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BIODIVERSITY - CHALLENGES AND OPPORTUNITIES

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The most reliable guess of scientists is that the universe, as we know it today, began as a great explosion of truly cosmic proportions about 25 billion years ago. Before this explosion, all matter of the universe is believed to have existed as a highly condensed "cosmic egg". This explosion, some what moderately termed the "big bang" is expected to have sent the matter in the "cosmic egg" flying out into the universe to form countless numbers of stars. Many such groups of stars constitute a galaxy and galaxies are known to be clustered into groups. Our own so-called cluster of galaxies called the "local group" consists of some 24 galaxies one of which is the Milky way. The milky way itself consists of over a hundred billion stars one of which deserves special attention - this is what we call the Sun. The sun, being one of these billions of stars, has 9 planets revolving around it. The third such planet, counted by distance from the sun is the **earth,** an approximately spherical body with a diameter of 12,754 kms and a surface area of over 510 million sq.kms. As far as we know our earth is the only planet among the many hundreds of billions that must be around, to possess that remarkable entity called Life.

The earth was born about 4.6 billion years ago and by complex chemical reactions, a primitive form of life is thought to have originated on earth about 3.6 billion years ago. The living entities, being capable of dividing and changing, set off a chain of events we now refer to as biological evolution. For nearly 3 out of these 3.6 billion years, life remained as microscopic blobs of protoplasm in the ocean. But about 600 million years ago living organisms became larger and more diverse and came to possess hard skeletal structures that leave behind impressions on rocks. These so-called fossils permit us a glimpse of the drama of life played on earth during the past 600 million years or *so.*

The major scenes in this drama were the evolution of plants and animals that could live on land instead of water about 400 million years ago, the arrival- of insects and reptiles about 300 million years ago, of birds and mammals about 200 million years ago and flowering plants about 150 million years ago (Figure 1). This gradual and relatively smooth evolution of progressively more complex forms of life received a major jolt about 2 million years ago with the origin of a rather special lineage of primates referred to as the genus *Homo*. About 40,000 years ago a single species of this line called Homo sapiens had arrived on earth with all the qualities of modem man as we know him today. Perhaps the most distinctive qualities of *Homo sapiens* were their intelligence and their ability to manipulate their environment. These qualities permitted *Homo* sapiens to gain unprecedented mastery over their environment. The most important element of their mastery was the ability to control and manipulate other forms of life. Quite naturally *Homo* sapiens perfected the art of cultivating species of plants and animals that were useful to them - agriculture and animal husbandry are modern terms that describe these arts. Never before had one form of life gained such mastery over its physical and biological environments. Not only did Homo sapiens control other forms of life but it also manipulated its physical environment to such an extent that for the first time a species of living organism cut loose from the constraints of biological evolution and produced five billion individuals. The same qualities of Homo sapiens that permitted space exploration and a visit to the moon also permit us to reflect on our past, present and future. This ability to reflect is perhaps our greatest saviour. The euphoria associated with mastery of the universe, with the ability to increase our own life expectancy, to genetically engineer other forms of life, to sequence the human genome, to contemplate setting up colonies of human being on other planets, unfortunately led us to neglect the state of our own planet - a state caused by our own activities.

In the last 25 years or so however, there has been a rather sudden realization that we have damaged our planet beyond recognition and perhaps beyond repair. We have destroyed its life-support systems that had evolved before us over billion of years. We have burnt fossil fuels and cut down forests on such a large scale that the temperature of the earth has increased perceptibly. The planet earth cannot support our efforts to grow food, provide shelter, not to speak of consumer goods, to a human population that is growing in numbers and in its demands at the present rate. This chilling realization has perhaps begun to dawn on a reasonable number of us today. *An* even more chilling realization is however on its way. Not many of us realize that we are destroying, perhaps by the dozens every day, our fellow living creatures that have evolved like us over billions of years. Man's activity on earth is rendering extinct these magnificent forms of life at a rate never before seen. This wealth of life is known by the term that has recently become fashionable - biodiversity. Biodiversity is on its way to becoming a house-hold word and has already entered the vocabulary of our politicians and administrators. But few of us realize that even scientists know very little about this biodiversity that we would now like to save.

What is this biodiversity after all. We do know a few things about biodiversity. We know that biodiversity is spectacular. The earth abounds in myriad forms of living organisms. Today it is customary to recognise five kingdoms of living organisms: (1) Protista (that consists of bacteria and blue-green algae), (2) Monera (that consists of advanced algae), (3) Fungi, (4) Plants and (5) Animals. Living organisms are found almost every where - the deep sea, the polar caps, the hot springs, not to mention the tropical rain forests. They range in size from viruses which may be not more than a millionth of a meter in size to the African elephant that weighs 6.5 tones and stands over three meters tall. the blue whale which may be over 30 meters long or the red wood tree that is over as 100 meters tall. They may swim in water, fly in the air, crawl on land or burrow under the soil, They may reproduce once every 20 minutes as some bacteria are capable of doing or once in 20 years as some mammals do. One especially surprising fact about biodiversity is its apparent "lopsidedness". An overwhelming proportion of the animal biomass in tropical forests is contributed by insects (Figure 2) and among the insects by social insects such as ants and termites (Figure 3). In a Brazilian tropical forest for example, it has been estimated that the biomass of ants is approximately 4 times that of all vertebrates (i.e., amphibians, reptiles, birds and mammals) put together. Few of us realize the "insignificant" role of higher animals such as vertebrates compared to ants and other insects in tropical forest ecosystems.

All this is fine but pray - how many kinds of living organism are there on earth? Unfortunately that's asking too much. Seems a bit embarrassing does it not - we know about distant galaxies and have a reasonable guess of the number of stars in the universe but cannot ever guess the number of species on earth - our own fellow creatures with whom we share our entire past? Even ignoring the fact that many species are going extinct every day, it is not an easy task to record, describe or even count the number of species. Life forms are so diverse that many years of specialized training is required to be able to recognize and describe them. Even such training drill render one literate only in the realm of one small group of living organisms. Small numbers of scientists, often unheard of and unsung have been painstakingly naming and describing living organisms for about 200 years. Indian taxonomists have so far named and described some eighty three thousand species (Figure 4) while taxonomists the world over have described about 1.8 million species (Figure 5).From these numbers the total number of species of living organisms was being estimated, until recently, at about 5-10 million. Then came a major jolt. Scientists from the Smithsonian Institution, especially T.L. Erwin realized that most insects studied so far were from the forest floor. The forest canopy was essentially unexplored. This last biotic frontier, the tropical forest canopy has now been carefully explored by using a new and more powerful method. This involves killing all insects and other forms of life inhabiting selected trees by covering the trees with a fog of insecticide. To everyone's surprise hundreds of species of insects entirely new to science were discovered on the canopies of just a few trees in Panama. Such richness and newness of tropical forest canopy arthropod fauna has been confirmed by other scientists such as Nigel Stork of the British Museum of Natural History using similar methods in Borneo. All this suggests the possibility that the number of species of insects on earth is really much larger than supposed earlier. One estimate puts the expected number at *30* million for arthropods alone (Table 1). Thus our estimate of the number of species of living organisms on earth varies from 5 million to over 30 million - not a very precise estimate indeed.

Conserving biodiversity is perhaps our most challenging task ahead. As Harvard University biologist Edward O. Wilson has said. 'The worst thing that can happen - will happen - is not energy depletion. economic collapse, limited nuclear war, or conquest by a totalitarian government. As terrible as these catastrophes would be for us, they can be repaired within a few generations. The one process ongoing, that will take millions of years to correct is the loss of species diversity by the destruction of natural habitats. This is the folly our descendants are least likely to forgive us." But we can hardly expect the political will, the hard work and the social participation needed to conserve biodiversity if there doesn't exist even a reasonable catalogue of biodiversity, let alone documented uses of different species. But estimating biodiversity is perhaps an even greater challenge. It will require millions of man days of painstaking work by highly trained biologists. More difficult, it will require foresight and imagination on the part of science administrators and the realization that this a worthwhile exercise, deserving of all our support, financial and otherwise.

Clearly we need an urgent debate among scientists as well as policy makers about the significance of the findings that insects constitute such an overwhelming proportion of animal biomass and animal species and even more about the possibility that the total number of species of life forms may be of the order of 30 million. How should educated, enlightened citizens of the world respond to these rather shocking findings? Should we readjust our priorities. Is there any point at all in taxonomists continuing to describe new species at the present slow rate? Should we forget about 30 million arthropod species and let them go extinct. Or should we catalogue, describe and try to conserve as many of them as possible. What are the investments in time, effort and money that will be needed. How can we compute costs and benefits of our decisions in these matters? At the very least we need an informed debate. ■

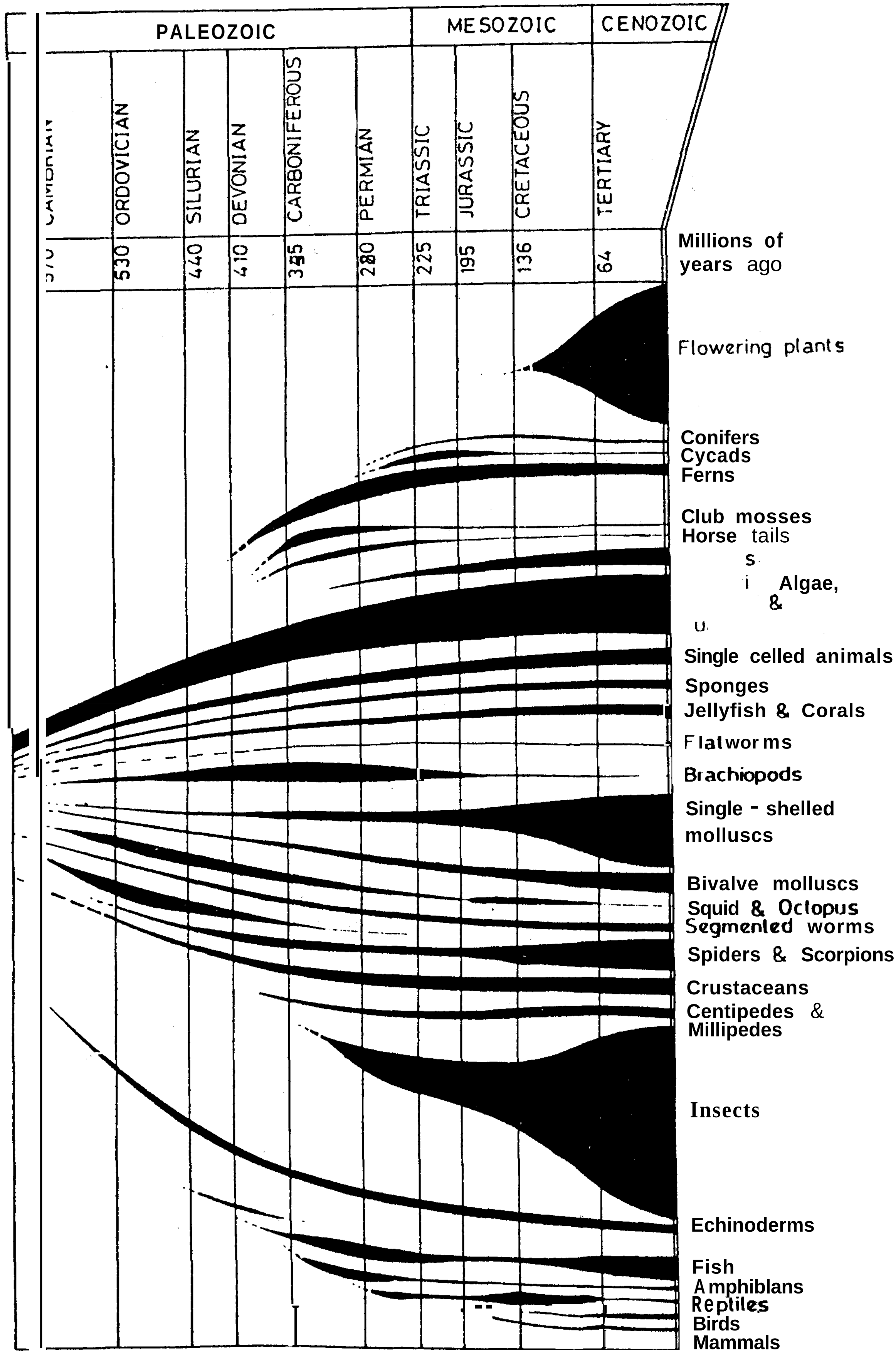
TABLE 1

ARTHROPOD SPECIES DIVERSITY - THE LOGIC OF THE 30 MILLION ESTIMATE

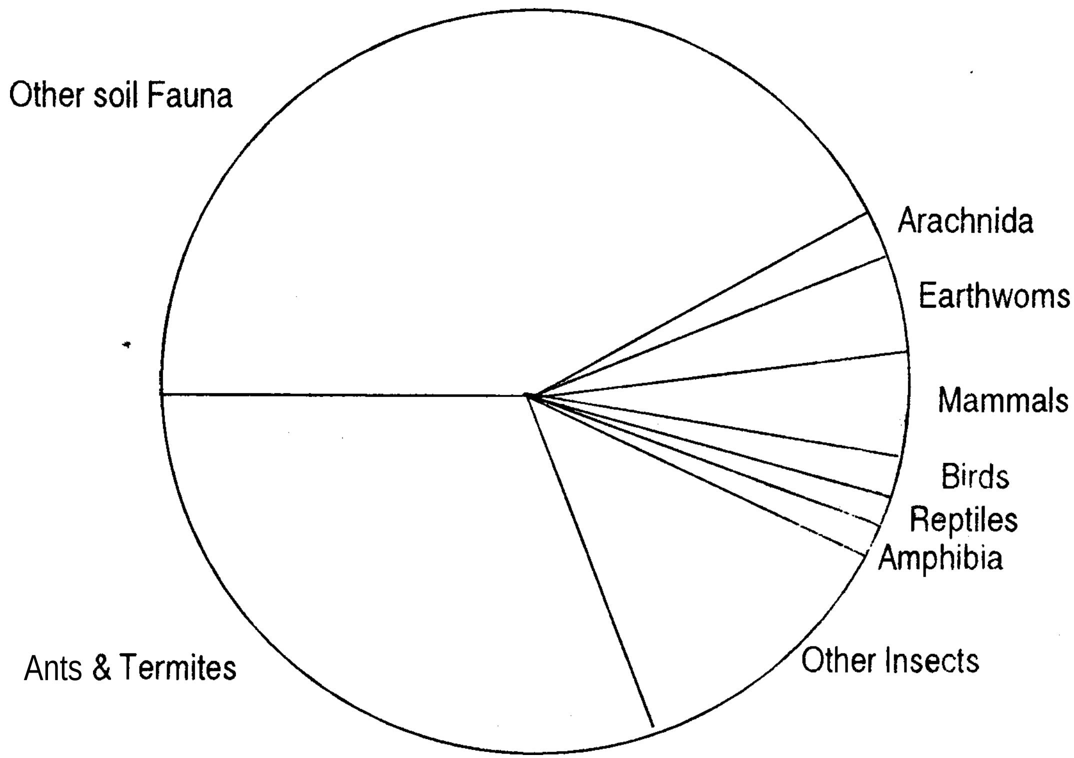
1.	Number of beetle species fogged from 19 *L. Seemannii* trees	**1,200**
2.	Average host-specificity for beetles is 13.5% - therefore number of beetle species host-specific to *L. seemannii*.	163
3.	Number of tropical tree species is about 50,000 - therefore number of beetle species host-specific to these	8,150,000
4.	Beetles represent 40% of canopy arthropod species, therefore number of species of tropical canopy arthropods	20,000,000
5.	Canopy is twice as rich as the ground in species of arthropods, therefore total number of tropical rain forest arthropods.	30,000,000

[Modified from **Stork** (1988). Data from Erwin (1982)]

Evolution Of Life On Earth



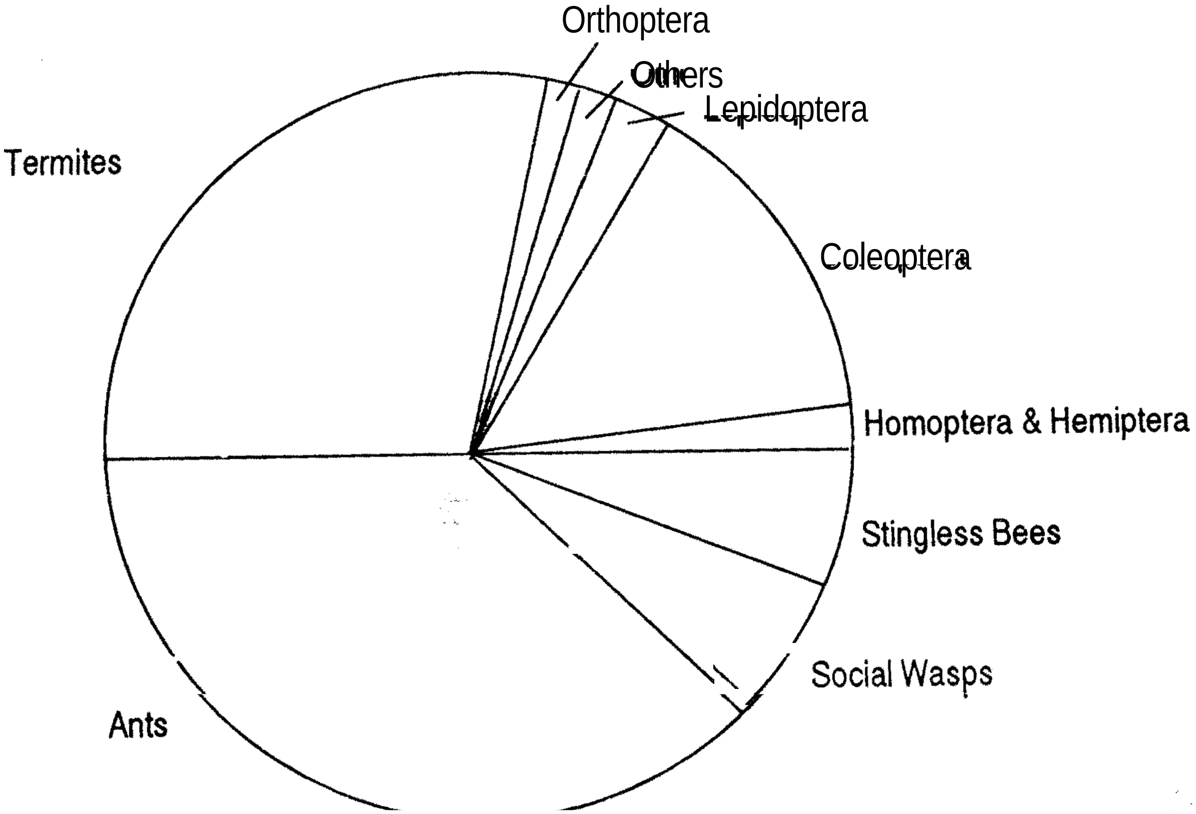
Total Animal Biomass



(Data from Fittkau **and** Klinge 1973)

Figure 2

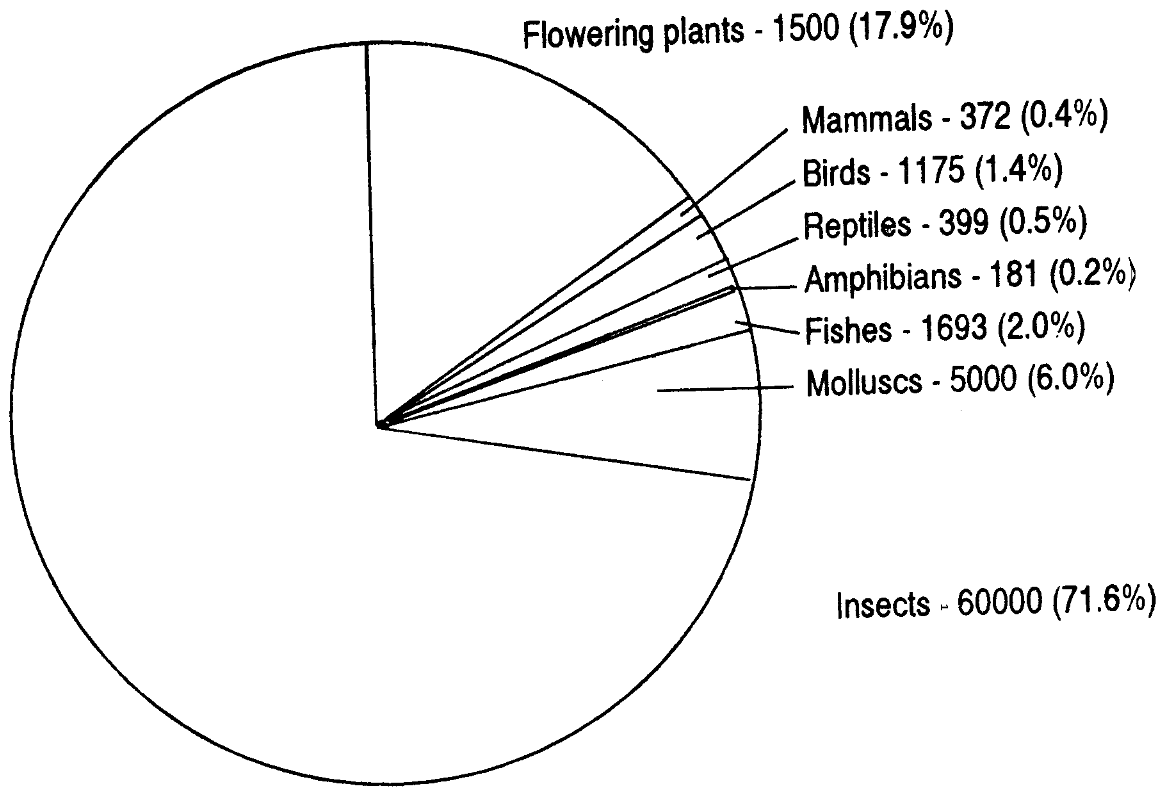
Insect Biomass



(Data from **Fittkau** and Klinge 1973)

Figure 3

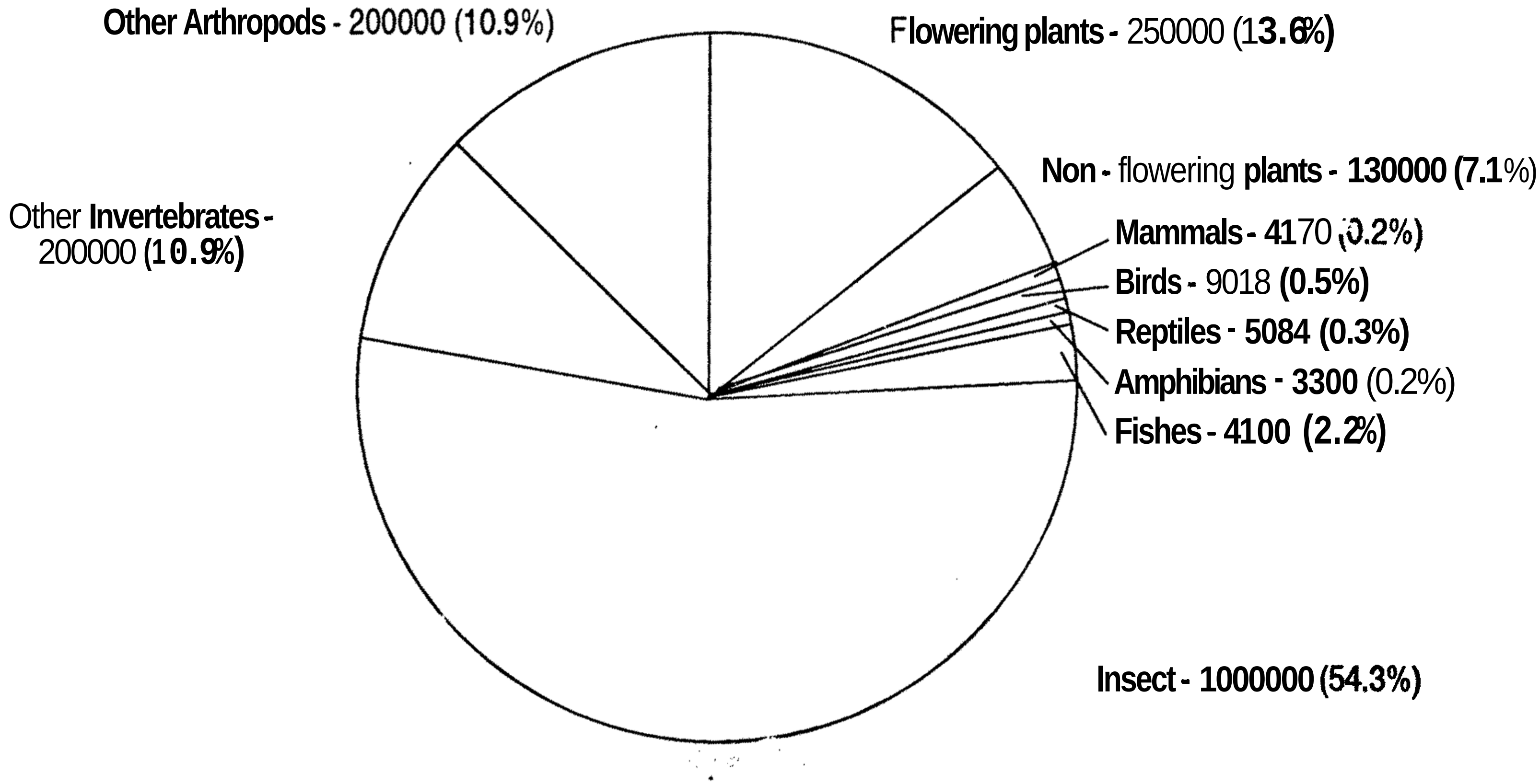
Described Indian Species



(Data from Jairajpuri (1991) and N.C. Nair & P. Danial (1986)

Figure 4

Described World Species



Data supplied by Marc Collins

Figure 5