ECOLOGY AND CONSERVATION IN GHANA

by

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An Inaugural Lecture delivered on 30th April, 1970 at the
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A former Professor of Education of this University once said to me that, bearing in mind the vast number of articles appearing in learned journals nowadays, all University workers should be allowed to write only a strictly limited number of papers in their whole academic life. He suggested an upper limit of ten. Now, while there are some academics who would, in any case, be unlikely to find such a provision unduly restrictive there are many others who are liable to break into print at the slightest opportunity without giving due thought to the importance of their topic.

We did not discuss inaugural lectures but I feel sure he would have strongly approved of them as it must be rare for one person, unless he is a particularly errant academic, to give more than a very limited number of these in one lifetime.

I have no doubt about the importance of the topic I have chosen, especially for Ghana at this point in time.

I begin with an initial difficulty however in that the very word conservation itself has all the wrong associations. It immediately evokes the idea of keeping things as they are with as little change as possible and therefore not doing this, or not doing that to disturb the present position. And the dictionary definition of ‘using carefully to avoid waste’ conjures up the image of doling out meagre portions to conserve our supplies. Nobody really wants to know about such restrictions. It is only when we use words such as exploitation, progress or development that everybody is happy. But conservation is becoming less of a dirty word in the developed countries nowadays and I hope it will also attain respectability in Ghana.

Another difficulty is that even among professionals themselves there are differences in usage. A forester, for example, might clear-fell an area of natural forest and re-plant with a single tree species. This would mean for him that forest was being conserved even though it would be of a different type from that which originally covered the same ground.

The agriculturalist is more concerned with the conservation of soil. He wants the soil to remain fertile and adequately watered,
and of constant composition and structure, while it goes on producing crop after crop. He is not interested in the natural vegetation which to him is merely a hindrance to be removed at the earliest opportunity so that the land can be exploited.

The ecologist, on the other hand, looks at the conservation of natural resources in a different way which, I hope, will become clear as this lecture proceeds.

In referring to natural resources I should add that I am concerned here only with renewable natural resources. This excludes such natural resources as minerals, for once a diamond or a piece of bauxite has been removed from the ground and from the country, that is the end of it, as far as Ghana is concerned. A renewable natural resource, on the other hand, is the goose that continues to lay golden eggs long after the last gold nuggets have been dug out of the ground—provided, of course, that we do not kill it in the meantime. But the definition is still too wide as the term renewable natural resources also includes water and air which I shall not deal with here. I am principally concerned with vegetation but, as I shall argue, this is inseparable from the conservation of animal life and of the soil.

Let us then first briefly take stock of these renewable natural resources in Ghana.

In a total land area of nearly 92,000 square miles about 30,000 square miles—or one third—is in the forest zone, and most of the other two thirds is savanna. Not all of this forest, however, is of the same type. In the south-west of Ghana near Axim where the rainfall is high and well spread throughout the year it can be described as evergreen forest because most of the trees remain in leaf throughout the year. The great bulk of the forest, however, which lies outside this area is usually described as moist semi-deciduous forest. Here the rainfall is lower and more seasonally distributed so that there are relatively dry periods during which many of the trees lose their leaves. Oddly enough the evergreen forest, despite its apparent luxuriant growth, is less productive than the moist semi-deciduous forest, mainly it seems because its soils have been impoverished by the excessive leaching away of nutrients by the high rainfall.
The other main vegetation type in Ghana, as I mentioned, is the savanna, which usually has a rather sharp boundary with the forest. The essential difference between these two types of vegetation is that whereas grasses are virtually absent in forest they are abundant in savanna and provide conditions in which bush fires take place.

Apart from the two main types of vegetation already dealt with there are a number of minor ones that might be mentioned. They include the vegetation of mangrove swamps, the coastal or strand vegetation associated with sandy beaches, the algal vegetation of rocky beaches, the vegetation of freshwater swamps and marshes, and the vegetation of the Accra plains, which, though often referred as savanna, is really very distinct.

These then very briefly are the renewable natural resources of Ghana as far as vegetation is concerned. How, we might ask, are they faring at present?

I want to confine my remarks in this lecture mainly to the forest vegetation, partly because other types are not in such immediate danger, and partly because the forest is so fragile and cannot be easily regenerated when lost.

Clearly a country cannot develop agriculturally while large tracts remain covered by bush and Ghana has, in fact, especially in recent years made rapid progress in clearing this wild vegetation to make way for farming and other commercial activities. As is well known the best farming land is in the forest zone and removal of forest is a difficult and expensive process. But it has been greatly helped by the fact that many of the forest trees are valuable for timber and, especially since World War II, very large quantities of this commodity have been exported.

After the timber has been removed, the timber roads provide easy access for the farmer and he is able to kill and burn most of the trees that remain, except for a few of the larger ones, thus making space for his farms. Nearly three quarters of Ghana’s original 30,000 square miles of forest have now been cleared in this or similar fashion leaving an estimated 8,000 or so square miles. So the very large areas on the maps marked as ‘forest’ do not represent the real state of affairs and would better be designated as ‘forest zone.’
The main areas of forest remaining, however, are in the wetter regions in the south and west where the soils are less productive, and these areas are being cleared at a rate so slow that there may be some forest surviving there perhaps even to the end of the century unless crops can be found to make farming more worth-while on these poorer soils.

It can be seen then that Ghana has an impressive record for the clearing of bush for agricultural purposes but it might be asked what will happen to the timber industry when the forest has been more or less completely cleared. I say 'more or less' as it is unusual in Ghana for forest ever to be completely destroyed—always some trees are left standing. The answer to this is that large areas of land totalling nearly 6,000 square miles have been designated as forest reserves. The word reserve here does not mean that these areas are free from exploitation. In fact most of them have already been given out as timber concessions, but exploitation is supposed to be carried out in a disciplined way and in accordance with the present policy of the Forestry Division. As the remainder of the unreserved forest is destroyed more and more of the timber production will come from these reserves. However they are not necessarily the richest timber areas as many of them were set up during the colonial era on hilly ground with the object not so much of conserving timber but of safeguarding water supplies.

The reason underlying such a policy is that the leafy canopy of forest has the property of breaking the full force of the heaviest tropical rain, simultaneously protecting the soil from erosion, even on steep slopes, and allowing the water to slowly percolate deep into the soil rather than to run quickly off its surface. The water sponged up in this way then gradually trickles away keeping the streams and rivers flowing even through the dry season. So the conservation of forest was closely linked to the conservation of water and it is perhaps worth adding here that there is some evidence—from other parts of the world—to show that when forest is removed even the rainfall may be reduced, so that forest may conserve water in a further way by influencing the climate itself. In a flight from Tamale to Kumasi one cannot help but be struck by the way the clouds appear to hang over the forest when they have evaporated
over the savanna leaving the sky there clear, and this may possibly represent a manifestation of this effect.

The present policy for forestry in Ghana is to maintain a sustained yield from the forests. In other words removal of timber should be matched by new growth of trees. But the amount of new growth of the whole forest can only be estimated from observations on the rates of growth of trees on a few sample plots. I am not myself a forester so I do not feel qualified to comment on the effectiveness of the methods in use for estimating timber productivity. I believe it is true to say however that even the foresters themselves are not always agreed on the validity of the estimates obtained. The honeymoon period of timber exploitation in Ghana is nearly over. The testing time will come when all the forest has been virtually destroyed except for the forest reserves. Then, all the timber produced will have to come from the reserves and we shall see how good the calculations have been.

Of course there could be policies other than that of sustained yield. For instance, the present forests could be liquidated and future production of timber could depend largely on plantations.

Either way the composition of the forests would be changed. In the latter instance suddenly and drastically; in the former instance gradually but nonetheless effectively for the present policy includes altering the proportions of young trees so as to reduce the number of non-commercial species and increase the numbers of commercial species.

Now if all of the forest outside the forest reserves is likely to be destroyed before the end of the present century, and if, with more and more of the commercial timber production coming from the forest reserves themselves, their composition and character will change, it is perhaps time we looked at the whole picture and attempted to take stock of what is likely to be gained and lost in this process.

People in the developed countries have just very recently woken up to the fact that their environment is in the process of being destroyed. Lakes and rivers have been polluted by millions of gallons of industrial effluent going into them. The land has been ravaged by among other things, roads, open cast mining and the spread of
towns; and the indiscriminate use of pesticides which, because they accumulate in tissues and are not readily destroyed, present an ever-increasing danger. For example women in the United States carry so much DDT in their bodies and even in their milk that a recent poster showed a woman’s breast with the caption “Do not drink anything out of this container!”

But these are things a long way away and need not worry us here in this open, thinly populated country with thousands of square miles of unused land, no industrial problems, clean air and not even—unless you happen to live near the airport—the modern pollution of noise!

We should not be panicked by what people are doing in what we might call over-developed societies but look at our own problems and decide for ourselves what we want to do.

This is what I want to deal with in what follows.

In considering our own treatment of the environment let us look first at the individual species of plants present in Ghana. It is estimated that in Ghana there are just under 3,300 species of flowering plants of which a little over half are forest species. The flora of Ghana is now relatively well known and the present revision of the *Flora of West Tropical Africa* is incorporating all that has been discovered in recent years.

But still new species are being found and new records made and it is not at all unusual for something new to be brought in during an excursion from my department. With regard to non-flowering plants much less is known, but the position is improving rapidly. For example virtually nothing was known about Ghana’s seaweeds twenty years ago. Now they have been more studied than those of any other part of West Africa and we are nearing the completion of a marine algal flora of the Guinea Coast which will deal comprehensively with these plants. This work of naming and classifying, which is a very time-consuming process, must precede or at least go along with ecological work for it is not possible to consider such things as plant distribution without a clear idea of the species involved. Thus a knowledge of the flora can be regarded as an essential part of the infrastructure of ecology.
Now of the 3,300 or so flowering plants in Ghana only a relatively small number are useful or economically important. For example only about ten percent of the 170 or so common trees in our forests are commercially valuable and the bulk of the timber exported from this country comes from only seven or eight species. What about the great majority of species that have no real use? Are they worth saving or does it not matter if they disappear in the process of development?

Of course many species of plants have become extinct in the course of time. The only reason we know they ever existed is because of the fossil remains they have left. No doubt others are dying out at this moment.

Some of the non-valuable species are plants that are rare or have considerable botanical interest in their own right. For example two unusual kinds of tree-ferns grow in some of the little valleys that run down the sides of the Atewa range of mountains near Kibi. They grow in the special conditions of high humidity along the stream banks where thousands of years of constantly flowing water has cut deep protective ravines. But the tops of these mountains are capped by a thick layer of bauxite which, or so the newspapers frequently tell us, is soon to be brought to Tema for conversion into aluminium.

When the forest on the flat tops of these mountains is removed to get at the bauxite and the bulldozers begin to scrape it off, it seems inevitable that the resulting debris will silt up the ravines and the tree-ferns will be lost. Perhaps we should not shed any tears for them, however, for their permanent loss, if it takes place, will no doubt be much outweighed by the great economic benefits to Ghana. It is worth pointing out however in case any of you may not have visited the area, that the Atewa Reserve is not only, because of its altitude, scenically the most beautiful area of forest we have in Ghana but is also, by an odd chance, the nearest Forest Reserve to Accra and can be easily reached in about two hours by car.

Very recently I received the visit of a botanist from the Canary Islands who had come to West Africa with instructions to buy 2,000 coconuts. Apparently tourists from Europe had expressed surprise at not finding coconut trees on the Canaries so the relevant
Ministry was determined that in future they should not be dis-
appointed. I know that Ghana’s tourist trade is not such a great
money-spinner at the present moment but the time is not far dis-
tant when the insatiable sight-seeing hordes from Europe and else-
where will tire of such places as Morocco and the Canary Islands.
When the Jumbos cut the cost of air travel sufficiently these same
tourists will want to visit the Guinea Coast, and, when they do, you
can bet your life that they will want to see not just coconut trees
but genuine primeval forest as well, as long as they don’t have to go
too far to see it!

This example by the way is a good illustration of the main differ-
bene between renewable and non-renewable natural resources.
When the last ton of bauxite has been scraped off and the mountains
are left bare that will be the end of a non-renewable natural-resource
but if the forest is left it could provide a tourist attraction for ever.
Those in authority over such matters might well pause a little before
they decide to sell their tourist industry birthright for a mess of
bauxite!

To take another nearby example; just north of Akosombo on a
little hill overlooking the lake is a most unusual patch of forest
consisting of virtually only one species of tree. The tree, *Talbotiella
gentii* is a species that occurs only in Ghana in a few small patches
similar to the one at Akosombo but nowhere else in the world.

This unique and very attractive piece of forest is of considerable
ecological interest firstly in that domination by a single species of
tree is a feature we normally associate with forests outside the	ropics, and secondly because trees of all ages are present from old
mature trunks to seedlings, which is a strong indication that this
forest has the capacity of regenerating itself indefinitely. It could
therefore be of considerable age and may, in fact, represent one of
the very few pieces of genuine primeval forest remaining in Ghana.
Although this forest is of no commercial importance the Forestry
Division, on the recommendation of my Department, has taken
steps to include the hill at Akosombo in a forest reserve. But the
forest covers only a few acres. People have to earn a living and
each time it is visited a new farm has been cleared on the slope of
the hill or some of the trees have been removed for firewood or
other purposes taking out a further bite of this vegetation. The last
time I visited it was with a party of students five days ago. There was further evidence of disturbance and heaps of recently cut poles indicated that someone had been felling young trees. So it seems unlikely that it will survive for very much longer.

This underlines another problem of conservation in Ghana namely that unless policy decisions made by the Forestry Division, or the Wildlife Division, or even the Lands Commission are backed up by effective protective action they will not be worth the paper on which they are written! This means, initially at least, that an adequate number of guards should be permanently stationed in these areas. But in the long run I think, it means that the areas will have to be safeguarded by public opinion and by the local people themselves who must be made to see that there is something in it for them, for instance from money brought in by the tourists. Both local and foreign, who will be attracted to these places. It was said of Lord Attlee that he treated his enemies as though they would one day be his friends. This is obviously a good attitude to adopt in the shifting sands of national and international politics. But if we can extend the thought into the biological world it could mean that we can never be sure that what we regard as a weed or a pest or something to be eradicated today may not turn out to be useful or beneficial tomorrow.

For example, the giant brown seaweeds of colder waters known as kelps were found in the last century to be a useful source of potash which could be obtained by burning them to ash. Later when large amounts of this substance were made available by mining, the practice ceased. But soon afterwards it was discovered that the kelps were great concentraters of iodine from sea water and a new industry developed to extract that element. Later again a much better source of iodine was found in bird droppings in Chile and the seaweeds were once more neglected. In some places they were even regarded as a nuisance by interfering with the navigation of small boats. But in the present century a substance called ‘algan’ was discovered in these same seaweeds and as alginates are used in the manufacture of thousands of food and pharmaceutical products the kelps are now back in favour again.

Some time ago a woman I knew went to buy guavas at a fruit shop and was aghast to be told that the price was three shillings
a dozen. "Before the war they used to be 20 a penny," she said. The greengrocer replied, "Ah, yes Madam, but before the war guavas gave you appendicitis—now they give you vitamin C!"

The point I am trying to make is that we can never make a final decision as to what a plant is worth. Its value is relative to what is known about it and what the needs are at any particular time. To use an example from nearer home we can take the case of the timber tree *Afrokomosia elata* whose ecology and regeneration have recently been a research project in my department. Before the second world war this tree was virtually unknown as a commercially desirable species, but after the war it was realised that its wood was a very good substitute for teak and the first major consignment of 100 tons was exported to Britain in 1948. Timber users are notoriously conservative and will normally only use what has been thoroughly tried and tested over a long period, but it was soon realised that its light coloured, strong wood was ideally suited to making the modern type of furniture that suddenly became popular at about that period.

Consequently there was a great demand for *Afrokomosia* and its price shot up so that it is now Ghana’s most highly priced timber and sells for practically twice the price of any other of what are known as Class I timber species. Unfortunately, for reasons which we are investigating, *Afrokomosia* does not regenerate easily and there are very few young trees coming up to replace the mature ones that are now being removed. So as regards this species the timber trade is simply living on the accumulated capital of many years and even now, after a peak period of production in the early 60’s, the amount exported has fallen off and will no doubt progressively diminish unless we can learn enough about the ecology of this species to enable it to regenerate once more.

This is an example of a formerly non-commercial species which later became very valuable but which we are now in danger of losing. There are of course many more plants for which we have no conceivable use at present. But we would have to be rash to predict that they will never have a useful function.

One can never be sure what plant will be the next to achieve fame. For instance after the recent banning in America of cyclamates as sweetening agents you would be surprised at the number of enquiries
I have had about a plant called *Synsepalum dulcificum* that grows in Ghana and whose fruits when eaten have the curious property of making everything else eaten for some time afterwards taste sweet.

In the growth rooms in my department where the conditions can be closely controlled it has been found that some plants, such as the silk cotton tree, actually grow better when they are given a higher night temperature than anything they ever get under natural conditions. Although this fact may sound as though it is of academic interest only, it shows that some plants have properties that are not realised under ordinary conditions.

Who can say when such unusual features may be required?

Some of the planets are believed to have atmospheres largely composed of carbon dioxide. Now as everyone knows any plant is capable of converting carbon dioxide to oxygen and if we wish to create an atmosphere in which human beings can live on such a planet it maybe convenient to begin by colonising it with plants from earth, which will bring about the necessary improvement in atmosphere. But such plants would need to have many special features. For example, many plants have their growth and reproductive processes closely geared to the length of day they receive. Now planetary day lengths are wildly different from those on earth. Similarly, conditions of temperature and water availability might be very stringent. But might there not be one or two plants in the thousands available that would fit into such a regime? We could only find out by testing them for suitability.

It is possible to envisage many other particular needs for plants that would have to be tested for in special ways.

You may think these speculations are very fanciful and I would agree with you. I only mention them to make the point that we can never know everything about every species and their potential value because their value is only relative to the special requirements of the moment.

The arguments for preserving individual plant species are similar to those used against capital punishment. If you hang a man and later evidence proves he was guiltless of the crime for which he
died—then a posthumous pardon is not very much consolation for him. But by giving him a life sentence and storing him away nothing irrevocable is done and he could be released at any time. It might be argued that most of these plants occur in other parts of West Africa and some even further afield. Why can’t someone else conserve them? Well, of course it might be possible to do this on a regional basis but I doubt the existence of that level of international co-operation. It seems to me it would be safer to have our own definite schemes rather than somewhat nebulous ones with other countries. If we accept the necessity for preserving individual species what then is the best way to do this? One way would be to grow them and keep them alive in botanical gardens. Certainly such plants as the tree-ferns I mentioned earlier might be kept alive in specially humidified greenhouses if their original habitat was completely destroyed. But the task of keeping several thousands of different kinds of plants alive in a botanical garden in perpetuity is an extremely formidable one. Many of them require very special conditions that would be extremely difficult, and expensive, and in some cases certainly impossible, to produce and maintain artificially.

There is however, another way in which this might be done.

More and more we have come in ecology to think of plants not just as individuals growing by themselves or merely in relation to other plants which shade them, compete with them or parasitise them. We are not even content to consider them in relation to animals that live in them, eat them, pollinate them and disperse their fruits and seeds. We now see it as necessary to think of them in relation to their total environment including its non-living as well as its living components. Earth, air, water and the fire of the sun are all elements of this system.

In such a system the plants are regarded as the producers as they fix a small portion of the solar energy in the organic matter they produce.

Some of this plant material is eaten by animals who thereby gain a fraction of the fixed energy for their own use. But they in turn may form the food of secondary or even tertiary consumers in an ever decreasing pinnacle of matter and energy. The cycle is
completed by micro-organisms that break down dead organic material and provide inorganic nutrients which are then available for recycling through the system.

Such a gross way of looking at nature is more akin to the way an economist looks at the economic processes that go on within a country, and just as an economy can be underdeveloped or developed so can an ecosystem—for that is the name we give to it—be relatively simple or very highly evolved. Again as in economics there are methods of measuring just how efficient or not the system is.

We in Ghana are only too well aware just how long it takes for an underdeveloped economy to reach the take-off point where it can compete with the highly complex industrialised economies of the developed nations. But the time taken for this is as nothing compared with the time—running perhaps into millions of years—taken to evolve a balanced and efficient ecosystem. Now the tropical forest, with which I have been mostly concerned in this lecture, is I believe, the most complex, the most highly evolved, the most sophisticated ecosystem in the world—but like many elaborate mechanisms it is also the most fragile.

It is not just a collection of several thousands of types of plants and animals all growing together. These things have all evolved along with each other—the pollinating insects have evolved along with the flowers they pollinate, the lianes have evolved along with the trees they festoon, and with which they compete on equal terms despite their ultimate dependence. All living things are adapted to their way of life but the adaptations in tropical forest have achieved an incredible degree of complexity.

So this, then, is what we have been destroying at an accelerating rate over the past few years and which will perhaps not be with us for many more.

Is it worth trying to preserve? An intact piece of the ecosystem would be a very good way to conserve the thousands of individual species of plants whose potentialities we have only a dim awareness of. But is there any other reason why we should endeavour to keep it as a going concern? I think a much more important reason is that it should be permanently available for study as an entire ecosystem. Only a few natural ecosystems have been studied in their
entirety and they are usually very simple ones such as small pools a few yards wide and a few inches deep. But attempts have been made on much more complex systems such as coral reefs. Tropical forest however is probably the most complex of all and we know relatively little about it. I say relatively little but in fact quite a lot is known for instance about the cycling of nutrients in Ghana’s forests from research undertaken by workers at this University, and data on productivity—the rate of production of organic matter—in forests is gradually accumulating. During the Easter vacation, for example, students and staff from my own department worked in the forest at Kade collecting figures on weight of plant material and the growth increments on previously marked and measured plots. Such growth measurements take time enough, but for a complete understanding of the ecosystem it is necessary to know the life history of each type of plant and animal and to determine how they are all inter-related. The problems are infinite.

Why then should we wish to study the forest ecosystem in this way? In the first place as scientists we are curious and simply wish to know how things work. But there are many more practical reasons why we should do this.

As far as biological systems are concerned we can never be quite sure what the results of a particular action might be. To give an example from marine biology, sub-littoral rocks off the coast of Ghana are mostly covered by a rich seaweed vegetation. It was thought therefore that when the rock breakwaters at Tema harbour were constructed they would provide a suitable base for such seaweeds and similarly support a luxuriant growth of these algae. But if you look at these rocks now you will find they are quite bare. What has caused this difference? The breakwaters are built from large blocks of stone that are not cemented together but have big spaces between them. These crevices provide a refuge for numbers of herbivorous fish that come out and graze on the seaweeds under normal conditions but retreat when larger fish that might eat them appear. They dare to venture only a few yards from their holes. The older rocks on the sea bed are smoother and do not provide the hiding places the small fish need. Therefore the seaweeds on these rocks escape destruction. Thus one new factor causes a complete change in the vegetation cover. But to return to the forest. Ghana’s
main export crop and source of revenue is cocoa, and cocoa is a forest crop. It grows in what might be called semi-natural conditions under the shade of some of the larger trees that have not been removed in the process of making the farms. In the past a good deal of attention has been paid to the control of particular diseases of cocoa and the methods evolved have been relatively crude ones such as cutting out of diseased trees or spraying with various types of chemicals. But plant diseases are caused by living organisms and these organisms have their own ways of feeding and reproducing, their own preferences and ways of getting around, their own enemies and friends among other organisms—in other words their own way of life.

In natural ecosystems a long process of trial and error has allowed such organisms to come into equilibrium with each other. The very fact that the ecosystem remains in existence and stable over a long period is proof that this is so, and that no single organism has the upper hand. But as soon as we re-arrange this nicely adjusted system for our own convenience—agriculturally or otherwise—it almost invariably means that some of its components are given the opportunity of going berserk. That is the real reason why diseases are so prevalent in cultivated crops. We are only just getting round to thinking about looking at these problems from an ecological viewpoint.

And they are not easy ones. It would be unusual for instance to find a simple causal relationship between say a change in microclimate and an increase in a particular disease. It is much more likely that there are several organisms involved and therefore several links in the chain. To discover what these links are and how they operate requires a great deal of research. Now where something has gone seriously wrong and where the whole balance has been upset as in the case of an epidemic disease it may be necessary to find out exactly what conditions have changed so as to bring about such a state of affairs. This is why we must have some standard of reference to go by—in other words an intact piece of the original ecosystem from which our present set-up was derived.

The future of cocoa may depend not so much on the discovery of this or that new chemical substance or type of application but on the way in which such methods are made use of in the context of
the ecosystem. And the real value of conserving portions of natural and undisturbed forest is thus seen as the very practical one of ensuring that we can take care of what is now, and will no doubt remain for some considerable time, Ghana's main source of income.

A famous biochemist once likened the method of studying the biochemistry of the cell to taking a watch, grinding it up with a pestle and mortar, and then studying the bits to see what made it tick! Despite the crudity of the method one can learn quite a lot as to how the watch—or the cell—works. The ecosystem is such another delicate mechanism and our methods of studying it are equally crude. But the point is that we need the whole ecosystem in working order before we can pull it to pieces to see how it works. The individual species are not enough, we need to have them in their relationship to each other and to the soil they grow in before we can begin to grasp the essential mechanism. Furthermore, however many watches we grind up in the course of science, it would seem advantageous to keep at least one ticking away so that we can refer back to it whenever we wish to confirm our interpretation of the function of a particular cog.

The argument is sometimes put forward that if scientists are given the opportunity to completely work over a natural system to find everything they want to know about it they can then have no objection to its subsequent destruction. In the Pacific, scientists were given all facilities to make a complete study of Bikini Atoll before it was destroyed by an atomic test. Apart from the enormous cost of such operations, the real answer to this is that there can never be any final solution. Each new generation of scientist has new instruments and new techniques and is looking at the old problems in new and different ways.

As I said earlier the forest ecosystem has evolved to the climax it now represents over a very long period of time. At each stage of its evolution small changes have taken place by a process of trial and error that have improved its efficiency, so that it now is getting the most that is possible by way of organic production from the materials available. Surely there are many things we can learn from its accumulated experience that we can use in turn to manipulate the environment to our own best advantage!
If you have accepted my arguments for preserving a portion of what remains of Ghana's unexploited forests as a strict nature reserve you might ask: "But how much is needed?" As regards vegetation alone probably only a small area would be sufficient. But it should be remembered that even plants require a certain amount of space—which might be considerable in the case of tropical forest where there are many species but low density of individual species—to allow their methods of reproduction and distribution of seeds to make place in a natural manner. As I have explained, however, the animals that live on and in the plants are an integral part of the ecosystem and as they are usually more wide-ranging than plants the area chosen must be large enough to allow for this. For example, if a herd of elephants is part of the ecosystem there must be room for them to wander as they list!

I would suggest that an area of something like 100 square miles divided between Ghana's two main types of forest might be sufficient provided that the areas chosen were buffered against the outside world by forest reserves where only limited exploitation would be allowed.

Such an area might sound rather large but it would represent only about one tenth of one per cent of Ghana's total land surface. The question we have to ask ourselves is, "Is this too much to hold in trust for future generations?"

Earlier, I said that I would be mainly concerned with the conservation of forest. With regard to savanna similar arguments apply but the position is infinitely better. In the first place there is much more of it, secondly it is more resilient to interference than forest, and finally there is not nearly as much pressure on it. But more important than any of these is the fact that there is already in existence a splendid nature reserve of over one thousand square miles at Mole near Damongo. Though this is a Game reserve it means of course that the vegetation is conserved incidentally.

It is worth noting here how much better animals fare with regard to conservation than plants. Desmond Morris has said that we prefer animals that resemble ourselves in some way. Thus animals with furry coats have an advantage over those who have to make do with scales, and if they have flat faces and can stand upon their
hind legs as well we practically welcome them as brethren. Unfortunately for plants they come off pretty badly on this anthropocentric scale of things and do not get all the love they deserve.

I mentioned earlier that *Afrormosia* trees were being slaughtered at a rate much greater than they are ever likely to be replaced. Something like this passes almost unnoticed but you can imagine what on outcry there would be from all over the world, if say, elephants were so near to extinction. In fact of course in some parts of Africa elephants have been so over-protected and so increased in numbers that they have turned savanna into desert by eating everything in view!

This illustrates yet a further point namely that conservation can never be a completely static thing. Changes are possible even in what appears to be the most stable ecosystem so there will always be need for conservationists and therefore ecologists to study such systems from a dynamic viewpoint and manipulate them wherever necessary.

Although I have spoken at length about nature reserves in forest and more briefly about nature reserves in savanna I do not wish to imply that the rest of Ghana should be forgotten. There are many other smaller areas that need to be conserved for scientific or aesthetic interest which there is not time to deal with here. What is needed in fact is a policy for conservation that would cover the whole country and the proper use of all land and water—in other words the complete environment. If such a policy were made effective now we might avoid some of the panic with regard to environment that is currently gripping Europe and North America. In such places there is now I think an increasing realisation that the natural resources of a country do not belong just to the present generation but to future generations as well for all time. They are learning that their tenure is as leaseholders rather than freeholders in that when they leave they are required to hand back in reasonable condition, the things they have made use of. The increasing population problem and the pressure it has put on all natural resources has forced people to think this way. They know that they cannot go on using the environment in the carefree way that has characterised the past, expecting things to remain unchanged, because the limits
to what it can take without permanent deleterious change are rapidly being reached and passed. It has been my purpose here to show that these limits, even for Ghana, are nearer than we might be tempted to think.

At the beginning of this lecture I said that as opportunities for delivering inaugural lectures were so limited there was every incentive to ensure that the topics covered were important ones.

I have attempted to make out a case for conservation in Ghana because I believe that it is important for this subject to be given the fullest publicity and discussion. I believe it is even more important, however, that resolute action should be taken along the lines I have suggested—and taken before it is too late to matter.
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