The system introduced by GSE Limited of Luton, UK, can be bought or hired and should be particularly useful for biologists, oceanographers, engineers, environmental control bodies and water authorities.

New Bottom Sampler

A new set of instruments should make investigations of the environment on the beds of lakes, waterways and coastal areas simpler and more accurate. The instruments, called System Borg, have been produced by a Swedish firm and include a sediment penetrometer, sediment samplers and traps. The new penetrometer weighs only 7.5 kg which means it can be easily handled by one person from a rowing boat. It is lowered on the end of a cable and three different cones are released to determine quickly the type of sediment in the area and 'bottom dynamics' – erosion transportation and accumulation.

Sediment sampling is used throughout the world in more than a million environmental and aquatic pollution confined studies. Investigations which have previously taken days to complete can now be done in just a few minutes and at a fraction of the cost, claims the system manufacturer C. H. Borgs Mekaniska AB of Enkoping.

Metals in the Environment

Europe's largest-ever conference on heavy metals in the environment will be held in Heidelberg, West Germany, from 6 to 9 September. Many of the world's leading environmental scientists will attend the conference, where 300 individual case studies from over 30 countries will be presented. Sessions will cover metals in surface waters and marine and fresh water sediments.

New Red Data Book

The first attempt to list endangered species of invertebrates on a worldwide scale and to relate them to their role in nature and usefulness to man is now available as the latest in the IUCN Red Data Book series on threatened wildlife.

An innovation in this volume of the continuing Red Data series is a section on Threatened Communities which includes as one example, marine environments. The section generally illustrates situations where human activities may endanger large and unique invertebrate populations.

The listings, of use to environmental planners, scientific researchers, teachers and libraries, identify some fascinating creatures, including the world's largest clam, the giant clam of Southern waters, with a diameter up to 1.4 m, a weight of over 200 kg and a lifespan of more than a century.

The IUCN Invertebrate Red Data Book also draws attention to the use of invertebrates in medical research. Many invertebrates which may be declining are used in this way. The blood of the horseshoe crab, for example, is used extensively in biomedical research. Many more examples abound in the book which was prepared with assistance from The World Wildlife Fund and The United Nations Environment Programme.

Manatee Sanctuary

A Sanctuary for endangered manatees has been saved – thanks to donations from more than 4000 individuals and corporations in the United States. The King's Bay area on the Crystal River is the largest natural manatee sanctuary in the US and now $425 000 in contributions has enabled the Nature Conservancy to establish 14 of the bay's islands as a permanent sanctuary. The region is the winter home of the only increasing manatee population in the US with approximately 120 of the mammals using the warm water springs and abundant vegetation in the bay during the cold months.

The 14-month campaign to raise funds for the Crystal River Manatee Sanctuary attracted wide-ranging support from school children to foundations. In particular, it received substantial financial assistance – two challenge grants of $50 000 each – from the New York Goodhill Foundation and the World Wildlife Fund – US.

Nathaniel. P. Reed, Manatee Campaign Chairman, said: "Nothing is so important in life as finding a home and, thanks to the Nature Conservancy, hundreds of manatees now have a safe winter sanctuary forever."

OCEANEXPO

"The new frontiers of the sea" will be the general theme of a symposium concerning the developing countries to be held alongside the OCEANEXPO/OCEANTROPIQUES exhibition in Bordeaux from 11 to 15 October. The symposium topics will include the new international maritime order and new sea frontiers; the new convention of the law of the sea; fresh developments in maritime training and the transfer in technologies; the development of maritime transports and port activities in countries belonging to the Ministerial Conference of West and Central Africa; and port and shipping development in Arab countries.

Round-the-World News

Thailand

Scientists are divided over the cause of a mystery disease which is killing millions of fish in Thailand. Pesticides are blamed by the toxicology division of the Thai agriculture department but British and Thai fish experts believe the fish are dying from an aquatic fungus, and it may or may not be linked to pesticides. Paraquat and other pesticides such as dieldrin and heptachlor have been found in most samples of fish tissue examined since the outbreak of the disease at the end of last year. More than half the provinces in Thailand are affected by the epidemic which is affecting many species including mudfish and snakehead, part of the staple diet of Thai peasants, and has forced up the price of other protein sources.

France

A protest at the dumping of noxious yellow sludge into the Seine estuary near le Havre was supported by French fishermen. Their boats joined the *Sirius* – the Greenpeace conservation pressure group's 'protest boat' – in the estuary to demand that French firms should stop dumping waste from the manufacture of phosphate fertilizer.

The fishermen say that the dumping has destroyed a rich fishing ground and that further out to sea the sludge has sterilized spawning grounds, caused tissue and bone damage in fish and helped to spread a phytoplankton which is toxic to marine life. Greenpeace claims the Seine is being poisoned by the 6000 tons of sludge pumped into the estuary every day by firms.

Canada

Following a 10 000 gallon oil spill on the St Lawrence River, near Massena, New York, clean-up crews have recovered 62 barrels of oil and 274 drums of oily debris from the shores.

On the date of the spill, 22 May, the 27 000 ton Yugoslav bulk carrier *Beograd* was seen by the US coast guard discharging oil into the river near the spill site and whether the spilled oil came from the vessel was being investigated. Northerly winds kept most of the oil on US islands in the St Lawrence and the USCG allocated $100 000 for the clean-up.

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RESEARCH REVIEW

Sister Chromatid Exchange and Mutagens in the Aquatic Environment

Recent advances in cytogenetics have provided some important new methods for measuring chromosome damage in cells exposed to environmental mutagens and carcinogens. Potentially the most useful new approach to mutation testing, and the one which has attracted the most interest from those involved in aquatic toxicology, is sister chromatid exchange (SCE), a sensitive indicator of chromosome damage based upon the switching of labelled arm segments within chromosomes (S. A. Latt, 1981, *Mutation Res.*, **87**, 17–62).

While sister chromatid exchanges (SCEs) are not mutational events in the conventional sense, since the chromosome concerned remains morphologically unchanged, they have been shown, both *in vitro* and *in vivo*, using a wide variety of cellular systems, to be extremely sensitive indicators of chromosomal damage, often at mutagen concentrations several orders below those at which significant increases in structural and numerical aberrations (e.g. chromosome breaks, deletions and structural rearrangements) are apparent (D. R. Dixon & K. R. Clarke, 1982, *Mar. Biol. Lett.*, **3**, 163–172). It is because of this proven sensitivity to a wide range of chemical mutagens and carcinogens (also some energy-related stimuli, e.g. UV-light and X-rays), coupled with a relatively fast response time (at least under laboratory conditions), and the speed and simplicity of scoring (a feature not shared by other cytogenetic methods), that has attracted many aquatic biologists to the SCE method when seeking a way to measure the effects of environmental contaminants on the chromosomes of aquatic organisms.

The modern method of SCE analysis involves exposing cells (organisms) for two DNA replication cycles (Fig. 1) to bromodeoxyuridine (BrdU), a chemical analogue of the DNA-nucleotide base, thymine (S. A. Latt, 1974, *Proc.*

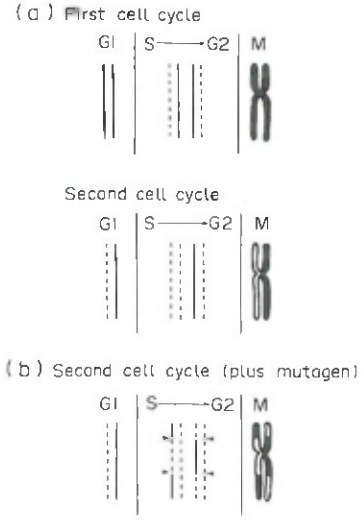

Fig. 1 (A) Formation of differentially labelled chromatids during two cell cycles in BrdU. G1, Pre-synthesis stage; S, DNA synthesis period; G2, post-synthesis period; M, metaphase. (B) SCE induction caused by mutagen exposure during S phase.

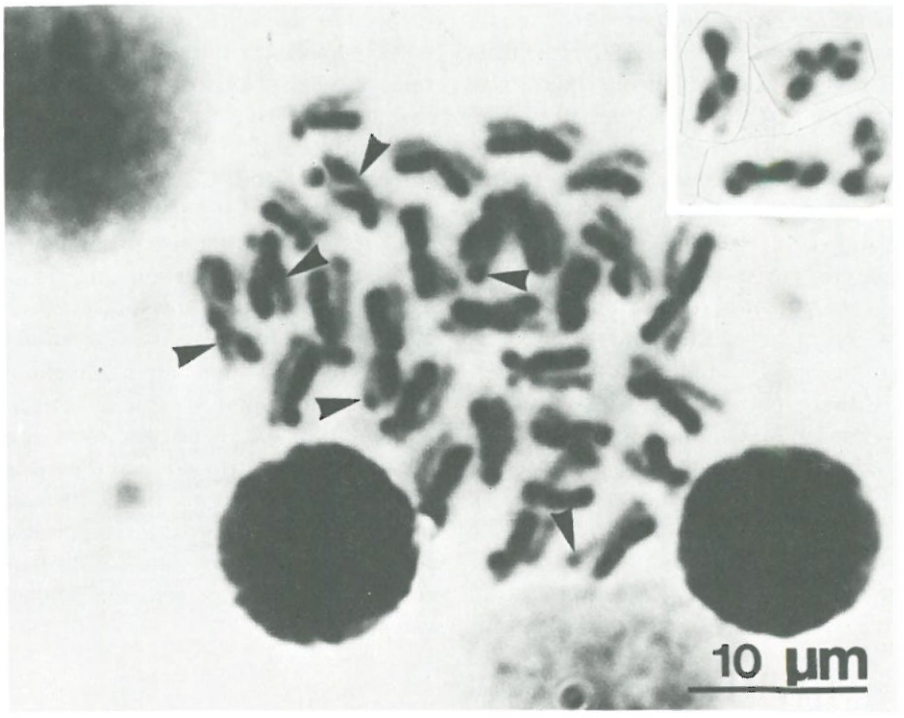

Fig. 2 Differentially stained chromosomes of *Mytilus edulis* showing a low 'spontaneous' frequency of SCEs caused by BrdU. Inset shows chromosomes from a mussel exposed to a mutagen (Mitomycin C) exhibiting the characteristic 'harlequin' pattern caused by enhanced SCE induction.

natn. Acad. Sci. (U.S.), **71**, 3162–3166; P. Perry & S. Wolff, 1974, *Nature, Lond.* **251**, 256–258). At the end of the two cell cycles one chromatid (chromosome arm) has its DNA molecule partially substituted with BrdU, while the sister chromatid is completely substituted with BrdU. Being able to distinguish microscopically between sister chromatids (arms within the same chromosome) at this stage depends upon chromatids which are completely substituted fluorescing less than their 'hybrid' sister chromatids when stained with a fluorescent dye (e.g. Hoechst 33258 or AO), and having reduced Giemsa staining with light microscopy (Fig. 2). It is at this stage the SCEs caused by mutagens can be scored to provide a sensitive assay for mutagenesis and carcinogenesis (P. Perry & H. J. Evans, 1975, *Nature, Lond.*, **258**, 121–124).

A. D. Kligerman & S. E. Bloom (1976, *Chromosoma (Berl.)*, **56**, 101–109) pioneered the introduction of SCE analysis in aquatic toxicology with their demonstration of BrdU incorporation and SCEs in a small, freshwater fish, *Umbra limi*. Kligerman (e.g. 1979, *Mutation Res.*, **64**, 205–217) subsequently reported how both direct-acting and indirect-acting mutagens (those requiring metabolic activation) were able to induce dose-related increases in SCE rate, and showed by means of laboratory demonstration (using as a test mutagen, neutral red) the feasibility of using fish such as *Umbra limi* as model systems for monitoring the aquatic environment for mutagens. Since then other fish species have similarly been identified as suitable candidates for screening both pure compounds and surface waters for genotoxic potential (e.g. J. C. M. van der Hoeven *et al.*, 1982, *Mutation Res.*, **97**, 35–42). Recently, this approach was applied to *Umbra* sp. under semi-natural conditions. Significantly higher rates of SCE induction were present in fish exposed to polluted water in cages in the river Rhine than in controls held in a similar way under clean water conditions (G. M. Alink *et al.*, 1980, *Mutation Res.*, **78**, 369–374; R. N. Hooftman & G. J. Vink, 1981, *Ecotoxicol. envir. Safety*, **5**, 261–269).

SCE studies relating to mutagens in the marine environment have been restricted for the most part to sedentary invertebrate species. Apart from the obvious limitations imposed by working on highly mobile subject organisms in a dynamic and spatially varied environment, there are some technical problems associated with the use of fish as material for cytogenetic studies, i.e. the large numbers of very small chromosomes that are characteristic of the group as a whole (J. R. Gold, 1979, In *Fish Physiology*, Vol. 8 (W. S. Hoar, D. J. Randall, & J. R. Brett, eds.) Academic Press). However, one potentially fruitful area may be the use of fish cell culture for the *in vitro* screening of environmental samples, as well as compounds and effluents destined for aquatic dissemination (e.g. C. J. Barker & B. D. Rackam, 1979, *Mutation Res.*, **68**, 381–387).

Pesch and co-workers (G. G. Pesch & C. E. Pesch, 1980, *Can. J. Fish. aquat. Sci.*, **37**, 1225–1228; G. G. Pesch *et al.*, 1981, *Aquat. Toxic.*, **1**, 301–311) were responsible for adapting Kligerman's SCE method to a marine invertebrate, *viz.* the benthic polychaete, *Neanthes arenaceodentata*. Their studies, to date, have shown *Neanthes* to be a sensitive indicator organism of both promutagens and mutagens including heavy metals in sediments (Pesch, pers. comm., 1982). Larval stages provide the best source of dividing cells for SCE analysis. Harrison's group (F. L. Harrison *et al.*, Abstract 1983, *Fourth International Ocean Disposal Symposium*,

Plymouth, U.K.), working on *Neanthes* larvae under laboratory conditions, have shown that SCE frequencies may be more useful than chromosomal aberrations for measuring genetic damage induced by low levels of irradiation (X-rays, ^{60}Co gamma rays). More detailed investigations, however, both of the responses and the factors affecting them, are of paramount importance before any direct cause–effect relationship between SCEs and environmental radiation can be considered proven.

Understandably, *Mytilus edulis*, the common mussel and major pollution indicator species, has received its share of attention in terms of SCE studies. Both adults (D. R. Dixon & K. R. Clarke, *loc. cit.*) and larvae (F. L. Harrison & I. M. Jones, 1982, *Mutation Res.*, **105**, 235–242) have been shown to yield adequate numbers of dividing cells for SCE analysis; although in adults the rate of cell division (in gill tissues) was only sufficient when the animals were actively growing. In common with other aquatic organisms, the cells of *Mytilus edulis* were shown to be very sensitive to a wide variety of chemical mutagens and carcinogens at low concentrations. However, with both these life-history stages there are serious practical difficulties associated with their application in the field, namely small size in the case of the larvae and low natural rates of cell division in the case of the adult organism.

A much more general limitation on the use of the SCE method under field conditions is the requirement for cells to be exposed to BrdU for two replication cycles before a response can be detected. While there may be ways around this problem, e.g. the use of implanted BrdU pellets such as are routinely used in some mammalian laboratories or, as was tried on a marine subject (P. T. Stromberg *et al.*, 1981, *NOAA Technical Memorandum* OMPA-10, 43 pp.), dispensing with the field treatment of BrdU altogether (thus relying upon a residual effect due to mutagens remaining in the tissues for some time after collection), these approaches do not represent a complete answer to the problem. It seems likely, therefore, that SCE will remain for the most part an important laboratory method for detecting chromosomal disturbances resulting from contact between cells and environmental mutagens and carcinogens.

D. R. DIXON

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VIEWPOINT

Viewpoint is a column which allows authors to express their own opinions about current events.

The Uses and Abuses of Ecotoxicology

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Dr David Monk is a biologist employed by the Environmental Control Centre of BP International. For the past six years he has been involved in various capacities in assessing the environmental impacts of the oil and chemical industries.

During the past two decades a new name – ecotoxicology – has been added to the list of disciplines which can be included under the banner of environmental science. Whilst ecotoxicology is concerned with the fate and effects of contaminants in ecosystems, the aspect which has received most attention, and with which ecotoxicology has become particularly identified, is the laboratory testing of chemicals in order to predict the hazards that they pose to the environment.

The enormous growth of activity in this field has been prompted partly by an increased scientific interest in the way that pollutants are distributed in and affect biological systems, but largely by an international proliferation of actual and threatened legislative activity which entails 'ecotoxicological' evaluation of potential environmental contaminants. To well known regulatory applications of aquatic toxicity testing such as the approval of pesticides, oil spill dispersants and industrial wastes to be dumped at sea can be added the determination of tax payable on industrial discharges (in parts of Europe), the monitoring of discharged effluent quality (e.g. in Canada and the USA), the establishment of water quality criteria and the assessment and notification of the environmental hazards posed by new chemicals prior to marketing or manufacture (in many parts of the world). The development of standard test methods and methods for the subsequent evaluation of the results has involved international organizations such as the Organization for Economic Co-operation and Development (OECD) and the International Standards Organization as well as national bodies and the EEC.

The worrying aspect of all this is that legislative respectability tends to endow the results of laboratory testing with a significance and precision which is not always merited. Although there is little doubt that testing of this sort can be