

Nuteeriat

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NUTEERIAT:

*Nut Trees,
the Expanding Earth,
Rottnest Island,
and All That ...*

David Noël

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NUTEERIAT:

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FOREWORD

“The purest gems lie hidden in the bottom of the ocean or in the depths of rocks. One has to dive into the ocean or delve into the rocks to find them out. Similarly, truth lies concealed in the language, which with the passage of time has become obsolete”

— *Motilal Banarsidass*

Dedication

This book is dedicated to Samuel Warren Carey —
Emeritus Professor in Geology, the University of
Tasmania
Pioneer in elucidation of the Expanding Earth
Toeless Z-Force veteran
Wise scientist and thoughtful humanitarian

It must be a rare event for material which may be of fundamental importance to geologists to have its first public airing at a conference of nutgrowers. But that was the case with the basic material presented in this book; it was the subject of a paper I gave at the 3rd Australasian Conference on Tree and Nut Crops, held in May 1986 in Auckland, New Zealand.

That paper, and this book, both contain two seemingly bizarre assertions. The first is that the Earth has, in the geological past, expanded like a blown-up balloon. It is shown that the present continents once covered the whole surface of the Earth; these have split apart under the expansion, and are now widely separated.

The second assertion is that the first assertion can be proved by a study of nut trees. Bizarre as that may seem, read on, gentle reader, and judge on the evidence presented. No doubt these two assertions are a mighty bite to take in. When I go on the third assertion, that fundamental knowledge on the origin of life, the evolution of man, and the structure and cosmology of the universe can stem from the same studies,!

As in most of man’s intellectual advances, much of what I present here is based on the work of others, extending back into the distant past. One pivot of the present argument is based on a study of plant distributions, and that is a subject which has had many distinguished contributors active in it, going back over at least two centuries. Indeed, this study could be claimed to have its roots in comments made by the ancient Greeks, so perhaps twenty centuries is closer.

The study of the Earth is at least as ancient. However, it is true that these topics have had their most active development in the recent past. Even this active phase is not so very modern, however; we shall see that it extends back to well over a century ago. To reach high, we all must need stand upon the shoulders of giants of the past.

So, turn the page, and start the journey along a road of propositions. Go armed with a critical and perceptive view, but be ready to accept the logic of evidence and the evidence of logic. Good travelling!

— *David Noël, 1989.*

SETTING THE SCENE

“The art of discovery is to see what everybody sees, and think what nobody thinks”

This book follows the conventional system of division into chapters, each dealing with one aspect of the fascinating whole to be unravelled and put back together. One novel feature is that, scattered throughout the chapters, and placed in boxes for emphasis, are a number of *Propositions*.

These Propositions are just that – propositions. They are succinct, unhedged, and uncomplicated suggestions on various aspects of the world of the present, the past, and the future. Some of them are mild and uncontroversial, virtually self-evident, others could be regarded as outrageous from the viewpoint of a conservative soul. I am not claiming that all these propositions are ‘true’ (for more on what ‘true’ means, see Chapter 17), and in fact they cannot all be true, as some of them (e.g. Propositions 12E and 12F on dinosaurs) are apparently mutually exclusive.

But I hope, at least, that they will provoke thought and perhaps some critical evaluation of their implications. Many of them have scope for setting up tests, for extrapolation, for prediction, in fact for running them through the whole gamut of objective probing which reveals the ‘truth’ or otherwise of any scientific theory.

Where the Evidence Comes From

A word about sources and data. This book contains almost no new data, no astounding new results of trials. Some of the conclusions reached may be quite novel. But these conclusions are based on the most prosaic data, much of it available for many years in standard sources. A lot of the hard data quoted is taken from either the current edition of the Encyclopaedia Britannica, or from the Ninth Edition of this work, published in 1875. Some comes from the Guinness Book of Records!

In fact probably half the evidence used in this book was already available a hundred years ago, and three-quarters available fifty years ago. Even the remaining 25% which has come to light more recently has been mostly in the nature of confirmatory detail, rather than some revolution in our views.

Hence the quotation at the head of this chapter. One of the side effects of this work will be to show that ‘old’ data can be reworked with success, like some mineral tailings, to reveal unsuspected new riches.

The Timescale of Events in this Book

It may be useful for the general reader if some background is given on the timescale of events which figure in this book.

Almost all references will be to events which occurred many millions of years (*my*) before the present. Currently, the age of our entire universe is believed to be about 15,000*my*; the

Earth itself (and its satellite, the Moon) are believed to be about 5,000my old.

Of course, life on Earth did not begin until a long time after the planet was formed (usually assumed to have been by condensation of gaseous material). An event occurred at around 600my ago which was very obvious from the record of fossils found in the rocks. Before 600my the rocks are almost empty of signs of life; after this time, rocks which were formed in a way suited to the preservation of fossils (say on the beds of shallow seas receiving a continuing load of sediments) may be crammed with fossils.

Fossils are often excellent indicators of the conditions which applied at the time and place where the creatures which left the fossil remains grew, and so they have been studied in great detail. Most of our knowledge of the geological past has been gained from fossils. So we have quite a good and detailed picture of events since around 600my, and a much poorer picture of what happened before that.

The Ages of the Rocks

Table 1 shows how geological time is divided up; the different slabs of time can be regarded as layers of rock, with the youngest at the top. The time since abundant life has existed is conventionally divided up into three large sections, called Eras. These are, in order of increasing age, the Cenozoic Era, the Mesozoic Era, and the Paleozoic Era (these terms mean, roughly, the times of Young, Middle, and Old Life).

Table 1. Time Divisions in Earth's History

| Age (my) | | Period/Epoch | Era |
|----------|------|---------------|--------------------------------|
| 1 | 3 | Quaternary | Cenozoic (Tertiary) |
| 2 | 7 | Pliocene | |
| 3 | 25 | Miocene | |
| 4 | 40 | Oligocene | |
| 5 | 60 | Eocene | |
| 6 | 70 | Paleocene | |
| 7 | 141 | Cretaceous | Mesozoic (Secondary) |
| 8 | 198 | Jurassic | |
| 9 | 230 | Triassic | |
| 10 | 285 | Permian | Paleozoic (Primary) |
| 11 | 350 | Carboniferous | |
| 12 | 400 | Devonian | |
| 13 | 440 | Silurian | |
| 14 | 510 | Ordovician | |
| 15 | 580 | Cambrian | |
| 16 | 4500 | | Precambrian |

Each Era is itself divided up into smaller units called Periods or Epochs. The names of these units are shown in the table. Rock and fossil dating methods are now accurate enough so that the beginning and end of each of these Periods can be dated to the nearest my, in the younger rocks at least. A change from one period to the next is usually marked by a significant change in the fossil record, and in fact this change is fundamental, because it is usually the *reason* for splitting the record of the rocks up into different parts.

The oldest Period of all, that at the bottom of the Paleozoic Era, is called the Cambrian Period. It is in the oldest Cambrian rocks that the first signs of profuse, active life are found. The change is quite sudden. Something happened at the start of the Cambrian which greatly favoured the development and expansion of life on Earth.

Once it was thought that the Cambrian actually marked the first appearance of any form of life on Earth, and that the older rocks were completely devoid of fossils. More recently it has been shown that these older rocks, called Precambrian and extending back to the beginnings of the Earth itself, do in fact have some traces of life. Some of this life could be as old as 3500my, but the evidence is not clearcut, and argument continues on the exact nature and age of this early life.

The actual figures quoted are subject to revision and refinement, but the general picture is clear. For seven eighths of its 5,000my life, the Earth was almost devoid of life. About 600my ago, life burst forth in abundance. About 230my ago, a major change occurred, and about 70my ago, another big change. Later in this book I will suggest some of the underlying reasons for these abrupt changes.

About Rock Types

This is not the place for a detailed explanation of the different types of rock, but there is one aspect of rock types which does have considerable relevance, and that is the distinction between 'continental' and 'oceanic' rock types.

Both these rock types are 'igneous', formed by the cooling down of molten material. But the continental rocks, which form the bulk of the material of the Earth's present continents, are lighter in weight (and often in colour) than the oceanic ones and have a somewhat different chemical composition. They are also called acidic rocks, and granite is the most typical example.

Oceanic rocks, also called 'basic' rocks, are heavier in weight and usually dark in colour. Basalt is a typical example. Oceanic rocks not only form the bedrock of all the major and deeper seas and oceans, they also underlie the continental rocks of the land masses. The situation has been represented as a continuous, solidified oceanic-rock 'sea' covering the whole of the Earth, with separate 'rafts' of continental material floating on this solid 'sea'.

In agreement with this picture, the continental 'rafts', which are usually 5-40km thick, are said to be actually 'immersed' in the oceanic-rock sea, their bases extending below the level of rock in adjacent seabeds. And, in a classic Archimedes' Principle situation, the depth of immersion is usually greater under higher mountains such as in the Tibet region — just as if the continents were really floating.

Naming Animals and Plants

Living creatures are identified by their ‘scientific names’, which consist of two parts, a genus name and a species name. For example, the walnuts are in the genus *Juglans* (from latin, ‘Jupiter’s nut’). The common walnut is *Juglans regia* (where ‘regia’ means royal). It is normal to print these scientific names in italics or underlined, and to have a capital for the name of the genus (plural ‘genera’) and a small letter for the species (plural ‘species’).

Basically, a species represents the whole of a population which can interbreed. The genus is the next broader grouping, representing all those species which are believed to be closely related. Within a genus, interbreeding between species is sometimes possible (giving ‘hybrids’), but not assured or common. The position is explained in rather more detail in Chapter 2.

Genera are themselves grouped into the next broadest division, the family. In plants, the names of these families usually end in ‘-ae’. The walnut family, the Juglandaceae, includes not only the true walnut genus *Juglans* but also *Carya*, the genus of the pecan and hickories, and others.

We have now painted a rapid picture of the Earth, its history, and its inhabitants, using a very broad brush. To continue this saga, we start by shrinking our focus right down, to look at a very minute part — Rottnest Island.

HOW PLANTS SPREAD AND CHANGE

“Indeed the whole of the Rottnest vegetation is so different to that on the mainland, and so much like that on the mainland 321 km north, as to warrant a surmise that the island had once formed part of the mainland in the neighbourhood of where Dongara now is, and had by some geological earth movement been shifted 321 km southward”.

— Somerville [1976]

Rottnest Island

Located some 19 kilometres off the coast of Western Australian, and visible from the taller buildings of its capital, Perth, lies the Island of Rottnest.

Rottnest is W.A.’s best-kept secret. A magic holiday island, with no private vehicles or private land ownership, it is a place tacitly kept for the local people; the increasing number of overseas visitors touring the rest of the State’s attractions are subtly not encouraged. Travel around the island is by bicycle, whether you are young or old. Jet-setters would be appalled at the salt-water showers.

Rottnest is an island with a history. It was probably the first landfall of Europeans in the southwest of Australia, when a Dutch party under Willem de Vlamingh landed there in 1696. Vlamingh saw the hordes of the small marsupials called quokkas on the island, and thought that they were large rats; hence the name Rottnest, meaning Rat’s Nest in his native language.

Vlamingh was enchanted with the island, too, reporting that “nature had spared nothing to render it delightful — a terrestrial paradise”. At that time, Rottnest was covered with trees, many of which, alas, were cleared away when later settlers attempted to farm the island. These trees and this island have features which, as we will see, have relevance for the ideas expressed in this book.

If there is a family of trees which is typical of Australia, it is the Eucalypts, the Australian gum trees. They exist all over the island continent. But Rottnest has no native gum trees, and moreover, it never did have [Somerville, 1976].

Its principal trees are in the genera *Melaleuca* (Tea Trees) and *Callitris* (Australian Pines). The *Melaleuca* species, *M. pubescens*, is the very distinctive Rottnest Island Tea Tree. This species is not confined to the island for which it is named, but occurs also on the mainland. But — it does not grow on the adjacent mainland around Perth, instead the closest occurrence is near Dongara, some 321 km further north!

Why does Rottnest Island have no gum trees? Why is the tea tree species so distant from its kin? These apparently trivial matters are a small part of a greater truth which we will try to uncover. For the moment we can be content with the important and perceptive observation of Somerville which is quoted at the head of this chapter.

The Spread of Plants

Plants and animals together have been of basic importance to man, extending back to the

earliest times that a creature which could be called a man first existed. Together, they provided man with all of his food, most of his clothing, and much of his fuel and raw materials for artefacts and construction.

So it is natural that he has had an intense interest in these two great divisions of life, kingdoms they are justly called. Through this interest and its resulting knowledge he has been able to exploit the twin kingdoms to his own advantage, and make himself the emperor over both.

Over the years of history, one topic which received attention was the way in which plants were able to disperse themselves, to spread and propagate themselves into new areas. Some of the mechanisms used by particular plants are strange indeed, and the rich diversity and range of these mechanisms is well known. A thorough treatment of the subject appears in Ridley [1930].

Ridley's book gives many examples of long journeys made by plant seeds, found washed up on distant coasts, taken from the feet of migrating birds, carried in the fur of nomadic animals, and so on. Of course most seed dispersion mechanisms strive to separate seeds as far as possible from the parent plant, and many mechanisms clearly have the potential capability to achieve very rapid spread of the species involved. If a dandelion seed can drift 500 metres in the wind, we might expect an initial planting of dandelions to extend over a circle 10km wide within 10 years. Does such a spread usually occur?

In fact, the answer is usually 'No'. Actual rates of spread of plants (and of animals too) are enormously smaller than their *potential* rates as worked out from the mobility of one generation of offspring. It is clear that this must be so, otherwise the spectrum of living creatures found in one place would be more or less identical to that of somewhere else not too far away. In fact it is not terribly unusual for the species list of a given area to differ by more than half its contents from that of another area only 100km away, even when the areas are directly connected and superficially similar in nature.

Proposition 2A
Actual rates of spread of plants are usually much less than the potential rates of spread implied by the dispersion mechanisms operating for an individual seed

There are a number of reasons which can be suggested for this. There may be an obvious physical barrier to the spread, such as a stretch of water or a high mountain range. There may be a more subtle change in the environment, such as a switch to a different soil type with different nutrients or moisture retention.

But the most important reason is a factor which can be called Ecological Pressure. Different plants, and different animals too, do not use the whole spectrum of conditions in which they exist. Instead, they occupy what are called 'ecological niches'. A clear example is the epiphytic plants which grow high up on the trunks of tall trees in a tropical jungle. These plants are not parasites, they just have a strongly position-dependent ecological niche.

Other ecological niches are much more subtly defined. The 'boundaries' of the niche may be formed by such things as a change in soil texture or composition, proximity to water or

rocks, exposure to winds moving in a particular direction, dependence on the presence of particular animals or other plants, and every possible permutation of factors like this.

In order to spread, a plant or animal species would usually need to displace some other creature which is already occupying the particular ecological niche for which it has evolved. In most cases, it is unable to overcome this ecological pressure, and so it does not succeed in spreading.

Proposition 2B
Plant and animal species do not expand their range because they are unable to overcome ecological pressure from other species already occupying their ecological niches

There have been cases where ecological pressure is absent, and in these, rapid colonization and expansion may occur. A dramatic example occurred during the last century, when the explosion of the volcano Krakatoa removed the whole top of a small island in the sea near Java, wiping it completely clean. Within a few years, however, recolonization of the 'new' island recommenced, and now the plant cover is similar to that on adjoining islands.

That was a natural example. A more familiar example, based on the activities of man, is when areas of forest or jungle are cleared for the planting of field crops. The crops are planted, and shortly afterwards the weeds move in — the clearing provided vacant ecological niches not only for the crops, but for the weeds as well. The human activity may be quite minor, such as digging a hole to plant a tree. It has been shown that weeds will invade trial plots in some open areas in Australia only if the soil is disturbed, adjacent plots with no soil disturbance are not affected. The minor action of disturbing the soil surface is sufficient to create a vacant ecological niche for the weeds. This does raise a neglected possibility for weed control.

Proposition 2C
Weeds may be controllable through manipulation of their microecological surroundings, rather than through direct attack by sprays or cultivation.

Plant Mutability and the Isocons

In this book I will be referring constantly to 'Isocons'. These are like the isobars on a weather map, the 'contour lines' showing areas of equal pressure, but instead of pressure they define the boundaries of an area of equal ecological conditions.

In other words, isocons are lines drawn on a map which delineate the local boundaries of a plant's ecological niche. The area enclosed by an isocon is that which we would expect to be rapidly filled by a plant if there was no ecological pressure operating, say if disease had wiped out all its competitors for that niche.

Under settled conditions, the isocon for a given plant species is the same as its natural wild range. The point is that the plant has evolved to fit that range. We speak about 'the plant' as though it were a particular genetic identity, but in fact any plant species is a great mixture of different gene types.

The genes are continually mixing, recombining, and to some extent mutating, within a species. The boundary between one species and a closely-related one in the same family is really rather arbitrary, and taxonomists, the people whose work it is to define these boundaries, are continually arguing and moving them around to include or exclude particular plant populations.

Two related species share a high proportion of identical genes, for example it has been estimated that 98% of the genetic material of man and chimpanzee is the same. The cut-off really comes at the point where cross-compatibility is a factor.

If any individual in a given population can potentially interbreed with any other individual (of appropriate sex) in a second population, to produce fertile offspring, then those two populations are certainly in the same species. If there is no compatibility between any individuals of either population, the two populations belong to different species.

In practice these two states grade imperceptibly into one another, hence the fertile (!) ground for the taxonomists to argue on. It is not physically possible to test every individual of the two populations against each other, but what usually happens is that individuals at the ends of the ranges, those most widely separated, get more and more out of kilter.

Whatever, it is appropriate here to make the point that the ragbag of genes which we perceive to lie within the bounds of a given 'species' is in a state of continual flux, due to mixing, recombination, and mutation. A species today is different to the 'same' species a hundred, a thousand, a million years ago. It is as if an ant colony undertook a long migration, occupying a hundred years, across a continent. The individuals which reached the final point would all be different to those which started. And on a more basic level, the genetic constitution of the colony would have changed too, as characteristics favourable to the conditions met with were selected.

Proposition 2D

The total genetic constitution of a species is subject to continual alteration, particularly if external conditions are changing

Crossing the Isocons

Figure 2.1 shows the mapped distributions of some species of *Canarium* in the southeast Asian region. This is a largely tropical family of trees, which includes the Pili nut and the Java almond. It can be seen that some of the species occur over fairly wide areas, while others are small in range.

In particular, note the black dot marked '7' on the map. That dot is the total range of the species *Canarium kinabaluense*, and it coincides exactly with the site of Mount Kinabalu, the highest mountain in southeast Asia. Due to this height, the physical conditions on the mountain are naturally quite different to those below the mountain — in other words, the isocon for *C. kinabaluense* is dependent on altitude.

Another way of looking at this situation is to ask how this species got to be a separate species, how it evolved from some former common stock. The answer is that, in the past, a group of the genetic elements in the common stock which were particularly suited to the high-

altitude conditions separated off to give the new species.

Perhaps a mutation occurred in some of the *Canarium* trees which were lapping up against the potential isocon ring round the mountain. Perhaps there was slow selection of cold-tolerant genes already present. It is even possible that the change was in the reverse direction, with the mountain species being the original one, with the others adapting from it as the climate warmed up or the sea-level fell.

In any event, to cross the isocon, the species had to undergo adaption and change. These changes were great enough to reach the level where the resulting plant population has been classed as a separate species.

This example of an isocon has a clear physical basis, it depends directly on altitude. Other isocons are more subtly based. For example, the different levels of a dense tropical jungle are worlds apart — on the upper canopy there is intense light and may be burning heat and fierce winds, accompanied by large daily temperature changes. Down below, on the forest floor, it is dim and still, with much less variation.

In one site in the Central American jungles, it has been found that of four species of bee, two are confined entirely to a lower level, and two to an upper one — there is no mixing [Perry, 1984]. Plant species may be similarly stratified, and these more subtle isocons lead to the situation where two distinct but related species evolve in what appears to be the same geographical area, because the isocon separating them is not based on location, but on some other factor.



Fig. 2.1. Distribution of some species of *Canarium* [Leenhouts, 1959]

Rates of Change in Species

Rottneest Island has one species of bird in the family *Lichenostomus*, the Singing Honeyeater, *L. virescens*. This species is the only one of the family on the island [Saunders, 1985].

The same species also occurs on the adjacent mainland, together with other species of honeyeater. What is interesting about the Rottneest population of Singing Honeyeater is the fact that it is appreciably different from the mainland population of the same species. The Rottneest birds tend to be larger, some 20% heavier, and much darker on the lower surface.

It has been suggested that these birds are evolving to fill the niches which are occupied by other honeyeater species on the mainland, because these other species are lacking on Rottneest.

They are on the way to becoming a separate species.

It has been stated that physical isolation of the two populations occurred only about 7000 years ago — 0.007my, a tiny amount on the scale we have been using.

Now let us look at the situation in another famous set of islands, the Galapagos islands off the coast of South America. Back in September 1835, Charles Darwin visited the Galapagos in the ship the ‘Beagle’, and the observations that he made there [Darwin, 1860] laid the foundations for the Theory of Evolution.

These islands are isolated some 900 km off the mainland of Ecuador, and consist of a group of about 5 larger islands and many small ones, all of recent volcanic appearance. What Darwin observed there can be summarized in terms of what are now called Darwin’s Finches, a group of small birds found only on the Galapagos. He found that this group of birds, clearly related, had taken on differing characteristics from one island to another, and the differences were great enough so that the birds had to be classed under different species, and even different genera. A current classification [Grant, 1986] shows that there are now 13 species of Darwin’s Finches on the Galapagos, all of which have apparently evolved from a single common stock.

It should be emphasized that most of the Galapagos islands are within sight of one another, and that these were normal birds, capable of flight. Even so, the forces which govern evolution are powerful enough so that even a relatively small separation in distance was enough to bring about genetic divergence, great enough to take the birds into different species and genera. And there was nothing special about this particular case of the finches, the same thing had happened with other animals, and with plants.

For example, Murray [1986] has shown that of the 543 native species of higher plants on the Galapagos, around 40% are endemic, that is they are species found only in that area. These endemic species must have evolved from older stocks which elsewhere have either disappeared or evolved in a different direction. Murray has calculated that ‘the minimum number of immigrant progenitors needed to account for indigenous angiosperms [higher seed plants] is 306’. We will return to the point of immigration later, now only noting this as the assumed route of origin of the plant populations.

Of course when we move up to the next broader level above that of species, to the level of genus, the level of endemism is much less. The majority of the plant genera, such as *Acacia* (wattles), *Psidium* (guavas), and *Opuntia* (prickly pears) have species which are native elsewhere.

The Galapagos appear to be relatively young in geological terms, having existed in isolation for no more than 3my, and possibly as little as 0.5my [Murray, 1986; Grant, 1986]. This period has been long enough to evolve 13 species of finch from the original one. On another isolated site, the Hawaiian archipelago, Grant has shown that at least 42 species of honeycreeper finches have evolved from a single ancestor during the last 6my.

From these two figures we can derive a rule of thumb to estimate the rate at which species will evolve and split in the absence of ecological pressure. If we assume that a species will diverge enough to split in two every million years (doubling every my), it would take about 3.5my to produce the 13 Galapagos finches and about 5.5my to end up with the 42 Hawaiian finches — both close enough for a first stab.

Proposition 2E

In the absence of ecological pressure, a species diverges into two species roughly every million years

Changing Climates — March of the Isocons

So far we have only looked at the situation as of now, with today’s conditions of climate and elevation in particular parts of the world. In fact, we know that both climate and sea-levels have varied dramatically in the past in most parts of the world.

We can also represent this position by saying that the isocon lines do not stay fixed with time, but move around as external conditions change. As the sea-level rises, the major sea/land isocon moves ‘inland’ into what was previously higher ground, as the oceans fall it moves out to sea. As the climate cools, the major frost/no-frost isocon moves towards more equatorial latitudes, and as the climate warms, so it drops back toward the poles.

In this way, every species population is subjected to a sort of ecological massage. The isocon boundary bag within which it lives is pushed back and forth, up hill and down, north and south. Every species is a nomad.

This picture leads to an important conclusion. As the isocon boundary bags are moved around over the terrain by various external changes, it is inevitable that some will cease to exist. Some will fall over a cliff into the sea (as when an island flora is inundated); others will evaporate off the tops of mountain (as when warming causes the frost line to cease to exist). When this happens, either one population of a species, or even the whole species, will also cease to exist.

Proposition 2F

Species tend to die out when the ecological niches in which they exist are eliminated, and this elimination is promoted by continuing changes in external factors such as climate and sea-level

There is also a most important counter-conclusion. When subjected to this ecological massage, when the isocon bag is nearing the edge of the cliff, some species will have the genetic resources to adapt and cross the isocons, thus becoming a new species. Natural selection is known to promote the formation of new varieties and species, so changes in natural selection pressures must speed the process of evolution up even more.

Proposition 2G

Changes in external conditions increase rates of natural selection and evolution

These two last propositions are clearly at the two ends of the tug-of-war rope. They imply that the rate of formation and extinction of species is much greater than has been assumed. During the last 2my, there have been five major glacial advances and five retreats (five ‘ice

ages'). Most isocon bags will have been shifted some hundreds of kilometres during each of these ten trips. Those situated on small islands must have had a hard time!

Conclusions on Plant Evolution and Spread

We have built up a picture of previously largely unrecognized rapid changes in the genetic bases of plant and animal species. It is clear that these species have the capacity to undergo marked changes in their total genetic bank over what are very short periods on the scale of the Earth's history.

In fact this conclusion is obvious, when we look at the rapid changes in species which have been brought about by man, purely through simple processes of selection, in periods measured in decades, not even centuries. An important point here is that most of these changes are very visible ones — bigger and brighter flowers or fruit, rapid or dwarfed growth, and so on.

Under natural selection, many of the genetic shifts which occur in species will not show up very visibly. If an isocon shift moves a plant population from a sandy soil onto a clay soil, selection of the population will occur to cope with the change in soil type and the associated nutritional factors which this implies. But there may be no visible change at all in the appearance of the plant, and even at the detailed genetic level, it could be hard to find a quantitative difference.

The ginkgo or maidenhair tree, a fascinating nut tree, has been claimed as the oldest 'living fossil'. Standing on the border between the major plant groups of gymnosperms (conifers) and angiosperms (broadleaved trees), the ginkgo was first recognized in fossil leaf impressions dating back some 200my, and was not originally known to Europeans as a living plant.

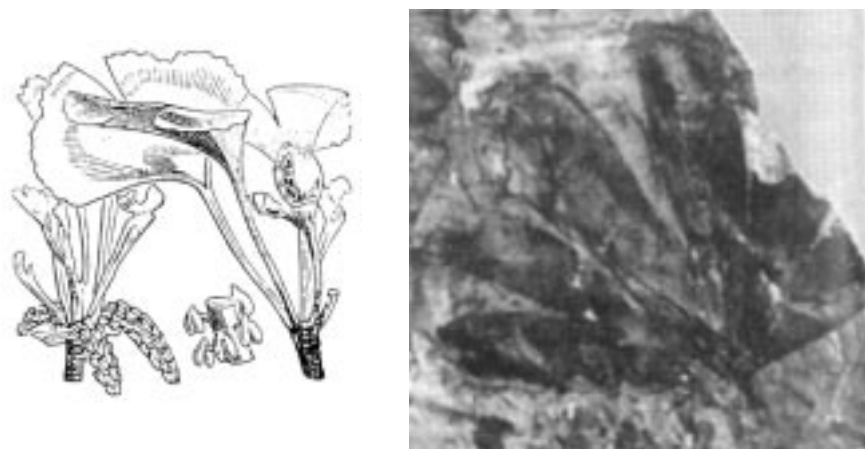


Fig. 2.2. Images of living and fossil ginkgos

However in 1712 an employee of the East India Company, Englebrecht Kaempfer, noted some cultivated ginkgos in Japan [Griffiths, 1987]. In later European travels in China, a number of living ginkgo trees were found, mostly planted around temples. It is still uncertain

whether there are any 'natural' or wild occurrences of ginkgos, although an area in Chekiang province in China has been suggested.

The point that is being made here is this. It has been claimed that the ginkgo has remained 'unchanged for 200 million years'. This is most unlikely. While modern ginkgos are undoubtedly related to those which produced the ancient fossil prints, they would certainly not be classed as the same species as the fossils if the latter were alive today — the underlying genetic differences must be enormous. Later on we will see why this must be so.

In fact it is likely that no species is capable of maintaining its genetic identity for any very long period, say much more than around 10my. Even less is it likely that this identity would be retained through a major physical turnaround like that at the end of the Mesozoic Era, some 70my ago. Reasons for this major upheaval will also be looked at later in this book.

Proposition 2H

No species can maintain its genetic identity for long periods, more than around ten million years

Are these suggestions reasonable in the light of logic and evidence? I have suggested that species are capable of splitting into two, doubling themselves, every million years (and this may turn out to be a low estimate). If there are a million different species of plant existing today (and current estimates approach this figure), then in the next 10my there could be ten doublings, to produce around one thousand times as many species as now.

It is believed that the 'density' of species has increased appreciably since life appeared on Earth, with less diversity in the earlier years. This is a reasonable supposition anyway, as the complexity of particular species has reached higher levels, fitting them to operate more and more efficiently in smaller and more defined ecological niches — the trend toward specialization.

Nonetheless, the actual increase in species density is far, far smaller than would be implied by general application of Proposition 2E, doubling every my. What is happening, of course, is that species are dying out as well as being formed, and these two processes more or less balance — the situation is not too far from a steady state as far as total number of species is concerned. Just like the atoms of a radioactive substance, we can assume that species have a half-life, the average time needed for half the total number to disappear. The actual numbers depend directly on Proposition 2E and the assumption of a long-term steady state:

Proposition 2I

The half-life of a species is approximately one million years.

This last proposition is actually a modification of 2H before it; the 10my in 2H becomes just the time at which the probability of a species surviving has become very small (around 0.1%).