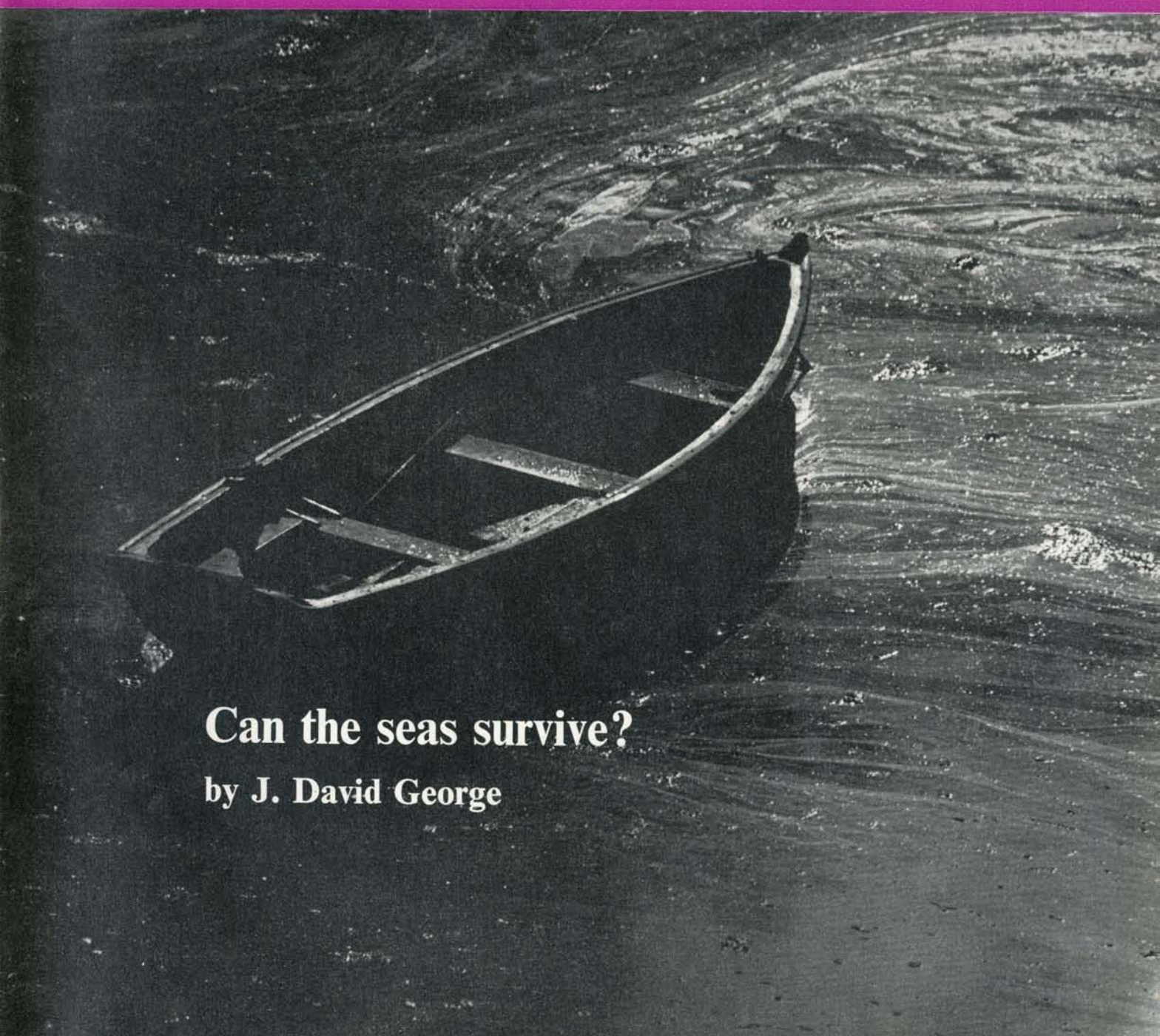
The
Ecologist

20p

Man and the environment ▪ The Quality of life ▪ Pollution ▪ Conservation

Vol. 1. No. 9 March 1971

Sir Ashley Clarke on disappearing Venice ▪ Eugene Odum on optimum population ▪ G. W. Dimbleby on the New Forest



Can the seas survive?

by J. David George

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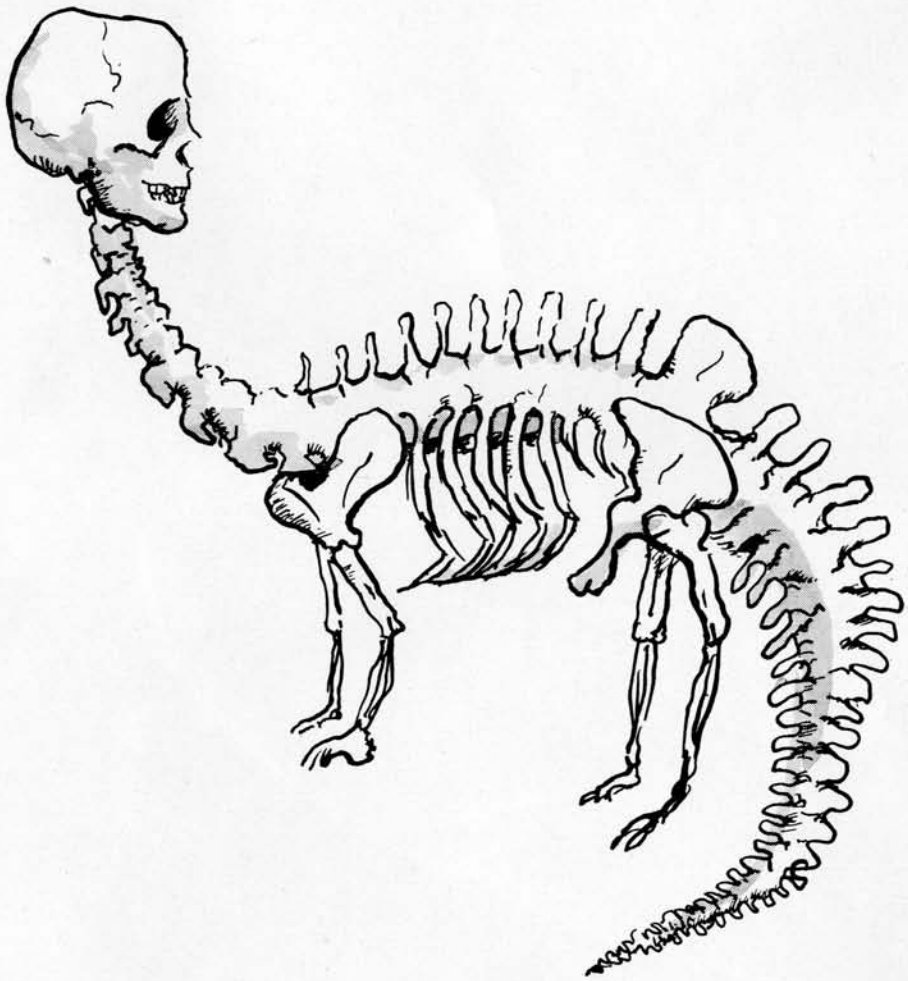

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A. Crosland, M.P.: sorcerer's apprentice.

Editorial

Crosland on growth

Anthony Crosland's Fabian tract, *A social democratic Britain,* is a unique pot pourri of the inaccurate, the exaggerated, and the mistaken.

Mr Crosland is a great believer in growth. Without it, he argues, social and environmental quality are unattainable, since they can be bought only through a reallocation of resources, which in turn requires increased public expenditure and higher taxation. Apparently these are out of the question, because they would involve "an *absolute* decline in the real incomes of the better off half of the population (which incidentally includes large numbers of working class voters); and this they will frustrate".

One would not bother to dismember such a feeble argument, were it not for the fear that Mr Crosland might one day return to watch over the environment. There are many good reasons why growth will not lead us to the good life, most quite simple. I hope he can manage these four:

1. Social quality does not depend on the accumulation of material goods. No member of a !Kung Bushman camp ever wants for food, all meat is shared, and all old people are respected and well-cared for. Their economy is in equilibrium—indeed they have no money. It is naive to expect people with a bit more cash to be any the more willing to part with it. It is no coincidence that England's period of greatest growth, the Industrial Revolution, was also its period of greatest public squalor. Nor that in the US today, with a much higher standard of living, old people are worse off than ever before. A Senate special committee has reported (*Guardian,* 18.1.71) that a quarter of Americans over 65 live in poverty, and the number is increasing by some 200,000 a year. Their medical bills alone went up 42.2 per cent in two years.

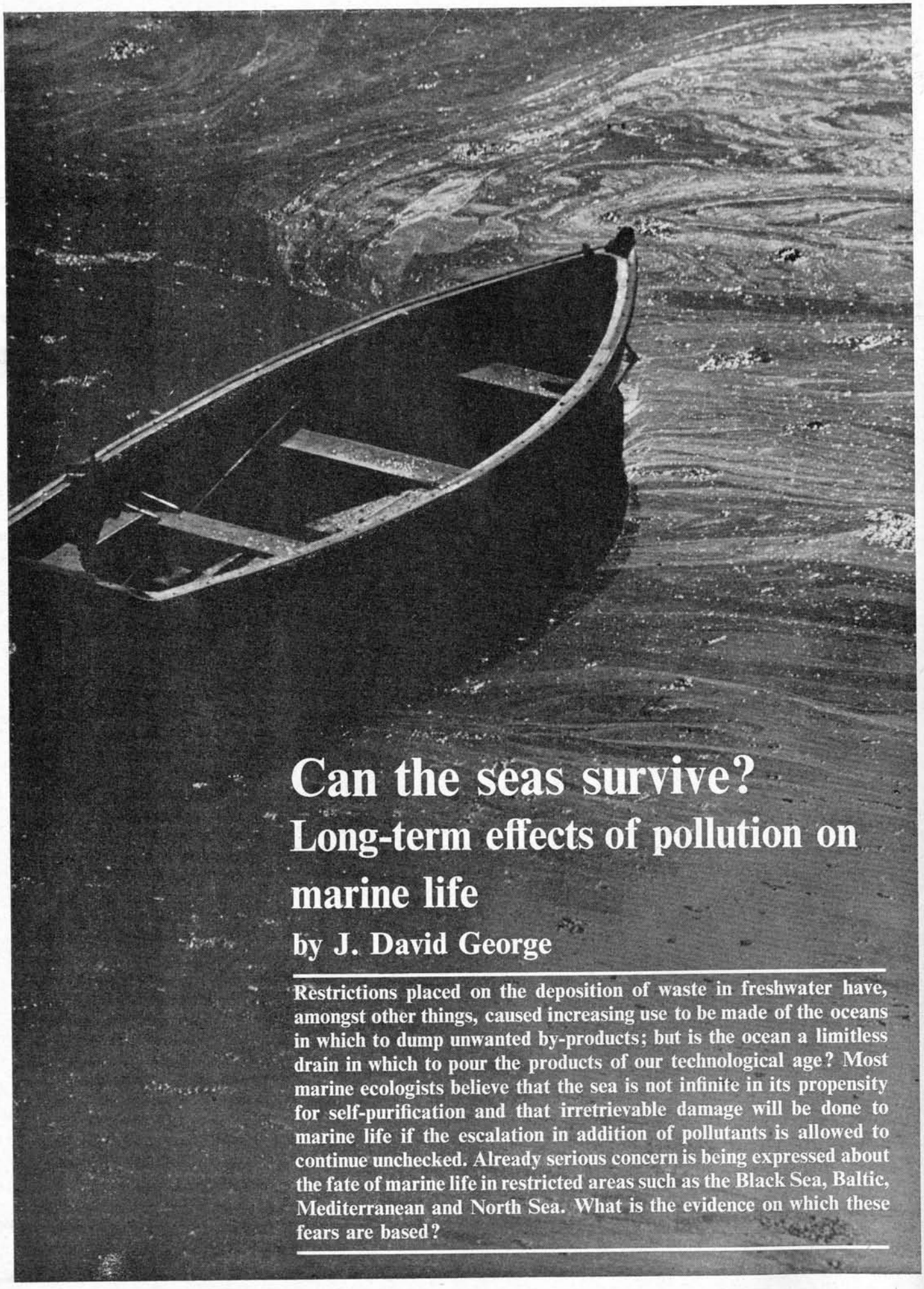
2. Social and environmental reform require a more honest and humane distribution of public money, not more taxation. Mr Crosland implies that current expenditure is not only sensible but immutable, when manifestly it is neither. The Concorde research and development programme has already cost the country £220 million and will cost us at least another £185 million, provided it isn't revised upwards again. We could reclaim all of Britain's derelict land in only 10 years for £190 million (12,000 acres at £19 million a year), but the Government prefers to spend £260 million *a year* on persuading industry to go to those development areas where the dereliction is concentrated.

3. An annual growth rate of 2.2 per cent means that the demand for goods and services (and hence on resources) will have doubled by the year 2003. There are insufficient raw materials to meet this demand for more than a couple of generations at the outside, let alone that of the rest of Europe, Japan, and North America. Mr Crosland castigates those of us who oppose growth as "indifferent to the needs of ordinary people". Fundamentally, he says, we want to kick the ladder down behind us. Selfish environmentalists, of course, were the chief proponents of London's Westway, dismissing the fuss about the suffering residents of Acklam Road as a sentimental and modish concern for social and environmental quality. Working class people, we said, don't need that sort of thing. Such a slight is not only demonstrably untrue, it is also brazenly hypocritical—since self-confessedly Mr Crosland will stomach equality as long as it doesn't mean less for Labour voters.

If he raised his humanitarian gaze beyond the confines of his constituency, he would see that we maintain our present standard of living at the expense of that of the undeveloped world, and if we genuinely wish for greater equality of wealth then we must expect and promote a diminution of our own.

4. The cost of pollution control grows with production. Mr Crosland's contention that "the greater part of the environmental problem stems not from present or future growth, but from past growth . . . it is a problem of *existing* slum housing, polluted rivers, derelict land and belching factories", shows that he is either mischievous or incapable. We continue to make land derelict much more quickly than we reclaim it: the official figure for the net increase in dereliction between 1965 and 1968 is 13,870 acres. Cleaning up existing mess costs very little compared with prevention of further pollution. To give an extreme example: if RTB's steelworks stopped production today, the grossly polluted River Ebbw would flush itself clean in no time. It is even possible that storm floods could remove the 4 inches of tar and iron hydroxide on its bed—but a few bulldozers could do the job quickly enough. However, to *prevent* pollution, RTB are installing a £1 million treatment plant. As with public, so with industrial expenditure—it is a question of how we distribute our costs. The Beaver Committee estimated that air pollution costs the country £350 million a year. Surely industry should spend more than £32 million a year on controlling it? It does not need to grow to pay a greater proportion, nor will growth help it to do so.

No, Mr Crosland, growth benefits only the few. Nobody can repeal the law of diminishing returns and already we are spending more and more on less and less, because there are too many of us and our standard of living is too high. If your working class constituents want lower housing densities, better schools and hospitals, and greater mobility, then you should press for a policy of population control. That, and a good deal more courage and honesty in Government.



Can the seas survive?

Long-term effects of pollution on marine life

by J. David George

Restrictions placed on the deposition of waste in freshwater have, amongst other things, caused increasing use to be made of the oceans in which to dump unwanted by-products; but is the ocean a limitless drain in which to pour the products of our technological age? Most marine ecologists believe that the sea is not infinite in its propensity for self-purification and that irretrievable damage will be done to marine life if the escalation in addition of pollutants is allowed to continue unchecked. Already serious concern is being expressed about the fate of marine life in restricted areas such as the Black Sea, Baltic, Mediterranean and North Sea. What is the evidence on which these fears are based?

Fertilisers and sewage

In Britain many millions of gallons of sewage-laden water flow into the sea daily from rivers and coastal habitations. This water is often already rich in dissolved minerals such as nitrates and phosphates from fertilisers applied to the land and from breakdown of domestic waste in sewage treatment works. Under normal conditions plant productivity in the sea is limited by the quantities of nitrates and phosphates naturally occurring there. Presented with unlimited supplies of these chemicals in the sea, minute plants (phytoplankton) often proliferate rapidly producing a phytoplankton bloom. In open waters this rarely presents a problem to the herbivorous animals which feed on the phytoplankton, and indeed, an increased yield of fish may result. However, in estuaries and other areas where water exchange with the open ocean is limited, overproduction of phytoplankton is often damaging. In extreme cases the phytoplankton may become so thick that the gills of fish and filter feeding mechanisms of other animals, such as shellfish, become clogged. The waste products produced by blooms can be extremely poisonous to other marine life. For instance, blooms of certain phytoplanktonic single-celled organisms known as dinoflagellates produce a particularly virulent type of nerve toxin which can kill or incapacitate thousands of larval and adult fish, and other animals. Beds of filter-feeding shellfish (oysters, clams, mussels, cockles) can be rendered unsaleable as a result of build up of these toxins within their bodies. Indeed many human deaths have resulted from eating shellfish polluted in this way. The increasingly regular occurrence of poisonous algal blooms is giving rise to some concern in certain parts of the world, including the Scandinavian and North European countries.

Organic matter piped or dumped into the sea produces similar signs of over production as marine bacteria break it down and minerals are released. Significant contributions to the quantity of organic material present on the sea bottom can result from a rain of dead phytoplankton produced in quantity as a result of high levels of dissolved nutrients. The decomposition of organic matter uses up oxygen and in many sheltered areas where excessive organic material is present deoxygenation occurs near the bottom, and in some cases throughout the water column. This results in death or decrease in viability of animals that are unable to move away from the area. The fauna thus tends to become impoverished with only a few of the most tolerant species remaining. An influx of non-toxic organic waste can cause serious deterioration of certain fish, shellfish, and prawn feeding and nursery grounds in several ways:

1 The oxygen levels are so reduced that adults cannot stay in the area.

2 The adults are able to spawn but there is too little oxygen for hatching of the eggs and development of the larvae.

3 The organisms on which the animals feed have been eliminated or seriously reduced in numbers.

4 The profuse growth of bacteria in these polluted waters is injurious to the hatching of eggs and survival of larvae.

5 The turbidity of the water is increased to such a degree that it influences development and survival of pelagic eggs and larvae.

All of these influences have been proved to operate in laboratory and field experiments. The Oslofjord is one site amongst many where growing evidence reveals that as a result of conditions caused primarily by sewage discharge the stocks of commercial marine animals are steadily declining.

The discharge of organic matter and effluent rich in minerals into the sea has many long-term disadvantages. These effluents could seemingly more profitably be returned to the land from which they came (*Ecologist*, 1 (5)).

Rubbish

Some organic products are very resistant to breakdown by bacteria and the current use of plastics and other durable materials presents a difficulty of disposal as landfill areas become scarce, which has been "solved" in some cases by dumping in nearshore waters. Reports have been made of such debris obliterating the habitats of many organisms, leading to the impoverishment of local flora and fauna. Even the deepest trenches of the ocean now frequently yield products of our civilisation. The unrestricted dumping of refuse from ocean-going vessels has led to the strandlines of even the remotest shores being cluttered with beer cans and plastic containers. The age of the non-returnable container is upon us!! The production of disposable containers cannot go on *ad infinitum* as the sources of material for construction are finite. It is surely better to make a greater effort now in seeking methods of recycling our rubbish than to wait until the cupboard is bare.

Pulp mill liquors

Industry, because of the demonstrable harm already done by its waste products on land and in fresh water, tends now to expel much of its liquid waste into the sea, but here also the effects on marine life are being noticed. Sulphite liquors from pulp mills have been seen to interfere with the assimilation processes of phytoplanktonic organisms which are the first essential link in the food chain of most marine life. Although in low concentrations liquors do not kill animals outright, feeding and growth of oysters can be interrupted, larval development and behaviour of herring affected, and many species of fish suffer respiratory difficulties.

Heavy metals

Many types of industrial waste contain heavy metals in solution. These metals are normally present in minute quantities in unpolluted seawater where their concentration has been reasonably constant for millions of years. Marine organisms therefore have not evolved mechanisms to protect themselves from large fluctuations in metal concentration. Thus most organisms are unable to prevent the concentration of metals within their body tissues passively rising to a level which, even if not lethal, may affect their body chemistry. In fact, some filter-feeding animals, especially those with calcareous shells, will actively concentrate metals to a level many thousands of times higher ($\times$200,000) than that in the surrounding seawater.

Copper and zinc The growth of the large brown seaweeds of inshore waters is adversely affected by an excess of copper and zinc in the water, and when a quantity of copper sulphate was dumped in Dutch coastal waters the mortality of mussels in beds several miles away was alarming.

Experiments on other shellfish more resistant to heavy metal poisoning have shown that sub-lethal amounts of cop-

per and zinc lead to regressive changes in the gut diverticula and damage to the stomach wall. Predatory animals which do not normally accumulate metals may as a result of their feeding behaviour attain a sufficient quantity of these metals to kill them. For example, an inshore demersal fish feeding on the ragworm may die as a result of the worm's ability to concentrate copper in its tissues. Copper and zinc discharged from estuaries may prevent Atlantic Salmon reaching their spawning grounds, for it has been discovered that they will avoid waters containing these pollutants even at very low concentrations.

Mercury and Silver The industrial uses of mercury compounds are numerous; they are used as fungicidal seed dressings, in paper making, and as catalysts in the manufacture of PVC. Numerous cases of sterility of seed-eating birds and predators, including man, have been traced to the habit of seed dressing with mercury compounds. This practice is also a hazard to coastal marine life which is exposed to mercury as a result of fresh-water run off. A recent research report that a very low concentration (1 part per billion) of fungicidal mercury is sufficient to cause a 50 per cent drop in photosynthetic activity of a phytoplanktonic test organism is particularly alarming, for such concentrations are frequently found at the mouths of rivers draining agricultural land and near industrial outfalls. It is possible that inshore phytoplankton (and consequently those animals that feed on it) are being seriously affected.

The concentration of mercury and silver found around certain industrial outfalls is also sufficient to cause abnormal or inhibited development of eggs and larvae of certain barnacles and sea urchins. Other marine organisms, however may accumulate metals without any readily apparent harm being done to them. Some shellfish and fish have such a high concentration of mercury within their tissues that people are advised not to eat them for fear of being poisoned. From 1953 to 1960 almost one hundred people were killed after eating fish and shellfish taken from Minamata Bay in Japan. The cause of their death was a lethal amount of mercury in the bodies of the marine life derived from the mercury-laden effluent of a plastics factory.

The danger of mercury in the marine environment has now been recognised by many governments, but how many other metals may be accumulating undetected in the bodies of sea life?

From the few examples cited it can be seen that the directly poisonous action of heavy metals is not the only consideration, for there is evidence that long-term accumulation and concentration of metals by marine organisms can lead, if not always to their own death, to death of others that eat them. Clearly discharge of heavy metals into coastal waters should be actively discouraged.

Pesticides and PCBs

Pesticides are deliberately applied in the terrestrial environment in order to control insect pests, weeds, fungi etc. They reach the sea not only as a result of land drainage, but also from the atmosphere. Indeed, it has been concluded by some American workers that the observed distribution of the chlorinated hydrocarbon pesticide DDT and its residues off the coast of California can only be explained by assuming distribution through the atmosphere. Corroboratory evidence for atmospheric distribution comes from the fact that organochlorine residues can be detected in ice and in the fatty tissues of penguins and seals from the Antarctic where pesticides to the best of our knowledge have never been applied.

Polychlorinated biphenyls (PCBs), unlike pesticides, reach the environment by accident. They are used in the manufacture of paints and varnishes, as softeners in plastics, and for improving electrical insulation in cables. Many high temperature lubrication oils now contain PCBs. PCBs reach the ocean in liquid waste from industrial and domestic sources, from decomposing rubbish dumped at sea, and from the atmosphere polluted by smoke from industry, motor vehicles and rubbish dumps.

The danger of both chlorinated hydrocarbon pesticides and PCBs is that they are extremely stable and persist for long periods of time without biodegrading into a harmless form. Some organochlorines have been in use for 30 years or more so that if only minute quantities have been reaching the sea during this period they have had time to build up in the water and sediments. In addition many invertebrates have the ability

Beach strandline in the age of the non-returnable container.

to concentrate them many thousands of times and store them in their fatty tissues in much the same way as metals are concentrated and stored.

Many planktonic species of animal and plant as well as fish and benthonic invertebrates are extraordinarily sensitive to organochlorine pesticides, especially in the earlier stages of their life history, and can be killed outright by residues reaching the sea by land drainage and in effluents from manufacturing plants. The waste from a parathion manufacturing plant on the Danish North Sea Coast led to many dead and dying lobsters being cast up on local beaches. Other species higher up food chains may be poisoned by eating animals and plants that have accumulated pesticides in their tissues. Sandwich Terns dying in tremors and convulsions in the Danish Waddenzee were found to have been poisoned by chlorinated hydrocarbons passed on from herrings and sand eels, which in turn had been feeding on planktonic and benthonic copepod invertebrates with a high level of organochlorine entering their diet due to pesticide discharge from the Rhine. By the time the pesticides had reached the Terns they had been concentrated many thousands of times. Due to the greater sensitivity to pesticides of some marine species as compared with others, the balance of certain ecosystems can be seriously affected, animals at the top of the food chain dying as a result of non-availability of a particular food source. The demise of the Californian Sardine industry has been attributed to such a situation.

As disturbing as the direct kills attributed to pesticides are the numerous sub-lethal effects that have been reported in scientific papers. These include alterations in body chemistry, disturbance of growth and gonad formation, interference with thermal acclimation mechanisms, lowering of resistance to disease, and changes in the basic behaviour patterns of various species. Of necessity much of this experimental work has been carried out on commercially important shellfish and fish but this does not mean that other groups of animals are any the less affected.

Organophosphorous and carbamate pesticides which are now being used increasingly for pest control are much less stable than organochlorines and consequently do not accumulate through food chains to the same degree. There is thus less chance that animals higher up the food chains will receive sufficiently large doses of pesticides to affect their biology.

The chemical similarity between PCBs and organochlorine pesticides suggests similar physiological effects on marine organisms. However, at present little is known of the adverse effects of PCBs, although in laboratory experiments it has been shown that these chemicals can effect the production of sex hormones in such a way that animals are rendered infertile. It may not be entirely coincidental that the fertility rate of guillemots at breeding sites on the British West coast is dropping. In September 1969 between 10 and 15,000 dead sea birds, mostly guillemots, were washed up along the west coast of Britain. Although it is by no means certain what caused their deaths, fatty tissues of the birds contained relatively high amounts of PCBs.

Marine life will be increasingly placed at risk if the release of chlorinated hydrocarbon pesticides and PCBs into the environment is allowed in anything but very small quantities. No-one will deny the short-term benefits that have been reaped by the use of DDT and its derivatives but we have got to consider the long-term consequences of their use. Already in a confined area like the Baltic marine species contain on average 8-10 times more DDT than the same species in the North Sea. Organochlorine pesticides should only be used in an emergency and should not be applied as a prophylactic.

Radioactive waste

Radiation has long been recognised as a factor constituting a potential hazard to human populations, if not to marine life. Radioactive materials reach the sea (1) from the atmosphere (2) as a result of natural leaching of rocks containing radioactive compounds (3) from containers of radioactive waste dumped at sea (4) from outfall pipes of coastal nuclear installations.

Due to concern over the wide dissemination of radioactive dust following nuclear explosions in the atmosphere very small amounts of radioactive dust take place above ground. Hence only very small amounts of radio active dust in excess of the background quantities now reach the sea via the atmosphere.

In certain coastal areas of the world high background radiation is present due to naturally occurring radionucleides in the soil. Unfortunately, there is as yet no published information available on the effects on marine life in these areas, although statistical surveys on human populations in one of these regions has shown a significantly higher than normal rate of occurrence of chromosome abnormalities.

Radioactive wastes of short half-life can be stored at the point of production until inactive, but the problems of storage of wastes which decay at a slow rate are enormous. Much radioactive waste is stored in heavily shielded containers on land, but other wastes are encased and dumped in selected deepwater sites in the ocean. Due to the high cost of providing adequate shielding for dumped containers, some do not completely prevent escape of radiation. It must be accepted, therefore, that damage to marine life may occur in the region of these dumps.

The continuous discharge of low level radioactive wastes from coastal nuclear plant may also be causing sub-lethal damage to marine life in the vicinity of the discharge point. For it has been shown experimentally that low levels of radiation can cause chromosomal damage, with subsequent growth abnormalities, in both marine invertebrates and vertebrates. Effects may be even more subtle, as there is some evidence to suggest that exposure of fish to radiation can reduce their ability to tolerate changes in temperature and salinity.

Marine organisms, such as algae and shellfish, which concentrate metals cannot discriminate between radioactive and non-radioactive elements. Thus the radiation levels in certain organisms may be many thousands of times higher than that in the surrounding seawater. For example, oysters gathered some 250 miles from a nuclear source were seen to contain 200,000 times more radioactive zinc than the surrounding ocean. In theory the existing regulations relating to the discharge of radioactive waste take into account the ability of many organisms to concentrate elements in their tissues. However, the number of species examined in relation to the number occurring in coastal waters is very small.

It is certainly unwise to set any acceptable dose levels of radiation as far as marine life is concerned in view of the subtle nature of radiation damage unless they are based on long-term statistical experiments.

Oil

Every year more and more crude and refined oils are transported across the oceans and the hazard of pollution of the sea by oil increases. Oil reaches the sea in some areas of the world as a result of natural seepage but the vast majority of oil present in the oceans today has been introduced by man either by accident or deliberately. The public are very much aware of the aesthetic threat posed by occasional major marine disasters which instantly release many thousands of tons of oil into the environment. However, much of the oil entering the sea accidentally results from minor spillages whilst oil is being loaded or off-loaded, from leaks at marine oil well-heads, and from river water and untreated sewage containing tars, fuels and lubricants. Small craft when present in large numbers may cause significant pollution.

By far the largest quantity of oil reaching the sea at the present time is deliberately discharged by vessels flushing out their oil tanks and pumping out contaminated ballast and bilge water. Happily the major oil companies of the world now only allow oil-contaminated water to be discharged into oil separators at their shore installations. At present International Conventions do not completely prevent discharge of oil at sea but only limit it to specified offshore areas. Thus oily residues can be found floating on the surface of the sea anywhere in the world, although, of course, they are found more frequently in the shipping lanes. If, as seems likely, at a future date the deliberate discharge of oil is completely banned anywhere at sea we can expect to see a drop in oil pollution.

Oil deposited at sea may effect marine organisms either mechanically or chemically. Crude oil consists of a complex mixture of hydrocarbons. The aromatic hydrocarbons represent its most dangerous fraction and are very poisonous to all marine life. Other fractions, although not necessarily acutely toxic, often cause long-term damage by affecting many body processes.

Whilst oil films remain floating at sea they do not present a physical hazard to marine life other than that which exists or feeds at the air/water interface. There is a specialised surface community, known as the neuston, which may be seriously affected mechanically by the oil, and the gills of fish feeding on the neuston also may become clogged by oil. Air-breathing marine vertebrates belonging to the reptiles, birds, and mammals may find their air passages and lungs become obstructed with oil, preventing gaseous exchange.

All seabirds (diving birds in particular) are very susceptible to oiling of the plumage which prevents them flying and eventually leads to their death by drowning or by starvation. The birds in their efforts to clean themselves ingest quantities of oil which cause enteritis and other damage to the digestive system. Toxins present in the ingested oil cause degenerative changes in the liver and kidneys of seabirds and there is evidence that they may lead to a reduction in breeding success. This knowledge combined with the fact that the species most usually affected by oil already have a low reproductive potential leads one to the conclusion that several species of seabird may be in danger of extinction as a result of oil pollution.

The neuston and other planktonic organisms are liable to be affected by the toxicity of soluble oil fractions disseminated from oil floating on the surface. Experimental exposure to oil of phytoplankton from the Black Sea, Mediterranean, Red Sea and Atlantic shows that death or retardation of cell division can result. The sensitivity of different species varies by several orders of magnitude. In sheltered waters where persistent oil pollution occurs the more sensitive species are probably slowly being excluded.

The eggs and larvae of many pelagic and benthic animals spend many weeks in the surface layers of the sea during their development. The egg and larval stages of the commercially important plaice and herring, for instance, display high mortality and various ontogenetic abnormalities when exposed to small quantities of various oil fractions. The larvae of hermit crabs and prawns are similarly affected. Generally speaking, however, development stages of wholly planktonic species are more sensitive to the toxins in oils than are the development stages of animals that do not spend the whole of their life-cycle in the plankton.

The severity of damage to marine life depends to some extent on the type of oil released into the environment. Refined fuel oils seem to cause considerably more immediate damage than crude oils. Thus when a spillage of diesel oil occurred in a restricted area as the result of the grounding of the *Tampico* on the western seaboard of North America, only four species of attached plants and two species of benthic animals survived. Similar mass mortality of benthic organisms has been reported as a result of the spillage of refined oil from a fuel barge which struck submerged rocks off West Falmouth USA. In contrast the Kuwait crude oil reaching the beaches of south-western England after the *Torrey Canyon* disaster appeared immediately to kill animals and plants only if it was so thick as to smother them. This does not mean, however, that animals surviving the initial onslaught of the oil survived unharmed, for it has been shown in long-term experiments that the filter feeding mechanisms and guts of shellfish may become so clogged with oil that the animals slowly die of starvation. In addition water soluble substances in crude oils have a narcotising effect on the rate of ciliary beat in filter feeding animals such as oysters and barnacles. Water soluble fractions further damage the feeding potential of oysters by retarding the growth of one of its major plant food sources.

In the region of certain refineries sufficient oil pollutants are present in the aquatic environment to cause tainting of shell fish, and many incidents have been reported of resistance to stress, and reproductive potential, being adversely affected by sub-lethal amounts of oil.

Once oil pollutants enter the tissues of animals they are retained for long periods of time without breaking down and thus they become a potential hazard to predators. Prolonged contact with refined oils leads to skin cancers in man and there is now evidence to suggest that some marine organisms are similarly affected.

Many fish rely on the reception of chemical clues to find their prey, sexual partners, and areas in which to spawn. The presence of high boiling point saturated and aromatic hydrocarbons in the sea, even in minute concentrations, can block their ability to receive such signals.

Furthermore, continuous low level pollution may cause a change in the ecology of a region bringing about a slow decline in the variety and quantity of marine life. It is obvious that the danger to marine life from oil and its compounds is such that every available

Oil on Chesil Beach, Dorset.

method of preventing entry of oil into the sea should be used.

Oil dispersants (Detergents)

Oil spills which foul beaches and shore installations, as well as slicks at sea which are considered a potential danger to the coastline, are often treated with oil dispersing liquids. The justification for deliberately dispersing oil through the water column instead of leaving it as a compact film on the water surface is primarily an aesthetic one, for nobody likes to see our coastline befouled by oil. One cannot fail to be upset by the pathetic sight of sea birds coated with oil washed ashore in their hundreds. The plight of some diving bird species is undeniably grave and justification can be found for dispersing oil when it occurs in quantity near their feeding areas.

Dispersal of oil into small droplets permits microbial action to proceed more rapidly than normal thus allowing oil to be removed from the environment more quickly than would otherwise be possible. However, in the majority of cases the use of dispersants is not justifiable since emulsification of the oil only distributes it more evenly through the environment making it virtually certain that every organism in the area will be exposed to the toxic fractions present in the oil. It has been found that many marine organisms, such as fish, which can normally avoid oil slicks, ingest and assimilate fairly large quantities of well dispersed hydrocarbons.

Until just recently the only "detergents" available for oil dispersal were dissolved in low boiling point aromatic hydrocarbons—the most toxic fraction of crude oils! Unfortunately, they are still in general use and can result in the death of many marine organisms when being used to clear oil. At the time of the *Torrey Canyon* disaster several shores were so thoroughly cleaned with detergent that it was difficult to find a live marine organism on them.

The sub-lethal long-term effects of these dispersants are less well-known but it has been noticed that the growth of many phytoplanktonic and attached algal species is seriously impaired. Among inshore species of animal, larval growth of clams and oysters is slowed and adult shell growth interrupted. Dog-whelks that have recovered from near-lethal doses of detergent show growth disturbances in the shell.

Behavioural patterns of animals can be modified as a consequence of detergent pollution. Observations made at the time of the *Torrey Canyon* spill showed that dispersant-laden seawater caused inhibition of the normal climbing response in winkles and topshells, and led to razor shells and heart urchins coming to the surface of the sand in which they are normally buried. Such effects put the animals at a competitive disadvantage and make them more susceptible to attack by predators.

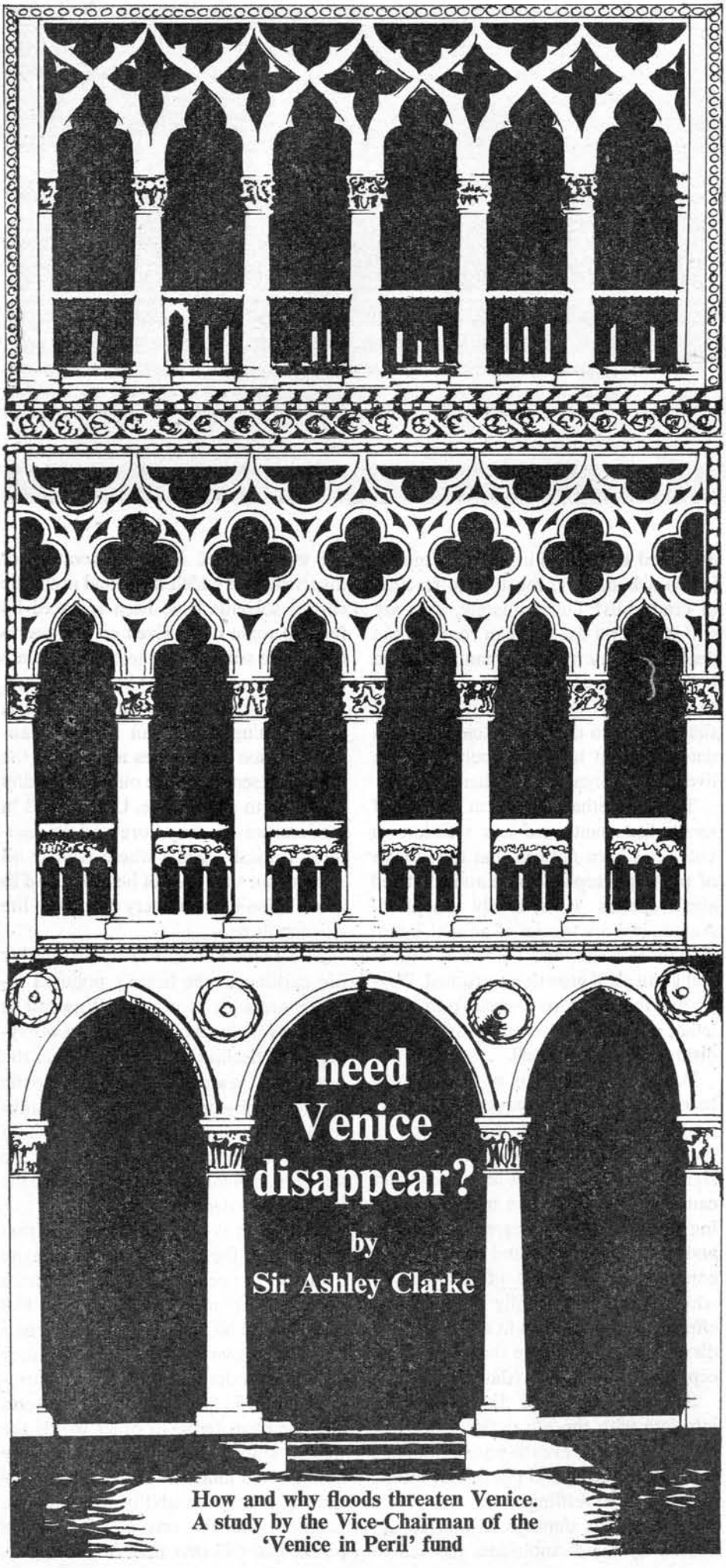
Sub-lethal doses of dispersants can interfere with the life cycle of shallow water species, preventing some animals from reproducing and planktonic larvae of others from settling.

The obvious damage to marine life caused by these emulsifiers has led to the evolution of a new generation of dispersants in which the lethal aromatic carrier solvents have been replaced by far less toxic ones. Even so, long-term effects are still noticeable, and it is these that are most important in the long run.

The use of oil dispersants, therefore, does nothing more than introduce another poison into the sea and makes the toxins present in crude oil more readily available to marine life. Unless used in moderation on the shore and in sheltered coastal regions where regular oil spills occur they cannot help but lead to a reduction in the variety of marine life existing there.

The reduction in variety of marine life existing in the heavily polluted inshore areas of North-east England is already very marked. Even more worrying is the decline in abundance over the last twenty years of many characteristic species of phytoplankton and zooplankton in the north-east Atlantic and North Sea; for the plankton is the grass of the sea on which all other life in the oceans is ultimately dependent.

Perhaps it is only a sick society that already has the ability to recycle many of its waste products, but finds it more "economical" to throw them away. The onus should be placed on potential polluters to prove that the products they wish to introduce into the sea are harmless to marine life in both the long-term and the short-term. In other words the wastes should be considered "guilty until proved innocent". For in the long-term it is only an ability to remain in balance with the rest of life on this planet that will save man from disaster.



need Venice disappear?

by

Sir Ashley Clarke

How and why floods threaten Venice. A study by the Vice-Chairman of the 'Venice in Peril' fund

Need Venice disappear? The answer to this question, so frequently asked nowadays, depends on the time-scale to which it relates. If we are thinking in terms of many thousands of years, even those most committed to the proposition that Venice must be "saved", would feel bound to reply yes. If, on the other hand, we are thinking of the immediate future the answer is that Venice is sinking and minor flooding is becoming more frequent and more severe. The city could disappear next week if a concatenation of adverse factors occurred in phase with each other. The mathematical probability of such an event is, however, one in 10,000 years.

Although the length of these odds is reassuring, they are being progressively shortened by the fact that Venice and, in varying degrees, the whole of the basin of the River Po immediately to the south are sinking at a pace which has notably accelerated over the past 40 years. This means that gradually something short of the worst cataclysm of which this part of the world is capable would be sufficient to submerge Venice. So when we speak of "saving" Venice we mean in the first place seeking and putting to effective use methods of protecting the lagoon from an exceptionally high inflow of water and stopping, or at least slowing down, subsidence of the land on which it rests.

To get this problem into perspective it is only necessary to reflect that in the Pliocene Age (more than a million years ago) what we now call Italy consisted of not much more than the Alps and the Apennines. Not only Venice but Milan also was in the middle of the Adriatic Sea which reached to beyond Turin (see figure 1). The filling in of the Lombard Plain, the valley of the Po and the coastal areas around the Adriatic as it now is, occurred during the recurrent glacial periods of the Pleistocene age, when, at its extreme, the level of the sea had fallen by nearly 300 feet. The Adriatic retreated so far southward that the present location of Venice was

Figure 1

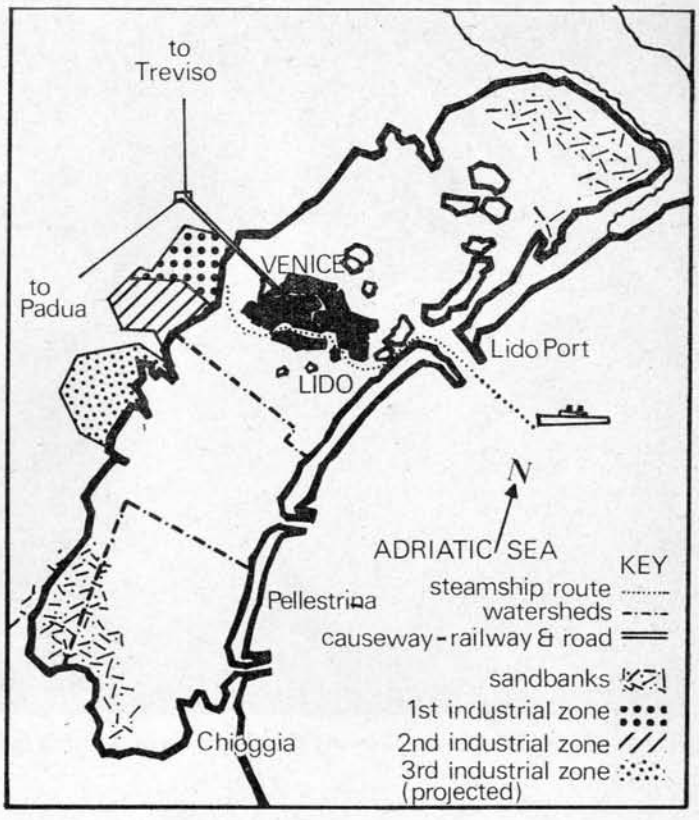


Figure 2

farther from its northern shore than from the Tyrrhenian Sea.

Interplay of forces

The last glacial period ended less than 10,000 years ago and the level of the sea, swollen by the melting of the ice, began to rise. Evidence has lately been discovered on the bed of the Adriatic, six miles out to sea from the present seaside resort of Lignano, to show that there was still a flourishing seaside resort there as recently as classical Roman times. As the sea steadily encroached on the land, another process was simultaneously taking place which in the course of the 15 centuries of Venetian history has become increasingly significant: alluvial soil was carried down by the rivers and deposited at and around the points where the rivers join the sea.

It is the interplay of these processes which has produced the jagged outline of the northern Adriatic and the precarious conditions surrounding the lower reaches and various mouths of the Po and the Adige, which debouch to the south of the lagoon of Venice. Apart from the natural tendency of recently deposited soil to subside, there are other more deep-seated factors causing subsidence, and the victory, so to speak, of the rivers over the sea is narrow and never definitive.

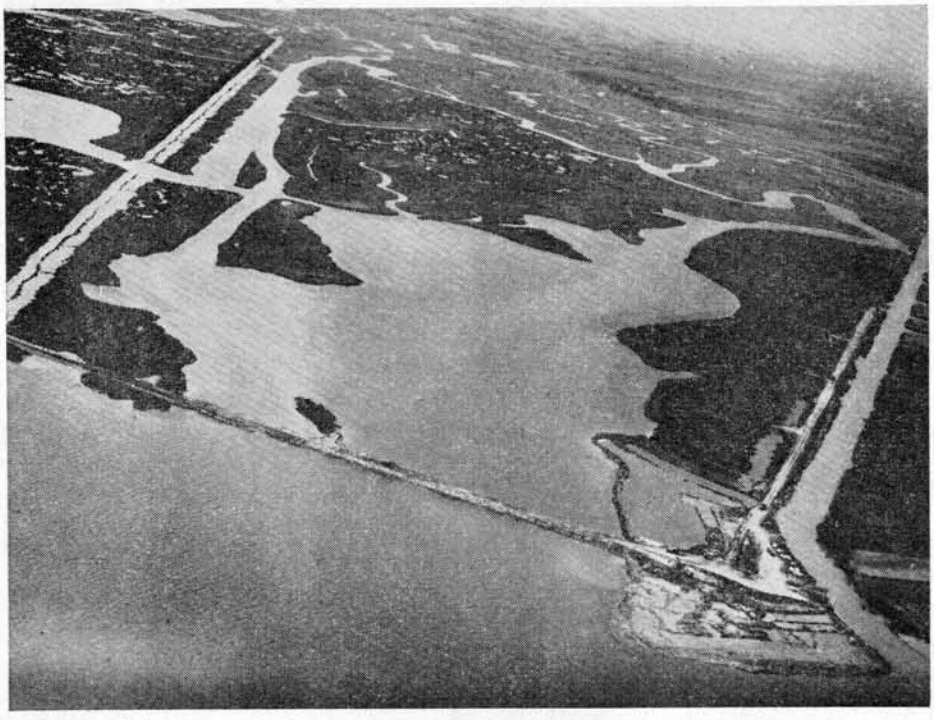
However, maximum subsidence over a long period appears to have occurred southward from the Po towards the low-lying region of Comacchio, rather than northward towards Venice. It is necessary therefore to look for other explanations of the present alarming rate of subsidence of Venice, now on an average, one inch in five years. Although the Venetian lagoon is by no means the only indentation in this part of the Adriatic coast, it is unique in the degree to which its present aspect and characteristics are the result of human intervention. For Venice, which began its history in the 5th century AD on the island of Torcello as a refuge from the hordes of Attila, became the centre of an empire and one of the most sophisticated capitals of Europe.

In the Republic of Venice the highest office of state under the Doge was the so-called Office of the Magistrate of the Waters (*Magistratura alle Acque*) and the weight of its authority was symbolic of the importance the Venetians attached to the control of the environment in which they lived. From early mediaeval times they were preoccupied by the degree to which the preservation of the lagoon depended on avoiding the deposit of too great a quantity of silt by the rivers. So they decided to divert the rivers that flowed into the lagoon. The first occasion arose when the citizens of Padua in the 12th century started to make short cuts for the Brenta so as to avoid flooding in their city, with the incidental result that it carried its burden of water and silt more directly to the lagoon of Venice. The Brenta, the Dese, the Sile, the Zero, the Marzenego and the Piave, were in turn diverted.

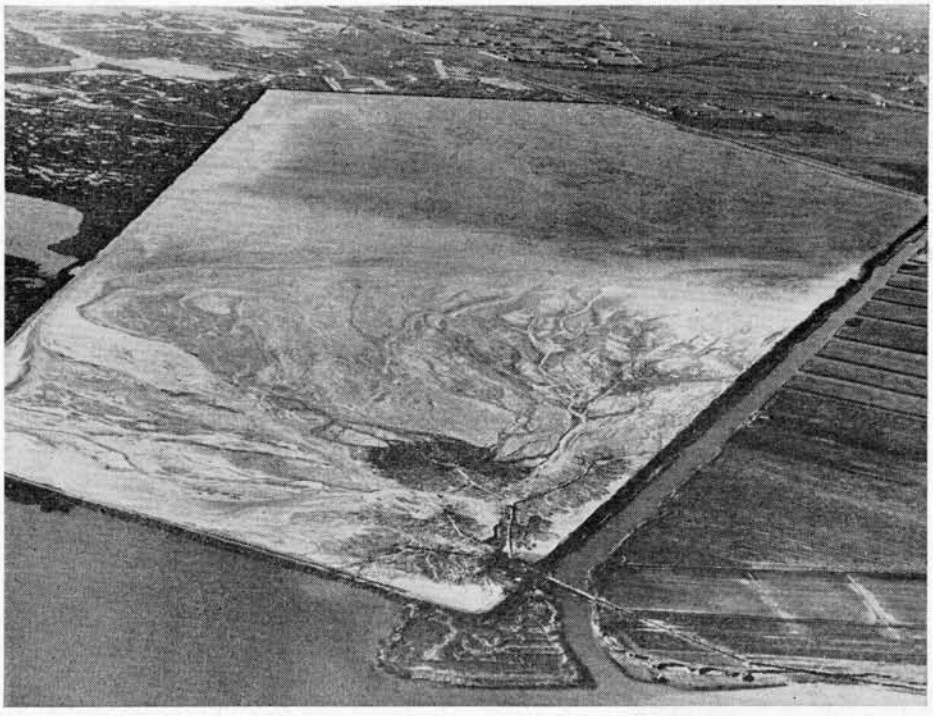
Lessons from Ravenna

Some wonder whether the lack of compensation for subsidence, which this policy involved, may not be one cause of Venice's present plight. But have they considered the case of Ravenna? Ravenna also was—in the 7th century—a political centre of great importance; surrounded by a lagoon, dependent like Venice on the tides. It was allowed to silt up and the Byzantine splendour of the city departed—save for S. Vitale and other basilicas. Today the land round Ravenna is subsiding even faster than Venice.

By the 18th century the Venetians in turn became less adventurous, but right up to the fall of the Republic they took



The third industrial zone, showing the closing in of the area before drainage.



The third industrial zone, already partly filled with mud and sand collected from the floor of the lagoon.

Photographs by GIORGIO LOTTI/MONDADORIPRESS

the deepest interest in defending the lagoon. The seaward defences are the narrow strips of land on which the Lido, Malamocco and Pellestrina stand (see fig. 2). By themselves they could not withstand the perilous seas which, at high tide and with a strong *scirocco* (south wind) blowing, could pour across them. Sea-walls of a kind were constructed in the 14th century and strengthened from time to time. But the great sea-walls—the *murazzi*—which have subsisted to the present day were built during the 18th century and were completed only 15 years before the city fell to Napoleon in 1797.

The French authorities suppressed among other things the *Magistratura alle Acque* (and incidentally, the newly created restoration laboratories for works of art) before handing over the city to Austria. It cannot be said that even after the liberation of the city in 1866 conservation was resumed in the purposeful tradition of the Republic. The price of neglect is probably higher in Venice than anywhere else in the world and the Venetians are now facing a bill which is far beyond their power to pay. The size and nature of the bill has been highlighted by the disaster which struck the city exactly 100 years after liberation.

High tides in November

Exceptionally high tides in the northern area of the Adriatic occur regularly at certain times of year, of which early November is one. If at the same time the periodical oscillatory motion of the Adriatic (like the water in a bath) is piling up water in the neighbourhood of Venice, if the sea-currents are running in that direction, if there is a violent *scirocco* blowing and there is a storm in the mountains causing spate conditions in the rivers, a formidable body of water is built up which is capable of crashing right over the present seaward defences.

This explains what happened on 4th November 1966, when a terrible storm over the whole of North Italy, combining with three days of violent *scirocco* produced in the city at high tide a flood 6 feet above the normal level of the lagoon. It stayed at that height for over 20 hours. Luckily the maximum force of the wind was not in phase with the factors governing the flow of the tide. Had it been so, it could have brought the flood up 3 or 4 feet higher, which

would have meant incalculably greater damage.

The result of this disaster has been to call the attention of the whole world to the situation in Venice. Foreign funds have offered considerable help and the Italian Government have asked Unesco to mobilise support for their own efforts. Only lately the Italian Government have promised support to the tune of £170 million, but even this is not enough. Meanwhile, perhaps the most significant campaign to resolve the physical problems of Venice has been undertaken by the new Institute set up by the Council of National Research in Venice itself. Its title is "Institute for the Study of the Dynamics of Great Masses" and it is headed by an oceanographer, Dr. Roberto Frassetto, who has for a number of years been associated with Columbia University.

The Institute's long term task is now concerned with the movement of great masses—land, sea and air—on a planetary scale. But its more immediate task is the physical safeguarding of Venice. The phenomena of subsidence and of persistent "high water" in the winter months are being analysed, new surveys of surrounding territory are being carried out, means are being studied of securing more effective early warnings of approaching tide surges and the effect of the withdrawal of water from the artesian layer is being tested. In these researches the Institute has the advantage of a computer manned by an I.B.M. team.

Furthermore, the Institute has organised a competition among a selected group of engineering firms for devising means of closing the Lido, Malamocco and Chioggia entrances to the Lagoon, but only when a dangerously high tide is forecast. This is, of course, only a provisional measure, not a cure, and concurrently it will be necessary to devise means of dealing with the sewage of the city. At present this is dealt with solely by the tides and any artificial stoppage of them would, of course, produce a serious problem.

Other problems will be studied

The numerous other problems that also beset Venice, such as pollution from the factories at Marghera, motor-boats, domestic fuel consumption, the erosion caused by motor-driven *vaporetti* as well as speed-boats, the inadequacy of internal communications, will also be under study at the Institute.

Venice from the air.

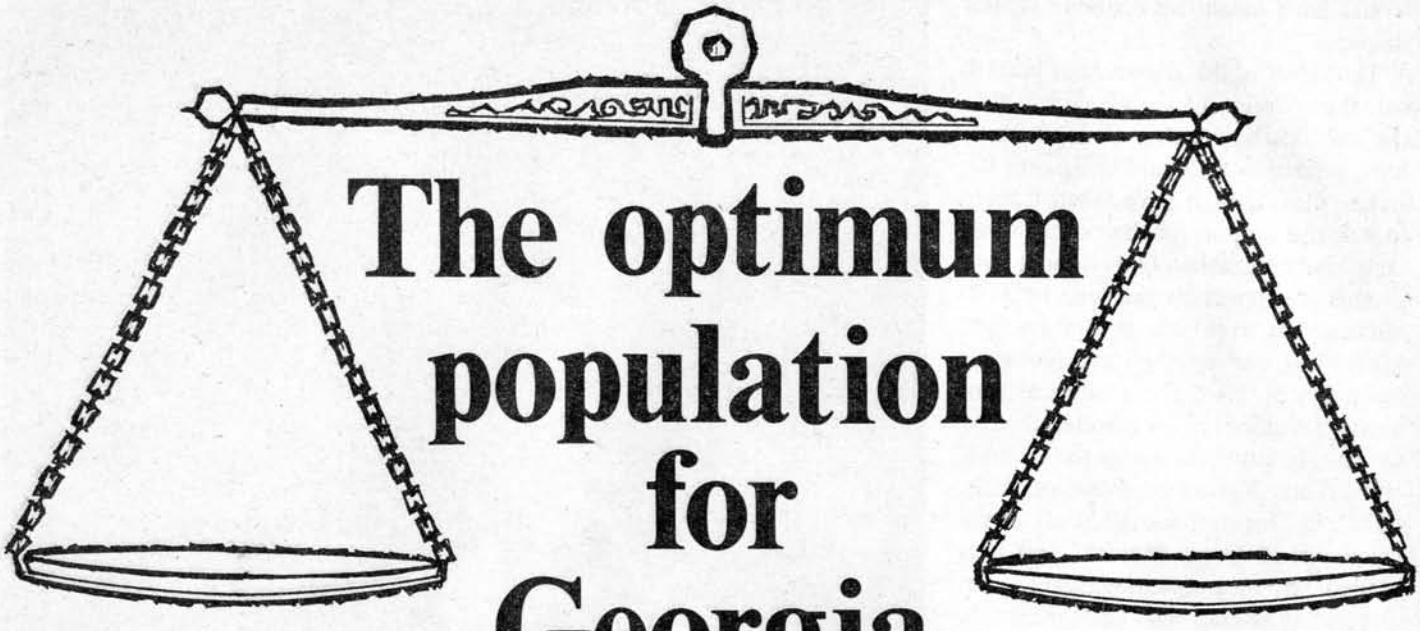
Of all these problems the most serious is undoubtedly the subsidence of the city. Pockets of water known as "water faulds" occur in the geological strata below the city. From time immemorial the Venetians have been accustomed to drive wells into these water faulds; and as long as this was practised only for domestic purposes, the harm, though probably appreciable, was not great. But when, in a well-intentioned endeavour to give Venice a stake in industrial development and to provide employment, the industrial zones were created on the very edge of the lagoon in the late twenties and after the war, the situation changed. Instead of piping water in from the mountains, the factories drew great quantities of water from the sub-soil. There can be little doubt that this is one of the major causes of the city's subsidence. The sinking of new wells is now forbidden.

A further ill-effect of the industrial zones has been the drying out and consolidation of many *barene* and *velme* (sandbanks) which act as absorbents of flood water.

In a nation of individualists, the Venetians are perhaps the most individualist of all. The tag *quot homines tot sententiae*, one is tempted to think, must have been coined by some late Roman after a visit to Venice. Probably this is the outcome of their history and of their surroundings. The precarious character of their early existence in the lagoon, the constant need to improvise defences against the forces of nature, the never-ending battle with the sea—all these things have made them self-reliant and hostile to conformity. They live as no other major city lives in the world—without motor vehicles and allowing themselves to be propelled (when time and money permits) along labyrinthine canals in the most archaic craft afloat. But make no mistake: when it comes to "industrial action" and other up-to-date ritual, gondoliers have nothing to learn from anyone and a student riot is the same in Venice as anywhere else.

London next?

Strange, indeed, to think that London is in almost the same predicament as Venice. London also rests on a cushion of water which has been unduly depleted and the force of wind and wave round our shores southward towards the bottle-neck of the Channel could produce under gale conditions a tremendous surge into the Thames estuary, as it did in 1953. No wonder the Government has agreed to build a barrage across the Thames at Woolwich just as the CNR Institute is seeking to hold excessive tides at the entrance to the Venetian lagoon. Any help which this country can give in solving the Venetian problem and any experience gained in so doing might well prove a good investment.



The optimum population for Georgia

by Eugene P. Odum

The distinguished American ecologist takes Georgia as a microcosm of the United States, and shows what factors should be taken into account in working out its optimum population.

In the fall of 1969, my class in advanced ecology at the University of Georgia elected to tackle the question of "the optimum population for Georgia". The basic question asked was: How many people can Georgia support at a reasonably high standard of living on a continuing, self-contained equilibrium basis, in the sense that imports and exports of food and resources would be balanced. As it turned out, Georgia is a good microcosm for the United States because its present density and growth rate, and the distribution of its human and domestic animal population are close to the mean for the whole nation. Likewise, food production and land use patterns in Georgia are average. Furthermore, since pollution, overcrowding and loss of non-renewable resources have not yet reached very serious proportions, the state, like most of the nation, has the opportunity to plan ahead for a new kind of "progress," based on the right of the individual to have a quality environment and to share in the economic benefits of wise use and recycling of resources.

Two general principles were adopted. The first principle can be stated as follows: "The optimum is almost always less than the maximum." In terms of human population density, the number of people in a given area that would be optimum from the standpoint of the quality of the individual's life and his environment is considerably fewer than the maximum number of people that might be supported, that is, merely fed, housed and clothed as dehumanised robots or "domestic animals." The same principle can be applied to automobiles; certainly the greatest number of cars that can be accommodated bumper-to-bumper on a freeway is not optimum for the forward progress of the individual automobile. Perhaps, then, the idea of the "greatest good for the greatest number" is not really a tenable principle. Maybe Dr. George Wald's slogan, "a better world for fewer babies" is more relevant to our times.

TABLE 1. MINIMUM PER CAPITA ACREAGE REQUIREMENTS FOR A QUALITY ENVIRONMENT

Food-producing land	1.5 acres
Fibre-producing land	1 acre
Natural use areas (watershed, airshed, greenbelt, recreation, waste disposal, etc.)	2 acres
Artificial systems (urban, industrial, highways, waste treatment facilities, etc.)	0.5 acres
TOTAL	5.0 acres

A second principle is that affluence actually reduces the number of people who can be supported by a given resource base. Thus, the optimum population for a highly developed, industrialised nation with a high per capita GNP (gross national product) is very much lower than the population that can be supported at a subsistence level in an undeveloped nation, because the *per capita* consumption of resources and the production of wastes are so much greater in the developed countries. Thus, if one person in the United States exerts 50 times more demand on his environment than does an Asian, then it is obvious that no environment can support as many Americans as

Asians without disastrous deterioration in the quality of that environment. Shocking as it may seem, the United States is now in as much danger of overpopulation at its level of per capita living as is India at her present standard of living. Population control must be an overriding issue in both the developed and undeveloped worlds, but the levels that are critical, the limiting factors and the strategy of control are quite different.

Minimum American per capita acreage requirements

Table 1 is the consensus estimate made by the students of the minimum acreage necessary to support one person at a standard of living now enjoyed by Americans, including a pollution-free living space, room for outdoor recreation and adequate biological capacity to recycle air, water and other vital resources. The per capita area required for food was obtained by taking the diet recommended by the President's Council on Physical Fitness and determining how much crop and grazing land is required to supply the annual requirement for each item. If Americans would be satisfied with merely getting enough calories and greatly reducing their consumption of meat, as little as a third of an acre per person would be adequate, but the kind of diet Americans now enjoy including orange juice, bacon and eggs for breakfast and steaks for dinner —all of which require a great deal of land space to produce—takes at least 1.5 acres per capita. Thus, the American "demands" from his agricultural environment 10 times the space that is required to produce the rice diet of the Oriental (assuming equally efficient crop production in both cases). The one-acre requirements for "fibres" is based on present per capita use of paper, wood, cotton and so forth, that equals the average annual production of one acre of forest and other fibre-producing land. The two acres for "natural area use" are based on the minimum space needs for watersheds, airsheds, green belt zones in urban areas, recreation areas (state golf courses) as estimated by recent land use surveys. Again, we could do with less by designing more artificial waste recycling systems and doing away with outdoor recreation, but at a high cost to society as a whole.

In considering the five-acre per capita estimate, two points must be emphasised: (1) If the per capita use goes up in the future, either more land is needed or greater production per acre must be forced by increased use of chemical controls that, in turn, tend to pollute the total environment creating a cost in taxes that would reduce the individual's "take home" pay. (2) The five-acre estimate is relevant only to an area such as Georgia that has a favourable climate (adequate rainfall and moderate temperature). The per capita area requirement would be much greater in regions with large areas of deserts, steep mountains or other extreme ecosystems.

The inventory of Georgia is summarised in Tables 2-4. The per capita density (Table 2) of 1 in 8 acres compares with the national average of 1 in 10 acres. The urban-rural distribution is comparable to the national average. A domestic animal population 5 times that of people is also close to the national average, as is the 10 per cent of land devoted to agriculture (see Table 3). In considering the impact of man on his environment, the importance of the domestic animal is too often overlooked; yet such animals are actually consuming more "primary production" (i.e., photosynthetic conversion of sun energy to organic matter) than man, and they require huge amounts of land. Also, in this country, pets such as dogs and cats are estimated to consume enough food to support five million people. We could do away with all domestic animals, of course, and substitute people, but to the ecologist that would mean not only giving up meat in the diet, but also dehumanising man to the level of a domestic animal. It is interesting that Georgia now produces enough food to feed 12 million people, provided that people actually consumed the crops directly. A diet of corn, other grains, soy beans, peanuts and vegetables could supply adequate calories and protein. In practice, of course, very little of Georgia's crop production is consumed directly; most of it is fed to animals or shipped out of state in exchange for food from elsewhere.

If we consider for the moment that one person in five acres is a reasonable per capita density, then Georgia is rapidly approaching that level. As shown in Table 4 the net growth rate is 2 per cent which, if continued, would mean a doubling of the population (leaving only four acres per capita) in 35 years. Almost before we realise it Georgia is moving from what was considered essentially a sparsely populated state to one that is beginning to feel the adverse effects of population pressure. As emphasised, this pressure is due not so much to the number of people, but to the great increase in the per capita demands on space and resources. It comes as a shock to everyone that Georgia and the nation could be badly overpopulated by the year 2000.

TABLE 2. GEORGIA: AREA AND DENSITY, PEOPLE AND DOMESTIC ANIMALS

Total area	37.7 million acres
Total people	4.8 million
Per capita density	1 in 8 acres
Population density— (31% Atlanta met. area.: 60% urban, 56% under 30 yrs. of age.)	
Domestic Animals Population equivalent*	21 million
Total Man-Animal Population equivalent*	26 million 1 in 1.5 acres

*Population equivalent is a unit of animal weight in metabolism to one adult person.

TABLE 3. GEORGIA—LAND USE IN 1968

	(per cent)
Crops	
food	7.5
fibre	0.8
idle (rotated)	3.7
Pasture	7.4
Forest	
private	66.3
public	4.5*
Recreation (public)	1.8*
Coastal wetlands	1.3*
Urban, etc.	4.5

*Total of these three categories or 7.6% is all land now set aside for "natural use" only (i.e., protected from exploitation).

TABLE 4. 1970 ESTIMATES OF POPULATION GROWTH-RATE IN GEORGIA

	(per year)
Birth rate	2.4%
Immigration	0.4%
Death rate	0.8%
Net growth rate	2.0%

Condensed from *Current History*, June 1970.

The Ancient and Ornamental Woods of the New Forest

by G. W. Dimbleby

In recent months there has been a good deal of comment in both local and national press about the operations being undertaken by the Forestry Commission in the unenclosed Ancient and Ornamental Woods of the New Forest. The Forestry Commission has the duty of maintaining these woods in their "ancient and ornamental" character, a term which lends itself to subjective interpretation. There are serious threats to the persistence of these woods, mainly due to the traditional practice of grazing stock in the woods, to which must be added the considerable effects of a resident deer population. As a result, in some of the woods no regeneration has survived for the last 200 years, so that there is nothing to replace the old trees as they die. In nearly all the woods, seedlings may be found where light conditions permit, but they are either killed or stunted by continuous grazing.

Recognising the failure of the regeneration the Forestry Commission have acted to preserve the woods by embarking on a programme described by them as regeneration thinning, or, in their working plan as selection felling. They propose to ensure the continuance of these woods in a healthy state by instituting regular management. The initiation of this plan raised an outcry from various quarters, particularly on grounds of destruction of amenity. Moreover, it had been generally understood that the Forestry Commission was entitled to carry out "health and hygiene" operations as and when necessary, but that systematic removal of timber that was going to be sold—as the culled timber certainly was—was outside their powers.

I am not competent to judge the legal position in the New Forest; there is a long and complex history of enactments, not always couched in explicit terms. What brought me into the general protest was something that is probably not covered by the legal code, but which in some ways is the most irreplaceable feature of these woods—their scientific value. In the arguments that followed my intervention, I found a widespread unawareness of the basic ecological issues on all sides. As there are ecological implications here beyond the problems of the New Forest itself, an outline of the questions involved may be of wider interest.

These magnificent woods are of fundamental ecological importance. Ironically, they are in danger of being ruined by the Forestry Commission's methods of conserving them.

It is generally held that the deciduous temperate forest, which covered most of Britain before man cleared it, is in association with a brown soil, a moderately acid soil in which the upper layers are not bleached by leaching, and which has a moderate to good fertility level. In fact, there are grounds for questioning the fundamental basis of this view, or at least for suggesting that we do not understand the whole story, but in this article we can only deal briefly with some of the questions involved.

It has been shown that man has brought about widespread changes in the soils of this country, particularly those on poor (non-calcareous) parent material. Large areas of what are now heathland and moorland were deciduous forest up to about 4,000 years ago, often apparently associated with brown soils. Now the soils are infertile podzols, very acid soils in which the upper horizons are leached of mobile chemical constituents, including iron, these being deposited lower down in an accumulation horizon. There has been a drastic change in which a near-equilibrium system has been upset and has been continuously exploited so that no new equilibrium could be established.

Whereas short-term crop patterns as found in agriculture can be adjusted at short-term intervals, this is less easy with long-term crops such as trees, when decades or even centuries may elapse before opportunity arises for an adjustment of the composition of the stand in relation to soil development. In forestry therefore, more than in any other land use, it is necessary to know whether the crops are maintaining an equilibrium with, or even improving the soil, or whether they are leading to soil degradation. At a time when so much of our land is under practices which are patently out of balance with the soil, so that some ecologists are sounding the warning, it is disturbing to find that in fact we do not know what such a system would be. One reason why we do not know is that it is so difficult to find places where such a system has survived man's activity so that we can study it from this angle. The New Forest woods may be such examples, though they have certainly not escaped considerable disturbance by man and his animals.

The view that on non-calcareous soils deciduous forest was originally always associated with brown soils can easily be refuted by a number of examples in this country of oakwoods, apparently of long standing, growing on strongly differentiated podzol soils. Care needs to be taken to be sure that these soils were produced by this type of forest, but there are cases where checks have been made and this conclusion seems to be justified. Pollen analysis of the soil beneath the forest is the most useful single check, and this involves the sampling of an undisturbed profile of the soil. If the soil has been ploughed at any time, or churned up by any means, such analyses cannot be interpreted satisfactorily.

If it is true that the deciduous forest does result in a podzol on non-calcareous soils, why is it that on such parent

materials this soil type was not general by the end of the Atlantic period, after some 5,000 years of soil development through the Postglacial? Whilst such soils would have been much modified since then, their essential character would still be detectable in the lower horizons. Furthermore, it is commonly found that soils under prehistoric earthworks are usually very young podzols, not mature ones. Clearly there has been a change of soil process as a result of man's activity. It has to be admitted that we do not know perhaps the most basic pedological fact of our own country, namely what the soil was under the deciduous forest that our ancestors cleared some 4,000-5,000 years ago. Yet this should be required knowledge before we embark on any scheme of land use of such non-calcareous soils.

In recent years, Dr. Johs Iversen, the Danish botanist, has developed the concept of "retrogressive succession" in the deciduous forest. He suggests that through the Postglacial, soil development under such forest led to a mature brown soil, but as time went on this soil became progressively acidified and leached. This in turn would result in a change of the humus type, the disappearance of earthworms, and a change in the forest composition to those species more tolerant of acid soils. There would be a tendency for the soil to become a podzol.

This concept adds a new twist to the whole problem, and raises the question again that has been troubling ecologists for years—does the influence of man bring about a sudden break in the soil/vegetation relationship, or does it merely speed up a process that would happen anyway? This is a vital question when we are thinking of ecological equilibrium, as foresters in particular should be. It is probable that Iversen would not have been able to propound his theory with such a convincing mass of scientific data had he not been fortunate in finding a small wood in Jutland called Draved forest. This wood is only some 5ha. in area, and had apparently escaped clearance and human influence since Neolithic times. In places the organic layer on the surface of the mineral soil was nearly a metre thick, making it possible to carry out pollen analyses and radiocarbon dating to establish the history. From this small relict he was able to build up a very complete picture of soil development and vegetation trends over a long period of time. There is no comparable site known in Europe, and its ecological value is incalculable.

However convincing this model put up by Iversen, there are grounds—some of which were touched on above—for doubting whether his conclusions are universally applicable. We therefore need evidence from similar relict forest communities. From a little work that I myself have carried out on a few of the Ancient and Ornamental Woods of the New Forest it seems that some of them may come into this category. Whilst accepting that they have not had the sheltered history of the Draved forest, they nevertheless appear to have had a long forest history, as indicated by soil pollen analysis. If this is so, they are invaluable reference material in a country which has been almost completely deforested, and they should be jealously protected. In Denmark, the Draved forest was immediately set aside for scientific research.

This being the position, how do these woods in the New Forest stand today? They are all threatened by grazing animals in numbers which give the woods little chance to regenerate. Some grazing is doubtless part of the natural balance, but it must be controlled. Since the commoners have their traditional grazing rights in these woods, the Forestry Commission cannot simply enclose them to allow regeneration to prosper; if they did, it would be sadly misunderstood as well as being illegal. They are therefore proposing to open the canopy and plant up the gaps in the hope that some young trees will survive. This involves the use of machines and as the operation will be repeated every 20 years, soil disturbance will be widespread. Soil which has been churned up is made permanently useless for the sort of soil study necessary for the investi-

There are serious threats to the Ancient and Ornamental Woods of the New Forest, partly due to the traditional practice of grazing stock in them.

gation of these questions. Whilst care may be taken to use transplants of local origin, one of the crucial aspects of research into these problems involves the trees and the many organisms associated with them in the natural state. There is a danger of "contaminating" the system with organisms alien to it or even of different genetic make-up. There are reasons for believing that beech, which is such a conspicuous component of many of the woods today, was not an important member of the original forest, but a late arrival. In view of this doubt, one must question the wisdom of using beech transplants in these woods. By doing so we are in danger of pre-determining the future of the woods, and we are really acting in ignorance.

The ideal solution, scientifically, would be to enclose all the Ancient and Ornamental Woods and let a natural balance re-establish itself. Various interested parties would object to this for a variety of reasons—but it must be accepted that unless something is done we may lose the very thing we are defending. It is perhaps more realistic to make a careful survey of the woods to see which are of outstanding interest ecologically. Some, I know, have a chequered history which reduces their value, but there may be others whose potential is not appreciated yet. This judgement must be purely ecological, and should be internationally agreed because of its importance to international science; it cannot be influenced by local interests such as forestry, commoner's rights or public access. Once judgement has been made then it is up to society to decide whether it will act to preserve any woods of outstanding value. As a first step towards making this possible, it was necessary to call a halt to any operations, however well intentioned, that might impair the value of these woods from this point of view. A pause in the operation has now been granted, and we have to use the time to assess the value of our asset and reach a decision on how to exercise responsible stewardship if it proves to fulfil the promise of preliminary investigations. All over the world balanced ecosystems are being destroyed before we have had time to study them. It would be a tragedy if we did the same here when there is no overriding necessity of hunger or economy that forces us to do so.

This month's contributors

J. David George is a marine ecologist at the Dept. of Zoology, Natural History Museum, London. He is particularly interested in the long-term and short-term effects of pollution on distributions of marine fauna, and has published a number of papers on marine ecology.

Eugene P. Odum is Director of the Institute of Ecology, University of Georgia. He has written a great many articles and books on ecology, including the classic *Fundamentals of Ecology*.

Sir Ashley Clarke is Vice-Chairman of the "Venice in Peril" Fund.

G. W. Dimbleby, who for 19 years lectured in forest ecology at the University of Oxford, is now Professor of Human Environment at the Institute of Archaeology, University of London. He was recently Chairman of the Inter-church Committee on the Environment and produced the report, ***Man in his living environment***, for the Church Assembly and the Countryside in 1970 Conference.

Coming events

Conservation '71—an exhibition arranged by joint local and national bodies, to be held at Prittlewell Priory Museum, Victoria Avenue, Southend-on-Sea, Essex. Open: 1-12 April (except Good Friday), 11 a.m. to 6 p.m. (Special arrangements for school and other parties should be made with the Curator.)

Air & Water Pollution Seminar.—Arranged by the Glass Manufacturers Federation, to be held at the British Glass Industry Research Association, Sheffield, on Wednesday 24 March. The seminar will be under the Chairmanship of Mr W. F. Spengler, Managing Director of United Glass Ltd., and speakers include Mr F. E. Ireland, Chief Alkali Inspector. The fee of £5 includes coffee, lunch and tea. Full details from the Assistant Director, Administration, Glass Manufacturers Federation, 19 Portland Place, London W1N 4BH. (Tel. 01–580 6952.)

In the next issue of The Ecologist . . .

we go up to 40 pages and include five major articles:

Paradise lost? by John Wehrheim. The story of the continuing rape of Hawaii.

Britain's dying chalk streams by D. S. Martin. Few are surviving our mockery of a water policy.

Population density and stress in zoo monkeys by Martin and Hilary Waterhouse. Some original research findings.

Environmental politics in Britain by Michael Gurstein. Why they don't exist and a plea that they be started.

Plastic decay by Allen Jones. The problems of plastic garbage.

Classified Advertisements

Reports

Cheaper cures without antibiotics

Antibiotic consumption has been rising at a near-exponential rate over the past decade. Wonderful for the pharmaceutical industry—but as wonderful for the patient?

Bitter experience in a neurosurgical unit at Killearn Hospital, some16 miles north of Glasgow, confirms what some doctors have feared for some time. Far from controlling post-operative infections antibiotics can create the very conditions whereby novel and dangerous types of infections take over. For the patient the outcome can be fatal.

At Killearn the problems arose in 1966 when post-operative wound infections caused by certain types of staphylococci and antibiotic-sensitive coliform organisms first became "troublesome". To keep these infections at bay the neurosurgical staff started giving prophylactic doses of broad-spectrum antibiotics such as ampicillin and cloxacillin to patients thought to be at special risk, as well as therapeutic doses to unconscious patients in whom the saliva and spit was already infected with bacteria.

The amounts of antibiotics administered to these patients steadily escalated and by the end of 1969 the neurosurgical unit's annual antibiotic bill for ampicillin and cloxacillin alone came to £9000.

A year after embarking on this antibiotic policy the consultant bacteriologist at Killearn, Dr Douglas Sleigh, found he was seeing a relatively unusual type of pathogenic bacteria in samples of the patients' urine and sputum. The organism was a coliform bacteria, *Klebsiella aerogenes*.

Soon one-quarter of all the patients in the neurosurgical intensive care ward were harbouring this organism. And the senior registrar, Mr David Price, armed with a swab, found the floors, walls, and ceiling of the ward to be generally contaminated.

In the late summer of 1967 a boy was brought into the ward with a moderately severe head injury as a result of which his nasal passages had opened up inside and were in direct communication with the cerebro-spinal fluid of the brain. Being one of the "special risk" patients he was immediately put on broad-spectrum antibiotics.

Despite these precautions he got infected with klebsiella and soon, antibiotics notwithstanding, the brain membranes were coated in a thick opaque purulent mass of mucus-producing bacteria. A little later the boy died of meningitis.

It so happened the intensive care ward was due for redecoration, and everyone hoped that after the general cleaning up and sterilising of the equipment klebsiella would have been banished for good. No such luck. Within four weeks of the ward being re-opened klebsiella infections had returned. Not only did the urinary and chest infections go back to the same level, but worse a further seven patients contracted klebsiella meningitis and all died.

In his bacteriological studies Dr Sleigh found that klebsiella was sensitive to two antibiotics in particular—colistin and gentamicin. The neurosurgical staff tried using these very powerful antibiotics in conventional dosages. "But this treatment did little to control infection," said Mr Price in *World Medicine* (1971, Jan 13, 67), "so we decided to use colistin in high dosages. We set up a completely isolated six-bedded intensive care unit and gave all infected patients admitted to it six times the normal dose of colistin for an average of ten days.

"In all we treated 16 patients like this—and the number of klebsiella chest and urinary infections did go down—but only by half. This still wasn't good enough and we were talking of closing the unit down. A very drastic step. I then came up with the almost equally drastic suggestion that rather than close the unit we should stop using antibiotics altogether."

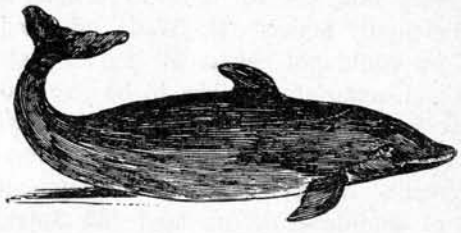
At first some of Mr Price's colleagues understandably disagreed, and others, though agreeing in principle, wanted to make exceptions for infections like pneumonia. In the end everyone cooperated in a ruthless "no antibiotics" policy. Luckily no patient in the unit had meningitis at the time.

The results were staggering. Within four weeks the incidence of klebsiella infections had fallen to nearly nil. Now there are no cases of chest and urinary infections caused by klebsiella. Perhaps even more surprising the "usual" infections caused by the more antibiotic-sensitive organisms—staphylococci and coliform organisms—also fell, and fell dramatically. During the first ten weeks of the new regime respiratory tract infections fell from 45 per cent to 15 per cent and urinary tract infections from 21 per cent to 8 per cent.

After four months of the no-antibiotic policy the neurosurgical staff agreed to use antibiotics in carefully selected circumstances. "And whenever we can," says Mr Price "we choose a narrow spectrum antibiotic." The problem of chest infections in the patients —many of whom are unconscious—has been overcome largely by using a technique known as percussive chest physiotherapy and combining this with suction and drainage of the mucus coming up from the lungs.

Hardly surprisingly the new antibiotic regime has had some effect on the annual antibiotic bill. For just the two broad-spectrum antibiotics—ampicillin and cloxacillin—this has come soaring down from £9000 to close on £500 a year.

Peter Bunyard



Killer whales

In a brief announcement in August last year the Canadian Government brought to an end a six-year sea story in which an engaging creature named *grampus orca* found itself in demand in the world's oceanariums. *Grampus orca* is the killer whale, the largest member of the porpoise family, but until 1964 none had been kept in captivity.

In July of that year the Vancouver Public Aquarium, which is headed by zoologist Dr Murray Newman, became the first organisation to capture and keep one of the species and discovered that the carnivorous killer whale is not dangerous to man. It was the first of dozens of recorded captures in Pacific Northwest waters. Today, performing killer whales are popular features in North American and European oceanariums.

The ban on taking, catching or killing the species in Canadian west-coast waters shows the Ottawa government's concern for the conservation of wildlife and was not even prompted by the danger of extinction. For the killer was not

Reports

one of the main types of whales hunted into oblivion by the whaling fleets of the world. The Canadian ban also covers elephant seals, otters and sea lions and according to a fisheries department spokesman "reflects greater concern by the department for the conservation of marine mammals."

This summer, prior to the Canadian announcement, a University of British Columbia scientist made a strong indictment of the capture of whales. Dr J. A. Wada, a physician who specialises in the study of mammal brains, said in an interview: "It is completely wrong for us to capture a killer whale, remove it from its lively environment, and place it in a small cement pool where it cannot even hear any sound. No wonder the whale is so anxious to jump up for fish to entertain the people. There is very little else for it to do to keep it mentally active." Dr Wada admitted we could not expect all zoo animals and aquarium exhibits to be released overnight but he believes man's increasing desire to protect his natural environment will see the further development of wildlife parks on land and water, instead of zoos and aquariums.

Dr Wada said he has found that the killer whale has a brain that is better developed, in physical ways, than man's. This did not mean the whale was more intelligent than man but that a greater part of its brain capacity is devoted to higher levels of functioning.

Dr Wada urged Canadian Fisheries Minister Jack Davis to set aside an underwater park for whales—a suggestion that is in line with Mr Davis's hopes for a protected underwater park in the Gulf of Georgia, between Vancouver Island and the mainland.

Dr Wada's opinions had been shared earlier by Dr Paul Spong, an assistant professor of psychiatry at the University of British Columbia, who had been studying the performing killer whale Skana at the Vancouver Public Aquarium. Spong told a seminar at the university: "We should put killer whales back in the ocean as soon as possible." Skana, he said, was "starved of stimulation."

The aquarium's chief, Dr Newman, responded by saying that Dr Spong's experiments had endangered the whale's life and his contract would not be renewed.

As for Vancouver's policy, it has just completed a $1,200,000 pool for Skana and her companion Hyak, and the old pool is to be used for six newly captured Arctic narwhals.

The killer whale story in the Pacific Northwest began with the Vancouver Aquarium's capture, in 1964, of Moby Doll, for study and measurements to be taken for a sculpture. The whale was only superficially wounded by harpooning so it was put into a flooded dry dock until a pen could be built at a nearby beach.

After its death three months later—an autopsy blamed low salinity of the water—Moby Doll was found to be a Moby Dick, although unlike Herman Melville's whale it was a friendly creature and did not even want to upset a dinghy. Moby's death closed the killer whale story until July, 1965, when two were accidentally caught in a net near Namu, 270 miles up the coast from Vancouver.

This is where Mr Ted Griffin, director of the Seattle Marine Aquarium, a private company, came on the scene and he has been closely connected ever since, directing many killer whale hunts in American waters in Puget Sound.

Mr Griffin bought one of the two Namu captives for $8,000 and achieved the feat of towing the whale, in a large pen, 350 miles south to a pen on the Seattle waterfront. Huge television and press coverage followed his progress. The whale, named Namu, proved a clever performer and soon returned Mr Griffin's investment. It also starred in a Hollywood movie. Namu died a year after its capture, an autopsy recording that it drowned, entangled in netting while apparently trying to escape.

Killer whale captures soon became common place on both sides of the international boundary. Mr. Griffin sold one in March 1967, to the Vancouver aquarium. It was named Skana and has been a star performer ever since. Out of a dozen captured in an inlet at Pender Harbour, north of Vancouver, in April 1968, several were bought by American interests. Five were captured in the same spot in August 1969, and four were sold to California oceanariums and the fifth went to Britain. It is known that in the past few years many killer whales have died in captivity or while trying to escape from pens.

A loophole in the new Canadian regulations exists in that there is no similar legislation covering adjacent American waters. But in August, Mr James Scripps, a major US newspaper publisher, led a group investigating what steps can be taken to restrict killer whale hunts on the United States side. "I am ready to subscribe to a fund to investigate and campaign for whatever regulation would appear suitable to restrain the capture of this type of wildlife," he told United Press International, when he visited Lopez Island, Washington state. Mr Scripps said he has asked the US Wildlife Department if any existing or pending legislation deals with the matter.

Barry Band

Biocontrol in agriculture: 1

Most of us have heard of "biological control". It is a method of controlling insect pests, usually by introducing other insects that prey on them. In fact it is far more than this. It is an attempt to tip the balance of nature a little in man's favour. In this series of articles I shall try to show how this science operates in different fields, but first I will confine myself to a definition of terms and a brief discussion of the general principles on which biocontrol must be based if it is to be of real value. You will note that I have abbreviated "biological control" to "biocontrol". This is the more common usage in modern literature. There is no change in the meaning.

Since the very dawn of history, when man first began to till the soil, he has had to contend with insect pests and weeds. References to this almost eternal warfare occur throughout literature and it is mentioned frequently in the Bible. In many cases, however, it is man who is to blame, for his farming methods may do more harm than good. Man is the one creature who can turn fertile land into arid desert and who can effect other drastic changes in ecosystems. Often he does not realise what he is doing. I hope to be able to discuss the Aswan Dam in some detail later, but this is a case in point. It has been suggested that in two generations the Egyptians may wish it had never been built. The catastrophic earthquakes in Peru may seem as nothing compared with

the damage that will be caused by the Aswan Dam: and we are only beginning to get the preliminary facts.

The lesson is a simple one and because it is so simple man will never really learn it by heart. It is that we cannot tamper with nature with impunity, that there must be very careful study before any new project is undertaken. We must learn to think hard before we introduce chemical insecticides, herbicides, hormones for faster growth in farm animals, rat poisons and so on. Nature provides warnings. If we ignore them we have only ourselves to blame. We need a science that will watch over our best interests and that will curb, to some extent at least, our basic instinct to make a quick profit regardless of the consequences in terms of our future prosperity.

This is what biocontrol aims to do. It is the science of nature in all its forms. It aims to use the results of its studies to improve agricultural methods and so produce more food, of higher quality, more cheaply. Obviously, the control of insect pests and weeds form an important part of its interest, but it is much wider than that. Essentially it is an integration of many other scientific disciplines: biology, botany, ecology, entomology and many others all play a part in its development and application.

Biocontrol does not reject out of hand the use of all chemical insecticides and fertilisers; but it insists that these be used in conjunction with natural methods which, although they may be slower, are likely to be more lasting and cheaper and which are less likely to produce adverse effects on the ecology of the area treated. The aim is always to observe the natural balance and to tip it, ever so gently, in man's favour, without upsetting it altogether.

The Aswan Dam project provides a typical example of how not to do things. It may provide more hydroelectrical power for industry, but the cost may be high in terms of the increase in malarial diseases, the loss of alluvial soil and natural manures brought down by the flood waters, together with the increased salinity of the Mediterranean around the Nile Delta, and the alteration of flora and fauna patterns brought about by these and other effects. All of this could have been foreseen had experts in biocontrol been consulted before the project was launched. What may turn out to be a catastrophe might have been averted.

The basic principles of biocontrol become clearer if we face an expert in biocontrol and a biochemist with the same problem: the control of a particular insect pest. The chemist is concerned with the development of a chemical product capable of eliminating the enemy. He is not concerned immediately with the side effects of his product so long as it is effective and provided it is not lethal to human beings. His point of view is simple and coincides with that of the farmer, whose only wish is to rid himself of the pest.

The expert in biocontrol takes a much broader view. He tries to see the same problem in its global aspect and in relation to the ecology of the region. He will pay attention to other factors, apart from the pest or weed that is to be brought under control. He will tend to employ subtler methods which will be more specific than chemical pesticides and herbicides and that will aim at the enemy while respecting man's friends.

If all this is so, then why are such methods not known more widely and used? The answer is that they are well known and they are used widely, but not in Britain. Here we are almost completely "sold" on the ideology of pesticides, to the extent that there is hardly a garden, an orchard or a farm in this country that has not suffered from their careless use at one time or another. Meanwhile, the work of the Commonwealth Institute for Biological Control remains unknown or is dismissed as inapplicable to these islands.

In the United States biocontrol is taken very seriously indeed. Most universities have a chair of biocontrol in their agricultural departments. The University of California has produced the most complete textbook on the subject so far and a glance at its bibliography shows how much has been, and is being done, quietly and patiently, to advance our knowledge of this subject.

In Britain, the Ministry of Agriculture published its Bulletin No. 20, on Beneficial Insects, in 1958. It is an outstanding publication, written by B. D. Moreton, and it deserves wider circulation and deeper study. The Henry Doubleday Research Association also publishes Biological Reports from time to time. Again, it is a pity they are not read more widely.

Britain is not the only country where biocontrol is almost unknown. Spain is particularly backward, in spite of the splendid possibilities for the application of this science to such pests as the Colorado beetle, *Leptinotarsa decemlineata*, and the fruit fly, which is a severe problem in southern regions. Both of these pests can now be brought under reasonable control without expensive and non-specific chemicals.

In spite of the outstanding successes of biocontrol methods, why is it that governments are unwilling to apply them or to encourage their development? This question is difficult to answer, for many factors are involved. The large firms producing pesticides fear a reduction in their profits should positive results be achieved by other, cheaper methods. That is not the only reason, however. Farmers themselves are difficult to convince. They demand quick results and it is not easy for them to grasp that the release of a particular insect, or the avoidance of spraying at a particular time will effectively control a pest, when all they can see is an immediate reduction in their profits as a result of its ravages.

Biocontrol is not wholly blameless in this. It has had outstanding successes, but there have been failures, too. These have often been due to the hasty launching of a project without adequate study of all the ecological factors involved. A scheme that should have worked in theory failed in practice. No harm was done, but the frustrated farmer saw only the failure.

It is unlikely that there will be further failures from this cause. All biocontrol projects nowadays are subjected to a long and searching investigation before they are tried in the field. Thus they generally have a fair chance of success and even if they should fail, they can do no actual harm, a factor worth remembering.

The procedure with regard to a particular insect pest begins with a study of the insect itself to discover vulnerable points in its life-cycle that would provide a possibility of control by harmless chemical methods. This is considered in conjunction with an appraisal of its economic significance. The study will include the creature's natural enemies in its country of origin. Many pests are introduced species that find an open field for their development for the

simple reason that their enemies did not accompany them. The Colorado beetle is a dangerous pest in Europe. In most States of America it is controlled by its natural enemies.

A list is compiled of natural enemies in order of their importance and then each one is studied in detail from several points of view. As much as possible must be known about its life-cycle, the ecosystem in which it thrives, whether it is a predator or a parasite and whether it attacks the pest at the egg, larval or adult stage. It is also important to know whether it is specific and whether it is good at seeking out its prey.

At this stage it is usual for the laboratory to take over from the field worker, because before any importation is made it must be established that no harm can come from importation. It speaks highly of the skill with which these studies have been carried out that so far there is not a single case on record of an insect that has been imported "officially" becoming a pest. I shall say more about these laboratory tests because of their importance but also because they establish biocontrol as a scientific discipline in its own right.

When these tests have been completed to everyone's satisfaction, attention is switched to the ecosystem into which the insect is to be introduced. Again, this must be studied from various angles, as must the problem of mass-breeding the insect in captivity. After all, there is no point in introducing a potentially beneficial insect into an environment in which it cannot survive. Sometimes there may be a number of adverse factors and the decision to abandon the project is clear-cut. In other cases it is marginal and there is an element of risk. Many of the failures of biocontrol projects have been due to the lack of survival potential of the immigrant. One enemy of the Colorado beetle, for example, satisfied all the field and laboratory tests, except one. This beetle could not be reared in numbers because it is so ferocious that, in captivity, it will attack and kill others of its own species. This could be overcome only by individual rearing. The project was abandoned for this reason, although eventually a solution may be found and it may be resurrected.

It can come as a great disappointment to those who have worked on a project for months, perhaps years, when it has to be abandoned, but the wise expert in biocontrol learns to accept setbacks with resignation. *Scolia flavifrona* was another example. It was considered as a possible control agent of the New Zealand grass grub. All went well until it was discovered that *Scolia*, a strong flier, would need large quantities of food in the form of nectar from wild flowers and wild flowers are scarce in the pasture lands of New Zealand. The project was abandoned reluctantly. Had a food supply been available for it, *Scolia* would have done the job. As it was it would not have established itself.

Sometimes a difficulty of this kind may be overcome by a deliberate sowing of wild flowers, but not on pasture land grazed by sheep that eat practically everything.

Is biocontrol economically feasible? How does it compare with chemical pest control in terms of costs? The answer here is simple and conclusive. In the long run biocontrol is much cheaper than any other method known at present. I have no wish to burden you with a mass of statistics, but they do exist, they speak for themselves, and they are open to inspection by all. Rather than quote them I will repeat the basic reasons for which biocontrol methods are cheaper and better than any others.

Where biocontrol succeeds, the ecosystem to which it has been applied is modified in man's favour once and for all. If the project was launched scientifically there is seldom need for further action. All that will be necessary is a periodical inspection to ensure that the balance continues to be favourable, and this inspection costs very little. For this reason alone biocontrol is bound to be cheaper over a period than chemical methods which require regular re-application, always with the risk of producing resistant strains.

Biocontrol methods are specific, because they are designed that way and due care is taken to assure that no beneficial factor in the ecosystem is adversely affected. We are becoming increasingly aware of the importance of this aspect as we learn to deal with nature as a whole. Hasty interference with natural laws, indiscriminate attacks that kill friend and foe alike, can do a great deal of harm.

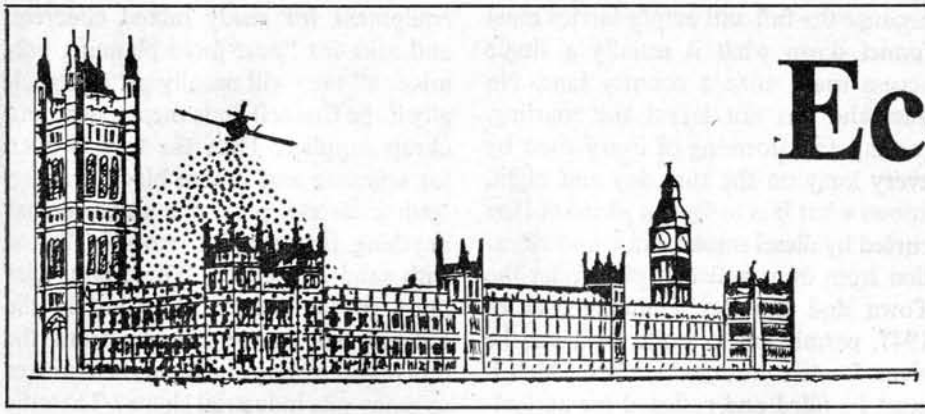
If biocontrol has not yet met with all the recognition it deserves, it is because of lack of funds for research—most Biological Research Associations work on a shoe-string budget—lack of dedicated staff, again for financial reasons, and lack of enthusiastic support from farmers and the general public.

Nor is time on our side, because if it is to succeed a biocontrol project works like nature, slowly but well. Some years ago we were consulted about a problem that had a solution, but if it was to work all chemical spraying would have had to cease long enough for the natural method to become established. We estimated that it would be two years before the results showed the value of biocontrol methods. The local university's Department of Agriculture rejected the advice we gave, but when chemical methods failed they decided, reluctantly, to give our method a trial. Within two years the pest was cleared and under control, at one tenth the cost of chemical treatment, and with the added advantage that there would be no need to repeat the operation provided chemical spraying was kept to a minimum.

I might venture to assert that biocontrol can come up with an answer in almost every case, given time and the opportunity to study. What it needs is support and co-operation.

David L. Greenstock

This is the first of three reports on biocontrol in agriculture.



Ecopolitics

New Forest emergency

Visitor pressure is killing the New Forest, largest single tract of semi-natural vegetation in lowland Britain. Every year there are 3.5 million day-visits to it; over 400,000 "camper-nights" are spent there; and at high season more than 200,000 vehicles drive onto heath and swards daily. Certain of its habitats—beech and oak woodland with holly understory, holly woodland and the "lawns"—are virtually unrepresented anywhere else in Britain. Yet they are being destroyed by the very people who come to them for their peace and beauty.

A recent report, *Conservation of the New Forest*, notes that "most of the rare species of fauna and flora which make the Forest of unique interest require a relatively stable and largely undisturbed habitat if they are to survive". Deeper and deeper recreational penetration progressively fragments these habitats and also destroys fragile ground flora. Over the last 10 years breeding populations of the stonechat, woodlark, lapwing, redshank, yellowhammer, and red-legged partridge have dramatically declined, while since 1964 the Montagu's harrier has virtually disappeared.

Red-backed shrike, redstarts, and wood warblers have vanished from wide areas around campsites in Hollands Wood. Campers have taken large quantities of dead timber from up to 300 yards from the Denny Wood camping area, thus removing the habitat of much of the insect fauna on which many vertebrates depend. Camp fires at Vinney Ridge "have caused significant damage to one of the most important sites in the British Isles containing epiphytic lichens".

Plant collectors have much reduced the population of wild gladioli, which in this country is confined to the New Forest. Bird's nests are frequently destroyed, and visitors kill the rare smooth snake, not knowing it is harmless.

The car is the chief culprit, because it enables more people to get to parts of the Forest they would not bother to walk to, and it is a direct cause of soil erosion, compaction of soil around trees, and destruction of sward.

How can the New Forest be protected so that its unique features may be enjoyed by succeeding generations, without entirely excluding access to the present one? The report recommends that the number of vehicle access points be reduced by about 1,000 to 200. 26 "car-free zones" should be created, selected for their high ecological value or because they require regeneration, and protected by gates and barriers across tracks, and by ditches, banks, or barriers of natural vegetation alongside main roads. Car visitors should be channelled into 140 areas, landscaped to be attractive yet withstand wear and tear, and equipped with lavatories and litter bins.

Open forest camping should be by permit only and confined to 16 informal campsites with litter bins and effluent disposal points, and/or 2 areas of up to 100 acres for "free" camping. Other campers would stay at 5 fully-equipped sites. Lighting of fires should be prohibited except where simple hearths are provided.

A New Forest Centre should be built, well-signposted so that visitors will naturally call there first. There they could see displays and recorded films, and be given three types of information—basic (location of sites, etc.), general (historical and natural items of interest near sites) and specialised (ecology of the area, how it is destroyed and why it must be protected). Counter-attractions like country parks and picnic sites *outside* the Forest could also be advertised.

The capital cost of the report's main recommendations would be some £440,000. Some of this, and certainly the running costs, could be recovered by charging for entry to the Forest (at campsites and the 140 visitor areas), which the report also recommends. This proposal is not without precedent: the upkeep of Ancient Monuments, for example, is financed by the taxpayer, but visitors must pay to go round them.

As a matter of the utmost urgency the Government should allocate these funds and see that the Forestry Commission implements the report's proposals. For, as the report points out, "public pressure becomes annually more severe and unless our proposals can be implemented *within five years* we anticipate that it will have grown dangerously out of control to the permanent detriment of the Forest, its animals and the livelihood of those who depend on it" (italics mine).

Conservation of the New Forest has been published in draft form, so that the public can comment on its proposals. If you are interested, copies can be obtained (price £1.50) from the participating authorities (addresses given below). Your comments must be sent to one of them to arrive not later than 31 March. At all events any reader who cares for the New Forest is strongly urged to write to the Minister of Agriculture *and* to his local MP endorsing the report and calling for its speedy implementation. A number of letters from private individuals does much more than an organised statement from a pressure group. Two letters are little trouble, yet it rests with each one of us to see that ecology is brought into politics, that ecopolitics is not an intellectual will-o'-the-wisp but a force for reform.

Robert Allen

The Forestry Commission, Queen's House, Lyndhurst; Hampshire County Council, The Castle, Winchester; The Nature Conservancy, Shrubbs Hill Road, Lyndhurst; Verderers of the New Forest, c/o 63 High Street, Lymington. (All are in Hampshire.)

Down to Earth

by Lawrence D. Hills

Fight the gravel grabbers

Every mile of new motorway demands 100,000 tons of gravel sorted into "aggregate" or small stones, sand for the concrete, and larger stones for the two foot thick bed below the solid surface. Every town centre torn out to be filled with high rental shops and offices, every new school, factory, hospital, airport or housing estate needs concrete, and there is nothing that planners plan that has not left a hole in the ground somewhere, where the gravel was grabbed to build it.

By December 1st 1968, 554 miles of motorway had been completed and another 446 miles will be finished in the "early 1970s". The 1969 Ministry of Transport Green Paper envisages a further 2,000 miles of inter-urban through-routes to feed the first 1,000 miles of motorway, which means a continued demand for at least half the 100 million tons a year of gravel dug in Britain today. Only 11.5 million tons is from shore dredging, because of the risk of coastal erosion. All the rest comes from wet pits dredged in river valleys or dry ones scooped out by mobile grabs.

New motorways can leave chains of desolation across the countryside, because once a pit has planning permission to open and supply the needs of a section, it stays open permanently, supplying the demand within economic range. This may well lower building and road making costs over a wide area, provide an income for the Local Authority from the levy on every ton (often exceeding the total revenue from other rates), and make possible all the developments for which we clamour with our votes, without thought of the consequences for those who live near the pits.

The further gravel must be hauled by road the higher the cost, and the longer the traffic jams. The nearer the pit the worse the damage to buildings, traffic congestion, noise, fumes and danger because the full and empty lorries must funnel down what is usually a single access road, once a country lane. No one who has not learnt the snarling, roaring and storming of every road by every lorry on the run, day and night, knows what it is to have a pleasant lane cursed by diesel smoke, noise and vibration from even a distant pit. Under the Town and Country Planning Act of 1947, permission to work a pit can be given for ten years only, after which it must be filled and restored for agriculture, although application can then be made to extend it. Gravel today is worked by giant companies who can afford the best legal advice and the most persuasive Public Relations to convince residents round a planned pit that, after ten years, the eyesore filled with grinding and snarling machinery will be a place of quiet beauty and an asset to the countryside.

The Sand and Gravel Association of Great Britain can point to many examples of restoration for housing and industry, farmland, or nature reserves, and lakes for yachting and angling. They own however that the heavy machinery needed to sort the gravel into its several sizes, and often to wash away the clay fraction, cannot be written off in only ten years.

They will put in for permission for another section to last a further ten years, and then another, so the pit continues indefinitely, with its traffic thundering out of the same country lanes, which may be widened and reinforced, but even larger lorries roar past the same unfortunate residents. The Company is making money, the owner of the land gains a second huge levy, which is larger as the pit expands for greater production. Apart from increasing their building and road costs by refusing permission, they are probably filling the worked out portion with dustbin refuse, adding flies, rats, smell and smoke when the tip catches fire, to the near resident's burden. Now, full and empty refuse vehicles, both Council and private, are added to the stream of gravel traffic.

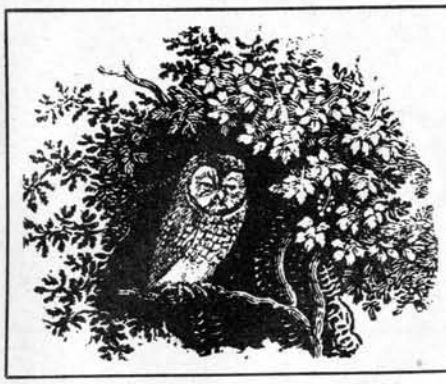
Even when the gravel formation is completely exhausted, there is danger from the fact that once planning permission has been given for any industrial development connected with gravel extraction, it cannot be refused for further developments. If, as an example, the company starts coating small stones with tar for road and pavement repairs, or puts up a silo for cement and loading equipment for ready mixed concrete, and asks for "*post facto* planning permission" they will usually get it, especially if the Council finds them a near and cheap supplier. Then the way is open for concrete and breeze block making, spun concrete pipe manufacture and anything that can be remotely linked with sand and gravel. These industries must go somewhere. Why not in the hole already made hideous from the refuse and rusting machinery that makes so many pits industrial slums? Then the noise and traffic continues indefinitely, as the sand and gravel is hauled in, and the products hauled out of a pit that should have been restored to agriculture after ten years by a law that is harder and harder to enforce.

There is hope from a new technical development in Germany. Here new motorways are made with polyurethane foam sprayed on at the rate of a hundred square feet a minute to harden in a layer $1\frac{1}{4}$ inches thick, that replaces the two foot gravel bed with $38\frac{1}{2}$ tons a mile of chemicals, in five road tanker fulls, instead of 2,000 lorry loads of gravel.

Until this cuts the gravel demand by about a third (the road surface must still be concrete) what can be done to ease the problem of the victims of the gravel grabbers. Those who demand theatres, old people's homes, art galleries, swimming pools or community centres are all gravel grabbers, just as every non-vegetarian runs a fraction of a slaughterhouse.

We need a Private Member's Bill to reinforce the 1947 Act, granting a maximum extension of five years, for 15 years should be the limit of sentence for the "crime" of having gravel found in your locality, not a train robber's term. Industrial development in worked-out pits should be illegal, the present limit of 28 feet from a dwelling house should be extended, and only pulverised refuse, not offensive raw rubbish should be used for filling. Infringement of these regulations should mean imprisonment for the Council officials responsible.

Until there is this protection for those who suffer in the "National Interest" which is always the financial interest of those who are most vocal in its defence, the only course of action for the residents of any gravel area is to fight by every means in their power—local press, radio, TV, MPs, the Council for the Protection of Rural England—everyone who will help.



Towards a unified science

Facts and Hypotheses—a false dichotomy

Most people—including many scientists—assume that there is a difference of kind between a "fact" and a "hypothesis!"

A fact, it is usually considered, is something that has been established "empirically", i.e. by observation; a "hypothesis" is just a hunch that remains to be verified empirically.

This is a false dichotomy, and is only made by those who are ignorant of the nature of perception or observation.

The latter is not simply a mechanical process like taking a photograph, as empiricists would have us believe. It is an organisational one. Data is detected, "transducted" or translated into the informational medium of the brain and organised in that pattern of information that the brain contains.

It is only when this has occurred that the data constitutes information; and this information is not a fact but rather a hypothesis based on the interpretation of the data in the light of our particular model of the system. Information is organised in our brain to form a model of our relationship with our environment, i.e. of the system of which the two are part.

However, each interpretation must vary in accordance with the model used and since, as a result of our different characteristics and different experience, we have all built up different models of our relationship with our environment, so our models and hence our interpretations will be different.

It is for this reason that people see, hear and smell different things and that perception is so subjective.

The information obtained by means of observation in terms of which we verify our hypotheses is itself but another hypothesis, from which it must follow that there can be no such things as facts as distinct from hypotheses.

The main reason why this is not more apparent is that for day-to-day requirements the subjective probability of the hypotheses postulated on the basis of our perception is so high that for all practical purposes they can be regarded as certain.

As a result, we have an innate tendency towards what might be called "perceptive realism"—a form of subjectivism in which we assume the reality of our perceptions, and which provides the psychological basis of the empiricist fallacy.

Thus if I see a dog sitting on the green and eating a bone, I feel I have established a fact. In reality I have postulated a hypothesis. It might for instance be a jackal, or a wolf, or a mechanical contrivance dressed up as a dog. Similarly, what I have interpreted as being a bone might be something quite different—a stone, for instance, or a porcelain figurine, or a piece of wood. However, I shall almost certainly treat these suggestions with the scorn they deserve, for the simple reason that my original hypothesis *fits in extremely well with my model, and therefore has high subjective probability, whereas the alternative hypotheses simply do not.*

The "hypothetical" nature of perception becomes much clearer in the case of models with a lower degree of probability. Thus, to return to our dog; once I am satisfied that he is eating a bone, I might postulate a number of further hypotheses. For instance, I might identify it as John Smith's dachshund eating a bone. I might go further and make certain assumptions about the origin of the bone. Since I know that John Smith's family is away on holiday and that the dog is being looked after by John Smith's mother-in-law, who is notoriously mean, and even more notoriously indifferent to dogs, I would be pretty certain that the bone had been given to the dog by the local butcher. I could complicate my model still further by guessing what sort of bone it was, at what time in the morning the dog visited the butcher, the expression on the butcher's face when he gave the bone to the dog, etc. Even the staunchest empiricist would admit that these final details were in the nature of hypotheses, and that they did not constitute "empirical knowledge", as did the original facts alluded to. *Empiricists would thus establish a sort of dualism between valid knowledge obtained by perception and not so valid hypotheses. If so, however, where then is the frontier to be drawn between these two categories of information*? Thus, if it cannot be said that I *saw* John Smith's dachshund eating a veal bone given to it by a smiling butcher at 11 a.m., since much of this information is assumed or deducted, can I say that I *saw* John Smith's dachshund eating a bone given to it by a butcher? If not, can I say that I *saw* John Smith's dachshund eating a bone? *If I must limit myself to saying that I saw a dog eating a bone, why should the frontier be drawn at this point rather than any other? The answer is that I did* not "see" any of these things, if "seeing" refers to an objective mechanical process such as detecting. What I saw was a mass of lights and shadows which I then proceeded to interpret, in terms of my systemic model, by postulating the most probable hypothesis, whose generalities I feel certain of, i.e. have very high subjective probability, and whose successive particularities I am increasingly less certain of, i.e. have increasingly lower subjective probability.

One is thereby forced to the conclusion that all knowledge simply consists of hypotheses with greater or lesser probability or what is the same thing . . . that there is no dichotomy between facts, however well they may be verified empirically, and mere hypotheses.

Edward Goldsmith

student action

The NUS Project

The history of the National Union of Students' involvement in conservation work is short. In August 1969 HRH the Duke of Edinburgh wrote to the then President of NUS, Trevor Fisk, asking him whether the Union wished to take part in the European Conservation Year programme by contributing to the Countryside in 1970 conference in October 1970, and by sponsoring what environmental projects it could. Mr Fisk replied that the Union would give its support to the campaign. Consequently the incoming President, Jack Straw, met with the Secretary of the Standing Committee of the Countryside in 1970 Organisation and representatives of the Nature Conservancy to discuss what sort of contribution NUS could make. It was decided that NUS should convene a Committee, made up of students from member-colleges and universities of the National Union, to stimulate interest in the environment and prepare a number of documents for presentation at the Countryside in 1970 Conference which would voice the opinions shared at least by some members of this section of society. The 600 or so member-organisations of NUS were circulated, and fourteen students from colleges up and down the country, were invited to form this working group.

The Committee produced three reports on Refuse Disposal; Agriculture, Forestry and Management; and Relations with Industry, the fundamentalist approach of which contrasted sharply with other reports presented to the Countryside Conference.

The students' most important contribution was their insistence firstly that the Gross National Product is a singularly poor measurement of even the economic health of the nation, and secondly that there exist very real conflicts between industry and the conservation movement—which conflicts were repeatedly and conveniently ignored by most of the specialist reports.

On the final day of the conference it was announced that the Carnegie (UK) Trust, the Countryside Commission for Scotland, and that for England and Wales, had between them agreed to finance a three-year experimental project whereby NUS appoint an Officer and Assistant to form a Conservation Department in Endsleigh Street. The aim is for the Officer to provide local University and College groups with information of what is happening in other colleges, to attempt to offer some means by which groups can liaise, and to encourage the establishment of societies in colleges hitherto inactive in the conservation movement.

For further information about the NUS project, write to the Conservation Officer, NUS, Endsleigh Street, London WC2.

The Hammersmith Study Group

Originally comprised solely of architectural students from the Central London Polytechnic, the Hammersmith Study Group has expanded since its formation in 1969 to include members of University College Town Planning Department and the Architectural Association. Hans Haenlein, a third year tutor in the Department of Architecture, was responsible for the idea, and it was his Chairmanship of the Hammersmith Society which made this region the obvious one on which to focus attention.

The Study's aim was to plan and to assist with environmental improvements in the Hammersmith area, and the activities of the students in this project were to be assessed as part of their course work. However, some staff now fear that the directions of the inquiry selected by the students have resulted in parts of the study "growing outside" their course structure. For instance the students have concerned themselves with film techniques, social surveys, traffic engineering, mass communication and feedback. They organised a travelling exhibition last summer, with ten sites being covered in ten consecutive days. Citizens were asked what aspects of life in Hammersmith should be improved, what should be changed and what should be retained. The Study Group are attempting to show local people what is possible, and to allow them to say what is desirable.

In the last two years the Group has done much to define the functions of the Polytechnic. Unlike Universities, these colleges were designed to play an active role in their neighbourhood. They were to provide expertise and to educate people not in a stiff and specialist way, but rather in a manner more appropriate to the larger community. However difficult it is to encompass activities like those of the Hammersmith Study Group within the framework of a syllabus, if the *raison d'être* of the Polytechnic is not to be lost, this must be done. There can be no artificial subject barriers separating architecture from its social implications any more than town planning should be divorced from the opinions of townspeople.

Members of the Study Group are now working towards a framework of co-operation between local architects via their RIBA Chapter; Department of Architecture, Town Planning and Sociology in the college, local groups, residents' associations, and schools; and the local Council and Borough administration. The local Council has benefited from the interest and enthusiasm of the students, and has been allowed access to the findings of their survey. Now the Council has been asked to give some measure of financial support in order that the Study Group's activities can continue. It would be wasteful if what has grown from a good idea into a challenging project should peter out through lack of funds.

Graham Searle

Feedback

1 Oil v. Eskimos

Rapid development of Alaskan oil reserves "is essential to the strength, growth and security of the United States", claims an Interior Department report on the Trans-Alaska Pipeline System. Without it, the US will be forced into "excessive dependence on oil from the Middle East".

The report admits that the pipeline will be the cause of much environmental disruption—that there will be oil spills, some melting of the permafrost, erosion, and water pollution. However the probable damage, it argues, will be offset by the advantages to the American economy. Valdez, the Alaskan port to which the oil will go, will benefit considerably. The Indians and Eskimos, apart from those dependent on the free movement of caribou who will suffer, will not.

Financial Times, 14.1.71

2 Wild woodmen in Weald

The Forestry Commission is to cut down almost 3,000 oaks at Orlestone in the Weald of Kent and replace them with conifers. They are being strongly opposed by the Committee for the Protection of Rural Kent, but to these woodmen economics speak louder than acorns. *Daily Telegraph*, 8.1.71

3 Abortion centres needed

Two gynaecologists at St Mary Abbots Hospital, Kensington, have stopped accepting bookings for abortions. They have been snowed under by the demand, and have had progressively less time for gynaecological work. A growing number of women want abortions because they feel they cannot cope with another child or lack adequate accommodation. "But surely", said one of the gynaecologists, "we are not here to terminate pregnancies to solve the housing problem even though the situation might be quite desperate for the patient". He suggested the Government set up abortion centres to take the pressure off hospitals.

Guardian, 9.1.71

4 Defence land to be reviewed

Lord Carrington, Secretary of State for Defence, has approved a 16-man committee under Lord Nugent to review the 600,000 acres of land occupied by the Armed Forces in Britain. The committee will consist of senior representatives of the Forces, officials from the Ministry of Defence, Department of the Environment, Ministry of Aviation Supply, Scottish Office, Welsh Office and Northern Ireland Government, and six independent members.

The independent members are Mr Duncan Alexander, a former High Sheriff of Glamorgan; Major J. H. Askew, Convener of Berwickshire County Council; Mr John Cripps, chairman of the Countryside Commission; Mr Jack Hargreaves, broadcaster and journalist; Col R. J. L. Jackson, chairman of Yorkshire Travel Association and Colonel of the Army Cadet Force in the North-east; and Mr Nigel Strutt, chairman of the Agricultural Advisory Council. *Times*, 15.1.71

5 Waste reform

According to the US Bureau of Solid Waste Management, 94 per cent of all authorised waste-disposal sites in the US are harmful to the environment. Almost half of them pollute rivers and streams and three-quarters of them pollute the air by open burning. The Bureau hopes to close 5,000 of the country's 12,000 open sites by the middle of 1972 and replace them with satisfactory facilities.

Land Pollution Reporter, Nov./Dec., 1970

6 Pesticides act on pesticides in fish

The ultimate effects of interactions between pesticides are unknown, and therefore no safe level can be fixed for any one of them. F. L. Mayer, Jr., J. C. Street and J. M. Neuhold of the Ecology Center, Utah State University, have shown that one pesticide can change a species' storage potential for another. Trout were exposed to three pesticides, methoxychlor, dieldrin and DDT, to see if the action of one altered the action of others. It was found that when fish ate dieldrin, they stored 157 per cent more DDT and 328 per cent more DDE.

Bulletin of Environmental Contamination and Toxicology, 5 (4)

7 Nerve gas mislaid

200 cylinders of VX nerve gas, fused for detonation, were left on the ice of a lake in the Fort Greely military test area, Alaska. The Army intended to destroy them, but forgot all about it. Summer came, the ice melted, the cylinders disappeared, and for three years lay there undiscovered. One drop of the gas on the skin can be fatal but, we are assured, none has escaped.

Daily Telegraph, 7.1.71

8 Undue editorial interference?

The Shell Guide to Kent describes the village of Wye as "unspoilt" and "of outstanding natural beauty". Doubtless that is why Shell-Mex have chosen it for a 12-acre petrol distribution centre. Kent County Council seem to think the proposal an excellent idea, an opinion not shared by the villagers who have formed an Action Group to fight it.

Sunday Times, 10.1.71

9 Ecomurder

20 per cent of South Vietnam's forests and enough crops to feed 600,000 people for a year have been destroyed by the military use of herbicides. It will take decades—and in some cases centuries—to restore animal life to normal, and it is more than likely that the unusual increase in stillbirths and congenital malformations can be ascribed to it.

An American Association for the Advancement of Science (AAAS) team under Professor Matthew S. Meselson, Professor of Biology at Harvard University, toured South Vietnam for six weeks to establish the effects of the widespread herbicide applications (10 times more concentrated than conventional agricultural ones).

They found that some coastal mangrove swamps still showed no sign of regeneration after six years. Crabs had taken over the unbalanced habitat, and it was probable they devoured what seedlings there were. Upland forests had been reduced to stands of skeletons, while in many areas only bamboo had returned—to such an extent that unless rapid remedial action is taken, the forests will not return for at least a century. The equivalent of Vietnam's timber needs for the next 31 years (more than £200 million worth) has been destroyed.

The AAAS team recommends that spraying be halted immediately. The US Government has announced that most herbicide operations will cease, but not at once. The South Vietnamese must wait until the stocks run out.

Observer, 3.1.71

10 Pesticide's long-term persistence in soil

It used to be thought that Parathion, an organophosphorus insecticide, was not particularly persistent in the soil. E. P. Lichtenstein and K. R. Schulz showed that 97 per cent of it disappeared within three months.

Now, with more sophisticated testing methods, D. K. R. Stewart, D. Chisholm and M. T. H. Ragab of the Canada Department of Agriculture, have shown that parathion remains in the soil for a good many years. 0.1 per cent of the amount applied was still present after 16 years. The reason for this persistence is not known. *Nature*, 229 (5279)

11 Pouring money on troubled oil

Oil companies owning over 80 per cent of the world's tanker tonnage between them have agreed to pay compensation of up to £12 million per accidental spillage. This voluntary agreement replaces the original ceiling of £4 million as from April 1.

Britain has announced that the maximum fine for wilful discharge in territorial waters will be increased from £1,000 to £50,000. Another Bill before Parliament—the Merchant Shipping (Oil Pollution) Bill—allows for damages of up to £5.8 million, or £56 a ton, compared with the present limit of £28 a ton.

10,000 birds, many of them eider ducks, died when an unidentified ship discharged oil off Samsoe Island, Denmark. *Guardian*, 15.1.71, *Times*, 16.1.71 and *Daily Telegraph*, 8.1.71

12 Recycling batteries

Crushed storage battery cases have been successfully used as aggregate in asphaltic concrete by the Texas Transportation Institute. Collection is no problem since most batteries are already returned to central points so that the lead can be recovered. In the US, more than 50 million used batteries are discarded each year.

Land Pollution Reporter, Nov./Dec., 1970

13 More on mercury

The US Federal Drug Administration is testing fishmeal for mercury and DDT residues. The Ministry of Agriculture is keeping in touch with the investigation.

"All controllable sources of mercury contamination should be either eliminated or maximally reduced", says a special report by government and independent scientists led by Dr Norton Nelson, director of the Institute of Environmental Medicine, New York University. As a matter of "utmost urgency" alkyl-mercury pesticides should be banned, and all other pesticides containing mercury should be severely restricted.

Financial Times, 6.1.71 and *Times*, 15.1.71

14 Ecological guidebook for development

The International Union for the Conservation of Nature (IUCN) and the Conservation Foundation are preparing an Ecological Guidebook for Development Planners. Written by Dr Raymond F. Dasmann, IUCN's Senior Ecologist, and John Milton of the Conservation Foundation, the book will be the first stage in a new programme designed to ensure that environmental considerations will be brought into the planning process and will be co-equal with economic and political considerations.

IUCN Bulletin, Oct./Dec., 1970

15 Farming's "disturbing failure"

The failure of farming to meet the National Economic Development Committee's import saving target over the past two years was described as "very disturbing" by Mr James Prior, the Minister of Agriculture. Farming faced a recession "unless we can get a better return into it", he warned. The short-fall (by some £119 million) was not attributed to modern farming methods. *Financial Times*, 14.1.71

16 Chiltern route stands

The Department of the Environment has stood by the decision of the previous (Labour) Government on the route of the M40 motorway over the Chilterns. Despite further representations by the Countryside Commission, and the views of the Nature Conservancy and the Royal Fine Arts Commission that the Arup-Jellicoe route is preferable, the Secretary of State for the Environment has refused even to evaluate it.

Times, 13.1.71

17 Hen-pecked

Mr Sidney Drabble, the public health inspector for Brackley, Northants, contracted fowl pest along with 69 of his fellow townsmen. The virus, rarely transmitted to humans, causes an infection of the eyes resembling conjunctivitis. *Daily Telegraph*, 14.1.71

18 Beware the yellow-bellied sea-snake

The proposed sea-level canal between the Atlantic and Pacific will definitely affect one species. Dr I. Rubinoff and Dr C. Kropach of the Smithsonian Tropical Research Institute have shown that the yellow-bellied sea-snake *Pelamis platurus*, now found only in the Pacific, would destroy many predators in the Atlantic. *Pelamis* is slow moving and easy to attack. It is also highly venomous, and Pacific predators have learned to leave it alone. Those that haven't have been wiped out.

In laboratory experiments Pacific predators have gone so far as to refuse to eat dead pieces of *Pelamis* even when they have been hidden in pieces of squid. Atlantic predators, however, lacking the benefit of experience, are quick to attack the snake, which retaliates viciously. Many of the Atlantic predators died as a result of *Pelamis*' venomous bites.

Nature, 228 (1288)

Ecotecnics

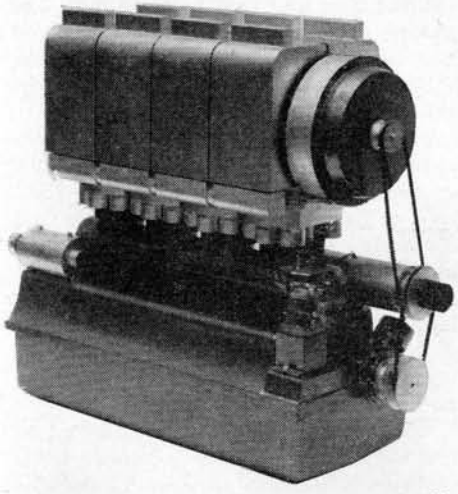
by Arthur J. Puffett

Philips engaged in stirling work

In 1817, a Scottish Presbyterian minister patented a hot-air engine which gives promise of revolutionising the commercial vehicle market over one hundred and fifty years later.

When the Rev. Dr Robert Stirling began looking for an alternative to the steam engine, pollution was far from his mind. His motive was to prevent the slaughter of mariners due to the explosion of the cast iron boilers installed on ships (of which over 50 per cent came to an untimely end). However, the Stirling engine has now been developed to the stage where buses are on test fitted with the latest design.

Philips Research Laboratories, at Eindhoven, Netherlands, have been working on the Stirling engine for 30 years, and as the search for a pollution-free power plant became more serious, their work became even more important.



The Stirling engine differs radically from the more familiar diesel and spark ignition engines. Although all these types depend for their power on a heat source which causes a working gas to expand and drive a piston, today's common engines burn their fuel internally and intermittently whereas the Stirling burns its fuel continuously and outside the engine itself. The Stirling has a number of striking advantages over its more firmly established competitors. Its exhaust is relatively clean (Stirling engine emissions are 100 to 1,000 times lower than those of conventional internal combustion engines); it is quiet and almost free of vibration. It has favourable torque characteristics and can run on almost any fuel, or other heat sources of sufficiently high temperature.

Philips have used the reverse process, in which mechanical energy is used to drive a Stirling cycle machine producing cold, for a number of years and it is a popular and cheap method of producing liquefied gases.

The closed system of the Stirling gives this engine its many advantages, and also some shortcomings. The continuous external heating of the closed system makes it possible, when fossil fuels are used, to cause the combustion to take place in such a way as to minimize air pollution by carbon monoxide, oxides of nitrogen and unburnt hydrocarbons. Through the intermediary of a suitable heat transport system any heat source at sufficiently high temperature can be used for this engine—radioisotopes, a nuclear reactor, heat storage, solar heat, or even burning coal or wood.

The almost sinusoidal cylinder pressure variation and continuous heating make the Stirling engine very quiet in operation. An engine having four or more cylinders gives a virtually constant torque over a very wide speed range, which is particularly valuable for traction purposes. The present design also makes complete balancing possible, thus eliminating vibrations. There is no oil consumption and virtually no contamination because a new type of seal for the reciprocating rods shuts off the cycle hermetically from the drive mechanism.

Where direct or indirect air cooling is required the closed cycle has the drawback that more heat has to be removed from the cooler than in comparable engines with open systems, where a greater quantity of heat inevitably escapes through the exhaust. This results, in a commercial vehicle, in a large radiator being needed.

Development of the Stirling will quicken during the next few years as licence agreements have been negotiated with General Motors, MAN/MWM in Germany and United Stirling in Sweden. Already a propulsion system is being developed which boasts a complete absence of exhaust, using a combination of heat storage and the Stirling engine where the transport of heat is achieved by so-called heat pipes.

Research by the Institute of Petroleum

As a result of the Torrey Canyon incident in 1967, the Institute of Petroleum (IP), which has amongst its members all the major oil companies, was approached by a committee appointed by the Advisory Committee on Oil Pollution of the Sea (the Callagham Committee), whose mandate was the rehabilitation of oiled seabirds.

At a joint meeting held in June 1967, the question of seabird rehabilitation was discussed. A suggested programme of research was put forward, but, on reviewing the problem, it was agreed that the first requirement was a wide literature survey to establish what information was already available. This survey was carried out by Professor R. B. Clark and J. R. Kennedy and became available in April 1969.

On 24 April 1969 Professor Clark was invited to a meeting of the IP Sea Pollution Committee, where he tabled a research project covering 5 years at a total cost of £40,000. This research project would be concerned with short term remedial measures of waterproofing the plumage of oiled auks (guillemots, razorbills and puffins) which are long-lived and slow in reproduction. Professor Clark felt that, if 10 per cent rehabilitation success was achieved, this would be a major research contribution. The project was subsequently accepted by the IP Advisory Committee, the necessary financial support guaranteed, and Professor Clark was asked to set it up at the University of Newcastle Rehabilitation of Oiled Birds Research Unit.

The first progress report of the project January-June 1970 has now been received. Staff have been recruited, a Scientific Director appointed, the necessary equipment is being installed, and the sequence of the research agreed. Visits have been made to bird cleaning centres around the country to compare at first hand cleaning methods, facilities, and rehabilitation success rates. Liaison has been established with the BTO and RSPCA to ensure a constant supply of information on the recoveries of rehabilitated seabirds. Contact has been made with the US Department of the Interior, the San Diego Zoo, and the Netherlands State Institute for Nature Management, who are also conducting investigation into the rehabilitation of oiled birds.

Books

The Population Bomb

POPULATION, RESOURCES, ENVIRONMENT by Paul R. Ehrlich and Anne H. Ehrlich. W. H. Freeman. £4.

There are some books, of which this is one, that are so authoritative that they make the reviewer's task almost impossible. Were it not for the price—which is outrageous—I would be satisfied to scrawl READ THIS BOOK across the page, and leave the Ehrlichs to speak for themselves.

They start with the contention that population growth will be the most important determinant of political, social and economic reality in the foreseeable future. In itself, that is nothing new, but the scope with which this idea is developed is breathtaking and terrifying. There is room here for only a few examples:

Controlling the "population bomb" is not a simple matter of distributing pills. In most under-developed countries, the age-structure, i.e. the number of people in various age groups, is heavily weighted on the side of youth. As these children grow up and have children of their own, population pressures will inevitably increase. "... even if great progress were made immediately in reducing the number of births per female ... it would be some *30 years before such birth control could significantly slow population growth.*"

Consequences? "The low UN forecast projects a world population of about 5,449 million in the year 2000, the medium forecast, 6,130 million, and the high, 6,994 million ... we feel that with the exception of the low forecast, these are too high. This, is not, however, because we share their optimism about the impact of family planning on birth rates. Instead ... we predict a drastic rise in the death rate will either slow or terminate the population explosion." If they are right, people will starve, kill one another, or fall victim to epidemics by the tens of millions every year.

Surely this is not inevitable. What of medical advances, projects to grow more food, and "farming" the sea? Like the gruesome events they prophesy, the authors run through these and other hopes, if not destroying them altogether, at least putting them in perspective:

We are too many and too greedy.

The situation in energy resources will do for an example. We are not only running out of fossil fuels; at the same time, we are wasting more than 90 per cent of the uranium in our atomic power plants. Unless breeders are made feasible within the next ten years, there will be no atomic power by 2025.

It is possible to live without electricity, but no man can survive without food. Equal distribution could probably ensure no one need go hungry in 1971. But within a very short time, even this improbable change in policy would be ineffective. The time will come very shortly when there simply won't be enough to go around however it is distributed.

The conventional wisdom as to what could be done in the face of ever expanding numbers of humans consists of alternative food sources. Grain concentrates such as Incaparina, algal extracts cultured on petroleum, or fish concentrate are believed to hold out the best hope. But, according to the Ehrlich's in the underdeveloped countries (UDCs) where they have been tried, these products *"have not been recognised as food."* The people will not eat them.

What about food from the sea? Summing up the consequences of the greedy way in which younger and younger catches are being accepted, with the result that several major banks have been fished out, the authors say:

"Judging from the fishing industry's behaviour towards the sea, one might conclude that if they went into the chicken farming business, they would plan to eat up all the feed, all the eggs, all the chicks and all the chickens simultaneously, while burning down the henhouses to keep themselves warm."

Fishing is also an excellent indicator of the real nature of relations between developed countries (DCs) and UDCs. "Although DCs deliver some 2.5 million tons of gross protein in the UDCs, every year, the latter send the DCs about 3.5 million tons of higher quality protein in fishmeal, etc ..." This situation applies to all trade, and is not a recent invention: "... in the famous famine of 1770 about one third of the population of Bengal is reputed to have perished, a circumstance that did not prevent the corrupt agents of the East India Company from increasing its revenue from Bengal province by more than fifty per cent during that year." And while we have been somewhat less than altruistic abroad, this has been largely prompted by events at home:

"Measured against food needs and production, Europe is already overpopulated." The continent is also a consumer of non-renewable resources that are largely imported from other areas, and it also has serious population-related pollution problems.

The ensuing discussion of pollution, though it is couched in the framework of wider problems above—something few, if any previous authors have been able to do—will be of less value, because it concerns itself largely with the US situation.

But the references are impressively complete, and they deal with all the pollutants we know and love.

In a sense the Ehrlichs, correctly stand the Ecology movement on its head. Pollution is determined by local industrial economics, which are determined by global economics, which are, in their turn, controlled by the relationship between essential materials (food and other resources) and the population. They show that the Conservation Society's slogan ("whatever your cause, it's a lost cause without population control") is literally true.

They refuse to take refuge in technological optimism, or as they would probably call it, science fiction. This comes out—shockingly—in their views on aid. UDCs, they say, can be divided into three groups, like those of the medical system for treating war wounds, triage. There are those which will eventually become self-supporting with or without foreign aid, those who can do so only with aid, and those which will not, regardless. The authors feel that we should devote all our help to the second category, and leave the third to starve, as according to them, they will anyhow.

This frightening, cold logic also comes out in relation to population control. In addition to free contraceptives, tax and other incentives to have small families, and voluntary sterilization, the Ehrlichs are already beginning to wonder whether it may not be necessary very soon to limit family size by law, not only in the UDCs, but in the DCs as well. But their tough-mindedness is tempered with idealism, and, to a limited extent, hope:

"Perhaps the major necessary ingredient that has been missing from a solution to the problems ... is a goal, a vision of the kind of Spaceship Earth that ought to be, and the kind of crew that should man her. Society has always had its visionaries who talked of love, beauty, peace, and plenty, but somehow, the 'practical' men have always been there to praise the smog as a sign of progress, to preach 'just' wars, and to restrict love, while giving hate free reign. It must be one of the greatest ironies of the History of Homo Sapiens that the only salvation for the practical man now lies in what they think of as the dreams of idealists. The question now is: can the realists be persuaded to face reality in time?"

Francis Arnold

The World of the Gulls

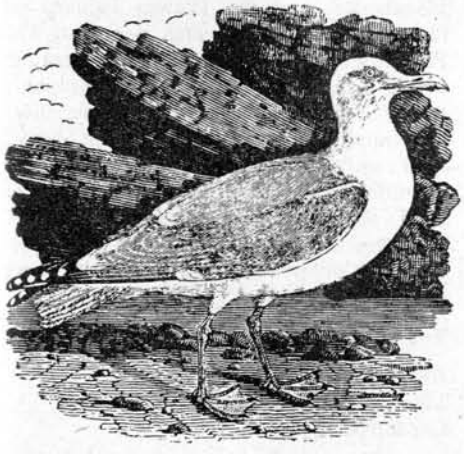
SIGNALS FOR SURVIVAL by Niko Tinbergen and Hugh Falkus, with drawings by Eric Ennion. Clarendon Press: Oxford University Press. 80 pp. £2.

"What is the use of a book", thought Alice, "without pictures or conversations?" Even a critic as exacting as Alice must enjoy this book. It is full of pictures: the lively, decorative and scrupulously accurate drawings by Eric Ennion, the superb photographs by Niko Tinbergen. It is full, in a way, of conversations: the conversations of the lesser black-backed gull.

The scene is set on the shore of the Walney Island Nature Reserve in Lancashire. The cast is a breeding colony of gulls. The book tells the story of their doings from early spring, when they arrive in their thousands, to autumn, when they fly southwards with the young they have produced and reared during the season. We see them setting up their territories, courting, preparing their nests, incubating their eggs, and feeding their chicks.

Packed together on the shore, "their nests often no more than a few yards apart", the gull colony is like a bird city. But this is not a society like those of higher mammals or man. There is none of the friendly good-neighbourliness, the greeting and grooming and mutual attraction we can see in a band of monkeys. Only under very severe or prolonged population pressure do human beings or monkeys lose this friendly interest in each other and above all in each other's young. But "a gullery is no city of friends. It is, indeed, a city of thieves and murderers". Eggs or chicks left for a moment unguarded are promptly eaten by neighbours. Congregation has its advantages; the gulls heed each other's alarm calls and fly up in a cloud to mob a predator. But they are not cooperating in defence, like a chimpanzee band fighting a leopard or a human community fighting a tiger. Even in such emergencies the gulls may themselves kill any of each other's chicks that fail to hide in time.

We are here witnessing social behaviour of a rudimentary kind. Relations between neighbours are purely hostile. But even "these cannibals" have friendly relations with their own particular chicks, and out of this primal sociability of parents and young there has grown a friendly relation between the male and female who cooperate in rearing. Courtship begins with a ceremony in which the male feeds the female, just as if they were parent and chick, and each pair forms a small but real "society."



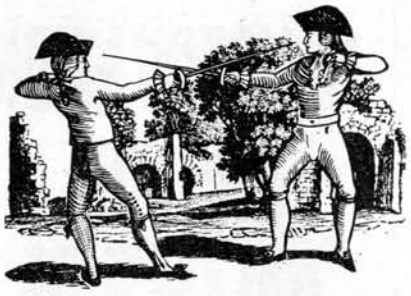
Even this simple social life needs an astonishingly elaborate and intricate code of sign language, from the mutual threats that keep neighbours out of each other's territories to the friendly intimation by a returning mate that he or she is ready to take a turn at incubating the eggs. These are the signals for survival, "a system of signalling, comprising posture, movement, sound and colour. When we begin to understand this language the gulls' behaviour assumes a tremendous new interest, and we enter a fascinating world—the world of animal communication."

The dream of understanding animal "language" is an old one. The Abbe Guillaume-Hyacinthe Bougeant published a glossary for several bird and mammal species in 1739. Dupont de Nemours compiled Crow-French and Nightingale-French dictionaries in 1807. More recently, a former assistant zoo director called Schwidetzky has discussed the linguistic affinities of German and Chimpanzee. These were more or less absurd speculations. But when Niko Tinbergen decodes the sign language of the gulls, it is the real thing, the product of literally thousands of scientific observations. How easily, how casually almost, he interprets every gesture for us! One would never guess that this account is the fruit of several decades of patient research and inspired analysis. It is all made so simple.

There are some intriguing sidelights in the story. Gulls, like rats, are hangers-on of human civilisation, snappers-up of unconsidered trifles around the fishing boat or the refuse dump. Some of the gulls at Walney have become involved in an odd way with human waste disposal problems. They swallow butter papers and milk-bottle tops, digest the traces of butter and cream on their way back to the nest, and regurgitate for their chicks the useless paper and metal, reminding one of the thoughtless father in Ibsen's play *The Wild Duck*, who promised to bring his little daughter scraps from the banquet, and only brought home the menu. The gulls, of course, know no better; their foraging is quite automatic.

The book is adapted from the prizewinning film of the same name, made by Tinbergen and Hugh Falkus. Words, drawings and photographs have been put together with an art that conceals art. It is all so clear, so enjoyable, so unputdownable, one would never notice the technique; between the covers of a book, we are almost watching a film unfold. It is a beautiful, richly informative book. It will help people of all ages to "enter a fascinating world—the world of animal communication". Intelligent interest in wild life, aroused in this way, may well make a vital contribution to the survival of gulls—and of human beings.

W. M. S. Russell



Letters

Airborne Sludge

Sir,

Thank you for the reprint from *The Ecologist* "Fertility or Pollution". You may be interested to learn that this authority has always disposed of sewage sludge from its treatment works in the form of dried cakes, directly on to farmland. This of course is not uncommon for authorities like this one with several relatively small works. Two new works are being commissioned where it is proposed to dispose of liquid sludge from aerobic treatment process directly on to farmland. Some interest has already been shown by local farmers and no difficulty is envisaged in disposing of the sludge.

Like all desirable objectives there are snags, however, and one of these is the possibility of the transmission of disease particularly by airborne droplets of relatively "immature" sewage sludge.

Such research as has been carried out into this aspect of sewage sludge disposal seems to have shown virtually no correlation with the incidence of disease but further research and the publication of results would, I believe, assist the cause you are promoting and could well be the subject of a further article.

Yours sincerely,

Frank Archer, Surveyor,
The Rural District Council of Gainsborough,
26 Spital Terrace, Gainsborough, Lincs.

Student Action

Sir,

As you are now reserving a page in your journal for student activity, the following may be of interest: 3rd Year Industrial Engineering Students at the Hatfield Polytechnic chose for the General Studies Section of their course, the subject "The Adverse Effect of Pollution upon Ecological Systems".

They chose the subject and lecturers, comprising four in all. A local Chemical Plant Engineer who is also an Environmental Studies enthusiast and reader of *The Ecologist* gave the introductory talk, other speakers invited are a River Board expert, a Biologist from within the College itself, and it is hoped an interested MP such as Mrs Lena Jeger may find time to give the concluding lecture on possible courses of action.

Yours sincerely,

R. J. Hartless,
5 High View, Hitchin, SG5 2HL.

Killing or Conservation?

Sir,

Mr Aspinall (*The Ecologist* I, 5) has had 8 infant gorillas supplied to him. This probably means the death of about 24 adults at least.

I have 3 chimpanzees, and realise how I may well have caused the killing of, say 9 adults.

Is this right, and does it fit in with your very good magazine? We have just returned from the Gombe Stream Reserve and it makes one think where the money should go if it is for genuine conservation.

Yours sincerely,

J. S. Johnstone, M.A. M.B. BCh.
Mole Hall, Widdington, Saffron Walden,
Essex.

Genuine conservation depends on the establishment of inviolate wilderness areas. Zoos can only be a poor second best—and then only when a population is threatened and this is the only way of saving it. Sometimes it's a difficult decision. Ed.

Writing to MPs

Sir,

In response to your plea to readers to write to their MPs and the Minister of Agriculture in the article "Mrs Butler's Bill" (*The Ecologist* I, 3), I wrote to Sir Gerald Nabarro, my MP, and the Minister. In response I received a cursory note from the Private Secretary of the Minister, and from Sir Gerald a letter written to him by Anthony Stodart, explaining the workings of the laws concerning the use and distribution of pesticides and a copy of *The Pesticides Safety Precautions Scheme.* This was, presumably, to let me know that everything is being done to ensure that dangerous chemicals are not let loose on the public, but I do not think that it *does* ensure this. The reason given for the omission of labelling on pesticides is that the classification of pesticide products is at present being discussed in the Council of Europe. Meanwhile the British Public is completely unaware of the disastrous effects of many of the pesticides that are, nowadays, for sale.

As a layman I would like very much to do something more concerning the matter of pesticides. These replies I have received discuss the problem and leave no room or further possibility for discussion or change, which makes it very difficult for me to continue to correspond with any person with authority and the means to have any effect on the contents of Bills passing through Parliament.

I expect many of your readers have had the same experience at the hands of their local MP, it is a great pity that such apathy is so deeply rooted amongst those who wield the power.

Yours sincerely,

Nicola Charles,
Churchill Mill, Broughton Hackett,
Crowle, Worcester WR7 4BG.

MPs are there to help the electorate. It is important that we encourage them to do so. Why not write to Sir Gerald that you find his apparent complacency disturbing, and suggest a meeting to discuss the problem. Ed.

PCB

Sir,

I was disappointed that in view of the potential danger of PCB's the authors of your article (*The Ecologist* I, 7) did not take more trouble to identify the sources of the pollution and point out that no steps are being taken to mitigate it. *The Times* (29.6.70) notes that PCB'S "are used in numerous industrial applications and would probably be far more costly to restrict than most pesticides. They find their way to the environment through the smoke and effluent from factories and the exhaust from aircraft engines". A most alarming report appeared in *Nature* (19.12.70) from scientists at the Freshwater Fisheries Laboratory at Pitlochry. From an examination of sewage sludge it was estimated that PCB's are being dumped in the Clyde, the Irish Sea (from Manchester) and the Thames Estuary—at least one ton in each area per year. The Pitlochry scientists were unable to ascertain which firms were responsible—presumably through lack of time and money—but surely this should be investigated without delay? PCB's are now present in the environment in quantities of the same order of magnitude as DDT; they are slightly less toxic than DDT but there are signs that they are more persistent. Conservationists should be very worried indeed.

Yours sincerely,

David S. Mill,
2 Rowan Court, 66 Burnt Ash Hill.
London SE12.

SYSTEMATICS

Journal of the Institute for the Comparative Study of History, Philosophy and the Sciences

Editors J. G. BENNETT and KARL S. SCHAFFER

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What has plastics to do with Ecology?

Our civilisation is a wasteful one. The treatment of harmful waste liquids and gases from factories is a matter of grave concern to everyone who cares about our environment.

Pollution can be beaten. Specialised plastics now play an important part in making industrial effluent and fumes safe. They are used in the construction of systems that combat the risks from noxious chemicals used in industry. Plastic Constructions is a public company brought to the market last year by Hambros Bank. Today it serves many branches of industry from water engineering to steel production, from paper making to road building. Plastics technology is playing a big part in helping to keep industry clean.

Plastic CONSTRUCTIONS GROUP

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