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**This issue: Modern Man
and his
Environment**

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This issue is devoted to the vitally important subject of modern man and his environment. It contains 32 extra pages.

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● OUR COVER: Inner suburbs of the city of Sydney—a scene typical of many metropolitan environments the world over. [Photo: C. V. Turner.]



The ocean is a repository for great quantities of the civilized world's toxic wastes. Man tends to think that all these wastes will be diluted by the vastness of the seas, but, because of the nature of food-chains, some potentially dangerous wastes actually become concentrated. [Photo: C. V. Turner.]

MODERN MAN AND HIS ENVIRONMENTAL CRISIS

By L. CHARLES BIRCH

Challis Professor of Biology, University of Sydney

THE world is facing an environmental crisis, swept as it is by a rising tide of environmental deterioration, depletion of resources, and pollution.

The force behind this tide is a twofold one: increasing numbers of people and economic growth. If men were mice we would say that there was a plague of men on this planet. Perhaps not many parts of the earth actually look very crowded with people. What we fail to take into account is the tremendous demand each single person makes on the environment. No other creature on earth has such enormous demands, and these grow as man becomes more "developed". Industrial man requires hundreds of times the

amount of resources that non-industrial man could get along with. This applies to minerals, fuels, housing materials, and food. In filling his complex needs he produces vast quantities of wastes that foul the air, the rivers, the sea, and the soil. Not long ago we thought there were plenty of resources to go around and plenty of air and water to soak up the wastes. We are discovering that the reverse is true. The new discovery of our time is that the earth is not like that at all. It is a spaceship with limited resources and with limited capacity to absorb the toxic wastes of civilization. Up to now we seem to have got along more or less without too much backlash from nature by adopting a cowboy economy of exploitation of nature. From

now on our survival is threatened unless we adopt a spaceship economy—one in which economics becomes a subsystem of ecology.

A central tenet of ecology is its declaration on interdependence—the interdependence of the materials in the earth and sea with gases in the atmosphere, with the plants in the ocean and on land, and with the animals, which in their turn depend upon plants.

All living things and all the business and technology that go on across the face of the earth are utterly dependent upon the cyclical processes of the twenty-odd elements that make up living things. The four elements that make up most of living matter are carbon, oxygen, hydrogen, and nitrogen. All the carbon and all the oxygen and all the nitrogen come from the air.

Nitrogen cycle

In the cycle of nitrogen, the first step in the chain of events from atmospheric nitrogen to living things takes place in micro-organisms that live in the soil, the sea, and other water masses. These micro-organisms make the nitrogen available to plants, which convert it into plant proteins. The plants hand it on to animals when animals feed on them. The animals convert it into animal proteins or "meat". In due course the plants and animals die. Their proteins are decomposed by another group of micro-organisms to salts of nitrogen in the soil and the waters. If the process stopped there, then all life would cease. The system would eventually turn all the nitrogen in the atmosphere to plants and animals and then to salts in the soil and sea. The cycle back to the atmosphere is completed by yet another group of micro-organisms called the denitrifiers, whose job it is to convert nitrogen salts into atmospheric nitrogen. And so the cycle goes on endlessly. At least we hope so.

Pollution threat

There is one creature on earth who could cut the cycle. If he did so, then all life would cease. That creature is man. It could happen if he produced some pollutant that destroyed, let us say, denitrifying micro-organisms. If such a pollutant became world-wide the nitrogen "life-system" would be severed. That is the sort of threat that

pollution poses to the life-systems of the earth. That is the reason why it is so essential that the industrialists and technologists of the age know something about life and its essential links with environment.

The carbon life-system

The life-system that involves the cycling of carbon from air to plants to animals and back to air is probably the most sensitive of all the cycles on which life is dependent. It happens to be the cycle we have tampered with most. Further, we know least about the possible effects of such tampering. Green plants convert the carbon dioxide in the atmosphere into food by trapping the sun's energy. Carbon dioxide is returned to the atmosphere when plants and animals die and are decomposed by micro-organisms. However, there are additional sources of carbon dioxide. Volcanoes have been a major source in the past. Today a major source is a human volcano: all the carbon dioxide that is produced when fuel is burned. This takes oxygen out of the atmosphere and returns carbon dioxide in equal amounts. Now, while the atmosphere contains 20 per cent oxygen, it has only 0.02 per cent carbon dioxide. Thus fuel combustion reducing the oxygen concentration by 1 per cent would simultaneously increase the carbon dioxide tenfold. Each year the burning of fuel (mostly petroleum and coal) produces an amount of carbon dioxide equal to about 0.5 per cent of the existing reservoir of carbon dioxide in the atmosphere. Half stays in the atmosphere; the other half gets bound with calcium or magnesium in the sea to become limestone or it gets stored in the bodies of plants and animals. If the present rate of increase of fuel-use continues there will be an increase of about 170 per cent in carbon dioxide in the atmosphere in the next 150 years! Just what effect this would have on the world we do not know. It could have a "glasshouse effect" and cause the earth to heat up. It might even have the reverse effect of starting an ice age. What we should aim to do is to preserve the status quo. To this end man could substitute water power, nuclear power, and solar energy for the burning of fossil fuels. The economic motivation to do this is, however, not strong, while it is cheaper to burn coal and petroleum.



Peaceful rivers can carry much pollutant, including insecticides and artificial fertilizers, into lakes and seas. [Photo: C. V. Turner.]

The oxygen life-system

All the oxygen in the air comes from plants; 70 per cent of it comes from plants that live on the surface of the oceans. Some people have supposed that if all the plants in the ocean were killed by pollutants then we too would die. But that is not what would happen. The 70 per cent of oxygen in the atmosphere which is produced by marine plants is nearly all used by marine animals when they eat the plants. If the plant life of the ocean died, all the animals in the ocean would starve. Since the animals would no longer be using oxygen, the effect of the death of the plants upon the world's oxygen supply would be quite small. What man is doing to the oxygen on the earth is causing major local alterations. For example, in the U.S.A. the "oxygen demand" in lakes and rivers due to municipal wastes and sewage will, in 1980, be equal to the oxygen content of the total flow of all U.S. river systems in the summer months. Micro-organisms that decompose organic wastes, such as sewage, use up huge quantities of oxygen. This was one of the contributory factors to the "death" of Lake Erie, in the U.S.A. and Canada.

The food-chain life-system

Animals are dependent on plants for food or on animals which, in their turn, have eaten

plants—hence the so-called food chains of nature. It is our knowledge of what happens in food chains that makes the ecologist greatly worried about the half million toxic wastes that are cast into the ocean each year by the civilized world, together with the poisons that are cast into the air and soil. We tend to think that the vastness of the seas would result in a diluting of all these wastes. Because of the nature of food chains, the reverse is true for some of these materials. We know much about the persistent insecticides such as DDT and especially what happens in the food chains in lakes and rivers.

In Lake Michigan, in the U.S.A., the insecticide DDT is washed from the sprayed forests and fields into the rivers and eventually gets into the lake and its bottom sediments. Here it seems dilute enough. In fact the concentration of DDT on the bottom sediments in one place measured was only 0.0085 parts per million. However, water from the lake is absorbed by plant life, and these plants concentrate the DDT from the water to 0.04 p.p.m. Plant life is eaten by small shrimp-like animals, and they contain 0.4 p.p.m. DDT. Next in the chain are fish which contain 8 p.p.m. and, last of all, there are birds that eat the fish. The herring gull concentrates the DDT from the fish it eats

so that in its fatty tissues the concentration is as high as 3,177 p.p.m. That is why living organisms have been called the biological amplifiers of poisons in the environment. Men feed on fish from the lake. At one stage this had to be forbidden because of the unknown threat to man of such a high content of DDT in his diet when he ate these fish. We know that man tends to concentrate the DDT from his food in the fatty tissues in his body, and as yet we do not know what long-term effect, if any, this may have on his well-being. Until we know for sure, the counsel is to be cautious.

The concept of earth as a spaceship means that we have to think of ourselves as being linked up with life-systems that extend right around the earth and through the oceans and the air. Up to now the life-systems of planet earth have not been threatened by any of its inhabitants. Man is doing what no other organism has ever done. He is placing a burden on the life-systems that could prove to be disastrous. There is a reason why man alone has come to earn that dubious distinction. We find what that reason is by considering another aspect of man's ecology.

Population and resources

Ecology teaches us that all living organisms have an enormous potential for increase. We have probably all heard about the pair of houseflies which, if allowed to increase unimpeded, would cover the face of the earth to a depth of 48 feet within 6 months. But it does not happen. Nor is the sea full of oysters, though they have a potential for increase millions of times greater than houseflies. Why don't they increase like this? Because organisms in nature are subject to severe checks to increase. Most organisms die without ever getting the opportunity to reproduce. That is why the eighteenth-century cleric Malthus, and later Darwin, used the phrase "struggle for existence" to describe the life of nature. Ecologists are interested in the nature of the checks and in those events that lead to cessation of the usual checks, with a resultant plague, say, of mice or locusts. Now it is a fact that most of the checks to increase imposed in nature cause an increase in the death-rate. Checks on birthrate are much less marked if they occur at all.

In all these aspects, man's ecology was one with the rest of creation for the first 200,000 years of his existence. He came into this world with an enormous capacity for increase, but for millenia he increased in numbers very slowly. His high birthrate was just one step ahead of a very high death-rate. The first release of checks came 8,000 years ago when agriculture was invented. Man's numbers increased, but the time it took to double his numbers was about 1,000 years. The next check came with the industrial revolution, when the doubling time was reduced to 200 years. With the mastery of disease in the nineteenth century, the doubling time was reduced to around our present 35 years. Man would never have survived as a species without his high potential birthrate. What was a necessity for his early survival has now become a threat to his continued survival. He has a birthrate far in excess of his now low death-rate. So he is like the mouse population that is fast building up to plague proportions. He is doing what is rarely allowed in nature, growing with checks at a rate of 2 per cent per annum. This means a doubling of numbers in every 35 years. Allow him two doublings from now, and we get a fourfold increase, four doublings is a thirty-two fold increase, twenty doublings is a millionfold increase! Twenty doublings will occur at the present rate in 700 years. To get an idea of how many people that is consider that the present world population could be squeezed shoulder to shoulder standing on King Island in Bass Strait. In 700 years' time the whole of the globe would be covered with people at that density shoulder to shoulder! We not only know that man, theoretically, can grow like that; we are seeing it happening before our very eyes.

What has ecology to tell us about the consequences of such growth? We can learn from the non-human animals that when natural checks to increase are released for a continuous period of time, then ultimately other sorts of checks come into play. Organisms begin to run out of necessary resources; the plague is followed by a crash. The crash is caused by increase in the death-rate brought about by crowding in the remaining depleted resources.

Control of births

That is the situation man is heading for. But there is a way out for man which is not vouchsafed to the non-human animals. Man can introduce a new sort of check into the picture. Instead of nature's way of increased deaths he can invoke a new and humane way to control his numbers, and that is control of births. That is the choice before us—nature's way, which is increase the death-rate, or the humane way, which is decrease the birthrate. There is absolutely no other choice. If we are serious about saving man and the environment, then we have to embark on a programme of world population control, and by we I mean Australia and the U.S.A. and similar western countries which have a high rate of increase and which, because of their high standard of living, are putting the major pressure on limited world resources. Our example may then spread to the rest of the world whose numbers may be higher but who, because of their underdeveloped state, are not causing the havoc we are causing.

What is the evidence that the world is running out of resources and fouling its own nest in the process? Consider first some of the so-called non-renewable resources, the materials we get out of the earth or the sea to keep our civilization going. The U.S. National Academy of Science has recently completed a 3-year study of non-renewable resources and produced some startling figures. They estimate that the world's supply of coal will be exhausted within the next 300 to 400 years. At present rate of usage the great bulk of the world's supply of recoverable petroleum and natural gas will be exhausted within a mere 50 years. The time it took to form these fossil fuels was about 600 million years. Fossil fuels are so slow in being formed that our fast use of them means that we are living, not on interest, but on capital.

Profligate use of energy

Civilized man is profligate in his use of energy. Our ancestors before the discovery of fire had one energy requirement, and that was their daily food. Their daily needs totalled the amount of energy used by burning a single 100-watt light bulb all day. The average westernized man needs 10,000 watts per day, and his needs are growing. Electric

power production is doubled in the U.S. every 10 years. The U.S. Committee for Environmental Information predicts that the U.S.A. is going to be in serious trouble before 30 years are out unless this increase is slowed down. At the present rate of increase they estimate that within 200 years every square yard of the U.S.A. would be a power station. Space is one problem, the other is the disposal of wastes—and no one knows the answers.

What happens in so-called advanced countries is that they make such enormous demands on non-renewable resources that they quickly become parasites of the rest of the world. The U.S.A. with 2 per cent of the population of the world, uses over half the world's resources and produces 30 per cent of the wastes that are put into the atmosphere. To keep itself going it has to get enormous amounts of resources from outside. Of the 100 minerals most important to its industries the U.S.A. possesses adequate supplies of about a dozen. The needs of the western world are enormous, and resources are running out. The over-consumption or waste of fuels and minerals and construction materials for the profit of the few who currently possess access to them should not be tolerated. These resources are the heritage not of the finders but of mankind.

World faces resources crisis

The world is running out of non-renewable resources. It is also facing a crisis in renewable resources, notably food. In the well-fed countries a great deal of nonsense is talked about the abundance of food, especially by economists. This is partly because the well-fed grow food as a cash crop and it is not as good a cash crop as it used to be. In that sense we have too much food. But when we come to look at food as something which people need to eat for life, we find that there is not enough to go around. If all the food in the world were equally distributed and each human received identical quantities, we would all be undernourished. If the entire world's food supply were parcelled out at the U.S. dietary level, it would feed only about one-third of the human race. Yet every year there are 70 million more people to be fed. Some people are lulled into a sense of false security because of the so-called green

revolution in Asia. Certainly, more food has been produced than ever before, but because of mounting populations the difference to the world is negligible. In India, the green revolution has resulted in an increase of a mere 1 per cent per person. The agriculturalists can hardly afford to crow yet. Moreover, intensive farming in India would require the total European production of artificial fertilizers to be sent to India. Fertilizer factories are amongst the major users of power and so add to that problem. In addition, the use of such fertilizers carries with it great dangers to streams and lakes and underground waters because of the run-off. And just as the developed countries have to get much of their non-renewable resources from developing countries, the same applies to food. The almost 3 million tons of grain protein recently contributed to the poor nations by the rich and well-fed have been more than counterbalanced by the flow to the western world of no less than 4 million tons of superior protein in the form of soybeans, oilseed cakes, and fish meal.

Australia and the world

Australia is a continent that has a unique contribution to make to the world. We are the only continent with one government. So we have a greater chance of producing a positive policy for this land mass and the oceans around it than any other continent. Instead of becoming part of the tide of increasing population and multiplied technology, with increasing deterioration of the environment, we could move to prevent the tide from overwhelming us. That may be an example to others as well as a help to ourselves. We could aim to have an optimum population in relation to the resources available to us, and that would mean deliberately fixing a ceiling to our human numbers. We could become a Scandinavia of Southeast Asia. We could show that bigger is not always better. Our objective would be not an exploitation of nature but a living in harmony with nature's life-systems. We would aim to conserve the resources of the earth and air and sea for the purposes of achieving a better quality of life.

The Goddess of the earth, Gaea, had a son named Anteus. He had such strength that none could overcome him in battle.

The secret of his great strength was that when he fell to mother earth in his combats he arose stronger than ever from the contact. Hercules sought to challenge the strength of Anteus in a wrestling bout. He had learned beforehand of the secret of his opponent's strength. Hercules lifted Anteus high up off the earth, holding him there until Anteus' strength entirely left him, whereupon Hercules crushed Anteus there and then high off the earth. The moral is clear. Nature is part of man. We have an umbilical cord attached to mother earth through which we gain life and strength. Cut the cord and something in us dies, first the zest for life as our environment deteriorates, and then life itself.

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BOOK REVIEW

THE NATIVE TRIBES OF CENTRAL AUSTRALIA, by Baldwin Spencer and F. J. Gillen. Dover edition, 1968. Unabridged republication of 1st (1899) edition. Appendices, glossary, index; 135 illustrations, including photographs, maps; additional tables of descent to illustrate kinship systems. xviii plus 699 pages of text. Paperbound, \$5.

This is a most welcome appearance of the famous Australian classic in paperback, because the price of the original edition has rocketed on the second-hand book market so much that it is well out of the reach of the average student. The reprint is clearly printed and well bound and the photographs have come out clearly. I hope that this is the first of a long run of reprints of Australian classics and would recommend it most enthusiastically to all serious workers in the field.—Carmel White, University of Sydney.



Rubbish dumped beside a road in the Sydney area. [Photo: Howard Hughes.]

HUMAN ECOLOGY—WHAT DOES IT MEAN?

By R. O. SLATYER

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ECOLOGY is the study of organisms in relation to their environment; it deals with the environmental requirements of single species and with whole populations or communities, with the way in which organisms influence, and are influenced by, their environment, and with the way in which organisms interact with one another.

Man is an organism, so human ecology is concerned with man in relation to other organisms and to his environment. Because of the complexity of the human environment, which is so strongly influenced by man's own actions, human ecology has many facets, and individual anthropologists, sociologists, and psychologists, as well as economists and biologists, have distinctive views as to what human ecology means.

In this article I wish to discuss first some general ecological principles and phenomena, then to look at man in relation to the ecosystems he occupies and which sustain him, and finally to point out the changes which are needed in his attitude to the environment in the interests of his long-term well-being as a species. To me this is the overview of what human ecology really means.

Ecology and environment

A primary feature of life on earth is that organisms do not exist in isolation; instead, the entire biosphere is composed of a range of ecosystems, each of which contains a number of species and a number of micro-environments, with each species tending to

utilize and occupy an environmental niche more effectively than its competitors, and the whole assemblage of species tending to cohabit in a manner that provides a high degree of internal self-regulation. A forest, or a lake, provides examples of typical ecosystems, but the scale can vary widely. The entire biosphere constitutes the earth's ecosystem.

A primary feature of an ecosystem is that it tends towards self-regulation. Solar energy is absorbed by the green plants to provide, through photosynthesis, the basic energy input. Plants also absorb water and mineral nutrients from the soil. The plant components thus produced are then passed through a food chain, in which the initial products are eaten by herbivores, herbivores by carnivores, carnivores by other carnivores, and so on until decomposer organisms return the organic wastes and the remnants of the organisms in the food chain to the soil, in a form that enables their re-absorption by the green plants.

In most natural ecosystems, therefore, there tends to be no net production—in the human sense of a net harvest of materials. The solar energy absorbed and stored by the green plants is gradually consumed by metabolism through the food chain and dissipated as heat. Thus there is a flow of energy through an ecosystem, starting from solar energy, passing through successive forms of chemical energy—at each stage some energy being lost as heat—until it is all dissipated. Associated with this flow of energy is a cycling of nutrients through food chains so that the ecosystem as a whole tends to be balanced and self-contained.

The stability of an ecosystem, its ability to adapt to invasion or catastrophe without major change, is largely a matter of its diversity. In turn, this is largely a matter of the rate of nutrient cycling, or the rate of energy flow. An ecosystem with little diversity is vulnerable to invasion and, especially if energy flow is slow, is often unable to adapt to the change, at least without a period of marked instability. The successful invasion of Australia by rabbits is a good example of limited species diversity in Australian ecosystems. The ability of rabbits to compete favourably with other herbivores for forage, and the absence of effective predators, meant that rabbit

numbers increased dramatically until in many areas competition for food, between rabbits themselves, was the main factor limiting their numbers. The successful invasion of Queensland pastures by prickly pear is another example of ineffective competition and the absence of suitable animals in the food chain to consume it. Fortunately, the absence of predators of the insect *Cactoblastis*, introduced to control prickly pear, meant that this insect could control it effectively and the existing ecosystems, perhaps enlarged by these two species alone forming another loop in the food chain, returned to a degree of stability.

The most impressive examples of potentially unstable communities ripe for invasion by other species, are agricultural crops, where a single species may be grown over thousands of square miles. The opportunities for invasion by "weed", "pest", and "disease" species—all words of modern man's vocabulary—are tremendous.

Management of an ecosystem ("management" is another such word), in the sense of increasing the numbers of one or a group of species within it, and perhaps in removing them from the ecosystem so that there is a net yield, need not disturb internal self-regulation. The primary need is to ensure that nutrients continue to be recycled, that other important organisms are not adversely affected, and that there is sufficient diversity in species composition to prevent the community from becoming unstable.

Man and environment

Let us now look at man's impact on the environment to see how he has adjusted ecologically to the biosphere in which he evolved. To my mind, it is easiest to do this by looking at man in three stages of his cultural evolution—man the hunter-gatherer, man the herder-cultivator, and man the technologist.

When man first appeared, of the order of a million or so years ago—a very brief period in geological time—the earth contained many of the species of plants and animals which exist today, most of the climates which exist today, and many of today's topographic features. Although the distribution of climates and the location of shorelines have changed, the range of ecological situations available for life has not changed

to a pronounced degree. In many regions the first men enjoyed the same type of weather, breathed the same kind of air, and ate the same kinds of animals as did Neanderthal man only a few tens of thousands of years ago, or today's huntsmen-campers in areas remote from industrial centres.

The place of early man in the ecosystems he occupied was a relatively passive one until his first deliberate activities in cultivation and animal herding. The first men preyed on, and were preyed on by, other animals. They gathered plant foods when and where they were available. They were, in all respects, part of the natural food chain of the ecosystems they lived in; the changes they were able to make to their immediate ecosystems were probably of minor significance.

Gradually man's hunting and gathering skills increased with the use of crude tools, and with the development of different strategies and procedures. Fire was undoubtedly an important factor in this regard and was his only real instrument of environmental manipulation. The deliberate use of fire enabled man to increase primary productivity by keeping vegetation communities in a relatively productive sub-climax condition. It also encouraged the concentration of food animals on fresh vegetative regrowth, discouraged their

concentration on burnt areas, and destroyed the cover offered to predatory animals.

The activities of the Australian Aborigine, prior to European colonization of Australia, in many respects epitomized the life of man the hunter-gatherer. If Aborigines could not be seen, evidence of their previous presence at any location was meagre and short-lived. In most respects they were as well adjusted to the natural environment as were the animals and plants they consumed.

Man the hunter-gatherer really lived his natural ecological role. Admirable though this was in the sense of permitting nature's overall fulfilment, it clearly left man vulnerable as a species. So it was that man the farmer gradually emerged.

Those of us who admire the noble savage must conclude that life since the emergence of agriculture has been one long downhill slide—from fun to work. Whether or not one agrees with this view, the fact is that as man's hunting-gathering activities gradually became those of herding and cultivating, and he became a farmer, he began a commitment from which there was no escape.

As we have seen, the numbers of any species in an ecosystem will tend to rise if it is protected from its competitors. Man the herder-cultivator sought to ensure his own survival by protecting his food supplies—the plants and animals he wished to

Prickly pear, which successfully invaded Queensland pastures until controlled by the insect *Cactoblastis*. [Photo: Howard Hughes.]



consume—from competition and predation, and by deliberately cultivating them. In ecological terms, he sought to maximize the energy flow passing through himself by maximizing the energy flow passing through the species directly ahead of him in the food chain.

Because he was also able to protect himself against predation, his numbers increased, and immediately his dependence on the managed ecosystems increased further. There was no going back. Not only did he become dependent on agriculture, but his increasing numbers started a demand-supply spiral which meant that continually he had to attempt to increase both the area under cultivation and the yield of any one area.

Furthermore, the more specialized his agriculture became—that is, the more he attempted to reduce the number of species in his managed ecosystems—the more unstable they tended to become. The tendency for undesirable species to invade his farms increased, the removal of existing vegetation exposed his lands to erosion, and this factor, combined with the removal of nutrients from his ecosystems without replacement, began to reduce their productive potential.

Although some specific ecosystems were badly damaged (for example, those on the fringes of the Sahara where herding of goats caused almost completely new, and much less productive, ecosystems to be established), man's activities, in most cases, were still of little consequence to the biosphere as a whole. Not only was his capacity for major change limited by his muscle power and that of his domesticated animals, but his numbers were still so small that there was always more land over the next hill or in the next valley.

Man the herder-cultivator was therefore able, if not to live an ecological role as fully as man the hunter, at least to avoid large-scale environmental change, although his low numbers were the main factor responsible. Even so, he barely managed to match food production against increasing numbers, as periodic famine in peasant agricultural systems, even today, testifies; thus, in ecological terms, he was stretching the capacity of his ecosystems.

The story of man the technologist is, in most respects, simply an extension of man the farmer. However, with the industrial revolution, man's ability to harness power

to his needs meant that the impact of his activities on the environment increased tremendously.

To my mind, this impact has two main, closely linked, aspects. The first has been the dramatic, and continuing, increase in man's numbers as his capacity to manipulate agricultural ecosystems for food production, and his control over human disease, have increased. The second has been the development of a great diversity of human activities, human demands, and human products. Thus not only has population itself increased rapidly, but the demands of each human being for factors other than basic food needs have also increased. Man the technologist expects, not merely to survive, but to enjoy a socio-economic infrastructure which provides transportation, education, housing, recreational space, and many other cultural facets.

To satisfy these desires and needs, man has affected the environment both directly and indirectly. In a direct sense, his mechanical activity—in constructing cities, highways, and dams, and in soil cultivation and mining—is the most striking and obvious. Indirectly, though, the other products of modern technology are also of great importance as agents of change.

In these activities, man the technologist has attempted to ignore the capacities and characteristics of his ecosystems. The agricultural ecosystems in which he produces his food have been still further removed from stability. He has loaded them with the products of chemical technology, thinking only of maximizing food yield from a few species. In the process, the nutrient and non-nutrient chemicals (fertilizers, pesticides, weedicides) which he has added have had repercussions far beyond the ecosystems to which they were applied.

In the ecosystems in which man has built his cities he has also added vast quantities of nutrient and non-nutrient compounds—both domestic and industrial wastes. These, too, have affected regions far greater than the areas where they were dumped.

The impact of these changes on the environment as a whole is now beginning to be appreciated. Ever since his appearance on earth, man has attempted to exploit his local environment for his own ends. In a sense, all organisms have done this, whether

deliberately or not. As long as man used natural methods and the power of his own metabolism for this exploitation, and as long as his numbers were low, there was little likelihood of the changes he induced affecting more than his immediate environment—and his early attempts at exploitation were still essentially conservative, in the sense that they preserved the basic diversity and character of the environment. Now, however, the situation has gone full circle: man is so abundant and so powerful that he is changing the properties of the entire biosphere. The rate of change is far greater than occurred even during the great transitions from one geological epoch to another. Clearly this trend must be reversed.

Ecology and man

What are the solutions to this collision course between man's numbers and demands on the one hand, and his environment on the other?

It is clear that the goal of "the greatest good for the greatest number" is impossible to achieve. Despite the bliss that this phrase may conjure up in some people's minds, man cannot maximize for both of these factors at once. Ecologically, it is probable he cannot maximize for either, unless "the greatest good" is identified with conservation of man as a species. But our present numbers, our present technology, and our present attitudes are not consistent with this goal.

What is really required is nothing less than a change in our basic philosophy of life—from an attitude to our environment which regards it as a resource to be exploited for short-term personal, regional, or national gain, to an attitude of living ecologically in a way that is essentially conservative of the environment.

Man the technologist must therefore become man the ecologist; not the same ecologist as man the hunter-gatherer, but rather one who can use the tremendous intelligence, experience, and power at his command to live in harmony with, rather than oppose, the natural workings of the biosphere. To my mind, human ecology, which spans the whole range of human activities, should have at its core the study

of man in relation to the biosphere, with a view to developing ecological guidelines for his future well-being.

[The bulk of this article is drawn largely from the author's "Man's Place in Nature" in "Man and the New Biology", A.N.U. Press, Canberra.]

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BOOK REVIEW

WILDFLOWERS OF SOUTH-EAST AUSTRALIA, by Jutta Hösel (ed., John Child), Periwinkle Colour Series, Lansdowne Press, Melbourne, 1969; 111 pages. Price, \$1.50.

This book has obviously been produced to display Jutta Hösel's superb colour photographs. With few exceptions they are outstanding in their clarity, composition, and colour, and the quality of the printing is extremely good. The 100 plates are grouped into herbs, shrubs, and prostrate or climbing plants for ease in recognition, representing over thirty families. All the species depicted occur in Victoria, and about 90 per cent extend into New South Wales, with smaller proportions in the other southeastern States.

While Dr John Child's clear and simple account of flower structure, classification, and specimen collecting is excellent, N.S.W. readers will be disappointed to find that the main text is almost identical with the first chapter of his *Wildflowers of the Sydney Region*, with some rearrangement and minor alterations. The alterations regrettably do not include the correction of "Actinotis" to *Actinotus* and "Dilwynnia" to *Dillwynia*. No keys are given. Interspersed with the text are twenty pleasing black and white reproductions of scenic photographs depicting various habitats of the native bush, e.g., heathlands, mallee, rocky outcrops, coastal areas, and forest and alpine areas.

To sum up, this volume can be recommended to anyone building up a reference collection of native plant illustrations, but its value would have been increased by an original text more closely related to the photographs.—N.C.F.



An example of an economic principle at work. Clear cutting is cheaper than other methods, so the wood can be sold at a lower price. But were the loss of the next generation of trees, soil erosion, and the ruination of the land taken into account? [Photo from Bronson, *How to Kill a Golden State*, Doubleday, New York.]

Man and a Vulnerable Earth: the Need for Ecological Sense

By THEODORE C. FOIN, Jr

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IN the past few months we have seen an unprecedented rise in awareness of the problems associated with the degradation of our environment. In this decade of ecological awareness, we should ask if our concern will penetrate society deeply enough or widely enough to really affect the fundamental nature of the human ecosystem. We have a great opportunity to revolutionize the role of man in the global ecosystem because people are interested and concerned, but the opportunity is transient and there are already signs that the movement may be

superficial. This is because we are concerned primarily with our own species. We think of ourselves as the centre of the universe, about which everything else had better revolve—or else.

Consider our concern with pollution. The basic question is still “What’s in it for me?” Is air pollution going to kill us or destroy one of our priceless resources? If it only exterminates a species we do not at present think important we can disregard it. Is water pollution going to affect our water supplies? Shall we be poisoned by DDT?

Recall that one of the arguments presented for continued use of DDT was that we would have to use other pesticides that were more dangerous—to us. Even some of our better qualities, our cherished virtues, may be virtues only as far as man is concerned. To help a man in need is a social virtue, as long as a short-term gain does not become a long-term loss. An example is the shipping of American wheat to India, which our sense of humanity dictated that we do. In the short term we helped minimize starvation; in the long term we worsened the situation by contributing more reproductive energy to an overgrown population and by economically ruining those farmers still left on the land.

Man's dilemma is that he has the capacity for great work and great destruction, while he lacks the wisdom and perspective to use his powers.

In an attempt to find solutions for our problem of development, we have been building mathematical models of processes of the human ecosystem in California. We have not yet progressed far enough to define exactly how useful modelling will be, so this article develops some insights gained into the nature and function of human society, with some of the results of our modelling used as examples.

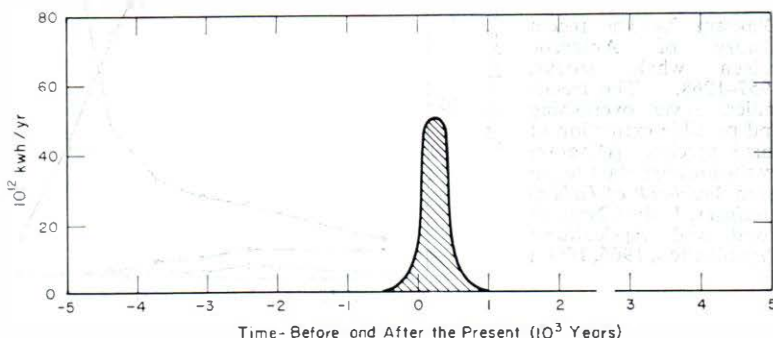
Energy-consumption crisis

Man has always considered nature, with its often hostile environments, as something he must conquer. In faithful pursuit of this goal, we have created a global system which will ultimately lead to our extinction. To ecologists, there is no question that man must live within the biological and physical restraints imposed by the Earth. To fail

to do so will lead to a breakdown of society, mass extinction of other species, and ultimately our own demise. There are several key areas which will illustrate how our achievements can create problems. One of these is our pattern of energy consumption. Whereas other plant and animal populations must depend solely on incoming solar radiation, man has used fossil fuels to build his complex civilization and to increase his numbers. Both functions depend on a continuous supply. We know that the supply is finite and that exhaustion of the fossil fuels may mean a crisis for civilization, but our demands continue to rise all over the world. M. King Hubbert has shown that our whole history of fossil-fuel usage is merely a short pulse in the time-scale of human existence (diagram 1) and that, given the history of petroleum exploration in North America, we can expect our domestic American petroleum reserves to be exhausted within another century. We have calculated that the time to exhaustion would be even shorter (26–33 years from now) if the history of oil utilization resembles that for bison or baleen whales, where resource depletion led to even greater rates of exploitation. Worse, we are in a situation of imbalance that cannot be corrected because we are dealing with a resource that is essentially non-renewable. Instead of conserving our supplies by decreasing demand, we continue to increase our demand, ensuring that the crisis will come that much sooner.

Energy is a fundamental need of life. With continued, sometimes explosive, population growth over much of the world, we have to use more and more technological tricks to meet the demand, and in so doing we maintain an unstable situation even more precariously.

Diagram 1.—The rate of use of petroleum products in the history of man measured in trillions of kilowatt hours per year (10^{12} kwh/yr). The period of time in which petroleum will be available will be only 1,500 years, and the time in which the bulk will be used is much shorter (about 400 years). [Fig. 54 from Hubbert, publication 1,000-D, National Academy of Sciences and National Research Council, by permission.]



What can we do to reverse the trend? The two root processes that we must contend with are population expansion and demand for goods and services. In the first place, it is by no means certain that the people of the world regard either process as undesirable, not even in the United States. Both processes (particularly the latter) are even encouraged. Secondly, each has engendered a set of contradictions in human society that demands nothing less than a halt in population growth and radical revision of the economic system. Together, these two processes and their ramifications portend an increasingly intolerable world unless the problems are recognized and rectified soon.

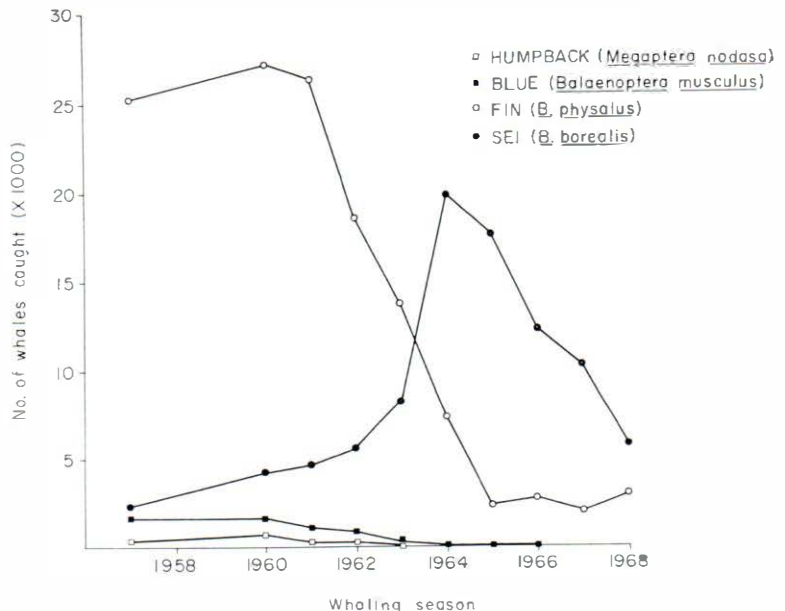
Let us examine three contradictions within our institutions that make it difficult, if not impossible, for a free society (and perhaps man) to survive.

"Mad game"

Any economic system, whether State-controlled or free-enterprise, must provide a motive for the workers to be productive. The problem common to all economic systems is simply that the higher the output, the better; thus, all economic systems have a built-in bias for exploitation and against conservation. A simple example should make the point. Diagram 2 depicts the

recent history of the Antarctic baleen whale fisheries in the era of the factory-ship with its deadly-efficient army of catchers. Year after year the scientists of the International Whaling Commission have set limits on the numbers of whales that can be taken. Arguments can be made that even these limits are too high, but, even more seriously, the quotas have been arbitrarily raised even higher, and there is evidence that undersize whales are being taken and falsified statistics used to hide the fact. The principal reason is economic; having built up their fleets, the whaling nations could not afford the cost of using them at anything less than full efficiency. The reason is simple: if you have equipment costing X dollars that lasts for only a certain number of years, and if you use it at only 50 per cent efficiency, your machinery costs will be twice as high. Given these constraints, it is not surprising that first the humpback, then the blue, then the fin, and finally the sei whales were rapidly driven toward extinction. The declining whale stocks have also taken their toll: there are now only three nations, Japan, Norway, and the U.S.S.R., left playing this mad game, in which the main losers are the whales themselves. The history of use of renewable resources—forests, kangaroos, fur seals, bison—confirms and reconfirms the exploitative nature of the economic system,

Diagram 2.—The recent history of Antarctic baleen whale stocks, 1957–1968. The trends indicate severe overfishing and possible extinction of some species. [Diagram by the author: data taken from *Yearbook of Fishery Statistics*, United Nations Food and Agricultural Organization, 1966, 1968.]



when conservation is called for. The concept of sustained yield has rarely been given more than lip-service.

Individual freedom "secondary to smooth function of society"

In all of free society, and I suspect in all countries, men cherish their individual freedom of action intensely—the freedom to think and act as one pleases. Of course, this is subject to the restraints that the law imposes limiting encroachment on the rights of others. Implicit in the freedom of action men have is that the society of which they are a part functions smoothly, because the services provided by the government and the goods and services circulated within the society must be freely available. If they are not, not only are the rights of citizens dependent on these flows being impinged upon, but the society begins to break down. Thus, I believe that individual freedom is not primary, but secondary, to the smooth function of society. A contradiction lies in the fact that we insist on the right of family planning as one of our basic freedoms, yet this freedom threatens all others. The more people in a society for any given level of goods and services, the more difficult it is to maintain those standards without imposing more and more regulations on the population to ensure that the society remains stable. The term "planning" is becoming more and more prominent and now means more than commissions for zoning and land use. It now refers to the development of whole regions on the grandest scale, with full integration between parts. To the American, governmental planning has always been anathema, a threat to his individual freedom; yet it is inevitable so long as we continue to reproduce freely. There are only two other options: either the government regresses toward anarchy, providing little or no services to the rest of society, or we halt population growth. Ultimately, there is no real choice at all for rational men.

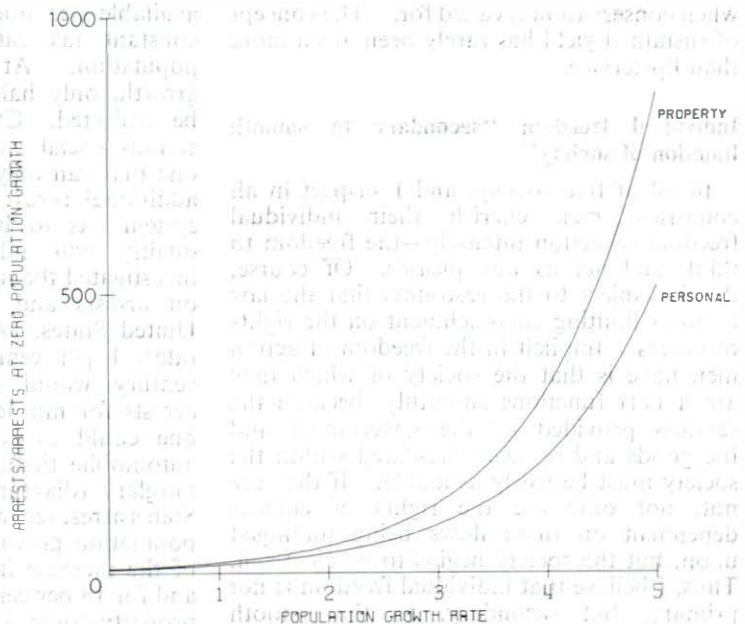
Mathematical models

We have built some mathematical models which will illustrate these points. In a hypothetical community growing at a given rate, we have shown that a population growth rate as low as 1 per cent means that only 70 per cent of the educational tax dollars

available per student can be collected at a constant tax rate compared to a stable population. At 2 per cent population growth, only half as many tax dollars can be collected. Clearly, this is one of the serious social costs of population growth, one that can only be corrected by collecting additional taxes; otherwise the educational system has to be much more efficient or quality will fall. In another case, we investigated the impact of population growth on arrests and reports of crimes in the United States. Assuming fixed age-specific rates, 1 per cent population growth for a century would mean 70 per cent more arrests for murder, rape, and assault, while one could expect 153 per cent more for automobile theft, grand theft, robbery, and burglary (diagram 3). Considering United States arrest records for the period 1960–1967, population growth accounts for 24 per cent of the increase in the three personal crimes and for 18 per cent of the increase in the four property-crime arrest classifications. Thus, increases in arrests were even greater than could be explained by population growth. Increased incidence of crime is another of the social costs of population growth; a growing population will have more crimes even without changes in rates.

In ecology, one of the principal findings about species relationships is that the numbers of kinds of species (the diversity) strongly influences the numbers of each (the stability) and how much energy they fix (their productivity). We know from several studies that the greater the diversity, the greater the stability, but the less the productivity for any single species. As long as we exercise the right to reproduce freely we must sacrifice diversity to gain enough productivity to feed the increased population. We must convert more and more land to farms, replacing natural ecosystems in the process. In so doing, we risk ecological stability, the key element of ecological concomitance. Either we restrict our global population to retain the maximum diversity and thus the best chance of stability, or we convert the whole world into an artificial system controlled by men, or we hope for very rapid evolution. Recent evidence about pesticide usage indicates what can happen. The history of pesticides features a positive feedback system in which each application of pesticide yields more pests, which brings

Diagram 3.—Increase in crime should also be expected as a consequence of population growth. This curve is the expected increase in crime at any specified growth rate compared to a stable population. Note that population growth can quickly lead to multifold increases in crime. [Diagram by the author.]



on more and deadlier pesticides, and the cycle repeats. The pesticides remove all elements of the system including predators and competitors (a loss of diversity), but genetic resistance allows one or more of the pests to take advantage of the simplified system to increase (a gain in these species' productivity). Use of the pesticide alters natural control, and the system may become extremely unstable. A good example of this is the continued epidemics of the spruce budworm in the forests of northeastern United States and eastern Canada. The use of pesticides on the spruce budworm was the direct cause of progressively worse epidemics.

Irreversible breakdown

The spruce budworm example also illustrates how irreversible a breakdown in community stability can be. A general principle of pesticide use is that once the decision is made to use them, all other alternatives are no longer available because the pesticide destroys all the other means of attaining stability. The real tragedy is that we have never really had any other alternative to pesticides because we had to have the highest possible productivity to feed ourselves and to make farming economically viable. This situation continues into the foreseeable future. The history of man is replete with

examples of species extinctions, as we have used other species for food, eliminated them as competitors, and taken their habitats as our own. Thus, we have been simplifying the world, and unless we are extremely skilful, more powerful, wiser, and luckier than we have been in the past, the price that will be exacted will be the loss of stability with all of its implications. Of course, no one knows if and when things will begin to break down, but the way we are playing the game is simple madness. The more there are of us, the more productivity we need—and at the same time the more stability becomes important.

Considering that no one can predict the course of the future, the conclusions seem extraordinarily clear. As long as man regards himself as the centre of the universe, as long as he insists on the freedom to reproduce freely, and as long as we continue to exploit our global resources, we can confidently predict that man will not find a stable ecological niche. He will be like the blowfly larvae that compete so intensely for food that all starve. The major difference is that by the time this happens, so many irreversible changes may have occurred that he could take many or all other species with him. Thus, we cannot depend on a disaster to stimulate action.



The spruce budworm is responsible for the many dead trees and extensive defoliation in the New Brunswick (Canada) spruce forest in the lower photo. The top photo shows undamaged forest. [From Morris, *Memoirs of the Entomological Society of Canada*, no. 31, 1963.]

The safe course

The only safe course we can follow is to find solutions for the three main problems: cessation of population growth; recognition that, while we can destroy the Earth by over-exploitation, we would also be destroying ourselves; and creation of new economic systems that are not basically exploitative. I cannot pretend that I have any of the answers, or that any of these solutions are even possible. All we can reasonably hope for is that our attitudes can be changed enough for the climate to be favourable for the search for and implementation of solutions. Perhaps the most critical of the three is population control, which experts agree is not likely to occur soon. Even in the United States, where one would expect favourable attitudes, a recent Gallup poll indicated that 48 per cent of those who were "deeply" or "moderately" concerned with deterioration of the environment did not see

population control as necessary. We have begun to think ecologically, but only belatedly. Unless a great deal of progress is made throughout the world, rational society may disappear, if not man himself.

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Paul Ehrlich. *The Population Bomb*. Sierra Club-Ballantine Books, New York, 1968.

Donald N. Michael. *The Unprepared Society*. Basic Books, New York, 1968. (The role of planning in the future of human society.)

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In addition, our work with mathematical models of human society is summarized in the unpublished document, *A Model of Society*, available on request from the author

BOOK REVIEW

BENEATH AUSTRALIAN SEAS, by Walter Deas and Clarrie Lawler, A. H. and A. W. Reed, 1970, Sydney. Price, \$3.95.

This is a very fine little book. It is well written, interesting, and informative. For a very welcome change among the current rash of "natural history" books, the text is something more than words to fill space between pretty pictures. There are very nice concise accounts of such diverse topics as the history of scuba, dangerous marine animals, underwater photography, and the sea at night. Emphasis is on some of the less well known marine life and smaller animals rather than big fish, sharks, and lobsters. Moreover, the underwater photographs—particularly the close-ups of marine invertebrates—are some of the best that I have seen and illustrate the very great advances in marine photography which have been made in the last decade. *Beneath Australian Seas* presents a concise picture of how diving can be more than spearing fish and tells how many divers, though not trained as scientists, are making important contributions to the scientific understanding and knowledge of marine life. Anyone who has even a passing interest in the sea will enjoy this book, but it is must reading for the beginning diver and the experienced spearfisherman looking for new challenges from his sport.—*H. F. Recher, Australian Museum.*



Man needs a varied environment, including wilderness. Mt Kosciusko alpine area, Kosciusko National Park, New South Wales. [Photo: Colin Totterdell.]

MODERN MAN AND NATURE CONSERVATION

By J. G. MOSLEY

Assistant Director, Australian Conservation Foundation, Parkville, Victoria

WITHIN the last year or so the conservation movement has come of age. A topic previously discussed by only a few is now on everybody's lips. A sure sign that conservation has become a matter which the public at large is concerned about is that it has become an electoral issue.

It seems that it was the shock of a sudden realization of the threat to health and life by air and water pollution which finally made conservation popular. At the same time it seems to have finally dawned upon a great many people that the traditional conservation arguments about the importance of preserving a diverse environment to ensure "the good life" make good sense.

Needless to say, these developments are excellent for the conservationist. At long last he has an attentive audience and therefore a unique opportunity to demonstrate the nature and benefits of conservation. To the man in the street his task seems easy. All the conservationist has to do, it seems, is to show what is needed and there is a good chance that his advice will be acted on.

In fact, though, the present wave of popular interest in conservation conceals the existence of deep-seated forms of resistance in our culture. The conservationist has problems, too, in presenting his advice, which not only has to be in a practical form applicable to each resource, but must also



A diverse coastal landscape near Batemans Bay, New South Wales. One of the major challenges of conservation in Australia is the maintenance of a balance between settlement, industry, and areas of natural beauty on the coast. [Photo: Colin Totterdell.]

take the form of a unified philosophy capable of being integrated into a government policy along with other aims reflecting basic human aspirations and interests.

There should be no difficulty in persuading man to tackle the more gross forms of pollution which threaten the very existence of living things on earth, even though this will require unprecedented international co-operation. But there will have to be big changes in our culture before the conservation of a high-quality environment is accepted as one of the major aims of society.

The meaning of conservation

Conservation is a very much misunderstood word, and one of the main obstacles which has stood, and to some extent still stands, in the way of its wider public acceptance is one of definition. This is ironic, because although the achievement of conservation

may be difficult the meaning of the word is very simple.

The dictionary definition, which is usually along the following lines—"the act of preserving, guarding, or protecting; the keeping (of a thing) in a safe or entire state; preservation"—gives a fairly adequate notion of what conservation is about. To be specific, conservation refers to measures and policies which have a certain type of effect on a resource. The key word which describes the effect is "preservation" or "saving". That is, the act has the effect of spreading the availability of the resource for use in terms of time. The opposite of conservation is "depletion".

The things to be preserved include not only the natural parts of the environment but those which man has created directly or indirectly. "Resources" is a difficult word, but if it is taken to refer to those parts of the environment which are useful to man,

the act of conservation can be defined as the deliberate attempt to manage and use resources in a way which will prolong their value for mankind.

The confusion which has arisen about the meaning of conservation has mainly resulted from people mistaking the parts for the whole, and in particular from the fact that there has been a tendency for many to think of conservation as being concerned only with the preservation of wildlife and natural areas. This has resulted from the fact that one of the main preoccupations of the conservation movement has been the fight for adequate systems of parks and reserves.

Perhaps the best way for the conservationists to have corrected this misunderstanding would have been to have given a straightforward explanation of the different conservation policies needed for different kinds of resource. What worried the conservationist most was the popular error that conservation was only concerned with maintaining the status quo and that the word implied the exclusion of use. In defence against this error, the word "use" was introduced into the definition. To try to express the general nature of conservation and to stress the conservationist's point that it is wise to conserve resources the word "wise" was also included. So the widely publicized definition of conservation as "the wise use of resources" was arrived at.

This has done more harm than good, since it not only gives no indication of what conservation is about, but also introduces the erroneous notion that what is wise in man's use of resources is also conservation. So, for instance, mining companies are able to claim that by simply extracting nationally important minerals from the ground they are engaged in an act of conservation. The act may well be wise, but if conservation is to have a specific meaning the extraction of minerals cannot be described as being conservational unless the effect of some policy or measure is to reduce the rate of consumption of the stock for the sake of future needs. If wisdom was the key word in the meaning of conservation the term could be used to describe resource situations which are the very opposite of the dictionary definition. A very persuasive thesis has been developed that it was wise for nations to go

through a phase of resource plundering in order to build up their technologies to a level which later made possible not only a high standard of living but the introduction of resource preservation measures.

If the conservation movement is to be properly understood at this critical stage in its development, it seems that it is important for the following points to be recognized:

- In scope conservation embraces all aspects of the maintenance of the habitability of the earth, and includes a concern for the environment as a source of food, fibre, energy, and enjoyment.
- The methods of conservation are different for different resources; some, such as resources for study and enjoyment, involve the exclusion of consumptive uses, but most do not.
- All resources are conserved for use.

Conservation objectives

There are no absolute standards of conservation to recommend, only various views about desirable levels, both with regard to the environment as a whole and to individual parts of it. It is easier to understand the importance of conservation to modern man if the main objectives are discussed separately, although, of course, there is a good deal of overlap between them.

Conservation for survival

The most recent conservation objective to be defined is also the most important. This is that part of conservation which is concerned with preventing irreversible changes in the environment, particularly those involving contamination of the air and water, which threaten the existence of the human race. The main factors causing concern and to be controlled are population, technology, and the use of nuclear weapons. Conservation has acted in this case as a kind of early warning system, alerting mankind to the dangers of the course he is on. It suggests the need for a measure of restraint which, defined in terms of minimum standards, should become a fundamental parameter for our culture.

Conservation for high productivity

The second objective and concern of conservation is the efficient utilization of both the renewable and non-renewable resources for material needs through the preservation of productivity. Unfortunately, as a philosophy it is often subordinate to the idea of bringing the maximum amount of land and resources into production. Whereas human survival was the concern of the first conservation objective, the primary motivation of the second is a higher standard of living and national security in the affluent countries of the West, and survival in those countries suffering already from over-population.

Much has been achieved in this sphere through the introduction of such measures as sustained yield cropping, and soil and water conservation. But the quest seems futile in those countries in which increased productivity cannot keep pace with the growing population. There is concern, too, in the western countries about the consequences for human well-being of the massive urbanization and high-density living and the

destruction of the rural and wildland amenity which are accompanying the drive for continuous economic growth. World over-population threatens to set at nought man's achievements in all conservation fields and it seems that the nations must eventually co-operate to prevent population from outstripping resources.

In the renewable resources field conservation is already playing an important part in keeping resources at an optimal level. In the mineral field, characterized by non-renewable resources, man still pins his faith on his ingenuity to find substitutes for resources which have been exhausted, and the only significant conservation measures have been those involving the re-use of metals, and the stock-piling of strategic materials.

Conservation for high-quality environment

The third kind of conservation objective—the quest for a high-quality environment—is also the most controversial. That is because this aim frequently conflicts with the search for optimal productivity which itself is



Clearing of native hardwood forests for pine plantations near Brindabella, New South Wales. One of the costs of the drive for higher forest productivity is the loss of natural diversity. [Photo: Colin Totterdell.]

essential for material well-being. The problem is to know what balance in the use of resources for these twin purposes is needed for optimum human happiness. The other main reason for controversy relates to differences of opinion over the importance of the character of the physical environment for man's psychological well-being. The main goal of those who seek a high-quality environment is environmental diversity, which is sought not only through reservations and species protection, but also through measures aimed at maintaining a balance between urban, rural, and wild areas.

Most conservationists believe that man needs a varied environment in which he can exercise his many tastes and talents. Some also believe that the change to a complex mechanized and urbanized world has been so rapid that man needs contact with nature in order to retain his very sanity. Such views are not accepted by all. Others feel that man's functional working and residential environment contain all the stimulus (including beauty) he needs.

The environmental conservationist has just as long a tradition as the resource utilization conservationist, but the programme which he advocates has always been given least priority by society. It is not surprising, then, that many people are defeatist about the prospect for this type of conservation in the face of present economic growth and population trends.

The prospects for conservation in Australia

If these are the main kinds of conservation what are the prospects of achieving high levels of conservation in Australia? With its relatively large areas of virgin land, its unused resources, and its small but affluent population, Australia is in a better position than most countries to achieve a high level of conservation, and could become a world model for conservation-oriented resource planning.

At present Australia also has exactly the same kind of growth and development philosophies that have carried other countries to their present crowded positions. Apart from the feeling that planning threatens the vital principle of free private enterprise, many Australians believe that we have no right to hold this country unless we develop

its resources to the fullest possible extent and populate it at a level approaching that of Europe and North America.

The official Government policy is that for reasons of material advancement and national security first priority in resource policy should be given to economic and population growth. This gives a wide scope for the activities of commercial organizations, many of them foreign-owned, which, naturally, have no reasons for considering the social costs of their actions in terms of lost amenity and irreplaceable natural areas.

Apathy

The attitude of the vast majority of people is one of apathy. Professor Manning-Clark has recently commented on the fact that Australians have a "sense of impotence as (the) price for the over drawn out years of independence".

Australians also share a more universal feeling of impotence—the feeling of helplessness before the giant forces of technology, big business, and burgeoning population. As Dr Boyden has recently said, the distressing thing is not so much these forces themselves but the way in which they are treated as inevitable.

It might well be asked even if Australia did accept the restrictions on resource development and population which would have to accompany an effort to conserve a high-quality environment, what would this avail if the trends of global overpopulation were to continue unabated? Political pressures would develop, which Australia would find very difficult to withstand. On the other hand, if Australia accepted the inevitability of a world-wide population crisis and kept its resources available for maximum food production, all that would be gained would be the possibility of a few extra years before the crisis.

It is surely wiser for Australia to base its national resources planning on the assumption that the population problem will be solved, at the same time joining in an international effort to solve the problem. Until these problems are solved resource policies may have to be relatively flexible. The setting of minimum conservation standards in the world as a whole could even have the beneficial effect of hastening the search for a

The Molonglo River, Australian Capital Territory, has been made foul by pollution. [Photo: Colin Totterdell.]



solution through better utilization of the most productive areas. In some cases it can be predicted that the main effect of some areas not being available for utilization will be an earlier turn to substitutes which are in better supply.

Australia is lucky in the sense that high standards of environmental quality could probably be achieved without greatly limiting the potential for economic development.

Problems to be tackled

The main value of conservation to date has been that it has set man thinking about his relationship to his environment, and has helped him to see the pitfalls of the future. This is important enough, but the potential value of conservation to mankind is even greater. We still think of conservation in terms of the measures required to conserve different kinds of resources, and these will continue to be of basic importance, but conservation is also a synthesizing concept which has the potential to help man to chart a programme for maintaining the earth as a productive, healthy, and enjoyable place. There will, of course, be little point in such high standards unless we are also prepared

to tackle even more energetically the avoidance of nuclear war and of a population out of balance with the environment and its resources.

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Naturalist Replies to Book Review

To the Editor,

Dear Sir,—I would like to reply to the extraordinary review of my book, *Australian Wildlife Conservation*, by Dr H. Recher in the June, 1970, issue of *Australian Natural History*.

He states it "is the classical emotional and alarmist appeal for wildlife conservation—an ooohing and ahhing over animals—which has pervaded the conservation movement among amateurs for too long."

I am an alarmist about the conservation picture in Australia. Dr Recher may be happy about it but I am not and will try to communicate that alarm to adults and children alike.

What is an "amateur" in conservation? Does Dr Recher consider himself a professional because he is a specialist in one segment of science? What are his skill and experience in the fields of engineering, economics, human and animal behaviour, law, tourism, public relations, and all the other aspects of a conservation programme? If the narrow specialism of a normal science course is sufficient to make a professional, why are we starting "conservation" courses at New England and Canberra? The opening section, to which he takes exception, was modelled on a very successful conservation wildlife show in which Australian Museum, National Parks and Wildlife Service, and Taronga Zoo experts played leading parts. This show attracted over 50,000 visitors, indicating its public appeal.

Towards the end of the review we get some idea of what Dr Recher thinks a good book should be. He apparently looks on children as little jugs, waiting to be filled with the right information. Then they will go out into the world and sin no more. He should remember the schoolgirl's comment on a famous book on penguins: "This book tells me more about penguins than I really want to know!"

Dr Recher goes on to discuss "inaccuracies". Space does not permit my dealing with all his comments, but pedants can read all sorts of meanings into popular statements. I was not writing for pedants.

He does not agree with the word "primitive". I suggest he does some more reading in the major works in conservation and wildlife and he will be surprised how many times it is used. Professor W. Stephenson, in his book *Places for Living*, a text geared for schools, writes about "primitive egg-laying monotremes".

I had written of estuarine areas as the "richest plant growing places on earth". I should have said "one of the richest", as Dr Recher points out. Yet he writes this remarkable sentence: "This is a rather unique way of expressing productivity and perhaps it should be conserved, but it also happens to be incorrect." I, in my old-fashioned way, still feel that all flesh is grass and that by putting the story in these words I tempt the reader to find out why. From Dr Recher's statement we come to the conclusion that he is dubious whether such

areas should be conserved. "Perhaps" is the strongest word he will use. This is the kind of comment from specialists which makes our work so much harder. We are battling to save estuarine areas and there is no perhaps where I am concerned.

Dr Recher makes play on my use of the word unique: "fallacious statements, clichés from nineteenth-century natural history. Any flora or fauna is unique . . . it is futile to justify conservation on the basis of uniqueness. . . ."

Do the majority of scientists share his view? For example, a leaflet put out in connection with the wildlife show already mentioned speaks of our "unique plants and animals". Again quoting Professor Stephenson: "the koala is . . . ecologically and structurally unique. . . ." Dr D. F. McMichael, Director of the National Parks and Wildlife Service, writes in a brochure: "these animals and plants are part of our heritage—they are some of the things which make our country unique". Many other examples could be given.

My book gives reasons why "uniqueness" is important in conservation.

Dr Recher also comments on my statement about the fascination of Australia, which has some plants and animals that have died out in other parts of the world: "There is very little evidence to support such a view".

From *The Last of Lands* I quote three eminent scientists: ". . . but the greatest impact on our visitor is reserved for those relics of bygone geological ages which, because of our isolation and—until recently—freedom from large-scale human interference, have survived to an unusual extent in this country. . . ."

However, in this review Dr Recher has gone beyond accepted levels in making the following statement: "Though Mr Serventy is to be commended for his astuteness in recognizing the need. . . ."

The implication I read into this is that I am "jumping on the conservation bandwagon".

Dr Recher again reveals his ignorance of the world outside his laboratory.

I was approached by the publisher to write this book. Knowing how little money there is in such work, either for the publisher or the author, I am willing to credit the publisher with some concern for our environment. I make no apologies for being paid for my writing. In earlier years I held a well-paid and worthwhile job in the science education field. One reason I turned to freelance work in mass media was because I thought that "what we save in this generation is all we will save", to quote an eminent conservationist. Only by influencing voting adults will we get action in time.

I am willing to stand on my record in the field of voluntary work in wildlife conservation, a record going back many years before the conservation bandwagon began to roll.—*Vincent Serventy, President, Wildlife Preservation Society of Australia.*



Effluent from an ore-crushing plant discharging into a freshwater river. For miles downstream the river is choked with silt.

Pollution in Australian Waters

By J. M. THOMSON

Head of the Zoology Department, University of Queensland, Brisbane

WATER is precious in Australia, for we have so little of it. The aquatic animals and plants are also precious because our continent has been scantily endowed with these resources. Yet each year the demand for water and for its live products is increasing as the number of human Australians increases and as the requirements of a technological age extend. But there are fears that the quality of our water may be declining and that, as a result, our slender aquatic resources may be facing either decimation or extinction.

We tend to think of pollution as effects that offend the eye or the nose and threaten human health. But any material which makes water less useful to either man or other animals is technically a pollutant. The results may also be displeasing aesthetically. Even the silt load in a river is a type of pollution. Heavy silt loads result from rain run-off from cleared land and their result is to cut down light for the photosynthesis of aquatic plants, to fill in the deeper holes of the river bed, and to change the nature of the available food

organisms by producing muddy conditions. Fish may even be driven away by the clogging effects of the silt on the gills.

The more generally recognized forms of pollution stem from almost every kind of human activity, including industrial effluents, sewage discharges, mining wastes, and household drainage. To these we can add the effects of agricultural chemicals, including both fertilizers and pesticides, the organic wastes of farm animals, and the chemical results of the dumping of car bodies, building rubble, and even garbage.

If we ask what waters are being polluted, the answer is: every river, every estuary, every bay, and a good proportion of the sea along the beaches and headlands. In addition, every inland and coastal lake and many farm dams are also polluted in some form or other.

Sewage effluent

To the seaside dweller sewage effluent is the most obvious pollutant. What the wind brings to the surfing beaches of Bondi and

Manly, in Sydney, is matched in Port Phillip Bay, Victoria, and in Darwin Harbour, Northern Territory. Much of the sewage discharged in Australia is untreated. As a result there is the constant threat of the spread of disease. Apart from the possibility of direct infection from sewage-containing water, transfer may be effected by the food chain. Molluscs such as oysters and mussels are known to accumulate live germs such as those which cause typhoid. The collection of oysters from Middle Harbour, in Port Jackson, and elsewhere in the neighbourhood of sewage outfalls, has been forbidden for many years for this reason. The oysters from one of New South Wales' best oyster-farming areas, Georges River, are specially treated before sale to prevent contamination. This should not deter you from eating your favourite sea-food, for if you avoided all food that could possibly be contaminated somewhere along the production line you would rapidly starve to death.

In rivers the sewage problem is worse. It is probably only the fact that Australia has no really large inland city that has not precipitated a crisis before now. Westbury, in Tasmania, is only one of many towns in Australia that draws its drinking water from a river into which another town upstream is discharging untreated sewage. Sewage can be treated and the final water discharged can be completely fit for human consumption. In America some towns on the lower reaches of rivers are drawing water which has already been two, three, four, or five times through sewerage treatment plants. But these treatment plants are expensive to set up and few Australian local government authorities feel able to find such capital.

Waste of fertilizer

Sewage discharge of solid wastes can create other problems. Each year 30,000 tons of sewage sludge drop to the bottom of the Tamar River from the city of Launceston, Tasmania. This adds to the problem of keeping the river channel navigable. It is also a waste of good fertilizer. This type of material, together with organic wastes such as those from food processing plants, kitchen refuse, etc., can be treated in a composting plant. The heat generated in the treatment effectively sterilizes the compost of germs such as

staphylococcus and of fly maggots, etc. Only humans' foolish distaste for fertilizing vegetables and other crops with their own excrement prevents this valuable material being used more widely. Such composting plants exist in many places in western Europe and in Israel, and there is one in Auckland, New Zealand.

One danger resulting from the discharge of sewage or of any organic wastes, such as the material from sugar mills, canneries, abattoirs, dairy factories, etc., is that the water may be depleted of its oxygen during the decomposition of these substances. Cane-milling in Queensland is in the dry winter period and those mills which still discharge waste material into the rivers create serious havoc, for, although at first only the local water adjacent to the mill becomes foul, with the first rain this foul water is pushed downstream as a solid wedge of water which kills off fish as it goes, for the fishes' instinctive reaction to running water is to head into it and so run into the danger instead of away from it.

In a similar way ponds and small lakes may suffer from the garbage left by human



A drain from a nearby town stains the waters of a Queensland harbour. The effluent was reported to smell like rotting beer.

picnickers. Edwardes Park Lake, in a Melbourne suburb, was recently the death-bed of hundreds of fish from such a cause. One of the two stretches of water in South Australia that rejoice in the name of Lake Bonney is a stinking mess devoid of life as the result of the discharge of wood fibre into the water.

Coastline hideously stained

Pollution from industrial sources other than food treatment plants is caused by acids, alkalis, metals, dyes, and other materials. The results may be unsightly. Almost 20 miles of the beautiful north coast of Tasmania is stained a ghastly orange-brown, emanating from an industrial plant at Burnie. A somewhat similar industrial product coats the coast to the north of Bunbury, in Western Australia, and stains both bathers and their swimming costumes.

Many industrial wastes find their way to our rivers by illegal use of drainage, or even sewerage systems. It is easy to detect the effluents where they discharge, but to track them back along the miles of the maze of drainage pipes to their origin is often virtually impossible. These effluents make rivers near any big town impossible to bathe in. Human beings can avoid them and build swimming pools of Olympic standard instead, but the seaweeds and the fish cannot. They dwindle or disappear. The Molonglo River near Canberra was once a flourishing trout stream. Zinc and other metal tailings from a mine poisoned considerable stretches over a number of years. The Brisbane River, the Parramatta River, the Yarra, and the Torrens no longer carry the fish populations of former years. The anglers who once lined their banks now make long journeys from the cities or head out to sea to fish.

One of the great worries of industrial discharge is the possibility of what is called a synergistic effect. This is the reinforcement of the effect of a single poison when it works in conjunction with another, so that the combined effect is several times as bad as the simple addition of the effects of each when acting alone. This happens when copper and zinc get together. The combined effect on fish is about seven times as toxic as the added toxicities when they act alone.



This was a mangrove swamp and lagoon—a nursery for young fish. It is now a town garbage dump and will eventually be filled in, which will be regarded as the march of progress.

Pollution by picnickers

Beer cans and soft-drink cans, papers and cardboard cartons, even scraps of food, pollute the creeks and pools where picnickers pause to refresh themselves. But we do not have to leave home to pollute our streams. In many places, particularly on rocky ground or where there is a heavy clay, household drainage, including washing-up water, slops from the table, etc., finds its way down drainage channels to creeks or rivers. Occasional banks of detergent foam emphasize this phenomenon. Detergents are lethal to many aquatic animals, and, although no studies have been made on this problem in Australia, almost certainly the microscopic plants and animals we call plankton must be reduced from this cause. Even larger animals like barnacles and anemones are known to succumb to these chemicals.

On the farms, the pig-pens, cow-bails, and stables are a focal point from which refuse and excrement can reach the nearest creeks, waterholes, or farm dams. Near the

big cities tar from roadways and oil may also pollute the water. For several years now the Queensland Fish Board has had to condemn kerosene-tainted mullet taken at the mouth of the Brisbane River. Chemical tests have shown that there is no doubt that it is a light-fraction petroleum product that is causing the trouble.

The fish-carrying capacity of many rivers has been reduced not only because of the direct effects of pollutants on the fish and their food, but also because the polluted regions of the river create a barrier to the dispersal of fish either upstream or downstream. If such a barrier exists at a critical time of the year, such as when fishes are moving to spawn, or when the fry are entering the river, the results may be serious indeed.

Synthetic pesticides

One of the gifts of modern technology to man is the host of synthetic pesticides which are used to rid the world of mice and rats, mites and ticks, and insects and weeds galore. Many of them need to be long-



This was once a beautiful creek. Observe the inroads of civilization.

acting, and this persistence means that they can easily be dispersed into creeks, rivers, and dams by rainfall run-off. Every creek and river in the land is contaminated by pesticides. In most places the levels washing into the water are low, but high levels have been measured in samples of water from the Tweed River, New South Wales, after rainfall has scoured the drainage ditches in the canefields and run off the banana plantations. The levels of lindane and dieldrin found in the Tweed River were sufficient to kill fish tested in the laboratory, and dead fish found in the Tweed had high concentrations of these two insecticides and of a weedicide 2, 4-D in their tissues.

In the Mary River, in Queensland, the water weeds have largely disappeared under the influence of a herbicide which is annually sprayed on the river banks to keep down weeds. This has reduced the cover for fish, which have become unprecedentedly scarce.

The generally low level of pesticides in our rivers has induced a false complacency, for recent work has shown that many aquatic organisms can accumulate these substances in their tissues till they reach quite high concentrations. In an estuary on the east coast of the U.S.A., DDT was in the water at a very great dilution of 0.00005 parts per million. But in the zooplankton it was concentrated to 0.04 p.p.m.; prawns showed levels of 0.16 p.p.m.; small fish which fed on zooplankton contained 1.25 p.p.m.; terns, diving birds that feed on small fish, had body residues at 2.8 to 5.17 p.p.m.; nestling cormorants contained 26.4 p.p.m., and immature sea-gulls 75.5 p.p.m., this last being some million times the concentration in the water. In some freshwater lakes in the U.S.A., DDT has appeared at concentrations of up to 60 p.p.m. in fish. The safe level for human consumption enforced by the U.S. Department of Health is 7 p.p.m.

It was recently stated in the Senate of the Australian Parliament that herbicides do not affect fish. This is not true. Some herbicides are very toxic indeed; others can be used to kill weeds at a level which will not kill the fish.

There are two main classes of chemical materials used in modern insecticides—the chlorinated hydrocarbons and the organophosphorus compounds. The effects of a



Detergent foam where a pipeline discharges into a drainage system.

new group, the carbamates, have yet to be fully evaluated. Of the older types, chlorinated hydrocarbons are relatively toxic to fish and to molluscs such as oysters, whereas prawns, crabs, and other crustacea are more susceptible to the organophosphorus compounds. The chlorinated hydrocarbons are persistent, lasting a long time in the environment. The widespread occurrence of DDT in places quite remote from any centre of use has alarmed zoologists. The organophosphorus compounds are not so persistent.

Invisible effects of pollutants

The visible effects of pollutants, including fish kills, etc., are alarming and evoke a response in both the public and those responsible for social regulation. But scientists are beginning to worry about the invisible chronic effects of sublethal levels

of pollutant materials. Laboratory test animals, such as mice and rats, do show chronic effects at sublethal levels of both metallic poisons, such as zinc and lead, and organic pesticides. A full study of effects in wild animals has yet to be made, but some studies in fish show a range of effects. Certain species were stunted in growth when kept in sublethal levels of insecticides. In others growth was more or less normal but the animals never matured. In others the gonads matured but the eggs or sperm were infertile. In other species the eggs were successfully fertilized, but, at the stage of embryonic development when the greatest demands were made upon the fatty material in the yolk, the embryos were killed by the release of the pesticide stored in the fat.

Insecticides, such as DDT, finding their way into farm dams which provided drinking water for stock, have contaminated farm produce. The persistence of traces of DDT in eggs long after DDT has been banned for use in hen-houses may well be the result of such contamination.

There can be no doubt of man's capacity to make his environment unhealthy, not only for his own use but also for the life of wild animals and fish. Whatever methods of control are devised, some pollutant material will escape into the rivers. Even ground-water becomes contaminated by pesticides, or even by septic tank seepages. But by stringent controls water can be kept fit to drink and fit for fish to live in. We obviously need to know much more about the effects of sublethal levels of pollutant materials, as death is not the only unhappy result of pollution. It is surely time that we guarded our water like the precious commodity it is.

[The photos in this article are by Brian Vicary, of the Queensland Littoral Society.]

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OIL POLLUTION

By DALE STRAUGHAN

Department of Biological Sciences and Allan Hancock Foundation, University of Southern California, U.S.A.

SINCE the development of the automobile early in this century, modern society has become more and more dependent on the oil industry. Conveniences and services based on oil are essential to modern living. Both with increasing populations and increasing affluence, greater and greater demands are being placed on the industry. It is estimated that as much oil will be consumed during the 1970's as has been consumed up until 1970. Larger and larger amounts of oil are being transported by sea in larger and larger vessels. Geologists are searching for oil in areas that require more advanced technology for development. Even if there is no increase in the percentage of oil spilled accidentally, this will still result in an increase in the amount of oil that pollutes the environment unless the technology to prevent and control spills increases with the expansion of the industry.

During the last few years, particularly in the areas of high population density in the over-developed countries, people have become aware of the dangers of uncontrolled pollution of the environment. The sea, in particular, was once regarded as a large dumping ground with endless capacity. While it does have a remarkable self-cleaning capacity, it is now realized that this capacity is not limitless.

All species, including man, cannot live without modifying their environment. However, reckless modification can make an area uninhabitable. One has to conserve one's resources by controlling pollution. In this it is not only health requirements, survival of food species, and maintenance of a balanced although frequently fluctuating community, that have to be considered. The aesthetical values of the environment are also important. Recreation areas, areas of beauty away from the crowded and usually polluted atmosphere of the large cities, are now recognized as essential parts of the human environment—essential perhaps, to the survival of the species.

Hence, even if the marine community can



Oil on rubbish and in the sand after the oil spill at Santa Barbara, California, U.S.A., in January, 1969. Drilling platforms A and B are seen in the background. [Photo: Margaret d'Hamer.]

survive the effects of oil pollution, the aesthetical side of the problem still must be considered. If most people were really honest with themselves, they would admit that the most immediately disturbing thing about oil pollution is its interference with their recreational activities and scenic pleasure. If oil had all its other properties, but was not sticky and was the colour of water, I wonder how many citizens would be concerned with the problem? How many people are concerned over sewage pollution if they

cannot see it and can still swim on their favourite beach?

Whatever the season, John Citizen is moving out of his complacent attitude and is now concerned about oil pollution. He wants some facts so that he can take action. He reads the newspapers and magazines and finds these a mass of confusing, conflicting information. The truth is that there are conflicting ideas about oil pollution. Considering the magnitude and complexity of the problem, we know very little. However, one must communicate enough knowledge to the layman for him to assess the situation for himself.

Recent oil spills

To illustrate the complexity of the problem, I will first consider several of the most publicized oil spills in recent years. In 1957 the *Tampico Maru* went aground and almost blocked the entrance to a small cove in Baja, California, U.S.A. Its cargo of diesel oil spilled into the cove and covered many areas to a depth of a foot. Mortality in the cove was high. Ten years later there was almost complete recovery of fauna and flora in the area.

In 1967 the *Torrey Canyon* went aground off Lands End. Here the cargo was Kuwait crude oil and it covered beaches in England, Wales, and France. In England and Wales, detergents, often dissolved in aromatic solvents, were used in intertidal and nearshore areas. The French avoided the use of detergents, but successfully used chalk to sink slicks at sea. In Great Britain, it is generally acknowledged that greater damage was caused by the detergents than the oil. Even so, most areas had recovered 2 years later.

On 28th January, 1969, following a blowout on a drilling platform, the Santa Barbara (California, U.S.A.) oil spill occurred. Predictions were dire—the area would be barren in no time, devoid of all fauna and flora. However, such is not the case. Mortalities were highest in the intertidal and bird populations. Resettlement is occurring in intertidal areas and it is still too early to determine the long-term effect on the birds. In this case, the oil was Santa Barbara oil. Minimal use was made of water soluble detergents in waters at least a mile offshore and in Santa Barbara Harbour.

The Santa Barbara incident was also complicated by several other factors. The spill occurred during unusually heavy winter rains, with peak flooding on 25th January and 25th February. This resulted in lower salinities and increased sedimentation rate (up to 30 cm in areas which usually only accumulate 0.5 cm per year). Flooding occurred immediately after the spraying of citrus orchards. Probably there was an increase in the amount of pesticides in the channel because large quantities of oranges were washed up on channel shores.

Natural seepage

The Santa Barbara Channel is also an area of natural seepage. As a result of this natural seepage, it is possible that organisms living in the Santa Barbara Channel have built up a higher tolerance to the presence of oil than organisms never exposed to oil. N. Nicholson and B. Cimberg (personal communication), working in intertidal areas in Santa Barbara Channel, found twenty-four intertidal species at Coal Oil Point—an area of active oil seeps—and forty-four and forty-two on beaches in the channel not in oil seep areas. While there were fewer species at Coal Oil Point, these species were more abundant than in areas of greater species diversity. This suggests that there may be selection for more "oil-tolerant" species in some areas of the Santa Barbara Channel.

Crude oils can be divided into a volatile fraction, a soluble fraction, and a remaining fraction which is either washed onto the beach or sinks at sea. This third fraction is attacked by oil-degrading bacteria. In the presence of natural seeps, there is probably a higher background count of oil-degrading bacteria than in other areas. Hence, following the Santa Barbara spill, one predicted a faster build-up in numbers of oil-degrading bacteria than in other areas.

The three instances differ in the type and amount of oil involved and in the type of detergents used. However, in all three cases the environment is recovering. It seems that one can be optimistic about the recovery of an area following an isolated spill. However, things do not appear so optimistic for areas surrounding permanent oil installations which could be subjected to repeated spills.

Relative toxicity of crude oil fractions

The type of damage one can expect in an area will vary with the type of oil that is spilled in the area. M. Bloomer (1969) discusses the composition of crude oil and relative toxicity of its fractions as follows:

Crude oil is one of the most complex mixtures of natural products, extending over a wide range of molecular weights and structures. The low boiling saturated hydrocarbons (gasoline range) have, until recently, been considered harmless to the marine environment. However, it has now been demonstrated that these hydrocarbons at low concentrations produce anesthesia and narcosis and, at greater concentration, cell damage and death in a wide variety of lower animals, and that they may be especially damaging to the larval and other young forms of marine life. Higher boiling saturated hydrocarbons (kerosene and lube oil range) occur naturally in many marine organisms and are, probably, not directly toxic though they may interfere with nutrition and possibly with the reception of the chemical clues which are necessary for communication between many marine animals. Olefinic hydrocarbons probably are absent from crude oil, but they are abundant in oil products, e.g., in gasoline and in cracking products. These hydrocarbons also are produced by many marine organisms, and may serve biological functions, e.g., in communication. However, their biological role is poorly understood. Aromatic hydrocarbons are abundant in petroleum; they represent its most dangerous fraction. Low boiling aromatics (benzene, toluene, xylenes, etc.) are acute poisons for man as well as for all other organisms.

The high boiling aromatic hydrocarbons are suspected as long-term poisons. Current research on the cancer producing hydrocarbons in tobacco smoke has demonstrated that the carcinogenic activity is not—as was previously thought—limited to the well known 3,4 benzopyrene. A wider range of related hydrocarbons can act as potent tumor initiators. While the direct causation of cancer by crude oil and crude oil residues has not yet been demonstrated conclusively, it should be pointed out that oil and tar residues contain hydrocarbons similar to those in tobacco tar. In their behaviour and toxicity, the non-hydrocarbons of crude oil (nitrogen, oxygen, sulfur, and metal compounds) closely resemble the corresponding aromatic compounds.

The great complexity of the marine food chain and the stability of the hydrocarbons in marine organisms, lead to a potentially dangerous situation. We have studied the fate of organic compounds in the marine food chain and have found that hydrocarbons, once they are incorporated into a particular marine organism are stable, regardless of their structure, and that they may pass through many members of the marine food chain without alteration. In fact, the stability of the hydrocarbons in marine life is so great that hydrocarbon analysis serves as a tool for the study of food sources. In the marine food chain, hydrocarbons may not only be retained but they can actually be concentrated. This is a situation akin to that of the chlorinated pesticides which are as refractory as the hydrocarbons.

An example of a spill of No. 2 fuel oil, the type of oil most commonly transported along the east coast of the United States of America, will perhaps illustrate the point that the lighter, more toxic oils are a greater immediate danger to the environment than the heavier oils in the spills mentioned earlier. This particular spill occurred when the *Florida* went aground in Massachusetts in September, 1969. Hampson and Sanders in a preliminary report in *Oceanus* (October, 1969) state:

Within a few days after the spill we investigated the area that seemed most affected, Wild Harbor and the Wild Harbor River. The toll taken on the marine life was obvious—the oil soaked beaches were littered with dead or dying fish as well as worms, crustaceans, and molluscs. Windrows of fish, crabs, and other invertebrates covered the shores of the Wild Harbor River and large masses of marine worms, forced from their natural habitat in the sediments, lay exposed and decaying in the tidal pools.

The lobster and certain species of fish (scup, *Stenotomus versicolor*, and tomcod, *Microgadus tomcod*) washed up on Silver Beach, North Falmouth, are primarily bottom-living forms. This was surprising, for it implied that the impact of the oil spill must have been felt not only between the tide levels, but also on the bottom below low tide (subtidal bottom). To ascertain the possible effects on the subtidal bottom fauna, we trawled about 300 metres off New Silver Beach on 19th September, 1969, in 3 metres of water. Our catch contained several species of fish, worms, and crustaceans and various other invertebrates. Approximately 95 per cent of the animals were dead and in various stages of decay.

Our preliminary observations suggest that the oil may have consistently penetrated the sediments at water depths of 7–10 metres in the heavily polluted zones. These preliminary findings strongly suggest that the oil either directly or indirectly has had a major adverse effect on some of the offshore bottom dwelling animals as well as the intertidal forms.

Aesthetic aspects

The oil dispersed rapidly through the water column. With a heavier oil, such as that found in the Santa Barbara Channel, only a very small fraction is soluble. R. Kolpack (personal communication) found only a very small fraction of oil dissolved in water in active natural seep areas, while divers from the University of Southern California have filmed a wide variety of species living in natural seeps at depths of 60 feet.

Earlier, I pointed out that I felt the aesthetics of the problem was often the real

issue. My point is borne out by the fact that the oil industry and a large section of the public favour the use of dispersants in dealing with oil pollution—"Out of sight, out of mind". What are the effects of the addition of dispersants? In the case of a typical crude oil, one has a thick layer of oil on the water surface which is losing volatiles to the atmosphere and a small soluble fraction below the surface of the water. Now add dispersants. The thick layer from the surface is broken up into tiny droplets and it, as well as the soluble fraction, is dispersed over a larger area in the water column. True, the concentration of oil at the surface is lower than before, but sections of the water column not previously exposed to oil are now exposed to it. Is the price of raising the concentration of oil through large areas of the water column worth paying for lowering the concentration at the surface?

Dispersion of the oil breaks the oil down into tiny droplets. Many marine species are filter feeders, and they selectively feed on particles below a certain size. By breaking the oil down into smaller and smaller droplets, one is making the oil available to more and more animals. In the light of Bloomer's comments, quoted above, is this price worth paying?

Following an oil spill, the distribution of the oil is dependent on wind and water currents in the area. Research following the *Torrey Canyon* spill indicated that wind had a greater effect on distributing the slick than water currents. In the Santa Barbara spill both were important in distributing the slick. A knowledge of water currents and wind conditions in the area of permanent oil installations is essential in predicting the distribution of a slick after a spill so that measures can be taken to combat the spill. In the Santa Barbara Channel, all beaches along the mainland eventually received some oil. Platform A is situated between two gyres—one flowing north along the coast and one flowing south along the coast. Over 100 miles of beaches were oiled on the mainland as well as beaches on many of the channel islands. Dr Radok, in a study of drift cards from B.H.P.-Esso Rig in Bass Strait, Australia, predicts that if a spill from this rig came ashore no more than 10 miles of coastline would be affected

(paper presented at 1970 APEA Conference). Different facilities are needed to control spills in these two instances.

Prevention the real answer

Of course, the real answer to oil pollution is to prevent it. This can be done by replacing oil with another source of fuel—a long-term project which could result in pollution of other kinds—or by increasing the technology required to prevent the spills. Here it becomes important for everyone to realize that the price in time and money to operate this technology is worth paying. This includes the workman operating the oil installation, who may have to spend more time and care on a job, and the man in the street, who may have to pay more taxes or the price of fuel to cover the cost. It is clear that if we want a clean environment we all have to be prepared to pay for it in some way.

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BOOK REVIEW

SOUTHERN WALKABOUT, by Vincent Serventy, published by A. H. and A. W. Reed, Sydney, 1969. Price, \$5.50.

In this book Vincent Serventy gives a personal, anecdotal account of a series of travels made by him and his peripatetic family through various parts of southern Australia between Sydney and Perth. It is an entertaining story, one to be read with pleasure by anyone with an interest in natural history or the outdoor life. It is lavishly illustrated with colour plates of high quality.

To this reviewer the book seems somewhat disjointed, lacking the smooth flow of the usual Serventy writing. Interesting snippets of natural history are often strung only loosely together, with little attempt at continuity. As a result, *Southern Walkabout* reads more like an anthology, without involving the reader in the book as a whole.

Nevertheless, this book can only serve to enhance Vincent Serventy's well-earned reputation as one of Australia's leading natural historians.—H. G. Cogger, *Australian Museum*.



Middle-income flats in Queens, New York City. There are miles of this housing. [Photo: Author.]

The Urban Environment

By AMOS RAPOPORT

Senior Lecturer in Architecture, University of Sydney

MOST of the problems of the urban environment are due to the growth of population and technology. As more people produce more goods and more waste, the result is more pollution of various kinds—not only material (such as air and water pollution) but what could be called sensory pollution (unwanted light, noise, and smells).

As people ask for more goods and more convenience, we all seem to have less comfort, and as they stress private affluence the result seems to be public squalor; the overall effect seems to be a lowering of the quality of life for all. These are all matters of values and goals of society, and these will probably have to change before designers and others can get a chance to do what they know.

Unfortunately, we know very much less than we need to know about the urban environment. There are several reasons for this. Firstly, until very recently, the urban environment was not seen as a problem—except by a few individuals who were considered very odd indeed and disregarded. Secondly, until recently, designers, who were

among the only ones concerned with the built environment, have had no research orientation. They have been action oriented—they built things—and they have not monitored their solutions so as to find out whether what they did was satisfactory. Neither did they collaborate with other disciplines which might have helped—and in any case those other disciplines also ignored these problems. Hence there are little theory, few facts, and little predictive power. Finally, knowledge is also lacking because very little research money is being allocated to these problem areas. While money does not always guarantee results it is a necessary first step.

Man-environment studies

There is now a greater awareness of these problems, and the design disciplines are becoming more research oriented. Over the past few years a new field has been developing called man-environment studies. It has been trying to develop some coherent body of fact and theory by drawing on the findings, insights, and techniques of a number of disciplines—ethology, ecology, psychology,

social psychology, sociology, anthropology, human geography. These, and others, are coming together in new and exciting ways with architecture, urban design and planning, and with each other.

Eventually this field, like any other, will develop its own techniques and methods, construct its own theories and models. After it has learned to describe it will move on to explanation and then to prediction. It is already starting to do so—and more knowledge is becoming available every day. In addition to modifying the attitudes of designers, the result has been to point out the unexpected (to some people) complexity of the field. It is some of this complexity which I will try and bring out in the limited space available.

It should be pointed out, at the outset, that the urban environment can hardly be separated from the natural environment, particularly if we take a holistic view of the environment and see it as a system. Such a view would hold that the environment is a system of relationships of elements such that *all* the elements are interdependent to some degree and cannot be independent of anything else. These relationships extend in all sorts of ways and cannot be separated. A change in any one element may have consequences in another far removed—and the consequences must be traced. The fact is, of course, that the built environment depends on the natural environment, on the

biosphere. Climatic change due to building, water and air pollution, resource use (and misuse) all affect what we could call the essential natural infrastructure without which man cannot survive (what has been called “spaceship earth”).

Environments linked with each other

There are other reasons why the natural and built environments cannot really be separated. There is hardly any part of the world not affected, and partly transformed, by man, so that *all* environments are partly man-made. Man also reacts both to the natural and urban settings—he lives in both. In fact the transitions between them are one important element in the creation of environmental richness and complexity, and there is much evidence for the need for certain levels of environmental complexity which many environments today do not satisfy.

Similarly the physical environment, whether natural or built, cannot be separated from the social, cultural, and psychological environments. These need to be known before one can design; in fact they need to be known before one can even *understand* the physical environment. This is so because the environment, as it is built and shaped, *communicates*—it expresses values and ideals. This is why designers and scientists alone can never solve the problems of the environment. The involvement and partici-



High-rise apartment blocks beside a freeway near Chicago, U.S.A. [Photo, by Orlando Cababan, from *Who Designs America?* (no. 6 in Princeton Studies in American Civilization)].



The car reigns supreme. Dandenong Rd, St Kilda Junction, Melbourne. [Photo: Author.]

pation of the public are essential in changing goals. Only if the public wishes it, will the expertise of designers and scientists be used.

Changes in goals and values in the social environment, whether related to population growth, proliferation of goods and waste and the like, would seem to hinge on accepting *environmental quality* (or, more generally, quality of life) as a major goal. Without tackling the problem of what the good life might be, an insight into the implication of such thinking in design can be obtained by considering a relatively simple problem—urban freeways.

Urban freeways

These are built at great cost on the assumption that saving some travel time is an important goal. But is the quality of life overall improved? If we consider that these freeways disrupt communities and make access to daily local needs more difficult without driving, thereby isolating children, the old and the less affluent from these facilities, and if these freeways disrupt the scale of the city, destroy historic areas, introduce noise, fumes, and headlight glare, make pedestrian movement impossible and make public transport less efficient and less viable, we may doubt that the quality of our life, or our environment, is improved. Many other specific questions could be asked about freeways—the numbers of people

affected by them, the traffic they generate, thus *increasing* congestion, whether they can ever meet unrestricted demand, and what trying to meet this demand would do to the urban setting, both spatially and in terms of pollution.

But I have said enough to show that the way the environment is shaped and organized reflects mainly social and cultural values. But it does not only that. It can also be seen as a *behaviour setting*, a stage for social and personal behaviour. Once shaped by various factors the environment in turn affects behaviour, but does not determine it. It can act as a catalyst, it can encourage or inhibit action, or it can be neutral. People can adapt to an unsuitable environment but at a cost—in effort, in stress, in energy wasted, in the impact on their mood or state of mind.

What precise degree of influence the environment has on people is a much debated topic. Traditionally, designers have believed in what has been called environmental determinism—that by redesigning the physical environment people's lives could be changed. As a reaction to this, some social scientists argued that the physical environment was rather unimportant. Currently, the accepted view seems to accept the interaction of many factors, physical, social, cultural, and psychological.

But sometimes the possible costs and consequences may be so grave that even if

conclusive evidence is lacking we need to act as though they have been proved. I would like to pick three such problems (out of many facing us) and discuss them briefly.

Three problems

The first problem is one I have already mentioned—that of *sensory complexity*. People react to the environment, whether built or natural, through their senses; they live in what has been called the *perceived environment*. But we do not observe it passively, like a picture. We are in it, and of it, and experience it through all our senses while we participate in it. While vision is the dominant sense in man, we react to the environment through smells, thermal properties, sound, kinesthetics, touch, and so on. Different individuals and groups may, in fact, stress different sense modalities, and hence the environment must allow all senses to be used.

Yet the urban environment in which we increasingly live tends to restrict and gradually suppress many of these sensory modalities. We have buildings with even temperature, reduction of day to night light contrasts, uniform smooth textures, suppression of smells (or replacement by the single smell of petrol fumes), mechanization of kinesthetic experience. The environment is hence impoverished. Decisions are taken for the wrong reasons, neglecting the sensory needs of people. Instead of a complex and rich sensory experience we have either monotony or chaos, both of which are experienced similarly to boredom. Yet there is evidence from studies with both animals and people that certain levels of complexity and interest are essential for well-being. It may well be that people compensate for this boredom and lack of sensory satisfaction in various ways, some of which may be anti-social (such as delinquency) and others detrimental to the environment (such as excessive driving to enrich the experienced environment).

The second problem is *density and crowding*. There are findings from animal studies which have shown the effects of crowding on populations—development of behavioural sinks, stress, and population collapse. The mechanisms of all this are very complex and not fully understood in all cases. The devices used to space out animal

populations are many and ingenious. The devices which have proved of particular interest to students of man-environment interactions are those based on spatial organization. They are known under the general name of territoriality, but include concepts such as home range, core area, territory, personal space, and jurisdiction.

These concepts have been applied to the study of human environments with modifications. There is a general question involved: can these concepts from animal studies be applied to man? To what extent do social and cultural mechanisms modify these effects? This is difficult to answer, yet these concepts seem to have some relevance and have had a major impact on man-environment studies.

Consider the problem of density in urban areas. This is still being discussed in terms of people per unit-area, with arbitrary figures defining “high” and “low” density. The behavioural implications of density are not considered, neither is the basic question of what density means in perceptual terms. There is no discussion of the influence on density of social mechanisms such as different notions of privacy, rules of behaviour and defences against unwanted social interaction and sensory involvement. Yet all these, and more, need to be investigated before decisions are made on anything as potentially critical as density or crowding. Yet density conditions are being altered drastically without anyone knowing what the consequences might be.

If one accepts recent suggestions that privacy does not mean being alone, but having the maximum number of options, this suggests that the urban environment needs variety not only in terms of sense modalities but also in terms of life-styles, dwelling styles, types of density, man-made and material environments, modes of transport, size of towns, and so on. It also brings up the final issue I wish to discuss—*people's involvement with the environment*.

Once again there is much evidence from animal studies that animals need to be actively involved with their environment. They need to be able to choose it, manipulate it, modify it—in a word, control it in some way. Depriving animals of such natural activities greatly influences their behaviour for the worse.



Housing Commission flats in South Melbourne, Victoria. [Photo: Author.]

This applies with even greater force to people, as has been shown by psychologists, sociologists, and some designers. There is a consensus that being interested in the environment is important, and that being interested implies some kind of satisfactory interaction with it. Satisfaction may lie in being able to choose one's habitat, in having an effect on it, in changing it in various ways—feeling that one has some *control* over it. Rather than passive adaptation to the environment, people seem to need and want to modify it and be involved in its creation. This would seem to mean involving the public in the design process, and also that the designed environment must not be so tight as to inhibit action and individual modification.

Yet increasingly the urban environment and the buildings within it block any possibility of the individual being able to exercise his desires and have an effect on the environment which he, and others, can observe. This seems to be linked with territoriality (through what has been called personalization), the need for identity, the effects of such more-or-less random changes within a designed framework on perceptual complexity and

many other issues, both numerous and difficult.

For example, it seems that our perception and memory of an urban environment may depend partly on the degree of our involvement with it and modifications of it. Considerations such as these may also help explain the attractiveness of many past environments which we admire because they show the effects of people's modifications, and may also explain why we find many recent environments unsatisfactory. The reason may be that these environments seem to be completely beyond people's control to *modify, affect, and change*. These may even be an environmental equivalent of the sociological concepts of anomie and alienation.

Much to be considered in designing cities

What I have tried to do is to show what a complex matter any aspect of the man-environment interaction is and how much we need to know and consider in designing our cities. At the same time, I have tried to show some of the newly developing ways of looking at these problems.

We cannot just keep on building things and creating environments which we have not really considered and which we do not understand. We cannot ignore all these relationships and expect the environment to work.

We can see the environment as a system of communication. The designers and creators of the environment give it meaning which the users, the public, decode. They can only do so if the code, the symbols used, are mutually shared and understood. At the moment they are not so shared and understood.

Man-environment studies can be seen as an attempt by some designers and scholars to understand the public's codes. The involvement and interest of the public in the urban environment can be seen as the public's attempt to learn the designers' meanings. Unless we can all understand this code—as well as be aware of the more strictly physical problems of the biosphere—the consequences will be grave. Too grave.

[This article is based on a lecture given at the Student Union, University of New England, Armidale, New South Wales, on 22nd April, 1970.]

TOWN PLANNING—A MODERN NEED FOR MODERN MAN

By NEIL INGHAM

Senior Town Planner, Clarke Gizzard Planners Pty Ltd, Sydney

TOWN planning in its modern form is a relatively new science. It is new because never before in the history of mankind have there been towns and cities of the population and extent that exist today.

Cities have always been the hub of creative thought, art forms, education, and political ideologies. The standards of living are higher, the death-rate is lower, and comfort and hygiene are more highly developed. The most urbanized societies in the world today are the best paid, fed, housed, and educated in the history of mankind.

The problems of modern civilization are basically the problems of the cities, and as large cities are new to man the problems are also new, making it often difficult to see the genesis of problems before the problems exist. The wealth and resources of most industrialized nations, in terms of investment and manpower, are tied up in their urban areas, thus creating a situation where modern town planning is directly related to the welfare and prosperity of the inhabitants.

The history of cities

Until the industrial revolution man existed basically in a rural economy. The vast majority of people lived on farms or in small villages. Even the so-called cities of the ancient world seldom grew beyond a population of 20,000. The cities that did exist were rich in architecture and sculpture. The physical forms of function and beauty, often developed over many centuries, were able to be retained because there was little population change and no real growth pressures.

The size of cities was restricted by the regional soil fertility, the methods of farming and the transportation forms available. The world population was kept reasonably stable by epidemics, wars, stillbirth, natural calamities, and ignorance of hygiene. It

had taken from the beginning of history to A.D. 1800 for the world population to reach 900 million. By A.D. 2000 it is expected to top 6,000 million.

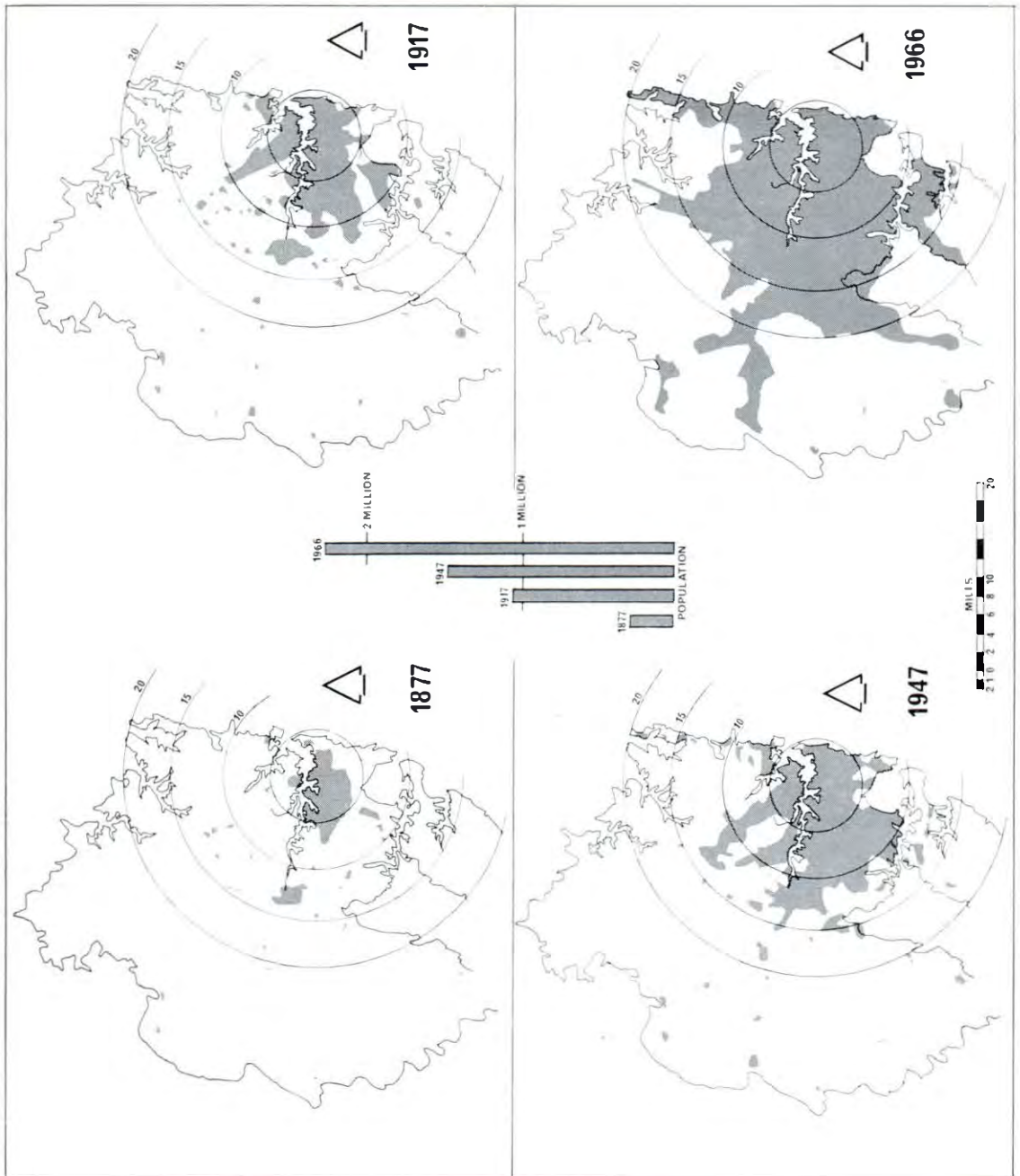
City growth has seen even more staggering results. London, with a population of 800,000 in A.D. 1800, now has over 12 million. In the same period Moscow has grown from 350,000 to over 8 million, and New York from 60,000 to over 15 million.

Australian cities have exploded in a similar fashion, and this, coupled with the geomorphology of the country and the historically recent colonization, has resulted in the most highly urbanized society in the world. Over 80 per cent of the population live in cities, with 44 per cent in Sydney and Melbourne.

The rush to the cities has been a phenomenon of the era since the industrial revolution. Mechanization of farming methods created a surplus of labour in rural areas and manufacturing of a multiplicity of goods and innovations created employment in the cities. The city migration that started in Europe two centuries ago is continuing today, creating serious social problems in the under-developed countries of the world. Shanty towns of more than 100,000 inhabitants have sprung up around many major cities, housing people in appalling hygienic conditions, with open-air sewers, polluted water, and uncollected garbage. In these areas physical and mental diseases are rampant and consequently the death-rate is high.

Cities today and town planning

Since the majority of people in industrialized nations live in cities, and since most of the problems of society, in physical, social, and spiritual terms, are concentrated in cities, town planning has been oriented primarily towards the problems of urban growth and form. The results of city and regional planning are achieved through



Urban growth of Sydney. [Diagram by the author.]

short-term priorities with long-term objectives. Cities are continually-changing organisms. With ever-increasing population, ever-changing workforce structure, and ever-changing innovations, there is no final solution.

The planner of 50 years ago could never have envisaged the phenomenal growth of car ownership, nor the apparent demise of the railway. The planner of 20 years ago could not have predicted the growth of air traffic, nor the noise and space problems associated with airports. The planner of today is gazing into a crystal ball, trying to foresee the new forms and requirements of society in 20 years' time.

Some basic questions are completely unresolved. Are cars going to be superseded by an alternative form of transportation? Are the freeways being built today, at tremendous cost, going to be redundant by the end of the century? Will future generations have a substantially shorter working week, and, if so, will social patterns require two houses per family, one of them for escaping from the city at weekends? How much additional recreation space will be required for additional leisure time? Is man going to make his cities unlivable by the air, water, and noise pollution he creates? Is man losing touch with reality by losing contact with nature? The questions are infinite.

London is a city where an attempt has been made to overcome some of the problems of urban growth. City sprawl has been controlled by a rural green belt. The overspill population has been located in "new towns", of from 40,000 to 100,000 people beyond the green belt. The policy has been to create employment within the "new towns", thus avoiding the dormitory-town situation and the long journey to work encountered in many other urban agglomerations. The results have only been partially successful. The towns were planned for a static population, and the problem now facing British planners is what to do with the additional millions expected in the London region before the end of the century. The present intention is to keep the green belt intact and to expand existing towns, up to 80 miles from London, to take populations of up to 250,000 people. No "new towns" will be started, even assuming a suitable

site for one could be found. Expansion will occur in some of the existing "new towns". Experience highlights the need for flexibility in urban growth forms and spatial requirements.

Another example of urban growth may be seen in the Randstad cities of Holland. These are a group of historical cities which have almost fused together in the shape of a ring, so that for planning purposes they form one city. Randstad Holland embraces the cities of Rotterdam, the Hague, Haarlem, Amsterdam, Hilversum, and Utrecht. The present total population is around 5 million. The object of planners is to prevent the various cities of this conurbation from becoming one amorphous mass. The cities will be kept separate by small open wedges, with the core of the ring remaining completely rural. Each city is to keep its identity and to be self-contained. Further expansion of the urban areas is to follow transportation routes outwards from the ring, avoiding natural forest areas and other regional assets.

In a period of just under two centuries, Sydney now has a population of 2½ million. This figure is conservatively estimated to reach 5 million by the end of the century. In terms of bricks and mortar, Sydney will have to repeat itself in less than 30 years. The pressures on land space will be enormous, and these pressures will be reflected in the price of land.

Sydney planners have determined to create a physical city form different to either London or the Randstad cities. The green belt concept, which was adopted in Sydney during the postwar period, vaporized in the face of growth pressures. The growth strategy is now based on a finger pattern extending outwards from the central core along transportation routes, divided by wedges of agricultural or non-urban land. A disadvantage of this form of growth is that it encourages further development, and thus employment, in and around the central core, creating public and private transportation and traffic movement problems.

Need for a planning team

Town planning today is a science which is extremely comprehensive and diversified. It would be more aptly named "city and regional planning". The problems

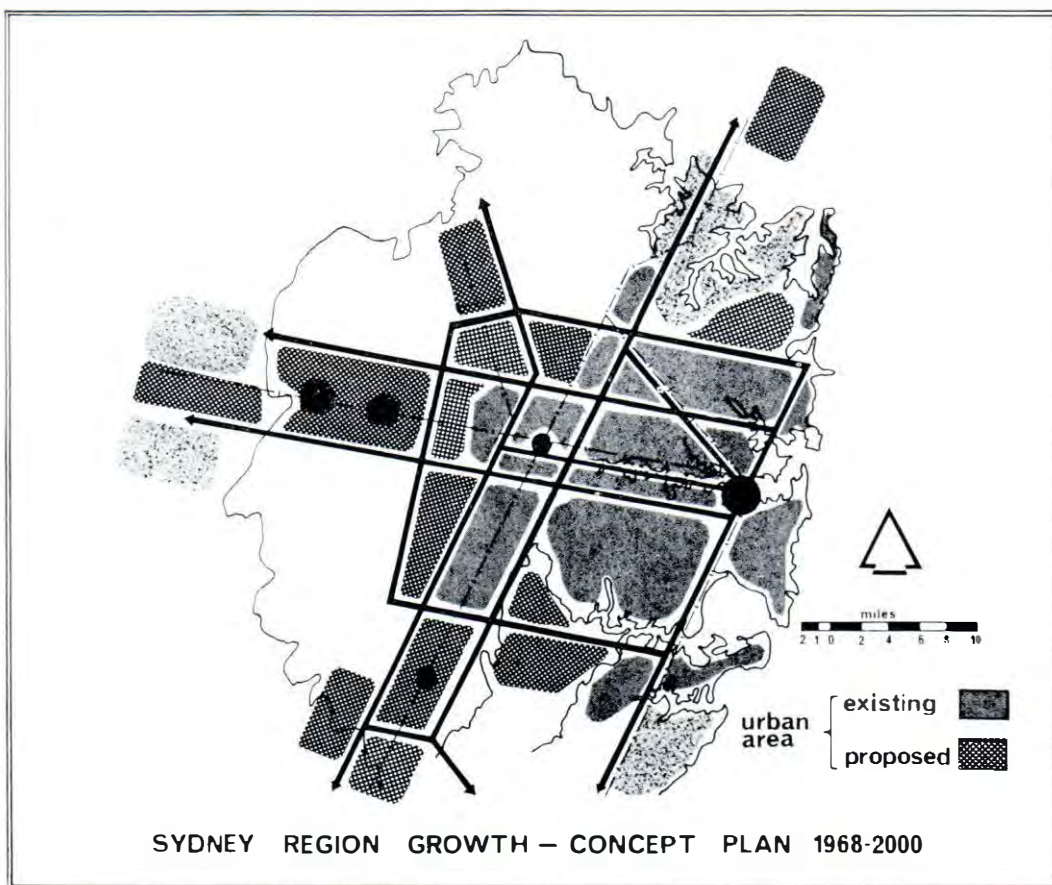


Diagram by the author. [Copied from *Sydney Region—Outline Plan, A.D. 1970–2000*, Report by the State Planning Authority of New South Wales, 1968.]

encountered range from national and regional economic problems to the physical detailed layout of small estates. The magnitude, variety, and complexity of planning problems are such that no one discipline is able to provide all the answers. As the population of cities increases so do the number, size, and diversity of a city's functions and the interaction between those functions.

The need, then, is not so much for lone town planners, but for planning teams. These multi-disciplined teams would comprise members from fields such as town planning, engineering, architecture, economics, sociology, traffic engineering, surveying, urban geography, and others.

If our environment is to be improved, then every city and every region needs a team

of experts to identify the problems of the area, to determine priorities for action, and to implement recommendations. The planning process must include a programme of public participation and education if the results are to achieve public acceptance—for planning is, after all, for people.

At the present time, the main problems in achieving worthwhile results in all aspects of planning lie in two areas:

- There is a lethargy on the part of governments in providing sufficient funds for planning and for the realistic implementation of planning proposals. This withholding of funds is a short-term expediency and a longer-term tragedy, for the results of non-planning are inconvenience and financial waste.

● There is a shortage of supply of experienced planners. The number of university graduates in planning is small enough. The number who practise in this field is much smaller.

The future

The planning of a city or region is not a problem which can be solved and then forgotten. Cities and regions are dynamic ever-changing organisms which require continual planning and research, as conditions and pressures change. Urban forms must be capable of accepting change.

It is obvious that the process of urbanization is inevitable as nations become industrialized, and that city regions will continue to grow, at least in terms of population if not in areal requirements. Cities of the future may be multi-level and less confined to the existing topography. Housing may be modular and expendable. Cars may be a conveyance of the past and electronically controlled devices may carry us to work and school. Perhaps, in some parts of our city we may even discover once again that we are two-legged mammals with a capacity for walking and running, free to roam and shop without the motor car endangering life and limb.

In our complex society of today the one certain feature is that the requirements and demands of the individual, and the innovation

of computer technology, will rapidly require variations and modifications of our urban structure. New cities today, therefore, are generally structured on a modular cell form of growth, where the individual cells are capable of change, without affecting the environment within the adjoining cells. Canberra's and Chandigarh's (India) proposed structures are typical of this pattern.

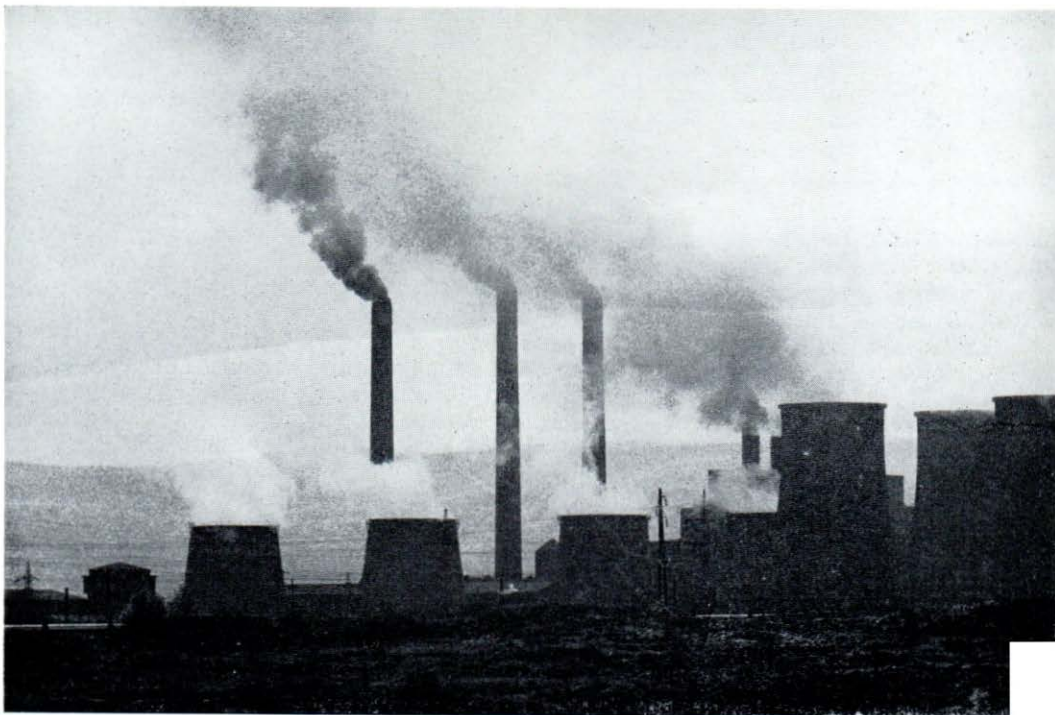
Perhaps the most serious threat to mankind is the possible isolation from nature and the pollution of both city and country. Certainly there will be hordes of city dwellers commuting to the country and seaside every weekend to escape city pressure, sterility, pollution, and noise. The result, however, could be the destruction and pollution of the country, ultimately providing no escape from the ravages of man.

The early preservation of large primitive areas is essential in all countries throughout the world, with access only by means of trails. The encroachment of the motor car into primitive areas is intolerable.

With sufficient far-reaching thinking today, and given sufficient public support, planners may be able to create cities which will exist in harmony with nature, and yet still provide all the benefits of the city. If not, the result could be cities under air-conditioned geodesic domes, isolating the bulk of the population from the polluted environment outside.

Town planners in Chandigarh, India, with that city's master plan. [World Health Organization photo by T. S. Satyan.]





Air pollution in Czechoslovakia. [World Health Organization photo by Jean Mohr.]

The importance of rational research and planning, assisted by computer technology, is unquestioned. What is in doubt is man's ability to understand the magnitude of the problem and to provide the means of satisfying the need.

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Many birds and mammals, including human beings, maintain characteristic distances between them, when free to do so. This indicates a need for privacy or "social space". [Photo: Howard Hughes.]

OVERCROWDING—A HUMAN PROBLEM

By **CLAIRE RUSSELL**, psychoanalyst, of Reading, England, and **W. M. S. RUSSELL**, Lecturer in Sociology, University of Reading

IN 1967, the City Planning Department of Newcastle (England) reported the results of a study of various social and medical symptoms in districts which differed from each other in various ways. The sharpest contrast was between the most and least crowded thirds of the city. The most crowded third produced more than five times as many offences against the person, more than four times as many larcenies, seven times as many people on probation, three times as much juvenile delinquency, more than five times as many cases of neglect of children, five times as much venereal disease, and 43 per cent more prenatal deaths. This unusually comprehensive study confirms earlier work on the manifold effects of overcrowding on human behaviour, health, and reproduction.

Why should overcrowding produce all these effects? Recent observations on higher animals have given us some clues. When communities of monkeys are observed in natural conditions, where they have plenty of food and space, they are found to be astonishingly peaceful; when they are crowded into zoo enclosures, where they have plenty of food but much less space, they become quarrelsome and violent. A prominent feature of monkey behaviour in the wild is the extent to which they keep out of each other's way, except when they make contact by mutual consent for grooming, mating, or huddling in cold weather. This need for privacy or "social space" is common to many mammals and birds. In a small enclosure, monkeys are forced into frequent proximity and contact,

and this makes for quarrelling, which often erupts into fighting. The weaker members of such a community are lean, unkempt, scarred, and nervous, and sleep badly. In the wild, females and young are protected by male leaders; under serious crowding they may be attacked and even killed, while the females in turn may neglect or kill their babies. When stress is not too severe, the monkeys respond quickly to an increase in space. Hilary and Martin Waterhouse recorded the number of fights in a rhesus community at the Bristol Zoo. When the zoo authorities removed half the monkeys and put them elsewhere, leaving twice as much room for the rest, the number of fights went down from 4.4 to 1.5 per hour.

To produce crowding, it is not necessary to confine mammals in a cage or enclosure. If their food, instead of being dispersed, is concentrated at a point, they may be obliged to invade each other's "social space", and all the symptoms of crowding appear. In a forest in Wisconsin, white-tailed deer gathered in winter for many years. Eventually they seriously depleted the trees on which they fed. To keep them in the neighbourhood, conservationists supplied hay at fixed feeding-stations. As the deer clustered in the small areas of the feeding-stations, they quickly established rigid rank orders, with bucks at the top, does in the middle, and fawns at the bottom. When only five to seven deer were present in the fixed area of a feeding-station, only one quarrel was seen per deer per hour. When twenty-three to thirty deer were present, the rate was 4.4 quarrels per deer per hour.

Monkeys are sacred in India, and many rhesus monkeys have come to live in towns or temple precincts. S. D. Singh has compared the behaviour of these urban monkeys with the rural ones which still live in the forests. In some circumstances, the urban monkeys had become more tolerant of proximity. A leader of a forest band would only permit an occasional female with her infant to feed near him, and only in the breeding season; a leader of an urban band would permit several females, infants, and juveniles to feed nearby all the year round. Presumably space conditions in the towns would make this necessary for the band's survival. But when individual monkeys were put together in a 6-foot cubic chamber

in various combinations, the urban ones were far more aggressive, whether put with urban or rural companions, and generally started fights which resulted in serious injuries: two of the combatants were killed.

In addition to these short-term and long-term effects on behaviour, the stress of crowding, and of the violence it provokes, has physiological effects, which have been demonstrated in mice, voles, woodchucks, muskrats, rabbits, dogs, and deer. Females who survive the violence are often reproductively damaged. They are likely to have miscarriages or to produce stunted young with permanent brain defects whom they cannot adequately feed. Another effect of the stress is a reduced immunity to parasites and infectious diseases, so a community weakened by overcrowding is liable to succumb to epidemics. Fast-breeding animals, such as rats, mice, and voles, have been allowed to breed in restricted areas, while supplied with unlimited food; when they reach a certain population density they become tense and violent, and the resulting casualties and stress, especially among the females and young, drastically reduce the population.

In 1916, five Sika deer were released on an island of 280 acres in Chesapeake Bay, U.S.A. They bred freely, and in 1955 the herd numbered more than 280, a density of about one deer per acre. In 1958, there was a sudden "die-off", and 161 carcasses were recovered. The population finally stabilized at around eighty. The carcasses of the deer that died in 1958 were compared with specimens shot in earlier and later years: their glands gave evidence of severe physiological stress. Most of them had, apparently, literally died of stress or shock; two had succumbed to hepatitis, probably through weakened immunity. At the time of the die-off, the food supply was still ample, and the carcasses were sleek and had deposits of fat. If the deer population had increased much further, they could have irretrievably depleted the food supply on the island, and then they would *all* have died out.

This and much other evidence suggests that all the responses to overcrowding, behavioural and physiological, have been evolved to reduce a population drastically for more than a generation. In this way, a

community of animals, which is in danger of outgrowing its natural resources, will be decimated before it has irretrievably depleted these resources, and so give them time to recover. The population crisis response has thus an evolutionary significance.

There are many indications that human beings, like monkeys, have a definite need for social space. Stanislaw Andreski made observations in transit stations for released prisoners of war on their way home. When these men sat down to a meal in the canteen, some of them would draw chalk lines round their bodies to show the elbow-room they wanted, a perfect visualization of social space. Paul Leyhausen observed that when prisoners of war were released into a new camp they would each start to fence off a part of the floor space with string or pieces of cardboard, to define an individual territory.

Edward T. Hall found that people, like higher animals, tend to maintain characteristic distances between them, except when engaged in intimate contact by mutual consent. There were at least four critical distances, used in different circumstances and bringing different senses into play. In ordinary conversation, American businessmen became uneasy at distances below 18 inches, feeling upset by the visual disturbance. "These people get so close, you're cross-eyed . . . it feels like they're *inside you*". This confusion of one's social space with one's own body becomes an actual delusion in American schizophrenics. Americans tended to have business interviews at 4 to 7 feet apart. Arabs, on the other hand, either talked farther apart, right across a room, or much closer together, where they could smell each other. But they felt crowded as soon as they smelt something unpleasant. There is clearly much to be discovered about cultural differences, but it seems that any healthy human being can feel overcrowded in some conditions.

Living in overcrowded conditions forces people to spend more time in close proximity to each other than they would choose. The resulting stress produces behavioural and physiological effects very similar to those seen in overcrowded animals. In London, in the 1950's, violent crime was found to be concentrated in areas of dense, bad housing, and spread into new areas as these became overcrowded. In Scotland in the same

period, the incidence of fatally malformed babies was higher in the more crowded regions. In the Newcastle study mentioned at the beginning of this article, the crowded districts showed greater amounts of anti-social behaviour and violence, prenatal mortality, and neglect of children.

Man differs from other mammals in having an even more highly developed parental urge. This is clear from the long and increasing period of parental care in man. So man is less ready than other mammals actually to hurt and kill his young, and even under severe stress many human beings will continue to love and protect their children. Nevertheless, a proportion of human beings do kill their children, and others severely injure them, as in the cases of "battered babies" which have come into prominence since 1962, when some American doctors found that certain injuries of children were caused in this way. Study of these cases indicates that people only treat their children in this way when under severe social and economic stress, or when they have experienced severe stress in their own childhood.

Human beings, then, resemble higher animals in needing social space, and in reacting to overcrowding with violent behaviour and impaired health, likely to reduce their populations. Is there any indication in man, on a large scale, of the kind of population crises and sudden massive death-rates found in animals? There is evidence that the large-scale violence of warfare has been more intense, and has involved more killing of women and children, at times of intense population pressure and accompanying widespread overcrowding. European wars of the 19th century, for instance, when population pressure was relieved by emigration, were much less cruel than those of the 17th and 20th centuries, when population pressure was unrelieved. The history of all human civilizations suggests that they have repeatedly succumbed to population crises of exactly the kind studied in animals, with increased social inequality and social tension, widespread and unrestrained violence, and a high mortality of women and children, culminating in spectacular death-rates such as those of the Plague of Justinian (6th century) and the Black Death (14th century),

each of which probably killed at least a third of the war-ravaged and severely stressed population of Europe.

Our century shows all the signs of a world-wide population crisis. Civilians, including women and children, made up 5 per cent of the dead in World War I, between 50 per cent and 75 per cent of the dead in World War II, and 84 per cent in Korea. Modern large-scale violence entails the possible use of weapons which could damage our natural environment on earth. For instance, insects are much less vulnerable to radio-active fall-out than either the plants they attack or the birds and mammals that normally prey on them. Extensive fall-out from bombs could thus bring about explosions of insect populations, which might destroy large areas of vegetation and create the conditions for widespread excessive soil erosion. This is only one of the known hazards of modern weapons. Evidently an ultimate population crisis response, far from sparing our natural resources, could irretrievably damage them. It is therefore a matter of some urgency to use a humane and harmless method of reducing our populations. If we are to

survive, we must substitute voluntary birth control for involuntary death control. Replacing "the old cruel methods by which Nature balanced our numbers", and with continuing research into the complex patterns of social space needed for mutually constructive relationships between people, it should become possible to bring about an environment in which every human being is truly entitled to life, liberty, and the pursuit of happiness.

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BOOK ON SPECIMEN COLLECTING

COLLECTING SPECIMENS, by John Child; Periwinkle Colour Series, Lansdowne Press, Melbourne, 1969; 112 pages. Price, \$1.50.

This is a further book in a very useful series intended for enthusiastic children and adults beginning to take an interest in natural history. Dr Child, who has written most of the series, must be regarded as a distinguished naturalist, and writes with authority on a wide range of natural history topics. His style is easy and does not take the beginner beyond his depth. Yet the book is packed with thoughtful advice which should contribute to the effectiveness and safety of the naturalist's operations. The completeness of the coverage of each topic is impressive.

The scope of the book may be best shown by listing the chapter headings: Collecting Land Animals; Collecting Water Animals; Keeping Alive—Land Animals; Keeping Alive—Water Animals; Animals—Preservation and Storage; Plants; Rocks and Minerals; Photography—Equipment; Photography—In Field and Studio; Aids to Study. The last chapter includes information on some of the most important items of equipment, the greater part of it being concerned with microscopes.

The book is generously illustrated in colour and black and white, but in several of the colour illustrations the blocks have not been correctly aligned and the resulting picture is blurred. In the captions to the illustrations we find a number of errors: the "Rust-red Firefly" (opposite page 19) is in fact a belid weevil; most zoologists would disagree with calling the hydrozoan (opposite page 26) a coral; the "Adult Mayfly" (opposite page 38) appears to be not an adult, but a subimago; some of the sea-shells are wrongly named.

It is indeed a pity that such a useful book has been marred by these shortcomings. I note that the brief "acknowledgement" does not include mention of help from scientific specialists, an omission which might explain some of the mistakes. It also omits mention of the fact that Dr Child was given permission by the Australian Museum to photograph the insects for the very attractive cover design.

Despite these defects I have no hesitation in recommending this book to all aspiring naturalists with some confidence that it will inspire a broader appreciation of natural history.—D. K. McAlpine, *Australian Museum*.

MODERN MAN AND DISEASE

By BASIL S. HETZEL

Foundation Professor of Social and Preventive Medicine, Monash University, Melbourne

At the beginning of the century most people in Australia died from infections. Today, the four commonest causes of death under the age of 55 in Australia are heart disease, cancer, accidents, and suicide. Infections as a cause of death have largely been controlled by the introduction of modern sanitation; antibiotics have also been important in the last 20 years. By contrast, the problem of control of heart disease, cancer, accidents, and suicide is indeed a formidable one for modern man, although some progress is being made.

Much effort has gone into research in heart disease and cancer. This has led to public education campaigns carried out by foundations set up by public subscription; some progress has been made. The importance of smoking in relation to heart disease and cancer of the lung is now well documented in Australia.

Accidents and suicides

In this article I would like to concentrate more attention on the problems of accident and suicide because they have received much less attention than heart disease and cancer. Yet accident is the major cause of death in males under 35 years of age; 71 per cent of deaths in males between the ages of 15 and 24 are due to accident and 47 per cent of deaths between the ages of 25 and 34. Cancer and heart disease are not important causes of death in males until after the age of 35. In women, accidents and suicide are equally as important as heart disease and cancer in the 25 to 34 age group, and accident is the major cause of death (43 per cent) between the ages of 15 and 24 years; suicide is the next most important (10 per cent).

It is becoming apparent that the use of the term "disease" is no longer appropriate for major causes of death such as accident and suicide, and thinking exclusively in terms of "diseases" leads to such conditions being overlooked by the medical profession and the community.

Last year the World Health Organization reported that traffic deaths (comprising approximately half of the total accident deaths) in Australia were the highest in the world. At present these stand at an average of 10 deaths per day in this country.

Suicide in Australia has increased from 10.3 per 100,000 of population in 1955 to 14.9 per 100,000 population in 1965—an increase of virtually 50 per cent, and our recent studies indicate that this increase is continuing.

We have some fragmentary evidence from pilot studies of the cause of traffic deaths. Approximately half of them are associated with high blood-levels of alcohol. Much more investigation is needed, which can only come with a proper system of notification and investigation similar to what we have already established for the study of maternal and infant deaths, which have to be notified and are systematically reviewed every year to identify causes and, if possible, prevent them. So far we have not been able to organize this system of notification, which would make all the difference in approaching the problem.

As far as alcoholism is concerned, a recent study of drinking habits in Sydney revealed evidence of heavy drinking as an integral part of the male role. This means that a vulnerable individual is much more likely to become addicted to alcohol in Australia. He is more likely to be concealed and, therefore, to reach treatment much later, with much less chance of success. Such findings help to explain the very high incidence of problem drinking in this country. At a recent international congress in Sydney, as many as 5 per cent of men and 1 per cent of women were reported to have a medical or social problem with drinking, yet the Alcoholism Foundations have only very modest support from the community in attempting to deal with this massive problem. Perhaps it is partly because we secretly reject the problem as it conflicts with our national image of the man who can hold his liquor. Medical

facilities for the management of alcoholic patients with social and medical problems are grossly inadequate.

My department in Melbourne is currently making an analysis of the features of suicide and suicidal behaviour in Victoria. This is the science known as epidemiology, which is familiar to us in relation to infectious disease. Epidemics of infectious disease occur from time to time, but we have now epidemics of non-infectious disease, such as traffic accidents and suicide. Our studies have revealed so far that suicidal behaviour has increased strikingly in women within the last 17 years and that this increase is apparent in the city of Melbourne but not outside it. For example, the suicide rate in women has risen from 4.2 to 10.1 per 100,000 since 1954 in the city of Melbourne, but outside Melbourne has remained relatively static. This increase is apparent in both younger and older women. We are also aware of a great increase in the number of women presenting in hospital casualty departments in Melbourne following an overdose of sedative drugs. Further analysis of these patients indicates that these suicide attempts are impulsive, associated with periods of marital and family difficulties in young women with young families. These women, for various reasons, do not call on their families or friends for support at times of difficulty or crisis. They have often suffered parental deprivation during childhood, and this seems to affect their capacity to establish relationships. They do not know about the social services available to them.

In this connection, a recent research seminar held last year by Australian Frontier in Melbourne estimated that there were 100,000 children and minors under 21 at risk in the State of Victoria, mainly from parental neglect, absence, or abuse. Many of these children are born out of wedlock or result from unsatisfactory marriages, often with deserted mothers. They are deprived of their natural birthright and parental upbringing and will be the source of many social and psychiatric problems for the rest of their lives. A report on child care prepared for the Victorian Government and published in 1964 has called for urgent measures, including community education, improved foster care, day nurseries and

children's homes and reception centres. Of all these recommendations only the homes have been provided, and these are now over-taxed with high costs for staff and maintenance.

I wish to point out that all these are major problems for the community: traffic deaths, with consequent loss of working years, apart from the personal suffering involved; alcoholism, with incalculable effects on personal and family life; suicidal behaviour, which, if unsuccessful, presents a great load on hard-pressed psychiatric hospitals and clinics; children at risk with a grim harvest for the future in welfare and health costs.

Now, these social problems are not insoluble. They will yield to the same methods of study and research as have been so valuable previously with other health problems, such as infectious diseases. We already know much more than we have applied in practice; more research will produce more knowledge that can be applied in turn. We have a problem, therefore, in the application and use of knowledge in this field.

Ways of using knowledge gained

What are our main means for using knowledge, as a society? There are three: first, education; second, legislation; and third, the establishment of appropriate public services—in this instance, the health and welfare services.

Education

Through our schools we can hand on to the next generation the benefits of research and new knowledge, but why do we restrict this to such a narrow range of subjects? Why can't we educate our children in a suitable preparation for life—to give them not just a knowledge of literature or physical science but a knowledge of human relations and of health hazards, such as smoking and alcohol.

Heavy smoking and heavy intake of alcohol are characteristic of modern man in a technological society. In Australia the consumption of cigarettes has quadrupled from 1 pound to 4 pounds per head of population per year in less than 30 years. The consumption of all forms of tobacco has increased by 50 per cent over the same time.

A significant relationship is also demonstrable between coronary heart disease and smoking; it was recently demonstrated in British doctors, as in the case of cancer of the lung earlier by Richard Doll and Bradford Hill. Smoking is also closely related to all other forms of chronic respiratory illness, such as chronic bronchitis.

A study, initiated by the National Health and Medical Research Council, of smoking habits in 20,000 Australian schoolchildren, aged 9–16, has been carried out. Preliminary findings indicate that, by the age of 15, 26 per cent of boys and 16 per cent of girls are smoking three to five cigarettes per day, which is certainly quite an alarmingly high incidence of smoking.

The importance of family attitudes is evidenced by studies of drinking patterns in high school students in Melbourne. One thousand and thirty-seven students from middle-class families, aged 15–18, answered a questionnaire which revealed that most of them drank with parental approval and sympathy; however, 10 per cent lacked a responsible approach and 2 per cent already had a drinking problem. It is clear that these children were following drinking patterns in the home, and the adolescents themselves agreed that there was a need for better education by parents, supplemented by teachers.

Recently, Mr A. R. Harcourt, Research Director for the Victorian Liquor Royal Commission (1964–65), said that the per capita consumption of beer for Australian adults in 1974–75 would be 46 gallons, compared with 38·3 gallons in 1966–67. Figures for 1966–67 showed that each Australian adult drank 2·3 gallons of wine and half a gallon of spirits in a year.

Mr Harcourt said that during the 1960's Australia's beer consumption had increased by 4·75 per cent each year, while the total population increased by less than 2 per cent each year. About \$900,000,000 was spent by Australian drinkers in retail purchases of alcohol—almost as much as the total health budget expenditure for Australia (\$1,200,000,000 annually).

All these facts indicate the urgency of a more responsible approach to health hazards in Australia. This involves the whole of our society—Parliament and mass media, as well as the educational system.

Legislation

The quality of life of a community depends to some extent on the legislative provisions made to safeguard it. We have heard in recent months much more about the dangers of the physical environment—air and water pollution and wholesale destruction of natural resources. Legislation is clearly going to be required to deal with this problem. We have heard again recently, following a periodic lull characteristic of Government concern in the matter, about the likelihood of legislation to control television advertising for cigarettes. We hear periodically of various proposals for legislation concerning the use of drugs. Today, in a society which increasingly regards man as free of the old paternalism, legislative action tends to be very unpopular; however, wise laws, liberal and flexible in their operation, are undoubtedly a major resource for safeguarding the quality of life for our children.

Legislative amendments are required in the field of child neglect in order to provide more effective mobilization of parent-substitutes and support for the many children who do not have parents.

Health and welfare services

We need to think beyond particular institutions to the whole community—for example, beyond the hospital to the community and the development of community resources to provide better community health services outside of hospitals. Experiments are urgently needed; modest financial outlay could mean big savings in the enormous health-care bill which has been highlighted over the last year in this country. The same applies to welfare institutions; bricks and mortar, with necessary staff, have become prohibitively expensive. We need to educate the community in such matters as adoption, foster care and day care nurseries, in order to diminish the need for institutional care and to provide a much better service. The fact is that we are now moving into a new era when “man is come of age”. He now stands on his own feet in greater control of his environment than ever before. In these circumstances he is fully responsible for what happens or does not happen in society.

Community action needed

To summarize, we need more research to pinpoint the nature of problems. We then have to give the community the benefit of the better understanding that comes from research, and, finally, the community has to take action. Not enough is happening in relation to the illnesses generated by our period of rapid social change. Large sums of money are being invested in order to develop the mining industry in Australia; substantial sums also need to be invested to ensure a future society and quality of life in Australia which will make the Australian community worthwhile living in. We are increasingly concerned about the problem of pollution, and rightly so; we are not enough concerned about the problems of family and community life, which, in a sense, are more subtle and difficult. Problems arising from traffic accidents, alcoholism, suicidal behaviour, and crime are intimately woven with our social environment. The wealth to be won from our great continent will turn to ashes in our mouths unless we make an appropriate investment in people to safeguard the quality of life of our society. We have learnt that man can create his own environment in physical terms; he is also responsible for the quality of his social environment and of his family and community life, as he is responsible for the quality of his own house and garden. Australia will not be worth living in in 20 years if man's responsibility virtually ends with his house and garden.

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BOOK REVIEWS

COMMON CITY BIRDS, by Graeme Chapman; Periwinkle Books, Lansdowne Press, Melbourne, 1969; 112 pages. Price, \$1.50.

This is a well-thought-out little paperback. The first five chapters give basic facts about birds. The first chapter describes simply where birds fit into the classification of living things. The second chapter describes the structure of birds, both externally and internally. The third, on the life of birds and on their distribution, gives information on subjects like preening, feeding, roosting, life expectancy, incubation, and development of young.

Chapter four constitutes the main part of the book, with descriptions and fifty-seven coloured photos of birds. These are arranged in systematic order with a useful table and index, at the beginning, of the birds under their families. The descriptions give the birds' main characteristics and with excellent, generally coloured photos. The birds should be easily recognized and the differences of the females and juveniles or immatures easily understood.

This book is recommended as an excellent introduction, not only to some of the common city birds, but also to ornithology and bird-watching in general. The text is simple and concise, with much information which is not available in similar books, and in his description of field behaviour the author is obviously writing from his own experiences. There are useful appendices on recommended books and guides, a list of gramophone recordings of birds, and the names of some of the societies which cater for ornithologists in Australia.—H. J. de S. Disney, *Australian Museum*.

HOW TO FIND AUSTRALIAN GEMSTONES, by Lois Sabine; an Australian House and Garden publication, Magazine Services Pty Ltd, Sydney; 1969; price \$1.

This book, obviously designed for the uninformed beginner, achieves its purpose very well, principally because it is written in a clear, simple style. The descriptions of prospecting tools and methods of washing and sieving for gem minerals in alluvial deposits, and the general description of the environments in which gemstones should be looked for, are made much clearer for the beginner by the many excellent black and white illustrations. The chapters on gemstones and ornamental stones and the accompanying tables set out clearly the chief Australian gem and ornamental minerals and their physical properties, but not chemical composition.

One of the most helpful features of this book is the series of very useful maps showing the location of the principal gem and ornamental minerals in each State and in the New England district, New South Wales, and also the productive areas in all the opal fields and in the Anakie sapphire field, Queensland.—R. O. Chalmers, *Australian Museum*.

LASSA FEVER: 1970-1972

By PAUL R. EHRLICH, Professor of Biology, Stanford University, California, U.S.A.,
and ANNE H. EHRLICH, Research Assistant, Stanford University

THE first three news stories are true: the rest are a scenario based upon them. A similar scenario could have been based on the 1967 Marburg virus incident. As world population grows and the world epidemiological situation becomes more serious, a sequence of events such as is depicted here becomes more and more likely.

NEW FEVER VIRUS SO DEADLY THAT RESEARCH HALTS, by Lawrence K. Altman. (*New York Times*, 10th February, 1970.)

American doctors have discovered a virus so virulent that they have stopped their research into its mysteries.

The virus, called Lassa Fever, killed three of the five Americans it infected during the last year

Lassa Fever infection can involve almost all the body's organs. The virus produces a fever as high as 107 degrees, mouth ulcers, a skin rash with tiny haemorrhages, pneumonia, infection of the heart leading to cardiac failure, kidney damage, and severe muscle aches.

Dr Jordi Casals . . . and his co-worker, Dr Sonja Buckley . . . named it for the place from which it came, which was Lassa, a village of about 1,000 Nigerians, situated about 150 miles below the Sahara

SPREAD OF DEADLY VIRAL FEVER IS SUSPECTED IN NIGERIA, by Lawrence K. Altman. (*New York Times*, 18th February, 1970.)

The American scientists who discovered the virus that causes Lassa Fever suspect that there is now an outbreak of the lethal disease in Jos, a tin-mining town in northern Nigeria.

Ten of twenty Nigerian and American patients died at Evangel Hospital in Jos of what is suspected to be Lassa Fever in recent weeks

Because of their experience with Lassa Fever a year ago, doctors at Jos suspected

the disease when the twenty patients became ill recently. They, too, had a high fatality rate—50 per cent

The greatest mystery is where the disease came from. Doctors suspect it was transmitted originally from an animal—which one they do not know—but that the patients with known Lassa Fever acquired the infection from each other.

Of more than curiosity now is the fact that last year's cases and this year's outbreak have occurred during the same months—January and February

THREAT TO NIGERIA FROM LASSA FEVER FOUND TO BE OVER. Lagos, Nigeria (Associated Press, 14th March, 1970).

Doctors studying Lassa Fever, a mystifying virus that has proved very dangerous to work on, say the disease no longer threatens the northern Nigeria area where it was discovered

LASSA FEVER AGAIN IN NIGERIA. Lagos, Nigeria (United Press, 12th February, 1971).

Fifteen people in Nigeria have come down with what is believed to be Lassa Fever . . . Three have died so far this year in Jos and two others from neighbouring villages . . . Doctors at the University of Ibadan are working to develop a plasma serum from the blood of an early survivor in an effort to save the eight who are still critically ill

NEW DISEASE REPORTED IN GHANA. Accra (Reuters, 5th March, 1971).

An unknown virus disease has stricken the village of Lmuto, 50 miles from Accra. Seven people have died in the last week. The village has been strictly quarantined and no new cases have appeared since last Tuesday

LASSA FEVER CONTAINED. Lagos, Nigeria (United Press, 17th March, 1971).

Last month's outbreak of Lassa Fever in Jos, Nigeria, is now believed controlled,

local medical authorities say. There have been no new cases since 2nd March . . . In total, twenty-seven people are believed to have been infected. Sixteen survived, in part thanks to prompt action by doctors at the University of Ibadan, whose serum was developed in time to save at least five of the survivors . . .

Research is proceeding in Ibadan and at a new virus laboratory in Atlanta, Georgia, U.S.A., to develop a more effective way of combating the dangerous virus . . .

EPIDEMIC IN MOZAMBIQUE. Tete, Mozambique (Reuters, 23rd August, 1971).

Reports from missionary medical stations in remote areas south and west of Tete indicate that some unknown disease is assuming epidemic proportions. At least 130 people have died from it. The disease does not respond either to sulpha or to antibiotic drugs . . .

DISEASE IN TANZANIA. Dar Es Salam, Tanzania (United Press, 16th September, 1971).

A mysterious virus disease that appeared in Mozambique last month has been reported in southern Tanzania . . . The borders between the two countries have been temporarily closed . . .

VIRUS ESCAPES IN ATLANTA. Atlanta, Ga. (Associated Press, 13th November, 1971).

Three technicians and a virologist have been diagnosed as having Lassa Fever . . . Two of the technicians were involved in research on the virus. The other is not known to have been in contact with the disease . . .

NEW CASES IN GEORGIA. Atlanta, Ga. (Associated Press, 6th December, 1971).

Lassa Fever has appeared in Athens, Georgia, where six people have contracted it . . . Two technicians in Atlanta have died, and the other two patients are still recuperating. Serum is being developed from their blood plasma. But so much plasma is needed for each new patient, there is little hope of curing all six . . .

No progress has been reported in the development of a vaccine either at the virus centre or in Nigeria, where the disease was first diagnosed . . .

AFRICAN DISEASE IN INDIA. Bombay, India (Reuters, 18th December, 1971).

A mysterious virus disease, probably one which is now epidemic in Mozambique and southern Tanzania, has broken out in Bombay. Doctors believe that it was brought by Indian residents of Tanzania who came to Bombay. . . .

INDIAN DISEASE MAY BE LASSA FEVER. New Delhi, India (United Press, 4th January, 1972).

Doctors at the University of Delhi believe that the unknown virus disease that is overrunning India may be Lassa Fever . . . Tests are now being conducted. . . .

New cases are being reported daily in Calcutta, Bombay, and Delhi. . . . Deaths seem to be running at a rate of 60 to 70 per cent. . . .

Tanzania and Mozambique both report failure at containing the disease. Cases have now been reported in Zambia, Kenya, and Rhodesia. . . .

The escaped virus in the United States seems to have been suppressed, after nine deaths and twenty-one reported cases in the State of Georgia. . . .

INDIAN DEATH TOLL REACHES 5,000. (*The Australian*, 6th January, 1972.)

Known deaths from Lassa Fever are 5,038 and cases are being reported from new states. . . .

Deaths in Africa are estimated to be as high as 7,000 by some authorities. . . . Squatters have begun leaving such cities as Dar Es Salam and Nairobi . . . Quarantines have proved ineffective in controlling the spread of the virus. . . Cases have appeared in West Africa and Egypt. . . .

LASSA FEVER IN EUROPE. Rome (United Press, 8th January, 1972).

Isolated cases of what may be Lassa Fever have appeared in two port cities in Italy and one in Greece. . . .

NEW CASES IN U.S. New York (United Press, 9th January, 1972).

Lassa Fever has broken out again in three southern states, Georgia, South Carolina, and Tennessee. . . . Three more deaths

have occurred since the earlier escape from an Atlanta laboratory. . . . Early incorrect diagnosis in rural clinics is believed to have contributed to deaths. . . .

LASSA FEVER CALLED PANDEMIC. (*The Australian*, 13th January, 1972.)

Lassa Fever has now appeared on all major continents except Australia. It was reported in Brazil and Chile yesterday. New cases have been at least tentatively identified in Odessa, U.S.S.R., most Mediterranean countries, England, France, Germany, Austria, Mexico, Turkey, Morocco, all of Africa south of the Sahara. The disease is believed to be widespread in parts of southeast Asia, but the turmoil caused by the war there makes certain identification difficult. . . . China has not admitted having Lassa Fever, but authorities feel that it will soon spread there if it has not already. . . .

AUSTRALIA AND NEW ZEALAND CLOSE BORDERS. (*The Australian*, 15th January, 1972.)

In an unprecedented move, the Prime Minister, Mr Gorton, and Federal Minister of Health, Dr Forbes, today jointly announced that Australia's borders will be closed from today until the Lassa Fever pandemic has run its course or has been halted through medical means. New Zealand's Government has made a similar announcement. . . . Only essential importation will be permitted, after suitable quarantine measures for delivery have been set up.

Medical authorities have reported no success in developing a vaccine for Lassa Fever or in discovering the means of transmission. . . .

India has declared a national emergency. . . . Medical stations have been established in towns and villages to treat the sick. The death toll has passed 10,000. The disease is fatal in about 70 per cent of diagnosed cases. . . . The disease spreads fastest and death rates are highest among the poor there, as in other countries. . . .

A U.N. spokesman has said that a combination of a very large, dense, generally poor and hungry population with rapid transportation systems is the basic cause of the severity of the pandemic. . . .

The disease is believed to be rampant in at least two Chinese cities and adjacent

rural areas. . . . It now exists in every country in Asia and Africa. . . .

CHINA ACCUSES U.S.S.R. OF B.W. (*The Australian*, 20th January, 1972.)

Radio Peking, in its most vindictive broadcast in months, today accused the Soviet Union of practising biological warfare. . . .

The outbreak in the U.S. is reported out of control. The disease is apparently increasing among slum dwellers in large cities and the rural poor, especially in the south. . . . The death-rates in North America and Europe seem to be about 55 per cent. As more plasma serum is developed and distributed, this percentage is expected to drop. . . .

WORLD DEATH TOLL NEARS MILLION. (*The Australian*, 21st January, 1972.)

The United Nations today announced that, at the present rate of acceleration, deaths from Lassa Fever would reach 1 million by 22nd January, and that 3 million cases will have appeared by the end of the week. . . .

Most countries report considerable disruption of normal activities and states of emergency prevail in most cities. . . . Refugees are fleeing from cities in Africa, Latin America, and India by the millions. Public transport and food distribution in cities around the world have been seriously hampered by absenteeism. Non-essential businesses in large U.S. and European cities have closed offices for the duration of the emergency. Volunteers are being mobilized to distribute food and keep power plants and transportation systems operating.

Medical authorities report that an effective vaccine is still months away. Crash research programmes are going on in several countries. Plasma serum is still scarce in developed countries, but the disease death-rate has dropped to 53 per cent. Top priority for serum is given to medical personnel and children. Minorities in the U.S. complain that serum is available only to "establishment patients" who can afford it. . . .

Serum is generally unavailable in under-developed areas, and medical facilities have been swamped. U.N. agencies have been

trying to distribute serum, but with little effect. Death rates run from 65 to 75 per cent. It is rumoured that black markets for serum have appeared in the Middle East, North Africa, and some Latin American countries. . . .

Australia has begun limited trade under strict quarantine regulations. . . .

EIGHT MILLION DEAD OF LASSA FEVER. (*The Australian*, 8th February, 1972.)

U.N. authorities now estimate that over 8 million victims have been claimed by Lassa Fever, 5 million of them in Asia. The disease continues to spread unchecked, except for quarantined Australia, New Zealand, and Hawaii. . . .

The social system is breaking down in India. Food riots have been reported in Calcutta and Bombay and several smaller cities. The dead are now being buried in mass graves. . . .

There is little news from Africa, but it is believed that conditions in most sub-Sahara countries except South Africa are nearly as bad as in India. . . .

The long recovery period of survivors is believed responsible for much of the social disruption. . . .

SYDNEY GETS L.F. (*The Australian*, 12th February, 1972.)

A Sydney dockworker today came down with what is believed to be Lassa Fever. Serum is being flown from the U.S. to treat him. . . .

The quarantine regulations regarding foreign trade have been further tightened to prevent more occurrences. . . .

The dockworker and medical personnel tending him are being kept in strict isolation. . . .

30 MILLION DEAD. (*The Australian*, 19th February 1972.)

U.N. sources say that the number of cases of Lassa Fever is doubling about every week. . . .

Agricultural leaders have expressed concern that spring planting of crops can be carried out. Some countries are establishing volunteer programmes utilizing urban workers in non-essential industry. . . .

CHINA ADMITS NO B.W., MOVES TO CO-OPERATE WITH U.S. AND U.S.S.R. TO FIND CURE. (*The Australian*, 23rd February, 1972.)

Radio Peking reversed its previous belligerent stand today. . . . China is estimated to have more than 6 million deaths from Lassa Fever. . . . Hong Kong reports a massive influx of refugees in the last week. These refugees describe scenes of mass disruption and chaos in China.

Nearly 1.5 million have died in the U.S., 4 million in Europe. . . . Bread lines and government food distribution centres have been established in all countries. . . . Mass migration from cities has been reported. . . .

Australia is still the lucky country. The Sydney dockworker is still the only case here. He is reported out of danger. . . .

A University of Sydney virologist has speculated that even if Lassa Fever should gain a foothold here, it would be relatively easy to contain it or to delay its spread. This is because Australia is so sparsely populated outside her cities. An infected city could be quarantined from the others. People in the outback might never be exposed. . . .

Government and medical authorities are developing a plan for dealing with the disease if the national quarantine should fail. . . .

Because of rampant Lassa Fever, the war in southeast Asia is virtually at a standstill. The withdrawal of American troops has been accelerated, and the last of them are expected to depart by 1st March.

The last Australian troops are now established in the quarantine compound near Lae, New Guinea. Approximately 50 of the 350 soldiers have perished. . . .

DISEASE CLAIMS 120 MILLION. (*The Australian*, 3rd March, 1972.)

U.N. sources report that the incidence of the disease is no longer accelerating quite so fast as a few weeks ago, although the absolute numbers of sick and dead continue to rise astronomically. They project that the ultimate death toll may be well over 1 billion, assuming there is no significant change in lethality of the virus. This might be mitigated by the perfection of an effective

vaccine. The disease is expected to run its course in 4 to 6 weeks at the present rate of spread.

The serum situation is slowly improving, but even in developed countries only about one-quarter of the sick can be treated. In underdeveloped areas, the situation is worse. . . .

Assessing the present world situation is becoming more difficult as wire services and radio news become more erratic. . . .

Many deaths from starvation have been reported from areas of rural India and Brazil, where sickness has destroyed normal food distribution channels. . . .

Let us end the scenario on a happy note:

CHINA LEADS WORLD TOWARDS UNITY AND SURVIVAL. (*The Australian*, 27th March, 1972.)

A U.N. spokesman announced today that secret talks initiated by the People's Republic of China have led to agreement among all the major powers that U.N. power will be increased and national sovereignty decreased. "The great Lassa virus tragedy," Premier Chu stated, "has shown all of mankind that we must co-operate to solve our population and environment problems and learn to live together in peace on our Spaceship Earth".

Book on Seashores Reviewed

AUSTRALIAN SEASHORES IN COLOUR, by Keith Gillett and John Yaldwyn; A. H. and A. W. Reed, Sydney, Melbourne, Wellington, Auckland; 1969; 112 pages, with 52 colour plates and 67 black and white photographs and diagrams. Price, \$3.95.

This book deals chiefly with organisms from the temperate shores of Australia, with a few tropical shore scenes and species added for good measure—a bias which is probably intentional, since it complements a previous book in the series by Gillett on the Great Barrier Reef. One of the chief values of the present volume is that it shows, in no uncertain manner, how the plants and animals from temperate shores are every bit as colourful and interesting as their tropical counterparts—a fact that is often overlooked by naturalists.

The text and diagrams are commendably clear and informative and the writing is concise, packing a great deal of information into a few paragraphs. It should be easily understood by laymen and young readers.

The book's coverage of shore plants and animals is fairly representative, with perhaps a slight favouring of coelenterate corals, jellyfish, and their relatives, but this is a good fault, if fault it be, since this group is generally sadly neglected. For instance, it will probably come as quite a surprise to some to find that corals flourish down the east coast, well south of the Great Barrier Reef.

The general introductory section between pages 10 and 23 describes the geographical patterns of intertidal zonation as they occur in Australia from cool temperate regions in the south to the tropical north, and if you are unfamiliar with what is meant by the term "zonation" that, too, is simply explained and illustrated by colour photos and a diagram. The types of shore ranging from muddy to rocky

bottom are illustrated, and the effect the texture of the substratum has on animal and plant populations is discussed.

All this background material for shore exploration in Australia has not previously been readily available in a single, moderately priced volume, and this should make the book a welcome aid to the teaching of biology.

The main part of the book is devoted to the reviewing of the various groups (phyla) of marine plants and animals; many of them are beautifully illustrated in colour, which, with one exception (plate 43), is true to life.

While the authors have meticulously indicated magnifications of structures in all photomicrographs, they have neglected to show the sizes of organisms in the bulk of the figures and plates, so that one has no indication, for instance on plate 11, how much bigger the giant kelp *Durvillea* is than *Ecklonia*; also, the fronds of the small, tufty, 2-inch-high alga, *Champia*, look larger than those of the adjacent *Phyllospora*, which may be from 4 to 6 feet long. This, however, could easily be remedied in future printings. Another criticism is that one or two animals which at present must be regarded as rare find a prominent place in the book—one suspects because good colour illustrations were available. Would it not be better rather to have chosen species likely to be seen by most shore fossickers? However, these slight criticisms in no way detract from the value of the book as a whole, which is a most welcome addition to the series, with its crisp text and fine illustrations. It can thoroughly be recommended to teachers for inclusion in biology reference libraries and should be popular with skin-divers.—*Elizabeth Pope, Australian Museum.*

ABORIGINAL MAN IN EUROPEAN AUSTRALIA

By DAVID R. MOORE
Curator of Anthropology, Australian Museum

IT is almost 200 years since European settlement began in Australia and during the whole of this period official policies have been, almost without exception, well-intentioned towards the indigenous inhabitants of the continent. Yet the "Aboriginal problem" is still with us and is, in many ways, just as far from solution as it was in 1840, when Lord John Russell, Under-Secretary for the Colonies, attempted to lay down a "positive plan for the better protection and civilization of the native tribes". In a letter to Governor Sir George Gipps he aptly summarized the situation:

There appears to be great difficulty in making Reserves of Land for the Natives which shall be really beneficial to them. Two sources of mischief mar the most benevolent design of this nature;

the one arising from the inaptitude of the Natives to change their desultory habits and learn those of settled industry; the other from the constant inroads of Europeans to rob, corrupt, and destroy them.

Today great efforts and very large amounts of money are being expended in attempts to assist the Aboriginal people to find a satisfactory place within the general Australian community. Yet many of the current plans appear certain to fail, as have innumerable well-meant schemes in the past, through the inability of both white and dark Australians to view the problem honestly and realistically in its historical perspective.

The intensive research of the past decade, as well as establishing a time span of more than 30,000 years for Aboriginal occupation



The fringe dwellers. A sad come-down from the old tribal co-operative virtues. Many Aborigines still have no option but to squat on unwanted border lands, seeking what casual employment becomes available. But even this kind of freedom is often preferable to institutionalized government settlements and missions where all hope and initiative are stifled.

of the Australian continent, has also shown that most of the traditional Australian beliefs about the Aborigines are false. Since it is essential to understand the past in order to plan effectively for the present and future, an informed look at certain aspects of the traditional life of the Aborigines could well have relevance to any plans made for and by the Aboriginal people. The aspects of this life that would appear to have most important applications are:

- Ecological, i.e., the way they used the land and exploited its products.
- Political, i.e., the way in which law and order were maintained and co-operative activity was ensured.
- Technical, i.e., the skills required of the individual in order to operate and co-operate within the tribal organization.
- Psychological, i.e., the drives or motivations that kept Aboriginal man in command of his environment and in amity with his fellows.

In the ensuing sections of this article our knowledge of these four aspects is applied to present-day problems of Aboriginal adaptation to European society.

Land use

Today Aboriginal leaders are agitating for the return of some part, at least, of the continent to the Aboriginal people, but there is little constructive thought as to what use they might make of land if it were granted to them. In the traditional life land was not owned in the western sense. Professor Elkin has put this clearly in a recent article entitled "Elements of Australian Aboriginal Philosophy" (*Oceania*, Vol. 40, No. 2, 1969, pages 85-98):

It is true, at least from our point of view, that members of such a local group owned their "country". But that is only one aspect of the situation. A more significant aspect is that they belonged to their "country"—that it owned them; it knew them and gave them sustenance and life. Therefore, no other "country", never mind how fertile, could be their country nor mean the same to them.

The implications of this to a people who have been progressively forced from their ancestral lands is not hard to imagine.

It is often stated that the Aborigines did nothing to increase the food supply of their "country", simply hunting and gathering

what was there, but this is not by any means true. Though they never became herdsmen or agriculturalists, nevertheless they did assist the natural supply of foodstuffs in a number of ways. The most important of these was the almost universal practice of deliberately "burning off" annually, as has been described by Rhys Jones in a recent article, "Firestick Farming", in *Australian Natural History* (Vol. 16, No. 7, 1969, pages 224-228).

There are a number of good reasons why the Aborigines never became farmers and herdsmen, even though they had long contacts with horticulturalists and farmers on the north coast—the Papuans at Cape York and the Macassans in Arnhem Land and the Kimberleys. Firstly, there are no indigenous Australian animals and plants suitable for domestication. How many of our profitable crops and herds have not been introduced from elsewhere? The other main reason is that there was no necessity for the Aborigines to become farmers and herdsmen, since the population nicely adjusted itself to the food resources naturally available. In normal seasons the continent produced ample food for the 300,000 or so inhabitants scattered throughout its 3 million square miles. If seasons were bad, permission could be obtained to hunt and collect in the territory of a neighbouring group more fortunately placed.

This happy equilibrium was rapidly overturned as soon as European settlement began to spread across the continent, and the process of detribalization and alienation is now complete, without any satisfactory alternative way of life having been found. It is worth noting, however, that the two European activities in which the Aborigines have operated most satisfactorily and happily (even though they have been grossly exploited in the past) have been the cattle industry in the north and seasonal crop-picking and collecting in the south. They have not usually been successful in more sedentary occupations requiring prolonged work in a restricted area, such as agricultural labouring. This may well be because in both cattle-herding and crop-picking they can move about the countryside and are, in a sort of way, living off the land; also, in all of these activities Aborigines can use their deep and subtle knowledge of landscape and ecology.



Aboriginal art. An aspect of Aboriginal creativity not usually stressed—the incised stone tjurunga of Central Australia. These display stylized simplicity of design combined with near-perfection of form; the colour, shape, and texture of the stone itself contribute greatly to the whole composition.

A people which has been ceaselessly on the move for more than 30 millenia cannot be expected to become wholly sedentary in two or three generations. Even today, quite sophisticated urban Aborigines travel around visiting and fulfilling kinship obligations to a far greater extent than their white counterparts. For this reason, it seems particularly unfortunate that large numbers of Aboriginal people who have been born and brought up in the country are now being forced into the cities by the intolerable living conditions, poor wages, and racial discrimination that are their lot in most rural areas.

Political control and co-operation

Contrary to popular belief, the Australian Aborigines never had any chiefs nor any form of hereditary chieftainship. Nor did they even have a fixed council of old men who ruled the tribe. It has only recently become clear, through detailed anthropological fieldwork in a number of areas, that the controlling body in the tribe or local group

varied according to the matter to be decided. As in other aspects of Aboriginal life, the Dreamtime (more appropriately termed the Dreaming) was the ruling factor, for the consultative body consisted of those men who had progressed farthest in the ritual life and were in the appropriate totemic relationship to the persons involved in the business under consideration. Such men were generally middle-aged by European standards. The very old were shown some deference, but had no actual control except in so far as they partook in the consultative process by sanction of the Dreamtime myths—the bible and book of laws of a people without writing. A more detailed account of Aboriginal government and a list of references are given in an article by R. M. Berndt, which forms Chapter 7 in *Aboriginal Man in Australia* (see the book list at the end of this article).

After the tribal life was disturbed by white encroachment, some outstanding men did endeavour to lead their tribes into a compromise existence and to establish a symbiotic relationship with the settlers, but the majority of the unfortunate old men who were presented with brass “King Billy” breastplates in an effort to boost their authority, had, in fact, no control whatsoever over their tribespeople. Undoubtedly many of the early misunderstandings and so-called “treacheries” of the Aboriginal people were due to the inability of the whites to comprehend the functioning of Aboriginal political control.

Turning to the other aspect of Aboriginal life which is still of importance—co-operation—it will have become clear already that in the old life this was virtually automatic. The tribe, entirely dependent on the natural resources of its territory, would not have functioned unless everyone co-operated fully in daily activities, especially in food-getting. Everyone had his or her duty to hunt or collect for the common good; everyone obtained a fair share, according to status, when food was distributed. Personal possessions were few and basic, so that stealing was practically unknown. Everyone had a correct place in camp, a correct mode of behaviour towards every other individual in the local group, the tribe, and even in other tribes—because these things were ordained by the kinship system, and this again derived its sanction from the Dreaming.

Not all the Aboriginal virtues evaporated overnight when the tribal lands were usurped by white settlers. Wherever Aboriginal groups were gathered together, kinship obligations were maintained, and still are to this day in many communities. But co-operation with whites was, and is, a different matter. Most Aboriginal people have suffered so much discrimination, contempt, cruelty, and hardship at the hands of the dominant group that their only wish is to be left in peace and to have no truck with white helpers, however well-intentioned. Nevertheless, many Aboriginal people do want better opportunities and an improved standard of living, but can see no way of attaining either, because few have developed the acquisitiveness and personal ambition necessary to flourish in white competitive society.

Australians should not be misled by the fact that today, when many Aboriginal leaders are beginning to take courage and speak their minds, their speeches are often filled with hostile demands for land and financial recompense for past cruelties and injustices, rather than putting forward constructive and co-operative plans. "Black Power" is sometimes threatened, without any clear understanding of what this catchphrase means or involves. Such outbursts are

inevitable in a people only now beginning to obtain some education and political rights. They are a most hopeful and healthy sign, for they indicate that at last the Aboriginal Australians are regaining some belief in themselves and their own future, rather than sitting back abjectly and waiting for extinction.

Technology and art

It might seem strange to some people to talk of technology in relation to Aboriginal traditional life, but the intention in this section is to point up the remarkable skill with which the Aborigines utilized virtually every material available to them in order to exploit their environment to the full in their food quest. One needs only to illustrate the superb stone implements and woodworking of the men and the manufacture of beautiful nets and baskets by the women in all parts of Australia to establish the high standard of technical skills which were the norm rather than the exception in Aboriginal society.

Where opportunity has been given for Aborigines to acquire western technical skills—for example, in the maintenance of mechanical devices of all sorts—they have shown themselves adaptable and quick to

Aboriginal technology. Stone tools of the final stage in the development of stone-working techniques, which began about 6,000 years ago. The implements illustrated above include various backed blades, adze flakes, and different types of spear points. The largest of them are about 2 inches long.



learn. However, the majority of Aborigines in European Australia can only obtain boring and totally unskilled work, often on a casual and intermittent basis, so that there is no incentive or opportunity for them to improve their knowledge. Only a minute minority have had any technical training to adapt their own innate skills to Western technological needs.

Apart from the concentrated and sustained efforts involved in ceremonies and rituals, Aboriginal traditional technology was directed almost entirely to pursuing the food quest as efficiently as possible. In the tribal life virtually every edible animal and plant was incorporated into the diet and, in general, this seems to have ensured a healthy, strong, well-built, and active people. On the other hand, the sort of diet handed out by Europeans on stations and missions has more often than not been seriously deficient in many vital elements, and the sad decline of physique and general health under such circumstances has played a considerable part in holding Aboriginal people back and retarding their advancement in European society. The old knowledge of beneficial plants and healthy bush diet has largely vanished, so that Aboriginal communities tend to subsist on cheap and unnutritious European foodstuffs.

The summit of Aboriginal creativity was undoubtedly reached in the great ritual cycles and religious art. These called for fine craftsmanship and for artistic and dramatic skills of a high order. Unfortunately, these aspects of Aboriginal ability have latterly been used mainly to produce poor facsimiles of the old visual and ritual arts for the titillation of white audiences, who are largely quite indiscriminating in their reactions. Hence, the reward received by Aboriginal artists has never been commensurate with the skill and time employed. For this reason, there is little incentive for Aborigines to continue to produce even traditional arts of high quality. Deterioration of standards has been rapid and is likely to accelerate as the Aborigines become increasingly the object of organized tourism, such as is being planned at present. In any case, the production of vast quantities of traditional artefacts and art objects is not a satisfactory long-term solution to the problems of improving living standards for any native peoples. Markets

become surfeited and tastes change. Without the religious or ecological spur, the business of reduplicating traditional arts and crafts becomes wearisome and pointless for the craftsman. Better by far that Aboriginal skills should be directed into constructive projects for the betterment of the Aboriginal people themselves and of Australians in general.

Motivation

Motivation is perhaps the key to the whole problem, because it is the conflict of Aboriginal norms of co-operation, conformity, and non-competitiveness with the cut-throat, individualistic drives of European society that predestines to failure most Aborigines who try to make the change-over.

In earlier days it was considered that if only the heathen "blacks" could be "christianized" their motivational eccentricity would be counteracted and they would become astute, ambitious, and conformable to the mores of western civilization. Many missionaries were utterly ruthless and brutal in their attempts to destroy the old motivations of the Dreaming. T. G. H. Strehlow (1964) quotes an old Aborigine at Hermannsburg Mission, Central Australia, who remembered the first missionaries saying to the Aranda ritual leaders:

"You are quite mad and ignorant . . . you heathen folk have wrong beliefs, your thoughts are utterly senseless and wrong. The true God is in the sky."

To which the old Aborigines replied: "We are a good (mara) and morally blameless (gatalarumba) people. We cannot imagine what your god is like. We are upright, we are altogether different and better (than you)—we children of the tjibulara (literally 'brightness'). When we gaze upon the tjilpa (totemic ancestor) on his own ground, then we are performing a virtuous deed."

In fairness it must be added that several later missionaries (including Strehlow's own father, who subsequently took charge of Hermannsburg) came to admire many aspects of the traditional life and encouraged the people to preserve them.

Today many Aboriginal parents do earnestly desire that their children shall have a less hopeless and poverty-stricken life than they themselves have had. They dimly realize that education is the key to everything, but do not comprehend what this involves. Most Aboriginal children do as well as white children in the primary grades, but

as soon as self-motivated study (e.g., homework) is required, they drop off. This is partly because the home background—crowded, noisy, and ill-lit—makes concentration impossible, while poor nutrition and consequent ill-health cause irregular attendance, but also because the incentive is absent, both in the community and in the individual. It is likely that limitations in vocabulary and in perception of the subtleties of English may also hold children back.

A most sensible and practical appraisal of the whole situation came recently from Margaret Valadian, an Aboriginal girl who graduated from the University of Queensland and has recently been studying at the East-West Centre in Hawaii. She says (*Sydney Morning Herald*, 6th April, 1970): "As things stand, we are not being given a choice; we are being told we must become white Australians, and children grow up knowing nothing of Aboriginal culture. But many Aborigines are not accepting this. They have withdrawn from the general community and are sitting on the fringes of society."

Miss Valadian considers that Aborigines can attain everything they want within the existing political system, but must learn to use to the full the powers already available to them. She sees the possibility, and perhaps the desirability, of wholly Aboriginal towns developing on existing missions and reserves, with community ownership of land and supported by co-operative projects. Such communities might operate pastoral stations, fishing co-operatives, or light industries on a profit-sharing basis. In the early stages, at least, European advice and guidance, tactfully given, would be essential, as would substantial capital investment. The important thing about such concepts is that they would utilize traditional Aboriginal motivations, because they would call for co-operation, not competition; they would provide a community life with continuation of Aboriginal virtues, such as the fulfilment of kinship obligations, and yet participants could earn a decent living. Of course, not all Aborigines would want to associate in such communities, but some more sophisticated Aborigines might find fulfilment in helping such ventures to succeed.

Where such settlements are no longer practicable, consideration might be given to assisting Aborigines to group themselves

into mobile work forces, so that they could be called upon whenever urgent work is required, whether by local councils, landowners, developers, or government agencies. Other sectors of employment for which Aborigines would seem to be particularly fitted include rangers, tourist guides, surveying and geological parties, and so on.

To sum up

The Australian Aborigines are a naturally good-humoured, co-operative, gregarious people. They must be given a share in their own land and a satisfactory place in the community. But this must be on their own terms, not on terms imposed on them by the alien intruders.

The Aboriginal people are likely to contribute far more to Australian life in general if they are allowed to retain their identity as a distinct ethnic group within the Commonwealth.

For their part, Aborigines must sink their differences and put aside their regional jealousies so they can work together for their own good and the good of Australia.

The European majority must listen sympathetically to Aboriginal aspirations and urge governments to provide every possible assistance to further Aboriginal education and community projects.

There is no place in Australia for a poverty-stricken and repressed minority. Aboriginal skills and virtues must be allowed to contribute to the common good and, in so doing, may perhaps help to restore some of the ecological balance which used to exist throughout the Australian continent.

[The photos in this article are by Douglass Baglin, and the specimens illustrated are from the Australian Museum's collections].

FURTHER READING

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MEET OUR CONTRIBUTORS . . .

L. CHARLES BIRCH, Challis Professor of Biology, University of Sydney, was educated at Scotch College, Melbourne, and the Universities of Melbourne and Adelaide. He was research entomologist at the Waite Institute in Adelaide for 6 years before proceeding to ecological studies at the University of Chicago and, later, Oxford University. He was appointed senior lecturer at the University of Sydney in 1948 and Challis Professor of Biology in 1960. Professor Birch has taught and carried out research in numerous universities in the U.S.A. and South America.

PAUL R. EHRLICH is Professor of Biology at Stanford University, California, U.S.A. He graduated B.A. (University of Pennsylvania) in 1953, and M.A. and Ph.D. (University of Kansas) in 1955 and 1957. His general field of research is population biology, including ecology. He is working on density effects in human populations. Professor Ehrlich's wife, ANNE H. EHRLICH, has been a research assistant and biological illustrator at Stanford University since 1959.

THEODORE C. FOIN, Jr, is Assistant Professor of Environmental Studies and a member of the Institute of Ecology, University of California, Davis, California, U.S.A. He received his training as a population ecologist from Professor Alan Stiven, University of North Carolina, Chapel Hill, and as a systems ecologist post-doctorally from Professor K. E. F. Watt. Dr Foin is engaged in a variety of research in the human ecosystem, including the areas of air pollution, public health, education, crime and violence, and the quantification of human attitudes.

BASIL S. HETZEL, M.D., F.R.A.C.P., became Foundation Professor of Social and Preventive Medicine at Monash University, Melbourne, 2 years ago. Prior to that he was Michell Professor of Medicine at the University of Adelaide for 4 years. Professor Hetzel graduated from the University of Adelaide in 1944, and has been engaged in research work and teaching, as well as the practice of medicine, since then. He was a Fulbright Research Scholar at the Cornell-New York Hospital, U.S.A., from 1951 to 1954. His major field of interest has been in psychological and social factors in illness, and in endocrinology.

NEIL INGHAM is Senior Town Planner with Clarke Gazzard Planners Pty Ltd, Sydney, a division of Urban Systems Corporation. He was educated in New South Wales, registered as a surveyor in 1957, and completed post-graduate studies in town and country planning at Sydney University in 1968. His experience has been with State government, local government, a statutory authority, and consultant planners. Mr Ingham's main professional interests lie in the fields of policy planning, regional planning, and environmental planning.

DAVID R. MOORE, Curator of Anthropology at the Australian Museum, has been involved in Aboriginal welfare and advancement for many years. He is an original committee member and vice-chairman of the Foundation for Aboriginal Affairs. A book, *The Dark Australians*, on which

he collaborated with Douglass Baglin, has recently been published.

J. G. MOSLEY was born and bred in the Peak District National Park, England. He received a university education as a geographer at the University of Nottingham, graduating B.A.(Hons) in 1953 and M.A. in 1955, and the Australian National University (Ph.D., 1964). In between he was an education officer in the Royal Air Force, a supervisor of the Rocky Mountain chain of youth hostels (Canada), and a member of New Zealand's National Resources Survey. His post-graduate studies have been entirely in the related fields of conservation and recreational land use.

AMOS RAPOPORT has taught at Melbourne University, University of California at Berkeley, and University College, London, and is at present Senior Lecturer in Architecture at Sydney University, where he specializes in man-environment studies. He has been involved in this field for a number of years and has published many articles and a book, *House Form and Culture*.

CLAIRE RUSSELL has practised as a psychoanalyst since 1946; W. M. S. RUSSELL has worked for several research organizations and is at present Lecturer in Sociology at the University of Reading (England). Singly or together, they have researched on most aspects of animal and human behaviour. Their publications include *Human Behaviour: a New Approach* (1961), the first attempt to apply to human behaviour the methods and concepts developed by Lorenz and Tinbergen to study animals.

R. O. SLATYER is Professor of Biology and Head of the Department of Environmental Biology in the Research School of Biological Sciences at the Australian National University. His main research interests have been in the water and energy relations of plants, especially in the effects of water stress on plant production. More recently he has extended his work to general considerations of man's use of the environment, and the factors underlying stability in ecological systems.

DALE STRAUGHAN graduated Ph.D. (Zoology) from the University of Queensland in 1966. She was then Senior Demonstrator at the University College of Townsville, and carried out research on problems of marine fouling. At present she holds a joint appointment in the Department of Biological Sciences and the Allan Hancock Foundation at the University of Southern California. She is project director of the research project to study "biological and oceanographic effects of oil spillage in the Santa Barbara Channel following the 1969 blowout", at the Allan Hancock Foundation.

J. M. THOMSON is head of the Department of Zoology, University of Queensland. He is a graduate of the University of Western Australia, from which he holds the degree of D.Sc. For 18 years he was a member of the CSIRO Division of Fisheries and Oceanography, and during that time became acquainted with rivers, estuaries, and the coastal waters of every State. Prof. Thomson's current research includes a study of the occurrence of pesticides in estuarine waters and estuarine fish.



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