HOUSE OF
COMMONS
LIBRARY

BIODIVERSITY

Research Paper 93/94 26 October 1993

The Biodiversity Convention signed at the Earth Summit in Rio comes into force on 29 December 1993. It has been estimated that 140 plant and animal species are becoming extinct in tropical rain forests every day and that perhaps half of all existing species will become extinct in the next 50 to 100 years. The UK is currently drawing up its National Biodiversity Action Plan as required by the Convention and is working to establish the basis for ratification of the Convention by the end of this year.

...cosmologists and astrophysicists spend huge amounts of money on documenting the universe. This exercise is of no greater intellectual content than the documentation of biodiversity and is certainly much less pressing. The heavenly bodies will be with us to document and study in 1000 years; 50% of the world's living species may be gone within our lifetimes [1].

What use are they, most of them? ...Many of them, we know, are disappearing by the hour, because the forests in which they live are being cleared away, and they do not live anywhere else. What care I, what care you, what difference does it make to anyone? ...When did you last see a Hyacinthine macaw, that you should regret its passing? What have Sumatran tigers ever done for us? [2].

Many plants are essential in human health care...Ironically, many plants that save lives are themselves in need of saving, not from diseases but from an ever-expanding human population whose growth and consumption of natural resources are threatening plant diversity in most parts of the world [Jorgen Thomson, Director, TRAFFIC International, in 3].

Patsy Hughes
Science and Environment Section

CONTENTS

I. INTRODUCTION

Biological diversity, or biodiversity, is the variety of life on earth. This is usually taken to mean the number of living plant and animal species. Biodiversity can also be used to express diversity at other than at the species level; the term is often applied to diversity in genetic material, or in ecosystems or habitats.

Estimates of the number of plant and animal species that are presently on the earth range from 5 million to 50 million, and beyond. Only between 1.5 and 2 million of these plants and animals have ever been classified [4,1]. Species are presently disappearing at a devastating rate.

Perhaps half of all existing species will become extinct in the next 50 to 100 years if current rates of tropical deforestation continue. Such a rate of extinction is about 1 million times faster than the rate of speciation (the rate at which new species of plants and animals can evolve) [4]. Deforestation is important because although tropical rain forests cover only 7% of the Earth's land surface they may contain at least 90% of its living plant and animal species [5]. Forests are being felled at the rate of about 4,500 acres every hour [6]. According to the UN Food and Agriculture Organisation, the rate of tropical forest loss during the 1980s was an area around 7.5 times the size of Wales yearly [7].

The loss of a species is irreversible. Although recent popular fantasies of "Jurassic Parks" do have tenuous links to reality [8], resurrecting animals from fossilised DNA is nowhere near ever being possible. Once an animal or plant becomes extinct, it is lost forever.

There are many selfish reasons why plant and animal species should be conserved, quite apart from moral and aesthetic considerations. All species perform a role, as part of complex ecosystems and in production and consumption cycles, in maintaining, stabilising and regenerating the so-called "biosphere". Mankind relies to a large extent on this stabilising nature to remedy man-made ecological mishaps and pollution incidents.

Biological resources provide us with food, clothing, housing, and medicine, and so far humans have tapped only a tiny proportion of the resources available. Creatures which we have not yet encountered may contain all sorts of properties and genetic resources which might be of use in the future. Such potential is enhanced by developments in biotechnology, which opens up new possibilities for the use of genetic material in medicine and agriculture. Endemic wildlife is now generating a major proportion of several developing countries' income through tourism [2,9].

There is no technological quick-fix to the loss of biodiversity [10], but one approach to conserve animal and plant species would be to attack the underlying causes of their decline,

which include over-population, over-harvesting, deforestation, pollution and the inappropriate introduction of plant and animal species into previously settled ecosystems [11]. Attempts are currently being made by the world community to address some of these fundamental issues through various means, notably Agenda 21, the action plan towards sustainable development which emerged from the Rio Earth Summit last year [12].

The Earth Summit also gave rise to a Convention on Biological Diversity, which 153 parties including the UK signed at Rio, and which the UK plans to ratify by the end of 1993. The convention is due to come into force officially on 29 December 1993 [68, 69].

A Statement of Forest Principles, which may have direct effects on biodiversity, was also produced, but this is not legally binding. In addition to signing the Biodiversity Convention at Rio, the Prime Minister announced the UK Darwin Initiative for the survival of species, which is intended to draw upon the UK's unique skills and resources to promote the conservation of biodiversity.

The UK contains some of the world leaders in this area of research, including the Royal Botanical Gardens at Kew, the Natural History Museum, and an extensive research base within the academic system. However, the level of funding for the Darwin Initiative has disappointed some observers, and a recent House of Lords Select Committee recommendation that funding be earmarked for systematic biology (which underpins much biodiversity conservation work) has recently been rejected by the Government.

GLOSSARY

Species

A species can breed within itself, but not with other species. Attempted matings might take place, but they would not produce a viable or fertile offspring. For instance, great danes are only a breed or race not a species, since they can breed with chihuahuas. On the other hand, humans constitute one species. Although there are many different races or populations of human beings, theoretically a person could breed with anyone else of the opposite sex on the planet, but there are no other species with which humans can breed and produce viable offspring.

Very often, two animal or plant species which look superficially extremely similar, such as two worms or two orchids, will differ outwardly only by the form of their sexual organs, which literally makes it physically impossible for accidental matings to occur across species. So a species is often a very much smaller and precise unit than one might expect. New techniques in identifying and classifying animals, such as by measuring genetic differences, are revealing much greater diversity in many groups of organisms than had previously been imagined [1].

Systematics and taxonomy

Taxonomy, or systematics, is the science of naming, describing and classifying organisms. The science involves much more than collecting animals, labelling them and filing them in drawers in the manner of Victorian butterfly collectors. Taxonomy has declined in teaching and research in the past 10-20 years [1], being seen as rather traditional and unfashionable compared to subjects such as molecular genetics or ecology. However, taxonomy has now started to come into its own, and particularly in recent times, has involved seeking out the evolutionary relationships between organisms, and answering fundamental questions about the development and maintenance of biological diversity.

Organisms are placed in hierarchical groups, at first containing many, perhaps outwardly quite diverse, organisms which are linked by only fundamental and gross similarities. The groups are then split successively using more and more subtle characteristics, until there is only one organism left in the group at the lowest level, which is called the species. Each organism is given a unique binomial latin name, consisting of the generic (the genus is the level above the species) and the specific name. Humans, for instance, are *Homo sapiens*, and the common daisy is *Bellis perennis*. The point of taxonomy is not only to give each organism a unique name however, but to attempt to identify the true evolutionary relationships between organisms.

Biodiversity

Biological diversity, or biodiversity, is the variety of life on earth. This is usually taken to mean the number of living plant and animal species. Biodiversity can also be used to express diversity at other than at the species level; the term is often applied to diversity in genetic material, or in ecosystems or habitats. Evolution leads to new species formation, or speciation, and this gives rise to biodiversity. Extinction of species leads to loss of biodiversity. Although for most of the earth's history extinction and speciation have been roughly in balance, it has been estimated that current rates of extinction are now around one million times too fast for speciation to keep up [4].

Biomass

Biomass and biodiversity are sometimes confused. Biomass is all about numbers, mass and bulk, of perhaps just one species of plant or animal. A conifer plantation and an ancient woodland probably contain very similar biomass. If harvested, they would provide a similar amount of wood for fuel, and they probably both recycle similar amounts of carbon dioxide to oxygen throughout the day during photosynthesis. However, the ancient woodland will contain many more plant species and support many more animal species. With its higher biodiversity, it would stand more chance of surviving pests and diseases and would support many more potentially useful species.

II. THE PRESENT SITUATION

Numbers of species

Estimates of the number of species on Earth have been made by several authors. There is no way of sitting down and directly counting the number of species since there is no central register, and only a tiny fraction of species has been classified anyway. Some animals are easier to spot than others. In the words of Robert May, *the furries and featheries are, of course, very well known by now* [13]. Other groups of organisms remain far less well-known.

Of the species which are known, there are more insects than all of the other animals and plants put together. Insects are a class of animals belonging to a group known as the arthropods (animals with jointed legs and an external skeleton, also including crustaceans, spiders and millipedes). Beetles make up 40% of all known arthropods, prompting the oft-quoted comment, attributed to J.B.S. Haldane, that *God had an inordinate fondness for beetles*. It was probably naturalists, rather than God, who were responsible for this, through choosing to study beetles in detail. Other groups of organisms, such as mites, will probably be found to be just as diverse, once explored [2]. Perhaps only 5% of microbes, and 3% of nematodes (a group of unsegmented worms) have been described [1].

The highest definite estimate of the number of species which have been described is 1.82 million [14]. Most authorities quote between 1 and 2 million.

Until the mid-1980s, it was generally thought that there were probably around 5 million species on earth in total. A huge jump in the estimates occurred following studies which used insecticidal fog to knock down samples of arthropods living in tropical forest tree canopies. Calculations based on the number of species collected in such samples, with a few simple steps of reasoning, indicated that there might be as many as 30 million species of tropical arthropods alone [14]. Although that figure is now believed to be rather lower [14, 13], it still extrapolates to there being around 30 million species on earth in total. This is the figure which is generally settled upon [2, 4, 13, 14], although it would take a very confident person to rule out the true number being as high as 100 million.

Extinction rates

New species probably arise when two populations become geographically isolated, or speciation may happen following a chromosome or other genetic mutation (the precise mechanism of speciation is a hotly debated subject). Speciation gives rise to biodiversity.

Rather than a steady gradual rate of speciation, it is today thought that evolution may have happened in bursts, interspersed with periods of stasis, when species remained unchanged even though their environment may have been altering. Judging by the fossil record, biodiversity was probably higher in the Cambrian period (600 million years ago) than at any other time. Since the Cambrian, there have been probably four main mass extinctions. The most famous of these was the Cretaceous extinction 60-65 million years ago when the dinosaurs disappeared and the mammals radiated. This may have been prompted by a meteorite hitting the earth. Whatever is happening now is unparalleled apart from that event, and it has been caused by human action. Estimates of current extinction rates make shocking reading.

Throughout most of the earth's history, the background rate of extinction has been in the order of one to ten species per year [15]. Over the next thirty years, 150,000 to 300,000 species per year may be lost if current deforestation rates continue [assuming 30 million species currently on earth, derived from numbers given in reference 16].

It has been estimated by the biologist Edward O. Wilson that in tropical rain forests, roughly 50,000 species per year are either becoming extinct, or being condemned to extinction by the eventual destruction of habitat [15]. This translates as 140 species per day becoming extinct in tropical rain forests alone. Some further estimates of extinction rates are given in the table below.

Estimate of loss	Basis	Source
33-55% of spp by 2000	forest area loss	Lovejoy (1980)
50% of spp by 2000	forest area loss	Erlich and Erlich (1981)
25-30% of spp by 2000	unknown	Myers (1983)
33% of spp by 21st century	forest area loss	Simberloff (1986)
20-25% of spp by 2025	present trends	Norton (1986)

[From reference 10].

Such rates of extinction may be around one million times faster than the rate of speciation [4]. The most recent estimates of extinction rates, using data for known extinctions and IUCN "Red lists" of threatened species, imply that half of mammal and bird species may be extinct within 200-300 years, and half of palm species may be extinct within 50-100 years [73].

Threatened habitats

It has been suggested that just 12 countries account for 70% of the world's biodiversity. These are Brazil, Colombia, China, Mexico, Australia, Indonesia, Peru, Malaysia, Ecuador, India, Zaire and Madagascar [10, 15, 16]. These are sometimes called "Megadiversity" countries, and threatened habitats or ecosystems within these countries that harbour a particularly large number of species can be termed "critical conservation hotspots". This paper can describe only a tiny sample of the habitats and species at particular risk.

Oceans and wetlands

Wetlands include a vast range of marine, coastal and inland habitats such as salt marsh, freshwater marsh, floodplains, lakes, open coast, swamps, peatland or bog, estuaries and mangroves. Although wetlands themselves are not notably diverse compared to tropical forests or coral reefs, their very inaccessibility and lack of attraction to humans have made them sanctuaries for many threatened species (Bengal tigers are a classic example). They are essential habitat for many unique wildfowl and fish, and are among the most productive of ecosystems, often supporting large human populations through, for example, fisheries.

Wetlands are primarily threatened through land reclamation and damming, for agriculture, urban development or for aquaculture. They are also particularly vulnerable to pollution, being open, dynamic systems that are influenced by remote events. 67% of the Philippines' mangroves were lost between 1920 and 1980 [24]. More than 90% of wetlands have been destroyed in California, New Zealand and Italy. At least three quarters of the mangroves in India, Pakistan and Thailand have been lost. 95% of the mangroves in the largest province of Indonesia are being cleared for pulpwood production [15]. Nearly half of the tidal flats in the Japanese archipelago, an important migration route for birds, have been reclaimed in the economic boom following the second world war, and less than half of the coastline of Japan's four main islands is now natural. Japan has designated only four wetlands for protection since signing the Ramsar Convention in 1980 [25].

Marine ecosystems cover 71% of the earth's surface, and are very poorly understood or explored. It is likely that deep ocean biodiversity has been relatively undamaged as yet, thanks to its inaccessibility, and the diluting effect of the oceans. However, the continuous nature of the world's seas and oceans means that environmental damage or pollution in one area cannot be easily contained.

A recent report published by several environmental groups for the first meeting of the Intergovernmental Committee for the Convention of Biological Diversity (see section IV) and funded by the IUCN, WWF, World Bank and UNEP among others, estimates that the deep sea may contain 10 million unnamed species. The report states that *The entire marine realm, from estuaries and coastal waters to the open oceans and the deep sea, is at risk...Virtually*

any substance loosed into the biosphere is carried seaward. Threats to ocean biodiversity cited by the report include oil drilling, ocean dumping, dredging and overfishing, including the use of floating plastic nets and trawl nets [65].

In general, shallow and coastal marine habitats have been the most seriously affected so far. Unfortunately, this is where some of the most diverse ecosystems occur. Coral reefs are perhaps the underwater equivalent to tropical rain forest. Occurring in shallow, warm tropical waters, they are considered more complex and dynamic than other marine ecosystems; individual reef sites may contain 3000 species of animals and plants [24]. Reef corals are slow-growing animals which live in symbiosis with algae. They are highly sensitive to pollution, smothering, over-grazing and stress.

Coral bleaching that has occurred on many reefs in recent years happens when the corals expel their algal symbionts, possibly because of raised water temperatures [26, 15]. In the early 1980s, it was estimated that reefs were being degraded in the coastal waters of 90 out of 109 countries by sedimentation, pollution and through direct damage from fishermen and tourists [15]. The Australian Institute of Marine Science recently calculated that human activity has killed off between 5 and 10% of the world's reefs and estimates that another 60% could be lost in the next 20-40 years [27].

Tropical forests

Tropical forests have been said to contain from half to over 90% of the world's plant and animal species, despite covering only about 7% of the earth's land surface [2,9,5,6]. There are many different types of tropical forest; the best known is probably tropical rain forest.

Deforestation, particularly in tropical forests, therefore leads to loss of biodiversity. Short term benefits of clearance are outweighed by the destruction of the livelihoods of people dependent on the forests' products and fuel wood, and of countries dependent on the forests for export goods. If the forest is burnt, carbon dioxide which those plants fixed during their lifetimes is liberated into the atmosphere, contributing to the amount of greenhouse gases (see section III below). Soil is usually impoverished or washed away as a result of deforestation; the water table may be upset, and ultimately, the former tropical forest land may become a barren wilderness [5].

Forests are being felled at a rate of about 4,500 acres every hour [6]. There was a 35% increase in tropical forest destruction over the last decade, according to the UN Food and Agriculture Organisation's (FAO) latest (post-Rio) estimates. In 1980, 28 billion acres of tropical forest were destroyed, and that figure rose to 38 billion acres in 1990. An area of tropical forest equivalent to 7.5 times the size of Wales or four times the size of Denmark was lost each year during the 1980s [7, 17, 15].

Data on tropical deforestation can be imprecise. Another estimate puts the increase in deforestation over the 1980s at 40%, and indicates that losses in 1992 were at least as high as those in the mid 1980s [9]. The FAO considers that continuing population growth and rural poverty, which lead to forest clearance for agriculture, will mean that deforestation will continue at a rate of at least 25 million acres a year up to the year 2050. Forests have practically disappeared in many countries (such as Nigeria, Benin, western Ecuador, El Salvador, The Gambia, Ghana, Haiti and Togo), or else have been fragmented into smaller and smaller patches; islands of biodiversity isolated by surrounding barren land, unable to sustain viable and self-perpetuating populations of animals and plants [15].

The forests in Haiti are among the most severely depleted ecosystems on earth. Total forest cover is below 1%, and since many Haitian species are found only in Haiti, mass extinctions of animals and plants are likely to occur in the next few years unless preventative measures are taken. The human population is 7 million and growing, and the remaining forests are being felled for charcoal [71].

The problem of forest loss is not restricted to the tropics.

Temperate forest

The world's temperate rain forests are far more endangered than the tropical rain forests, covering only one-fortieth of the area, and having been reduced by 56% through clearance and logging.

In the United States, a temperate rain forest once stretched from California to Alaska, but only fragments of this are now left in the Pacific Northwest. In British Columbia, over 90% of the original forest has been destroyed by logging, and environmentalists have predicted that the remaining parts of the forest there will be largely cut down in the next 15 years. Although some of this is being replanted, this is a poor substitute for the original old-growth forest. In all, 2.5 million hectares of federal land, including ancient forests in the states of Oregon, California and Washington, are threatened by logging.

This land is inhabited by the northern spotted owl, a species which was declared threatened under the 1990 US Endangered Species Act. The presence of the owl in the forests has been cited by environmentalists as a reason why the forests must be protected. However, logging restrictions which were imposed in response to the environmentalist's demands have threatened the jobs of up to 32,000 people in areas with up to 23% unemployment. Local families have worked in the woods for generations. The dilemma has been coined the "jobs vs owls" debate in the United States [18, 19, 15].

Old-growth hardwood forests have also more or less disappeared in Europe. Very little of the 8000 year old ancient Caledonian pine forest, which once covered much of Scotland, is

left. Fragments in the Cairngorms which are within Sites of Special Scientific Interest are in danger of being destroyed by deer, which have been encouraged by landowners to generate revenue through hunting. By their grazing, the deer are preventing the forests from regenerating [20].

Around 90% of the woodland which once covered Europe has been lost, and this has been accompanied by severe declines in the populations of woodland mammals (such as bats, dormice, bears, the wolf and lynx). Britain lost 45% of its ancient broad-leaved woodlands between the second world war and the 1980s. Two thirds of the 45m acres of forests which were replanted worldwide during the 1980s were in Europe [21], but natural ancient broad-leafed woodland, developed over thousands of years and rich in plant and animal species, has been largely replaced by timber plantations, often consisting of one tree species, such as Sitka spruce. These homogenous plantations support a negligible number of species in comparison to ancient woodlands [22, 23].

Endangered species

Although definitions vary, an "endangered" species is one that is in imminent danger of extinction, or whose survival is unlikely if causal factors continue. "Vulnerable" species are likely to become endangered if trends continue. "Rare" species are not necessarily threatened but are vulnerable to endangerment. Some species are naturally rare, and others have been made that way by humans. Some species occur only in one particular type of habitat, or in one particular place (they are then said to be endemic to that area), whereas other species may have a much wider range. Most of the lemurs in Madagascar are confined to certain pockets of forest [2], and many species of fish occur in only one stream or lake. A species' range or degree of endemism will influence its susceptibility to extinction, and resistance to habitat destruction.

Animals

The UN Food and Agriculture Organisation (FAO) recently announced that in Europe, half of the animal species that were in existence at the turn of the century are now extinct. A third of the remaining 770 animal species in Europe are faced with the threat of extinction in the next 20 years, and over 21% of the 2,048 breeds of domestic animals in the world used for food are threatened by extinction [28].

The International Council for Bird Preservation (ICBP) 1988 publication **Birds to Watch** estimated that 1,029 bird species were in risk of global extinction, and a further 637 were almost at that point. 88 bird species are known to have become extinct since 1600 AD. This gives a total of one fifth of known bird species that are either already extinct or in imminent danger of becoming so [2].

In 1981, 41 species of Hawaiian tree snail were listed as endangered by the US Government, and only two of these species remain in substantial numbers today. In the main rivers and seas of the southern republics of the former Soviet Union, more than 90% of the major commercial fish species have been killed off [15]. In the past 30 years in Lake Victoria, 200 out of 300 native species of a particular genus of fish have been wiped out by Nile Perch, which were introduced for food [2]. Nearly half of the global population of mountain gorillas, around 300 animals, live in one park in Rwanda and are seriously endangered by the civil war in the country [29]. The last Arabian oryx in the wild was eliminated by hunters in 1972. Poaching has reduced the African elephant from several millions in 1980 to around 650,000 today [2].

Black rhino, hunted for their horn, have fallen from 65,000 animals in 1977 to 2,300 today, despite a 15 year ban on trade in rhino horn. Their numbers are still falling by 28% a year [30]. The US is reported to be presently considering trade sanctions against China and Taiwan for illegally trading in rhino horn. Zimbabwe registered 1,500 rhino last year, but this year announced it had only 300 animals left. Worldwide, White rhino are down to 5,200 animals, Sumatran rhino to 500-900, Indian rhino to 1,900 and Javan rhino to 80 [31].

Last year, the mouse-eared bat became the first mammal to be declared extinct in the UK since the wolf in the 1740s [32], and populations of the greater horseshoe bat in the UK are now possibly only 1% of those at the start of the century. A recent two-year survey indicated that 94% of water voles may be lost in Britain by the end of the century, largely through predation by mink [33].

Plants

At least 650 plant species are known to have become extinct in recent times. Obviously, this number excludes those that have become extinct without ever having been discovered. The World Conservation Monitoring Centre has estimated that up to 25,000 species, or 10% of the world's plant species are currently under threat [34].

Two-thirds of the world's plant species are found in the tropics. It has been calculated that one quarter of these tropical plants may become extinct in the next 30 years. 13% of the plants endemic to southern Africa (2,300 species) are threatened. In the USA, nearly one in every eight native species are considered in danger of extinction [15].

Plants used in agriculture whose genetic diversity has been encouraged by farmers for thousands of years are in danger of being replaced by a few varieties of high-yielding, genetically bland crops. One indigenous people in the Philippines identify more than 200 varieties of sweet potato by name. Farmers in India have planted perhaps 30,000 different strains of rice over the past 50 years. However, three quarters of India's rice fields may be planted with only 10 varieties by the year 2005. 1,500 local varieties of rice have

disappeared in Indonesia in the past 15 years, and nearly three-quarters of the rice planted there today derives from a single maternal plant [15]. Some implications of this are discussed in the next section of this paper.

Grazing animals such as rabbits and goats which have been introduced onto islands have obliterated much of the flora which had evolved on these in the absence of pressure from grazing animals [ibid]. Plants which may have been introduced into countries for one use or another have often escaped from cultivation and are smothering or replacing less competitive native species. One example in the UK is the Australian stonecrop, *Crassula helmsii*, which was first introduced into this country to be sold for aerating garden ponds in 1927. It first established itself as an alien in 1956 and has been expanding since [35]. English Nature are concerned about stonecrop invading freshwater SSSIs and reducing the plant diversity within these [36].

Plants are collected from the wild for horticultural trade. Such trade usually involves common species, but more seriously, rare plants are often taken from the wild by specialist collectors deliberately seeking exotic or rare species; precisely the species which cannot sustain any kind of harvest. Such species include the Mexican cactus, *Ariocarpus agavoides*, the giant pitcher plant *Nepenthes rajah* and the lady's slipper orchid, *Paphiopedilum druyi*. The last was feared extinct in the wild until a colony of over 3000 plants was discovered in 1972 in southern India. Within a few years Government officials could find only 3 plants left at the site, following commercial collection [34].

Cycads are slow-growing and slow-reproducing plants related to conifers, generally considered to be the dinosaurs of the plant world, having existed largely unchanged for tens of millions of years. Habitat destruction and collection have devastated populations; over 50 cycad species are now Endangered or Vulnerable according to the International Union for the Conservation of Nature and Natural Resources (IUCN) and all are covered by CITES. One cycad species, *Encephalartos dolomiticus* was collected to extinction in the wild during 1989; fewer than 20 plants remain.

Palms (sold as houseplants) and tree ferns (used as a horticultural growth medium) are being taken unsustainably from the wild for sale in Europe. It has been estimated that around one-third of Mexico's endemic cacti are now threatened with extinction in the wild. Over two-thirds of the one million or more venus flytraps sold in Europe each year are probably taken from the wild. The plant is found in the wild only in North and South Carolina USA, and 90% of the plants sold die within a few weeks because of incorrect care [34].

This section has described a random and small sample of species in danger. A recent Worldwatch Paper included the following table of animal species in jeopardy [adapted from reference 15];

SPECIES TYPE	OBSERVATION
Amphibians (frogs, toads, salamanders)	Worldwide decline observed in recent years. Wetland drainage and invading species have extinguished nearly half of New Zealand's unique frog fauna. Biologists cite European demand for frogs' legs as a cause of the rapid nationwide decline of India's two most common bullfrogs.
Birds	Three fourths of the world's bird species are declining in population or threatened with extinction.
Fish	One third of North America's freshwater fish are rare, threatened or endangered. Introduction of the Nile perch has helped drive half of the 400 species of Lake Victoria, Africa's largest lake, to or near extinction.
Invertebrates	Of the order of 100 species lost to deforestation each day.
Mammals: general	Almost half of Australia's surviving mammals are threatened with extinction. France, [Western] Germany, the Netherlands, and Portugal report more than 40% of their mammals as threatened. All cetaceans (whales and dolphins) are treated by CITES as threatened or likely to become so.
Mammals: carnivores	Virtually all species of wild cats and most bears are declining seriously in numbers.
Mammals: primates	116 of the world's roughly 200 species are threatened with extinction.
Reptiles	42% of the world's 270 turtle species are rare or threatened with extinction.

Some underlying causes; Brazil

Patterns of habitat loss and destruction can be shaped by very complex social, historical and economic reasons. Brazil provides an example.

Brazil is accredited with having more species than any other country on earth; over a fifth of the World's flowering plant species, for example [6, 15]. This is largely because the country contains more tropical forest than anywhere else. The Brazilian Amazonian rain forest covers 60% of Brazil, and surprisingly perhaps, only just over 10% of this has so far been lost [6, 15]. Deforestation in Brazil has slowed since its 1987 peak, for a variety of reasons. These include changes in government policy, wet weather and a general slow-down in the country's economy [15]. The Amazonian rain forest may have been spared from some of the worst ravages also because it is so inaccessible. Such largely unplanned good fortune has not extended to other areas of tropical forest in the country, however.

The Atlantic Forest once ran all along the Atlantic coast of Brazil, covering around 12% of the country. It is a different type of forest from the Amazonian rainforest (which lies further to the northwest). Because it runs a long way from north to south, it encompasses many different soils, climates and altitudes, and thus contains a mosaic of sub-regions or habitat types (such as coastal rain forest, dunes, mangroves and grasslands) which make the forest uniquely rich and varied in plant and animal life [37].

Because this part of Brazil was the first to be colonised, Brazil's main centres of population (including Sao Paulo and Rio de Janeiro) sprung up in this area, and the forest has been devastated over the past 20-30 years through cattle ranching, timber, firewood and charcoal and pulp plantations, industry, urban development, coffee and sugar plantations and tourism. Now only 8% of the original forest cover remains, in fragments, and perhaps only 1% is primary uncut forest. Conservation efforts being made by the Brazilian authorities appear to be well-meaning but inadequate and disorganised [37].

The Atlantic Forest is a Megadiversity hotspot [10, 37]. Many of the plants and animals which live in the Atlantic Forest are endemic and unique to that area, and many are on the verge of extinction. For instance, 17 of the 20 primate species found there are endemic to the forest, and of these, all 17 are endangered. One of the areas containing the greatest biodiversity and many endemic or unique species is in the southern part of the state of Bahia. This area has a warm, stable and humid climate, which makes it ideal for cocoa cultivation. Southern Bahia is today the second largest cocoa producing area in the world after the Ivory Coast. This has lead to large patches of forest being unintentionally preserved, because of the way in which cocoa is cultivated.

Historically, cocoa has been planted *under* the native forest overstory [canopy] leaving the trees and larger plants intact. The cocoa was also planted in small areas within extensive

tracts of land held by major land owners, who left parts of forest undeveloped, even after the government started subsidising cocoa production in the 1960s. However, the world cocoa industry is currently in a state of crisis, with prices at record lows in real terms [38]. With the collapse of world cocoa prices, cocoa planters have had to try to cut costs. Some have stopped using fertilisers, and some are now selling timber from their forest patches to meet expenses. A government ban on logging in the Atlantic Forest in 1980 closed many sawmills, but logging is now again increasing.

Pessimism about the future of cocoa markets gives rise to fears that land owners will not hold on to their cocoa land as an investment in the future of cocoa. Unemployment is rising, so subsistence farming (slash and burn) is increasing, there are conflicts over land ownership, and unsustainable hunting and logging are on the rise. To make matters worse, a fungal disease called witches' broom disease has also recently hit Bahia's cocoa crop [39].

Brazil's present problems include a debt of $121 billion, massive poverty and one of the most unequal distributions of wealth in the world. 4.5% of the landowners control 81% of farmland. These problems do not encourage complacency about the prospects for any of Brazil's forests. Around 79 million hectares of land in Brazil have been designated as reserves for indigenous people. The Kayapo alone control 10 million hectares, which is an area of land roughly the size of Ontario. Such land is rich in minerals and timber and much has been illegally infiltrated by loggers and gold miners, leading in several cases to violence, political conflict and the introduction of disease to the native inhabitants [6, 22].

With Brazil being the guardian of more of the world's animals and plants than anywhere else, its economic and social problems must be seen as a constant threat to the world's biodiversity. Sadly, they are also typical of the problems existing in many developing and megadiversity countries.

III. WHY CONSERVE BIODIVERSITY?

Potential uses for animals and plants and their products are legion, ranging from medicines, clothing and housing to disease and industrial pollution control, environmental indicators and spiritual fulfilment. This section will consider just some of the more powerful reasons for conserving biodiversity.

Moral reasons

The moral imperative...we are only temporary stewards of planet earth and have a duty to hand it on to future generations in the same state, or nearly the same state, as that in which we found it. This is similar to the argument for preserving Rembrandts in art galleries rather than using them as a form of fuel for power stations. As Margaret Thatcher put it when she was Prime Minister "...*we do not hold a freehold on our world, but only a full repairing lease*" [1].

Why should disappearing beetles, plants or birds concern us? To a biologist, and to many others, the question hardly needs asking; a species is the unique and irreplaceable product of millions of years of evolution, a thing of value for scientific study, for its beauty and for itself [15].

For my part...I have junked all the hundreds of pages in which I have attempted to explain why I feel in my bones that it is right to conserve animals...it is simply proper for us, as intelligent members of the universe, to try to look after our fellow creatures, and evil for us to do otherwise [2].

Agriculture and food

Most food crops and livestock have been selectively bred by mankind over thousands of years to give better yields, greater disease resistance and tolerance to drought and cold. However, the intense specialisation of modern animal and plant production techniques is leading to a depletion of genetic diversity [28], which is a large factor in the resistance of disease and adaptability to changing conditions.

As a very general rule, inbreeding gives rise to genetic blandness within a population, and this may lead to loss of fitness, or to increased susceptibility to disease, or to lack of competitiveness. Conversely, bringing in new strains or breeds occasionally will keep up the genetic diversity in a population (or "increase heterozygosity"). Such enhanced fitness and general health and sturdiness through greater genetic complexity is sometimes known as hybrid vigour.

So long as many different strains of a crop are cultivated or kept, there is the possibility of interbreeding to create new cultivars should environmental conditions change, and to prevent a genetically uniform monoculture being vulnerable to eradication by a single pest or disease. The Irish potato famine of 1846 devastated the entire country's potato crop. In 1991 in Brazil there was the worst ever outbreak of infections such as citrus cancer in orange trees, aided by the genetic similarity of the orange trees .

Wild relatives of crop plants such as wheat, rice and potatoes often possess genetic characteristics that confer resistance to diseases, pests or environmental stresses, and so long as these wild relatives are preserved, there is the possibility that such characteristics can be incorporated into the strains in cultivation [40]. The extent of biodiversity in cultivated crops and livestock is greatest in developing countries in the tropics, where the centres of diversity for major food crops and livestock including rice, maize, wheat, sweet potato, potato, soya bean, plantains, buffalo and chicken are located [10]. 98% of US crop production is based on species originating outside its borders [24].

As well as the need to maintain traditional and wild varieties as a source of genetic diversity, traditional or native strains of crops and livestock are probably better adapted than high yielding modern cultivars to given local conditions. It has been noted that whereas antelope and zebra survive easily on the African savannah, domestic cattle, even those of the tropical zebu kind, find it much harder to survive. This suggests that it might be more sensible to attempt to use native species in agriculture where conditions are demanding, and indeed there have been schemes to cull antelope for meat or to milk elands [2]. At the very least, it might be feasible to use traditional strains adapted to local conditions to develop higher yielding locally appropriate crops, so long as these traditional strains have not already been lost [15].

The UN FAO recently warned that, from an agricultural point of view, the world had lost nearly three-quarters of the genetic diversity of plants grown since the beginning of the century, and over 21% of the breeds of domestic animals used for food are threatened by extinction in the wild. Citing threats to the supply of food for future generations by reductions in biodiversity, the FAO recently launched a programme for the conservation of animal genetic resources and called for the use of a wider range of species and genetic resources in agriculture [28].

Periodic infusions of new genetic material to crop varieties are essential for several reasons. If improved varieties continue to become more genetically uniform, they will not only be more vulnerable to pests and disease, but will also be less flexible to changing environmental conditions. If global climate change alters the conditions in the world's crop growing areas, then access to genetic diversity will be essential, particularly in transition zones, to give the crops the necessary flexibility to respond to changing climates [24].

Pharmaceuticals

One quarter of all prescriptions dispensed in the USA are likely to contain one or more ingredients derived from higher plants (*i.e.* vascular plants, not including fungi or algae). The figure is very similar in Europe. It has been estimated that the global value of plant based pharmaceuticals will be $500 billion in OECD countries by the year 2000. The WHO estimated in 1985 that perhaps 80% of the world's population relied chiefly on traditional

medicines for their primary health care needs. It has been estimated that 35-70,000 species of plants have been used by some culture or other at one time or another for medicinal purposes [3, 34].

Around half of the world's pharmaceutical compounds may be derived from plants. Many of the most valuable plant-derived drugs, such as digitoxin, digoxin, morphine, atropine, and tubocurarine, cannot be commercially synthesized and are unsurpassed in the treatment of specific conditions. Although since the second world war, the pharmaceutical industry has isolated, copied or synthesised active plant ingredients, many plant substances are too complex to be synthesised at all or without prohibitive expense, so many are still used directly in modern medicine. For instance, morphine is a single purified drug derived from the opium poppy, and an enormous range of plant extracts (such as eucalyptus, thyme, mint and castor oils, liquorice and others) are used in common medications in cold and cough treatments and laxatives [ibid]. Taxol, an anti-cancer drug which has only recently been discovered, is extracted from the bark of Pacific yew trees; it takes six 100-year old trees to produce enough drug to treat one patient [9]. According to one commentator [Fellows, quoted in reference 3];

> *The chemicals in today's wild plants have, we believe, arisen in response to pressures from pathogens and predators, and reflect the end product of almost 300 million years of selection for what are essentially plant protection agents...All wild plants are potential sources of biologically active molecules.*

In 1985, 2,618 new plant structures were isolated, "*most beyond the imagination of the most inventive chemist*" [ibid]. With new techniques now available, and encouraged by the success of some plant derived drugs and promising trials, including some substances which show activity against the AIDS virus, there has been renewed interest in types of plants never before considered as "medicinal". One genus alone has been the starting point for around 40 steroidal drugs. To date, less than 5% of the species of higher plants have been studied chemically

This section has focused on higher plants, but the "lower plants" such as algae and fungi, and microbes, are becoming increasingly important in the pharmaceutical industry. Since 1950, 3000 antibiotics have been developed from the genus *Actinomycetes* alone. Animals also show potential; the Madagascan golden baboon lemur can detoxify cyanide, which is found in large amounts in the bamboo which it eats. This species is endangered. Anticoagulants produced by snakes, ticks and vampire bats may have relevance in the prevention of blocked arteries [15]. Australian corals (exposed in shallow seas to the sun) produce protective materials which are being extracted and synthesised by the manufacturers of suntan lotion [2]. Antitumour chemicals have been isolated from marine groups such as tunicates, bryozoans, and sea hares [65].

Recent advances in biotechnological techniques can only serve to enhance this potential. In addition, as well as the drugs developed within the modern pharmaceutical industry, there are those which fall within the vast area of herbal and traditional remedies. For instance, the Chinese system of medicine uses perhaps more than 10,000 types of plant [3]. In the West, herbal medicines sometimes appear to represent an ever-increasing market.

Generation of wealth; genetic prospecting rights

The report on Conservation of Biological Diversity prepared for the DoE/DTI by Touche Ross management consultants before UNCED [10] stated that

> *The public nature of biodiversity is reflected in the way in which the exploration and collection of genetic resources is organised. Just as oil companies make heavy investments in prospecting and in exploration, if pharmaceutical and agribusiness companies could capture value by appropriating genetic resources for themselves, they would establish their own exploration activities in areas of high biodiversity. This is not the case. Collection in the wild is undertaken in a fragmented fashion by a wide variety of low cost entrepreneurs, charities and state funded scientists.*

This situation has now changed. Particularly since the Rio summit, there have been moves by several nations to establish ownership of their genetic resources, and to alter this "public nature" of biodiversity, rather than allow its free exploitation. This realisation on the part of countries that their genetic resources are commercially valuable may in turn lead to pharmaceutical and other companies prospecting and setting up exploration activities on larger commercial scales.

The World Resources Institute (WRI) in Washington recently published a report stating that the growing number of "biodiversity prospectors", whether commercial or scientific, should perhaps be made to pay fees, similar to mineral rights concessions, to exploit genetic diversity. This would contribute to conservation and to equal sharing of profits, particularly with developing countries, and perhaps help avoid *historical patterns of resource exploitation* which lead to *the resource's exhaustion and to the destruction of local communities and cultures*. The WRI report included guidelines for developing countries to draw up contracts and regulations for the exploitation of biodiversity, and suggested strategies by which developing countries could increase their share of royalties from 1% to up to 15% of profits [41].

At the beginning of 1993 the Indian Government banned the export of wild medicinal plants [42]. The state of Queensland in Australia announced in May 1993 that it would declare sovereignty over its plants and animals, to stop *a systematic search of [the state's] biota for potentially million-dollar earners* by foreign laboratories and pharmaceutical companies. The

Head of the Queensland herbarium added that Queensland had the right to own and profit from its plants and animals *like a mining lease or permit* [43].

One of the first large "genetic prospecting" agreements to be made between a developing country and an international company is between Costa Rica and Merck & Co, a US company. Merck will pay the Costa Rican National Biodiversity Institute $1 million for the rights to screen the country's flora and fauna for medicinal purposes. Costa Rican workers will collect and catalogue species, and royalties from drugs developed will be shared between the country and Merck. It is intended that those profits accruing to Costa Rica will be directed into the country's conservation programme [15, 9].

The channelling of biodiversity profits may raise some dilemmas. Even if developed nations feel that they have the right to insist that profits from biodiversity should be directed at conservation programmes, rather than at other parts of a developing nation's budget, clearly some controls may be necessary to ensure that this is done in practice.

The extent to which developing nations may establish ownership or control of their genetic resources will rely in part on the interpretation of the Biodiversity convention signed at UNCED. The USA initially declined to sign the Convention, and it has been alleged that this was mainly because of pressure from US biotechnology and pharmaceutical companies who feared that their genetic prospecting and exploitation rights would be removed. The Biodiversity convention is discussed in greater detail in section IV of this paper.

Generation of wealth: ecotourism

The biological resources of many developing countries form the major attraction to visitors to those countries. Ecotourism, or nature tourism, accounted for between $2 and $12 billion of the $55 billion that tourism generated for developing countries in 1988 [9]. Ecotourism is a growing industry, and although it is a niche market, the cost of visiting sites which are geographically remote and limited in number is high [9, 10].

Developing countries perceive ecotourism as environmentally benign, sustainable and lucrative compared to mass tourism, and in many Latin American and Caribbean countries legislation has recently been passed which encourages investment in ecotourism infrastructure. Some parks in Thailand generate income which totals from three to ten times the cost of park management. In Costa Rica, Indonesia and other countries, the US Agency for International Development is sponsoring work with NGOs aimed at making the rewards of ecotourism benefit local people [9]. One third of Kenya's income arises from tourism, and it is believed that most of this is due to the Kenyan wildlife and large mammals. Rwanda, north of Kenya, would have little of a tourism industry were it not for its mountain gorillas [2]. However, ecotourism has to be carefully managed, to prevent damage to the very sites, species and cultures that are visited.

Ecological balance

There may be unpredictable and serious consequences for life on earth, including mankind, if biodiversity is not protected. This is because every organism has some role to play in cycles, whether on a global or much smaller scale, of production, consumption, breakdown and regeneration.

One of the most familiar global cycles is that of carbon. In essence, plants absorb carbon dioxide and release oxygen (which is exactly the opposite to what animals do; we breathe in oxygen and breathe out carbon dioxide). Much of the present uncertainty about the speed at which global warming may occur is due to uncertainty about carbon dioxide "sources" and "sinks". Carbon dioxide is a major greenhouse gas. Tropical forests are an important carbon sink, because the carbon dioxide which the plants absorb is fixed or stored in their tissues.

Net tropical forest loss contributed around one quarter of all carbon released to the atmosphere over the past decade. Tropical reforestation, and forest management to preserve the biodiversity and hence the stability of the forests, might have significant potential to help trap or remove carbon dioxide gas from the atmosphere, and thus combat global warming [9]. Tropical forests are not the only carbon sink. Unicellular marine algae may absorb 80% of the carbon dioxide that is produced by animals and other organisms [2].

If loss of biodiversity may have serious consequences for global warming, the opposite is also true. Global warming will put biodiversity at great risk. If the climate alters and rainfall or temperature patterns shift geographically and at a fast pace, although some species may be able to disperse or adapt, other species, and ecosystems as a whole, will not be able to migrate quickly enough to avoid the new conditions. Coastal zones, wetlands, island, mountain and tundra habitats may be among the worst affected by rising sea levels, atmospheric temperatures, shifting sea currents and increasing storms [15, 9]. One fear must be that loss of biodiversity and climate change will have a feedback effect on one another.

Nitrogen availability is an important factor regulating plant growth, which is why the use of nitrogenous fertilisers is so widespread. Models suggest that 70% of the nitrogen flux through soil is in a chain consisting of bacteria, fungi, and their predators; hence plant growth, and therefore the world's crop production, is vitally dependent on bacterial activity [1].

On a different scale, in some situations the removal of just one species may alter the structure of a whole community. For example, in intertidal communities, starfish may be what is known in some quarters as a keystone species. The starfish affect the number of grazing animals and thus the density of algal populations [1].

The US Vice-President Al Gore, who has campaigned on global environmental issues, wrote in his book "Earth in the Balance" [44] that *if we could find a way to understand our own connection to the earth we might recognize the danger of destroying so many living species and disrupting the climatic balance.* Al Gore summed up Lovelock's Gaia hypothesis thus; *the entire earth system behaves in a self-regulating manner characteristic of something alive...it has managed to maintain critical components of the earth's life support systems in perfect balance over eons of time- until the unprecedented interference of modern civilisation.*

IV. BIODIVERSITY INITIATIVES

Biodiversity Convention

The United Nations Conference on Environment Development (UNCED) held in Rio de Janeiro in June 1992, also known as the Earth Summit, gave rise to a Convention on Biological Diversity. Please see Library Research Paper 93/71 and preceeding papers for further details of this and of other agreements reached at UNCED. The treaty's objectives were as follows:

> *The objectives of this Convention, to be pursued in accordance with its relevant provisions, are the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of benefits arising out of the utilization of genetic resources, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding* [45].

In other words, the Convention has three parts;

* conservation of biodiversity
* sustainable uses of resources
* equitable distribution of profits from biodiversity

The last section has been described as a "leap of faith", because countries have not yet decided how this might be achieved [46]. The Biodiversity treaty has been promoted as a much needed conservation measure for the world's plant and animal species by governments of developed nations, who can thus show themselves to be responding to public demand for such action. Developing nations, on the other hand, see the treaty primarily as a means of protection for their natural heritages from plunder by the richer nations, in search of better crops, farm animals and drugs.

By the end of the Earth Summit, 153 states had signed the biodiversity convention. The most notable exception was the USA, and without the US signature it was feared by some observers that developing nations would have difficulty enforcing any conditions they might seek to set for the exploitation of their natural resources [47].

The US Bush administration had considered that the convention would hinder the commercial development of genetic resources and biotechnological advances being made by US companies. It was argued by several large US companies that the convention would force them to surrender product and drug licenses to the countries which had supplied the genetic resources. Following the summit and the adoption by the US of its stance, Venezuela began legal action against American pharmaceutical companies to prevent them gaining access to Venezuela's native flora and fauna, on the grounds that the companies would not be obliged to pay for this use [47].

The biodiversity convention closed for signature on 4 June 1993. By this time 163 countries had signed, including, just in time, the USA. To reassure American companies that signature of the treaty would not adversely affect the US pharmaceutical industry, an interpretive statement was drafted by the White House with the help of representatives from the pharmaceutical and environmental sectors. This statement clarified some of the ambiguities in the treaty as perceived by the US, by indicating that drugs companies would not be forced to, for instance, surrender patents to the countries that supplied the genetic resources for products [47, 48].

Despite the interpretation placed on the treaty by the US, it is likely that developing nations will continue to view the convention as a mandate for companies and government laboratories in developed countries to share with them profits, scientific findings and product licenses for products developed from their plants and animals [47].

It is possible that other countries may also issue their own interpretive statements of the treaty [47]. It is perhaps to be hoped that the situation does not deteriorate into a protectionist battle, with countries, or states within countries, following a lead recently set by the state of Queensland in Australia, which has unilaterally declared sovereignty over its plants and animals [48, see section III of this paper].

The Convention requires developed and undeveloped countries to *"develop national strategies, plans, or programmes for the conservation and sustainable use of biological diversity or adapt for this purpose existing strategies..."*. In drawing up such plans, countries must identify *components of biological diversity important for its conservation and sustainable use* and subsequently monitor these components. The Convention also contains measures, *inter alia*, on conservation, sustainable use, research, public education and environmental impact assessments.

Developed countries are required under the Convention to provide *new and additional financial resources* to enable developing countries to meet the agreed full incremental costs to them of implementing measures. A list of such "developed countries" will be established at the first Conference of the Parties to the Convention. This first meeting will be convened within one year of the entry into force of the Convention, and will also draw up an indicative list of the incremental costs of the developing countries.

An Intergovernmental Committee for the Convention on Biological Diversity (ICCBD) has now been established as an interim body before the first meeting of the Conference of the Parties. The ICCBD met for the first time in Geneva from 11-15 October 1993. Its role will be to "get the ball rolling" by making recommendations concerning the projects to be considered under the convention, and the advice to be given to the Global Enviornment Facility (GEF) [49, 69].

The Biodiversity Convention will come into force officially on 29 December 1993, 90 days after ratification by Mongolia, which happened to be the thirtieth nation to ratify. The US, UK, EC and Russia have yet to ratify [68, 69]. The UK has pledged to ratify the Convention with the EC, by the end of 1993 (**HCDeb.**, 8 February 1993, c*521W*, see below).

UK response to the Convention

Before the summit, in 1991, the Overseas Development Administration (ODA) produced a position document which pledged to support work towards a biodiversity convention in Brazil, to fund research in British institutions on biodiversity, and to help finance UNEP-led work to assess the costs of specific action to conserve biodiversity in identified developing countries [24].

At the Summit, the UK Government expressed concern over the financial implications of the Convention, and attached a declaration to its signature. This declaration stated the Government's understanding that the decisions to be taken by the Conference of the Parties concerned the amount of resources needed by the financial mechanism. There was nothing which authorised the Conference of the Parties to take decisions concerning the amount, nature, frequency or size of the contributions of the Parties under the Convention. When announcing the decision to sign the treaty, the Environment Secretary Michael Howard said that "*We are now satisfied that means can be found within the convention to ensure that no country is obliged to contribute an open-ended blank cheque to implement it*" [50].

Following the summit, the Government announced that it would prepare its national biodiversity plan as required under the convention, with a target date for publication at the end of 1993 (**HC Deb**, 4 Feb 1993, c*241W*). The plan is expected to bring together the Government's policies and programmes for wildlife, covering the conservation and sustainable use of the UK's national heritage.

A DoE consultation paper issued in October 1993 on the UK implementation of the EC Habitats Directive (92/43/EEC) mentioned various elements which would be brought together in the UK Biodiversity National Action Plan. These included hedgerow incentives, management rules for set-aside, the Forestry Commission woodland grant scheme, a Highland Birchwoods Initiative and Peatlands Management Scheme [66].

The action plan is also meant to address UK policies which threaten biodiversity abroad, for example, the import of timber from non-sustainable sources, or the collection of debts from developing countries. It has been alleged by the biodiversity campaigner of Friends of the Earth that current drafts of the Biodiversity Action Plan *ignore the international dimensions and aspects [of the Biodiversity Convention] altogether* [72].

The date for formal ratification of the treaty has been delayed more than once. When explaining that the ratification would not take place before May 1993, the DOE said that "*problems*" with the treaty needed to be clarified, and that Britain's ratification depended "*also on whether other European countries ratified*" [50]. Together with the EC, the Government has now stated that it is working to *establish the basis for ratification of the convention on biological diversity by the end of 1993* (**HCDeb.**, 8 February 1993, c*521W*).

UK Darwin initiative and the UK biodiversity base

As well as signing the biodiversity convention and calling for its speedy implementation, the Prime Minister announced at Rio an additional British initiative which would help achieve the aims of the biodiversity convention. The Darwin Initiative for the survival of species aims *to deploy British scientific, managerial and commercial strengths in biodiversity to assist with the conservation and sustainable use of biodiversity and natural habitats* (**HC Deb**, 17 Feb 1993, c*282W*).

A consultation note issued by the DOE [51] in December 1992 sought views on the scope of the initiative and ideas for projects which might meet the initiative's objectives. Specific suggestions for funding included, for example

* providing a grounding in biodiversity for managers, researchers and technicians from developing countries being trained in the UK
* supplying key scientific journals to researchers in developing countries
* the establishment of international information networks
* the economic exploitation of UK taxonomic collections and methods
* clarifying the links between industry and biological resources, and benefit sharing
* increasing public awareness of the UK capacity in biodiversity.

A small but highly qualified advisory committee on the Darwin Initiative has been established, chaired by Sir Crispin Tickell, Master of Green College Oxford and a former

ambassador to the UN. The membership of the committee was announced in February 1993 in response to a written PQ which also gave details of the remit of the committee (**HC Deb**, 17 Feb 1993, c*282W*):

> *This Committee will have regard to the work already in progress on biodiversity and the available resources, and will make recommendations on the areas on which the Darwin Initiative should initially be targeted, the relative priority to be given to different programmes, and the financial support to be made available to them.*

In November 1992 the Environment Secretary announced that Darwin Initiative would

> *draw on the wealth of talent and expertise that exists in centres of excellence throughout the country. The initiative will provide funding for new and additional biodiversity projects...I was pleased to announce on 16 November [1992] that over the initial three years we will provide funding of £6m for projects which will meet the objectives of the initiative* [52].

This £6m funding for the initiative will be available from 1993-94 onwards, and will consist of provisions of £1m, £2m and £3m respectively in the three subsequent financial years. It will be considered as part of the annual public expenditure round thereafter. The funding will be subject to Parliamentary approval [51].

The level of funding for the initiative has disappointed many biologists and other scientific observers who, in the light of the Prime Minister's enthusiasm for the Initiative in Rio, and spurred on by rumours from officials, had speculated that a budget of up to £10m annually might be made available for the initiative. The Director of the Royal Botanical Gardens at Kew, although welcoming the government funding, has indicated that private funding is now likely to be more important than public money in supporting Kew's biodiversity work, and the Director of the World Conservation Monitoring Centre in Cambridge has estimated that the Darwin Initiative probably needs at least £5m a year to be viable [53, 54].

The Natural History Museum (NHM), Britain's premier biodiversity institute, launched a major biodiversity programme in 1992 which encompasses various collaborative projects and training programmes worldwide. For instance, one project is assessing the mineral status of soils in African game reserves. This affects the health and populations of grazing and browsing animals such as elephants, which in turn affects the success of ecotourism. Young Costa Rican biologists are being trained in taxonomic techniques. Surveys are being performed of freshwater fish in Indonesia, of moths in South East Asia and of plants in Middle America. All of these projects have very practical spin-offs [67].

The NHM has applauded the recognition that the Darwin Initiative gives to the issue of conserving biodiversity and to the UK's unique level of expertise in this area. However, the

NHM feels that the Government needs to show a commitment to biodiversity by increasing the funding of systematic biology, the science of identifying, naming and classifying organisms, which is the fundamental research that underpins work on conserving biodiversity [55].

Systematic biology funding

Following its investigation into Systematic Biology Research, the House of Lords Select Committee on Science and Technology concluded in its report that systematic biology was fundamental to biodiversity and its conservation. The report's principal recommendations included that core funding for research and curation in the major systematics institutions should be maintained in real terms, that extra funding of £1m annually for five years should be made available for systematic biology research, and that a rolling programme of £0.5m a year should be set up to assist systematics collections outside the grant-in-aided institutions [40].

However, while agreeing that systematic biology underpins the Government's policy initiatives on the environment and biodiversity, in its response to the Lords Report the Government stated that claims for systematic biology support had to be considered alongside those from other important branches of science and other claims on public funds. The Government accepted the view of the Advisory Board for the Research Councils that there was no need to single out further funds for systematic biology at present [56]. The Director of the NHM has said he is "*Underwhelmed...just when systematic biology was poised to come back into its own...it is being substantially impeded by lack of funds*" [57].

This paper has not considered in detail the role which could be played by systematics and taxonomy in conserving biodiversity, partly because this subject has been dealt with comprehensively by, among other publications, the recent House of Lords Science and Technology Select Committee report [40], and by the report of the Natural Environment Research Council Review Group published in May 1992 [1].

Statement on Forest Principles

Because tropical forests harbour so much of the world's biodiversity, the Statement on Forest Principles which emerged from Rio will, like the Biodiversity Convention itself, have a direct bearing on the conservation of biodiversity.

The preamble to the Forest Principles states that their Guiding Objective is to *contribute to the management, conservation and sustainable development of forests, and to provide for their multiple and complementary functions and uses.* The principles apply to all kinds of forest

throughout the world, and recognise that *forests are essential to economic development and the maintenance of all forms of life.*

The UK and US had wanted a legally binding convention on forests to emerge from the Summit. Instead, a non-legally binding Statement of Forest Principles was negotiated, following pressure from developing countries, led by India, who feared internationally imposed targets on the development of their countries' national resources, and following doubts about the feasibility of defining a "sustainable" forest product [58]. In the immediate aftermath of the Summit, Friends of the Earth International called the Statement of Forest Principles a "*chainsaw charter*" [59]. The Statement did however represent the first world-wide consensus on forests, and it was hoped that it would carry a moral obligation, if no legal commitment. Malaysia inserted into the principles a "greening of the World" concept, asking *all* countries to take steps towards afforestation [60], and making the principles apply as much to bluebell woods in Britain as to rainforests in the Tropics.

The World Wide Fund for Nature (WWF), Friends of the Earth (FOE) and Survival International have criticised the UK Government's policy on rainforests. They have called for an integrated policy which would include an immediate halt to imports of illegally produced timber such as mahogany, and for legislation to phase out UK timber imports from non-sustainable sources. The Rainforest Campaigner of Friends of the Earth has also said that in pressing for International Tropical Timber Agreements (ITTA) to remain limited to the tropical timber trade only, the UK Government, which represented the EC at ITTA negotiations in April 1993 was

> *...flying in the face of agreements reached at the Earth Summit by blocking moves for an international pact on the trade in timber from all countries. The rich nations are pressing the developing nations to protect and "sustainably manage" their forests, while steadfastly refusing to abide by the same principles.* [61].

According to some observers, this may have the result of giving Third World nations a licence to opt out themselves. A Malaysian forestry negotiator has said: "*They want us to lock up our forests and continue exploiting their own. How can they say that tropical timber must be sustainable but timber from the rest of the world doesn't ?*" [62]. For further details see Library Research Note 93/71.

A third round of ITTA talks began in Geneva on 4 October 1993. Producer countries are still calling for temperate timber to be included in the ITTA negotiations, and have said that financial assistance will be necessary if they are to produce all tropical timber from sustainable sources by the year 2000. The present ITTA arrangements expire in March 1994 [70].

Proposed European Council regulations

Proposed Council Regulation on Operations to Promote Tropical Forests.
This proposed EC regulation will give a legal framework for the provision of £50 mecu (approximately £41m) of forest aid in 1993. 76% of the 1993 budget will go to field projects, 8% to education and 16% to research studies [63].

Proposed Council Regulation on Genetic Resources in Agriculture
The explanatory memorandum to this draft regulation states that, after examining the state of genetic resources in Community agriculture, the Commission has found, inter alia, that certain genetic resources are being substantially eroded and that biodiversity is being reduced. Since genetic resources have a transnational dimension and importance, the regulation proposes a Community action programme on the conservation, characterisation and utilisation of plant and animal genetic resources in agriculture [64].

V. REFERENCES

1. Evolution and Biodiversity: The New Taxonomy. Natural Environment Research Council Review Committee, NERC, May 1992.

2. Last Animals at the Zoo. Colin Tudge, Hutchinson Radius, London, 1991.

3. Medicinal Plants and Plant Extracts. A review of their importation into Europe. Anna Lewington. TRAFFIC International, Cambridge, 1993.

4. How many species are there on Earth? Robert May, Science **241**, 16 September 1988, pp 1441-1449.

5. Government White Paper This Common Inheritence, cm 1200, HMSO 1990

6. Sustaining the Amazon. Marguerite Holloway, Scientific American, 6 July 1993 pp. 77-84

7. Financial Times, 9 March 1993 p.28

8. Cool response to dinosaur DNA. New Scientist, 10 July 1993 p.5

9. Combined Summaries: Technologies to Sustain Tropical Forest Resources and Biological Diversity. US Congress, Office of Technology Assessment. Washington DC, US Government Printing Office, May 1992.

10. Conservation of Biological Diversity. The Role of Technology Transfer. Touche Ross Management Consultants, for the DoE and DTI, July 1991.

11. Earth Summit '92: The United Nations Conference on Environment and Development Rio de Janeiro 1992. Regency Press, 1992.

12. The Earth Summit: One Year On. House of Commons Library Research Paper 93/71. June 1993.

13. How many species? Robert M. May, *Phil Trans. R. Soc. Lond.* **B** (1990), **330**, pp.293-304.

14. Insect diversity: facts, fiction and speculation. Nigel E. Stork, *Biological Journal of the Linnean Society* (1988), **35**, pp.321-337.

15. Worldwatch Paper 108. Life Support: Conserving Biological Diversity. John C Ryan, Worldwatch Institute, April 1992.

16. Putting biodiversity on the map: priority areas for global conservation. Summary. International Council for Bird Preservation, Cambridge, 1992.

17. The Observer, 11 April 1993

18. The Observer, 27 June 1993

19. New Scientist, 10 April 1993. Clinton wants plan to reconcile forestry and wildlife

20. New Scientist, 18 September 1993 pp. 30-33. Last chance for the wasting wilderness?

21. The Financial Times, 9 March 1993, p.28

22. Rainforest Action Report Issue 4. Friends of the Earth, Spring 1993

23. The European, 6 May 1993

24. Biological Diversity and Developing Countries Issues and Options. Overseas Development Administration 1991.

25. New Scientist, 1 May 1993

26. Zoology. R.L.Dorit, W.F.Walker, R.D.Barnes. Saunders Publishing, 1991.

27. The Observer, 25 April 1993

28. European Environment, 8 June 1993, p.4

29. New Scientist, 4 March 1993

30. New Scientist, 10 July 1993. US measures to save rhino anger African states.

31. The Financial Times, 8 September 1993.

32. The Independent, 7 June 1993

33. The Independent, 22 April 1993

34. Wild plants in trade. Martin Jenkins and Sara Oldfield. TRAFFIC Europe, Cambridge, 1992.

35. Flora of the British Isles, 3rd edn, Clapham, Tutin and Moore. Cambridge University Press, 1987.

36. Telephone conversation, English Nature, 26 August 1993

37. WWF International, Fax to the House of Commons Library, 7 September 1993.

38. The Financial Times, 16 March 1993

39. The Financial Times, 9 February 1993

40. House of Lords Select Committee on Science and Technology First Report Session 1991-92. Systematic Biology Research. Volume I- report. HL Paper 22-I 1991-92. HMSO.

41. New Scientist, 19 June 1993, p. 5. How to police the plant plunderers.

42. The Economist, 26 June 1993, p. 109. Buyer diversity

43. New Scientist, 1 May 1993, Queensland sets out rights over native species.

44. Earth in the Balance. Forging a new common purpose. Al Gore. Earthscan Publications Ltd, London 1992.

45. Convention on Biological Diversity opened for signature at Rio de Janeiro 5 June 1992. Cm 2127, Miscellaneous Series No. 3 (1993) (HMSO 1993).

46. The Centre for our Common Future, The Independent Sector's Network, September 1993.

47. New Scientist, 1 May 1993, p.3. One nation's interpretation.

48. New Scientist, 1 May 1993, p.7. Clinton vows to take lead over conservation.

49. The Centre for Our Common Future, September 1993, p. 11. Pace gathers on Biodiversity Convention.

50. New Scientist, 5 September 1992, p. 5. Britain loses initiative on biodiversity.

51. Darwin Initiative for the Survival of Species Consultation Note. DoE, December 1992.
52. DoE News Release 796, 30 November 1992. British expertise turns ideas into action on species survival.

53. New Scientist, 21 November 1992, p. 5. Disappointment over Darwin Cash.

54. The Scotsman, 23 November 1992, p. 3. Cash blow hits high hopes for green project.

55. Natural History Museum, pers. comm., 24 June 1993.

56. Systematic Biology Research. Government Response to the First Report of the House of Lords Select Committee on Science and Technology, 1991-92 Session. Cm 2243, June 1993, HMSO.

57. New Scientist, 19 June 1993, p. 12. Systematics spurned.

58. The Financial Times, 11 June 1993.

59. FoE International News Release, 12 June1992..

60. The Financial Times, 15 June 1992, p.5.

61. FoE Press Release, 24 September 1992.

62. The European, 6 May 1993.

63. Financial Statement to Council Regulation on operations to promote tropical forests. EC Draft 5296/93.

64. Proposal for a Council Regulation on the conservation, characterization and utilization of genetic resources in agriculture. EC Draft 8670/93.

65. New Scientist, 16 October 1993, p. 7. Greens turn blue to save the seas.

66. Implementation in Great Britain of the Council Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC), "The Habitats Directive". Consultation Paper. DoE/Welsh Office, 4 October 1993.

67. Biodiversity Resource Development. The Natural History Museum, 1992.

68. Europe Environment **418,** 12 October 1993. p. 45. Biodiversity convention comes into force.

69. The Financial Times, 8 October 1993. p. 4. Meeting to seek halt to biodiversity loss.

70. The Financial Times, 5 October 1993. p.30. Tropical timber pact talks resume.

71. Caribbean hot spot. S. Blair Hedges and Charles A. Woods. Nature **364**, 29 July 1993. p.375.

72. New Scientist, 11 September 1993. p. 5. Britain "ignores" Rio summit pledges.

73. Estimating extinction rates. F.D.M. Smith, R.M. May. R. Pellew, T.H. Johnson., K.S. Walter. Nature **364**, 5 August 1993, p. 494-496.