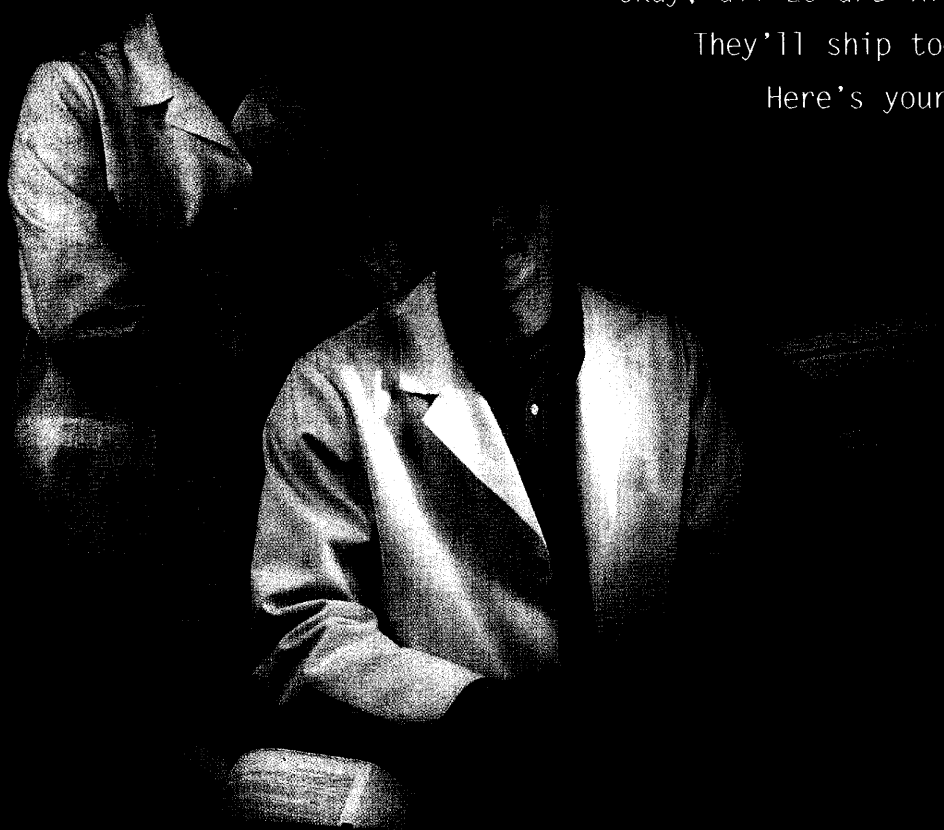

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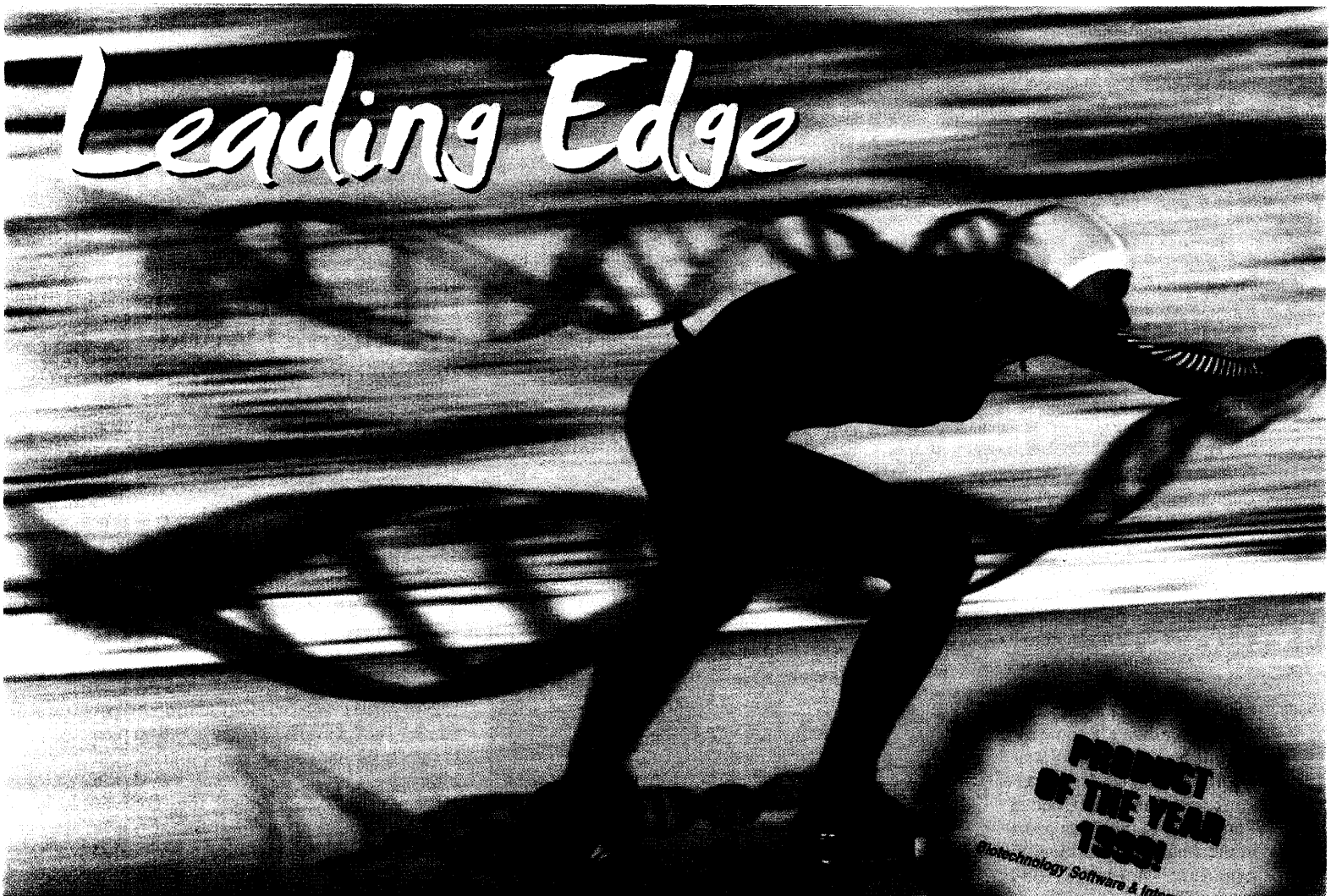

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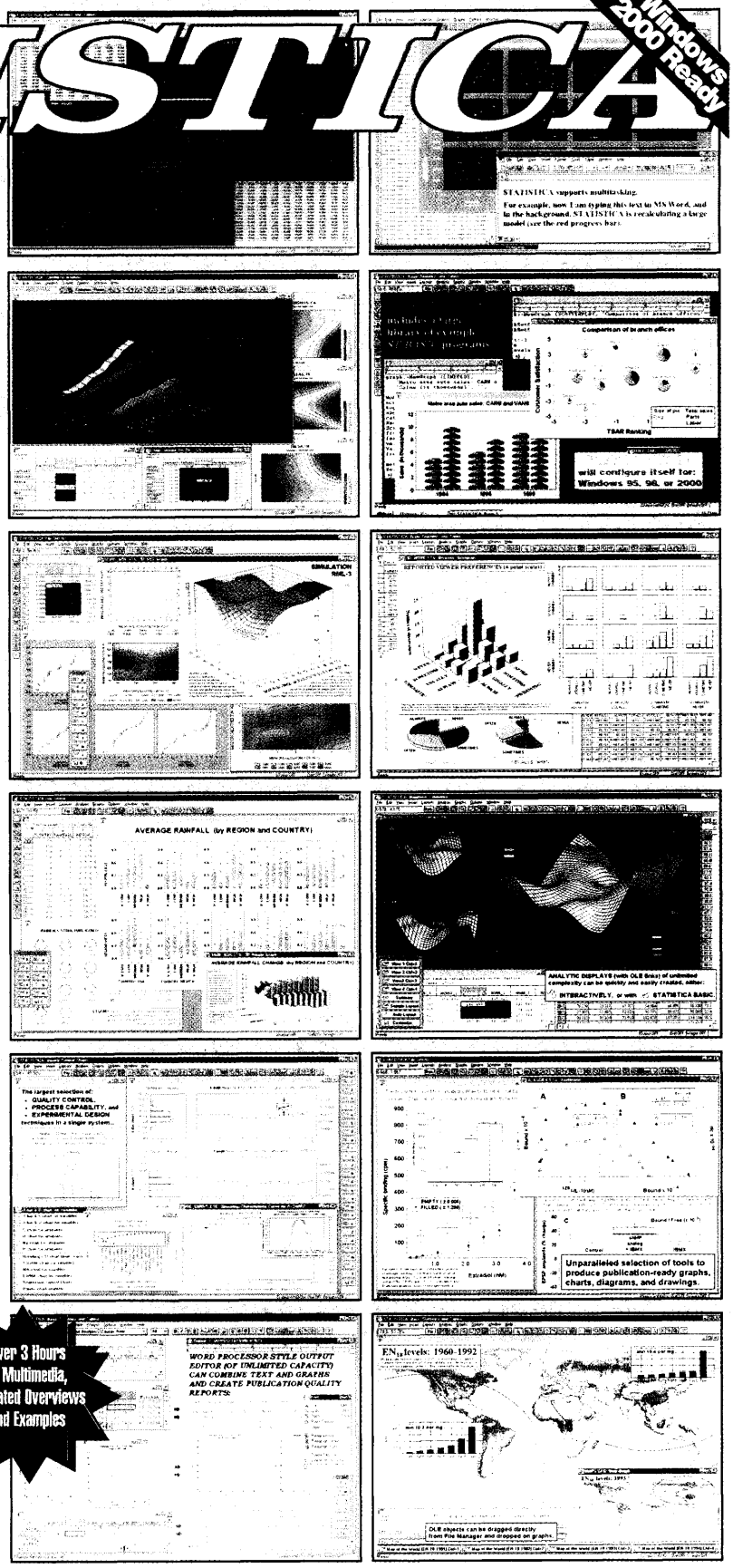

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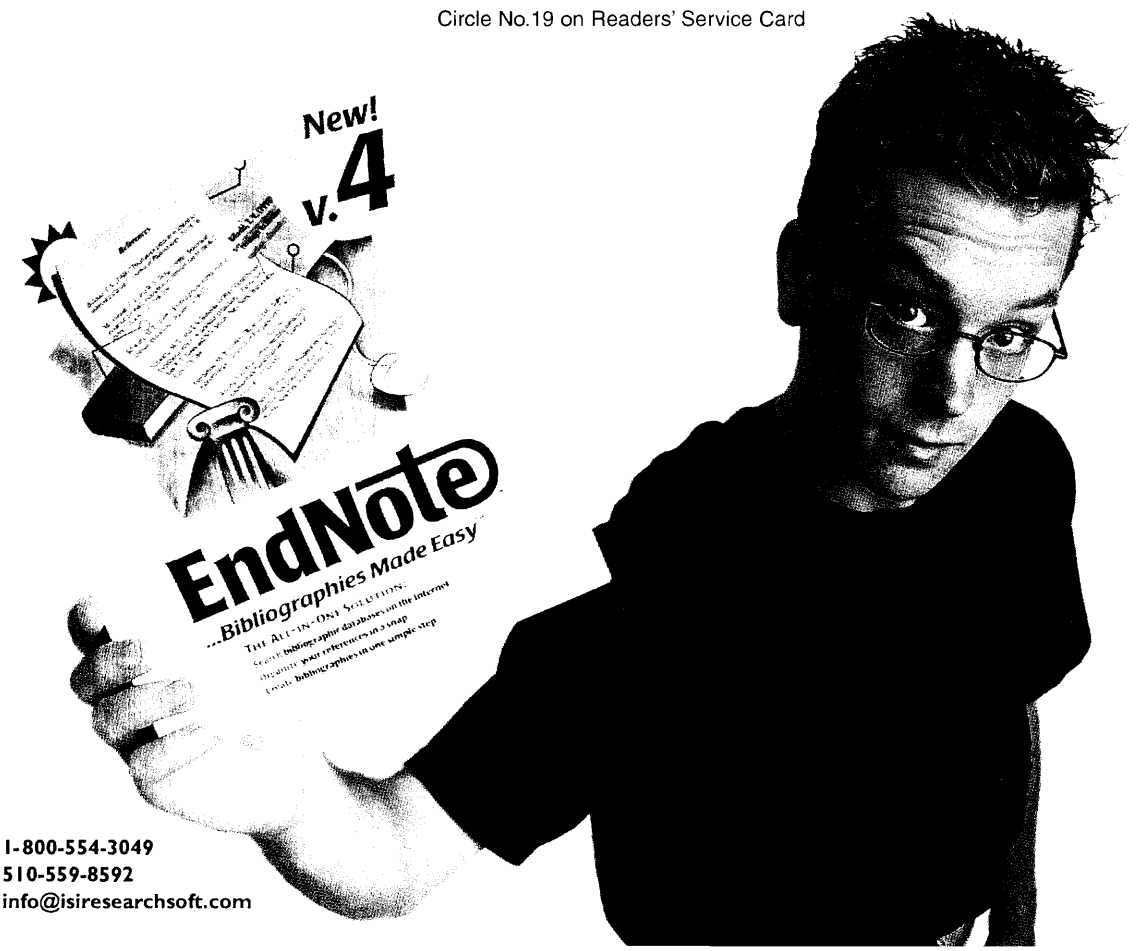

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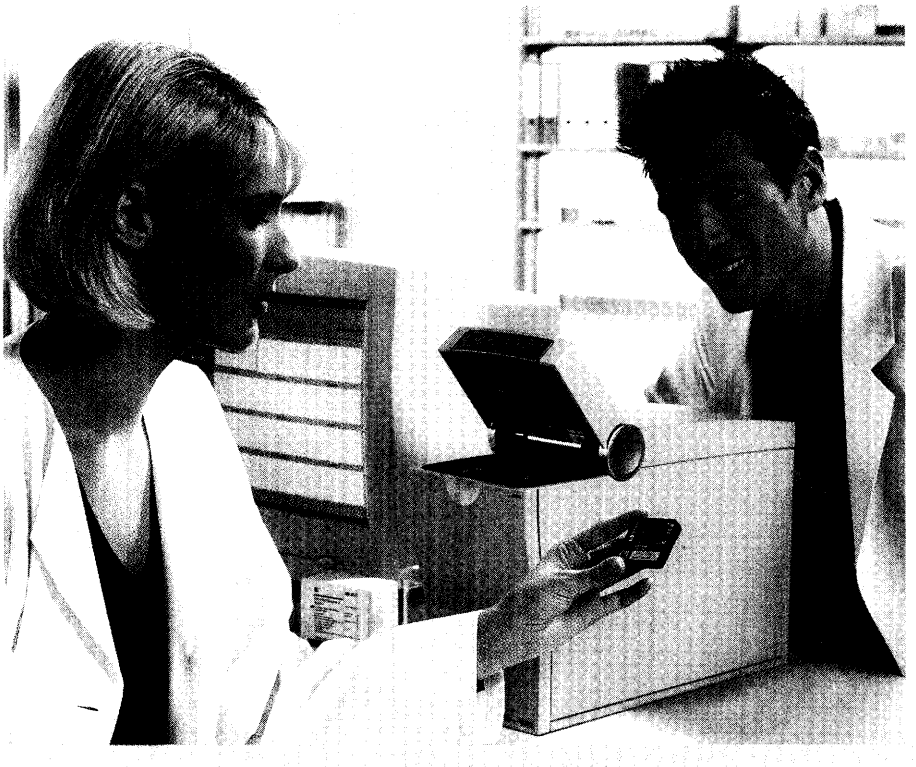

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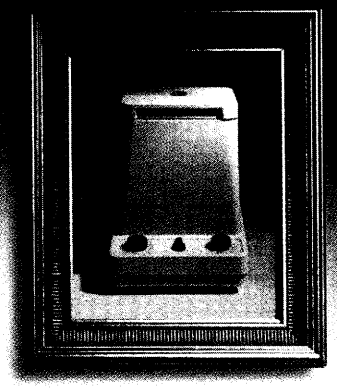

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