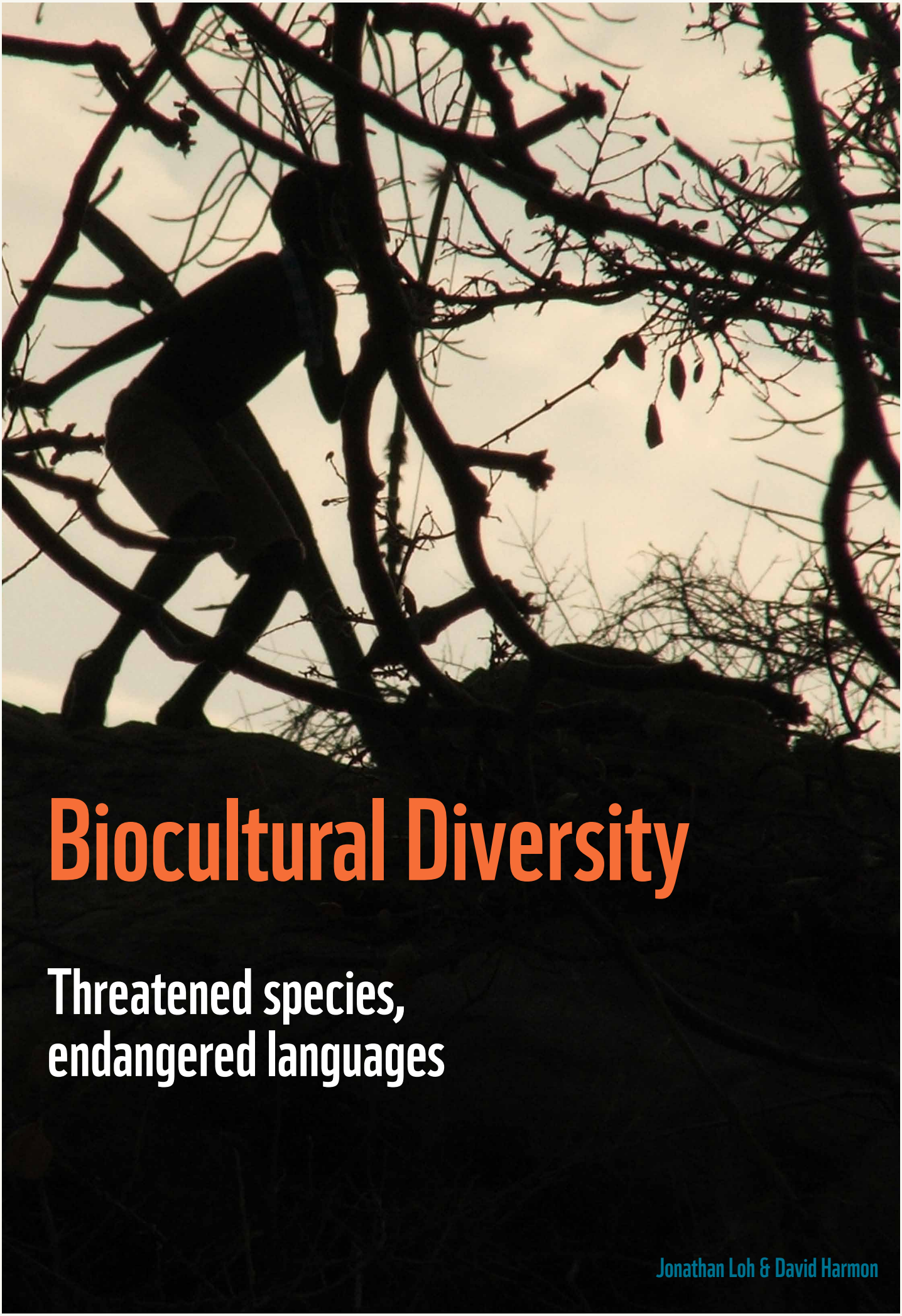

Biocultural Diversity

Threatened species, endangered languages

Jonathan Loh & David Harmon

This research and report has been commissioned by WWF Netherlands

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Acknowledgements
We would like to thank Johan van de Gronden, Monique Grooten, Natasja Oerlemans and Natascha Zwaal of WWF-Netherlands for their enthusiasm, support and comments on earlier drafts of this report. We are also grateful to Terralingua and The Christensen Fund for supporting precursors to the work presented here. We should point out that the opinions expressed in this report are those of the authors and not necessarily those of WWF or any other of the organizations we work with.

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Citation
Loh, J. & D. Harmon. 2014. Biocultural Diversity: threatened species, endangered languages. WWF Netherlands, Zeist, The Netherlands.

Design
peer&dedigitalesupermarkt (www.pdds.nl) and Jonathan Loh

Front cover photograph: Hadza boy, speaker of a Khoi-san language, hunting. Fewer than 1,000 speakers of Hadza remain. Lake Eyasi, Tanzania © Jonathan Loh

ISBN 978-90-74595-00-1

BIOCULTURAL DIVERSITY: THREATENED SPECIES, ENDANGERED LANGUAGES

BIOCULTURAL DIVERSITY

Nature and culture as dual aspects of a single entity

The Oxford English Dictionary offers the following definitions (OED Online):

Nature
The phenomena of the physical world collectively; esp. plants, animals, and other features and products of the earth itself, as opposed to humans and human creations.

Culture
The distinctive ideas, customs, social behaviour, products, or way of life of a particular nation, society, people, or period. Hence: a society or group characterized by such customs, etc.

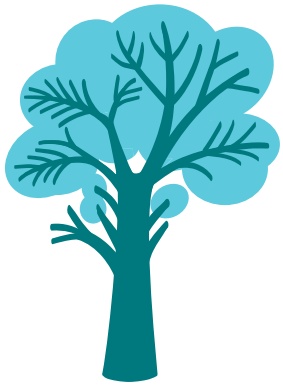
It is customary to think of nature and culture as being quite different, belonging to entirely separate domains, one contains items such as butterflies, the Amazon rainforest and photosynthesis, while the other contains items such as Beethoven's piano sonatas, wedding ceremonies or sushi. Yet nature and culture often interpenetrate and overlap. What is wine-making, bee-keeping or gardening: nature or culture? They are undoubtedly human activities, and each has its own culture, but there is a strong element of nature involved. What about varieties of domesticated plants and animals? They are human creations because their genomes have been altered by thousands of generations of selective breeding, and particular breeds may be associated with particular places or peoples, so they are as much a product of culture as of nature. What about landscapes? Is there anywhere left in the world that is entirely natural, untouched by human intervention? The deep sea bed perhaps, and possibly Antarctica; but most landscapes are, to a greater or lesser extent, the product of human culture too. Even the Amazon rainforest is what it is not just because of the natural evolution of its ecosystems, but also because of centuries of human manipulations to those ecosystems. So would it make more sense to think of all the myriad manifestations of nature and culture as expressions of a single concept, a nature-culture nexus?

BOTH NATURE AND CULTURE ARE WHAT THEY ARE AS A RESULT OF EVOLUTION, AND THEY HAVE EVOLVED IN SIMILAR WAYS

We can think of nature and culture as being dual aspects of a single entity, biocultural diversity; but not just because the two concepts are blurred at their interface. It is because both nature and culture, as defined above, are what they are as a result of evolution, and they have evolved in similar ways. So similar, in fact, that in this report we will describe culture and cultural evolution in the same terms as nature and natural evolution, using concepts borrowed from genetics, ecology and population biology. We will go on to examine the extinction crisis facing both biological and cultural diversity, and use methods developed in conservation biology to assess and compare the state of biodiversity with the state of cultural diversity, and contrast recent trends in the two.

In order to assess status and trends we need a unit of measure. Biodiversity and cultural diversity are such broad concepts that we need to focus on something specific

and measureable, so we have chosen two fundamental units or classifiers of nature and culture: species and languages. Species are the basic units of biodiversity; languages are a useful proxy to stand for the world's diverse cultures. Other elements of biodiversity such as ecosystems or genes, and other aspects of culture such as religions, arts, or livelihood and subsistence strategies, are much harder to define and very much harder to measure.



There are striking parallels between species and languages (Harmon 2002). A species is a group of similar individual organisms that is capable of interbreeding. The ability to produce fertile offspring is fundamental to the biological definition of a species. Horses and donkeys belong to different species, even though they are closely related, as their offspring, mules, are infertile. Humans all belong to a single species, *Homo sapiens*. The genetic variation among humans is remarkably small, reflecting the fact that the modern human species is relatively young, only about 200,000 years old, and yet there is a staggering amount of cultural and linguistic variation among the human population (Pagel & Mace 2004). Linguists identify around 7,000 languages spoken worldwide (Lewis *et al.* 2013). By analogy with the definition of a species, two human individuals can be said to speak the same language if they can understand one another. If they find each other unintelligible, they are speaking different languages.[1] Dialects, by this definition, are analogous to subspecies: communication is possible between two individuals, although it may not be as easy. There are several subspecies of tiger, Siberian, Bengal or Sumatran for example, which can interbreed successfully in zoos, but their geographic ranges do not overlap in the wild. Given time, sadly something which is not on the tiger's side, the geographically isolated subspecies would evolve into reproductively separate species, a process known as speciation. New languages can evolve through a process that is akin to biological speciation, and the formation of dialects is the first step along the path to the evolution of two separate languages, provided that there is limited intercommunication between the two dialect populations.[2]

By using species to stand for all biological diversity and languages to stand for cultural diversity we are taking a narrow view, but making a useful simplification at the same time. Biological diversity is broader than species richness. It spans across scales from genes and proteins at the microscopic level to ecosystems and landscapes at the macroscopic level. Species lie somewhere in the middle, but as the carriers of genes and the components of ecosystems, they can fairly represent all biological diversity. In the same way, languages will stand as a proxy for all of cultural diversity, from the micro level of words, ideas and behaviours to the macro level of peoples and societies.

Fisherman, a speaker of a Trans-New Guinean language, hanging nets up to dry. Western Province, Papua New Guinea.

EVOLUTION OF SPECIES AND LANGUAGES

Explaining biocultural diversity in terms of the Tree of Life

The parallels between species and languages have been noted and commented upon since the 19th century, famously by Charles Darwin in The Descent of Man (1874).

> *The formation of different languages and of distinct species, and the proofs that both have been developed through a gradual process, are curiously parallel.... We find in distinct languages striking homologies due to community of descent, and analogies due to a similar process of formation.... The frequent presence of rudiments, both in languages and species, is still more remarkable....In the spelling also of words, letters often remain as the rudiments of ancient forms of pronunciation. Languages, like organic beings, can be classed in groups under groups; and they can be classed either naturally according to descent, or artificially by other characters. Dominant languages and dialects spread widely, and lead to the gradual extinction of other tongues. A language, like a species, when once extinct, never, as Sir C. Lyell remarks, reappears.*

THE BIOCULTURAL TREE DIFFERS FROM THE USUAL VERSION IN THAT IT HAS GONE THROUGH NOT ONE BUT TWO DISTINCT TYPES OF BRANCHING OR DIVERSIFICATION

To illustrate the analogy between species and languages, picture that well-known Darwinian metaphor, the Tree of Life. The biocultural version of the tree differs from the usual version in that it has gone through not one but two distinct types of branching or diversification; the second diversification took place near the end of one the myriad outer twigs of the first tree (Figure 1). The first diversification was the evolution of multicellular organisms on Earth today, and the second diversification represents the evolution of human cultural diversity. Both of these evolutionary diversifications can be represented as trees, or phylogenies, but with one tree growing from the end of one branch of the other.[3] Figure 1 shows these two great radiations – the biological and the cultural – on a log scale. The first radiation took place near the bottom of the tree, between around 550 million years ago and the second radiation occurred about halfway up the tree at around 70-80 thousand years ago.

Life first appeared around 3.5-4.0 billion years ago; the earliest fossils of the simplest cells, bacteria, date back about 3.5 billion years. More complex life did not evolve until 1.8 billion years ago when the first plant and animal cells appeared in the form of algae and protozoa. These eukaryotic cells contained a nucleus to hold their DNA and had a more complex internal structure, which arose from the symbiotic union of prokaryotic (bacterial) cells, but remained unicellular. For the first three billion years of the evolution of life on earth the most complex organisms were single-celled organisms. It was not until about 550 million years ago that colonies of cells grouped together into the first multicellular life forms, known as the Ediacaran fauna, which resembled quilted discs and pillows.

The Ediacaran period lasted only a few millions of years before the quilted pillows were blown away in a massive, unprecedented and unrepeated diversification of animal biota that happened around 540 million years ago, known as the Cambrian Explosion. This explosion, or radiation, produced new life forms or species more rapidly than at any time before or since. Multicellular organisms appeared of enormous complexity by comparison with the Ediacaran fauna, including some of the most bizarre animals in the fossil record: many had hard body armour and possessed a range of formidable weaponry. Within a geological blink it was all over, but the Cambrian Explosion had produced myriad life forms including all known basic body plans of animals. The ancestors of arthropods, molluscs, annelid worms, echinoderms and all other modern phyla including the chordates (and therefore us) were there in one form or another, and all animal species since that time have conformed to the basic blue prints that evolved in that sudden burst of activity.

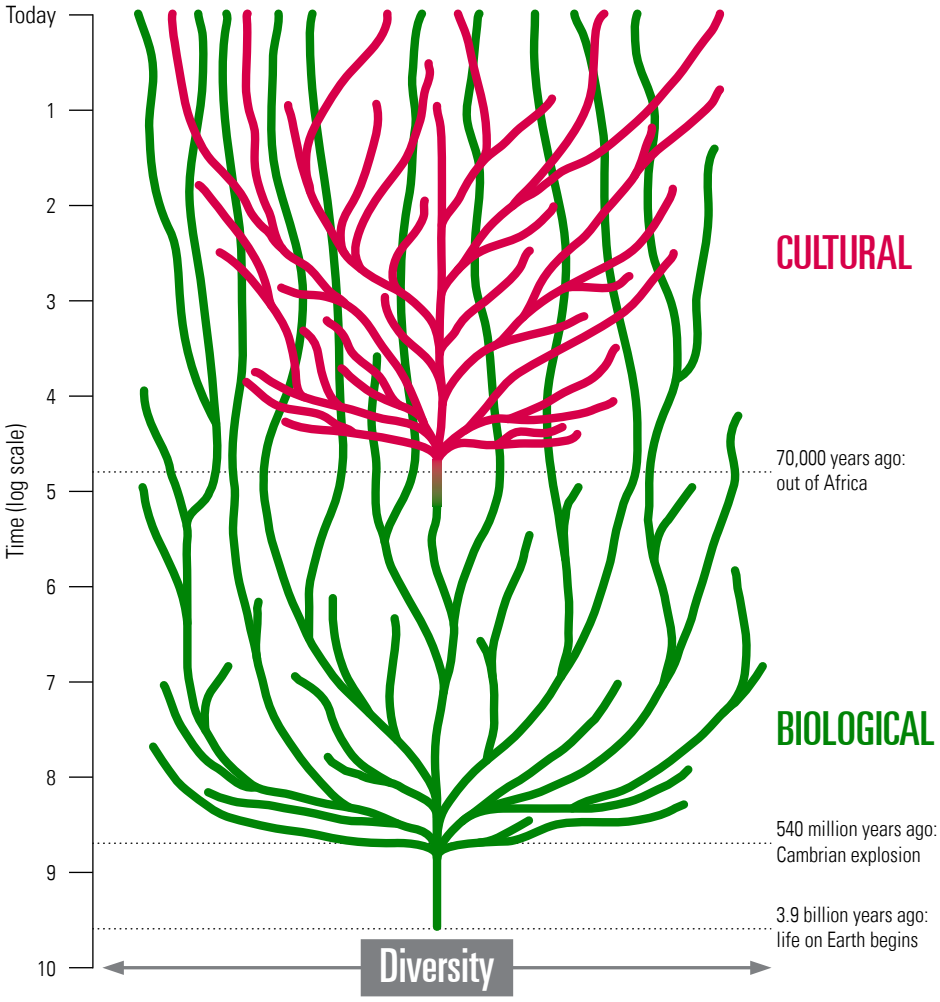


Figure 1:
The Biocultural Tree of Life
The biological tree (in green) of species diversity began its diversification with the Cambrian Explosion around 540 million years ago; the cultural tree (in red) of linguistic diversity began to diversify about 70-80,000 years ago, near the end of one of the myriad branches of the biological tree.

The reason for the Cambrian Explosion is unknown, but a number of possibilities have been proposed. The entire planet during the time immediately preceding the Cambrian was glaciated, a period known as Snowball Earth (Walker 2003). The warming that ended Snowball Earth seems to have jump-started a new phase of multicellular evolution: initially the Ediacaran, followed by the Cambrian Explosion.

Another physical change at that time in Earth's history was a rise in the atmospheric oxygen content to its current level of around 21%, which would have aided the evolution of complex multicellular organisms. A third possibility is that a new type of gene that controls morphological development in the embryo, known as Hox genes, first appeared at the time of the Cambrian Explosion, enabling a plethora of new body plans to evolve.

The Cultural Explosion

The Tree of Life continued to branch and grow, continually evolving new species and losing old ones through extinction. Where whole groups of species died out, those branches stopped growing. This process went on for more than half a billion years, until the number of individual twigs at the outer edge of the tree numbered in the millions. Then an extraordinary, unparalleled event occurred at the end of one of its twigs. To an external observer, that twig would not have appeared exceptional, for although it represented a large mammalian species, it was by no means the biggest, or fastest, or the one with the most impressive body armour or weapons. But at some point, for reasons that are still unknown, the species on that twig began to talk. That species was our own, and as a result of our remarkable and unique innovation, language, the tree began a second massive evolutionary radiation, as significant as the Cambrian Explosion 540 million years earlier.[4]

THE HEREDITARY TRANSMISSION OF CULTURE IS MEDIATED NOT BY PASSING DNA FROM PARENT TO OFFSPRING, BUT BY ONE INDIVIDUAL LEARNING SOMETHING FROM ANOTHER, AND THIS TRANSMISSION IS GREATLY FACILITATED AND ACCELERATED BY MEANS OF LANGUAGE

Modern *Homo sapiens* first appeared only around 200,000 years ago, but we can trace our lineage back to the last common ancestor that we share with our closest living cousins, the chimpanzee and the bonobo, who lived about six million years ago. Exactly how or when language evolved is not known. But once it had taken hold it enabled an entirely new mode of evolution to take off – cultural evolution. Cultures evolve like species in many ways. Cultural items or traits are subject to hereditary transmission, variation by mutation and selection: the prerequisites of evolutionary change. Heredity in biology involves passing genetic information encoded in DNA from parent to offspring. The hereditary transmission of culture is mediated not by passing DNA from parent to offspring, but by one individual learning something from another, be it an idea, a behaviour, custom or another aspect of a way of life, and this transmission is greatly facilitated and accelerated by means of language. One can think of cultural information being transmitted as memes – the cultural analogue of genes (Dawkins 2006, Dennett 2002. See box "What is a Meme?" for further explanation). A meme, such as a song for example, existing in the brain of one individual is passed out of the mouth and via the ear into the brain of another individual. The meme has been copied, and can be replicated again and again in the brains of more individuals. Variation among memes occurs in a manner similar to mutation in genes. The tune of the song can be altered, the words can change, verses added or dropped. Selection is carried out by the individuals who come in contact with the meme, sometimes deliberately, sometimes unconsciously. A memorable, useful or otherwise interesting meme will be replicated many times, and spread successfully through a population – it becomes an element of a culture. Less memorable memes will be less successful; unmemorable memes will be forgotten.

Ashaninka woman, a speaker of an Arawakan language. Nueva Victoria, Yurua River, Ucayali Province, Peru.

What is a Meme?

The word meme was coined by Richard Dawkins in his book The Selfish Gene (2006), and the word itself has become a successful meme. Dawkins proposed memes as the basic units of cultural evolution, and the idea has been developed by other thinkers such as Daniel Dennett (2002), although it remains controversial and is not widely accepted by sociologists and cultural theorists. Dawkins introduces the concept of cultural evolution with a linguistic example:

> *Geoffrey Chaucer [c.1343-1400] could not hold a conversation with a modern Englishman, even though they are linked to each other by an unbroken chain of some twenty generations of Englishmen, each of whom could speak to his immediate neighbours in the chain as a son speaks to his father. Language seems to evolve by non-genetic means, and at a rate which is orders of magnitude faster than genetic evolution.*

Just three conditions are necessary and sufficient for evolution to occur: replication (or heredity), variation (or mutation) and competition (or selection). If these three conditions are met, evolution will happen. In nature, the first two conditions are met by DNA, the molecule that encodes genetic information in all plants and animals, which replicates itself, but not perfectly (because of mutation). The third condition is provided by the fact that resources are finite, so individual organisms (and therefore their DNA) must compete for them in the Darwinian struggle for existence. But is there any other material apart from DNA which can replicate with variation and competes in the struggle for life? Yes, but not a material in the literal sense. Ideas. Memes are ideas which meet the three conditions. Firstly, an idea can be copied from the brain of one individual to the brain of another, so it can replicate. Secondly, ideas show variation from one individual brain to another, either because of imperfect copying or because of an innovation by an individual brain. Finally, ideas compete for finite brain-space in a population of brains, some are very successful and become very common, others are less successful and remain rare, and others still are not copied at all and go extinct. These ideas could be songs, stories, games, recipes, customs, clothing, art, technologies, anything in fact that constitutes culture. The basic unit of cultural heredity is the meme. The song “Happy Birthday to You” is an example of a phenomenally successful meme. As is wearing a tie. How to make an origami frog is a less successful meme, as it is more difficult to learn, and not very useful, but that also makes it a more interesting meme. A language is not a meme, it is a vast collection of memes working together – a meme complex – but which are largely copied as a group. Most elements of culture are in fact meme complexes. The rules of chess, for example, is a very successful set of memes, although not every brain remembers them all correctly. There are many other chess memes, such as opening gambits which are very successful at propagating themselves, but only among serious chess players.

It takes several years for the infant brain to acquire language, but once it has grasped it sufficiently, it enormously accelerates the learning of other types of behaviour, such as how to make tools, to hunt animals and gather edible plants, to cook, to grow crops and raise livestock, to make clothes, to build homes, to tell stories, to paint pictures, to write books, to play games, to do anything, in fact, that constitutes culture. Language is a tool for encoding and transmitting memes. Because of the fundamental importance of language to culture, linguistic evolution usually goes hand-in-hand with cultural evolution, and languages can be viewed as a proxy for cultural groupings in terms of the Tree of Life. It is possible for cultural behaviour to be transmitted between linguistic groups, but the transmission is faster and more accurate within a single group.

The 7,000 languages spoken in the world today represent the outermost twigs of the second tree, but of course there are many more extinct languages whose branches ended before reaching the outer edge of the tree. Like species, some languages can be classified into closely-related families, while others stand alone in families of one. Languages belonging to the same family have a common ancestor, just as families of species do. Germanic languages for example must have evolved from a single, ancestral proto-Germanic language. All Germanic languages belong to the much larger, extended family of Indo-European languages, which includes among others French, Irish, Greek, Russian, Persian and Hindi. Indo-European includes about 430 languages and is among the half-dozen largest families, of which the most diverse are Austronesian (about 1,250 languages spoken in Southeast Asia and the Pacific) and Niger-Congo (about 1,500 African languages) (Lewis *et al.* 2013).

LIKE SPECIES, SOME LANGUAGES CAN BE CLASSIFIED INTO CLOSELY-RELATED FAMILIES, WHILE OTHERS STAND ALONE IN FAMILIES OF ONE

LANGUAGES BELONGING TO THE SAME FAMILY HAVE A COMMON ANCESTOR, JUST AS FAMILIES OF SPECIES DO

Perhaps the biggest difference between biological evolution and linguistic-cultural evolution is speed. Biological evolution is slow while cultural evolution is so rapid that it can be observed taking place within our own lifetimes or even in front of our very eyes and ears: by watching a film made more than 50 or 60 years ago it is possible to hear how much language has changed in terms of pronunciation, accent and some words and phrases. Hence classifying languages into evolutionary families is tricky, as many if not all similarities between related languages can be erased within a few centuries. This is the problem that bugs the reconstruction of ancestral languages such as proto-Indo-European, and makes it paradoxically harder for linguists to draw phylogenetic trees and date the appearance and disappearance of languages than it is for biologists to draw and date phylogenetic trees of species. Another major difference between species and languages is that borrowing occurs far more readily between languages. Borrowing words is the equivalent of different species exchanging genetic material, something bacteria can do easily, but is less common among multicellular organisms. English is an example of a language whose origins lie in one part of the tree, the Germanic branch, but has incorporated a vast number of words from a language belonging to a neighbouring branch, French.[5] So horizontal transmission of language, and hence culture, does take place, but not so much as to destroy the basically tree-like structure of cultural diversity.

Walking the talk

Around 100,000 years ago the modern human population comprised somewhere in the order of 100,000 individuals, largely confined to the African continent, with a few living north of the Sahara and as far east as Palestine. Between 70-80,000 years ago, during the last ice age, people began to migrate out of Africa, probably crossing from the Red Sea to the Arabian Peninsula as sea levels were much lower, rather than moving north across the Middle East where deserts barred the way.[6] From Arabia, the migrants spread inexorably across Asia, probably following coastlines and moving up river valleys. Their descendants colonised South Asia first, and reached East Asia 60-70,000 years ago. About 40-60,000 years ago they succeeded in crossing the straits between mainland Southeast Asia and Australia.

One pathway led the migration north from the Arabian Sea up the Persian Gulf, at that time a broad, forested river valley into which the Tigris and Euphrates flowed. This was the route that led to Mesopotamia, Anatolia and eventually, around 30,000 years ago, to Europe. Another pathway led into northern Asia, and then, about 15,000 years ago, across the Bering Sea into North America. Within another thousand years the descendants of the first migrants to America reached Tierra del Fuego.

The last great migration was not by land but by sea, across the Pacific Ocean from Southeast Asia around 5,000 years ago, finally reaching New Zealand about 1,000 years ago (and, surprisingly, eastward across the Indian Ocean to reach Madagascar about 1,200 years ago). The human colonization of the globe, save for Antarctica, was complete.

Between 160,000 and 80,000 years ago, back in Africa, humans learned to make composite tools such as spears, decorate themselves with beads, catch seafood, use pigments and carry out ritual burials. It is possible that this was the period in which complex language, culture and art first appeared,[7] and people carried these with them as they crossed the globe. As they spread, living in small isolated groups, cultural and linguistic evolution would have rapidly given rise to thousands of local and regional variations, leading ultimately to a vast diversity of human languages and cultures.

Drawing the Family Tree

One way to look at linguistic evolution in action is to compare closely related modern languages. For example, English and Dutch are related languages in the Germanic family, descended from a common ancestral language that would have been spoken somewhere on the northwest coast of mainland Europe around 2,000 years ago. Frisian is a language that is spoken in Friesland in the north of the Netherlands[8] and is closely related to both Dutch and English. Scots is a language also very closely related to English that is still spoken at home by a substantial proportion of the population in Scotland; it contains many words that are closer to their Germanic roots than modern English, and would be unintelligible to most English speakers outside Scotland. It is easy to see how the languages have diverged from a common root by comparing words for the numbers from one to ten (Table 1).

Table 1: The names of numbers 1-10 in four Western Germanic languages

Number	Dutch	Frisian	Scots	English
1	een	ien	ane	one
2	twee	twa	twa	two
3	drie	trije	thrie	three
4	vier	fjouwer	fower	four
5	vijf	fiif	fyve	five
6	zes	seis	sax	six
7	zeven	sân	seiven	seven
8	acht	acht	aicht	eight
9	negen	njoggen	nyne	nine
10	tien	tsien	ten	ten

The similarity between English and Frisian is demonstrated by the saying “Good butter and good cheese is good English and good Fries”, which when spoken sounds virtually the same in both languages. Tellingly, the saying also demonstrates the importance of dairy-based agriculture in both cultures. So it is not difficult to imagine members of the Frisii tribe after the end of the western Roman Empire in 410 CE (along with their cousins the Anglii and the Saxones) crossing the North Sea to Britain, at first as raiders but later as settlers, taking with them their language and perhaps a few of their cows.

Baka woman, a speaker of a Niger-Congo language, with collecting basket, gathering plants in the forest of La trinationale de la Sangha. Central African Republic.

Linguists have made comparisons between the thousands of languages spoken in the world in order to work out the evolutionary relationships between them. These comparisons rely on similarities between words which have descended from common ancestral words, like the numbers one to ten in Dutch, English, Frisian and Scots. Such words are termed cognate, and by knowing how sounds have changed systematically in different languages over time, comparative linguists have reconstructed language phylogenies or family trees.

European visitors to India as early as the sixteenth century began to notice similarities between Sanskrit, Latin and Greek, but the most famous of these was William Jones (1746-94), who is considered to be the founding father of comparative linguistics. Jones was a scholar and magistrate living in Calcutta in the 1780s. He was a polyglot fluent in a dozen languages and familiar with two dozen more. He became fascinated with Indian culture and co-founded the Asiatic Society of Bengal in 1784. In a paper he delivered to the Asiatic Society in 1786 he noted that Sanskrit, Latin and Greek bear

> *...a stronger affinity, both in the roots of verbs and the forms of grammar, than could possibly have been produced by accident; so strong indeed, that no philologer could examine them all three, without believing them to have sprung from some common source, which, perhaps, no longer exists... there is a similar reason, though not quite so forcible, for supposing that both the Gothic and the Celtic... and the old Persian might be added to the same family* (Jones 1824).

That common source came to be known as Proto-Indo-European (or sometimes proto-Indo-Germanic) or PIE. It is not difficult – with hindsight - to see how Jones and others reached their conclusion. Look, for example, at the names of the numbers one to ten in Sanskrit, Latin, Ancient Greek, Gothic (an old Germanic language), Welsh and Hindi.

Table 2: The names of numbers 1-10 in selected ancient and modern Indo-European languages

Number	Ancient Greek (c.400 BCE)	Latin (c.100 BCE)	Sanskrit	Hindi (modern)	Gothic (Germanic c.350 CE)	Welsh (modern)
1	oinos	una	eka	Ek	ains	un
2	duo	duo	dvi	do	twai/twos/twa	dau/dwy
3	treis	tres	tri	tin	þreis	tri/tair
4	tessares	quattuor	chatur	car	fidwor	pedwar/pedair
5	pente	quinque	pancan	panch	fimf	pump
6	hex	sex	sash	chhah	saíhs	chwech
7	hepta	septem	saptan	sat	sibun	saith
8	okto	octo	ashta	Ath	ahtau	wyth
9	ennea	novem	navan	nau	niun	naw
10	deka	decem	dasan	das	taíhun	deg

By using this method a family tree for the Indo-European languages was being put together even before Darwin proposed his theory of evolution of species by descent from a common ancestor (see Figure 2).

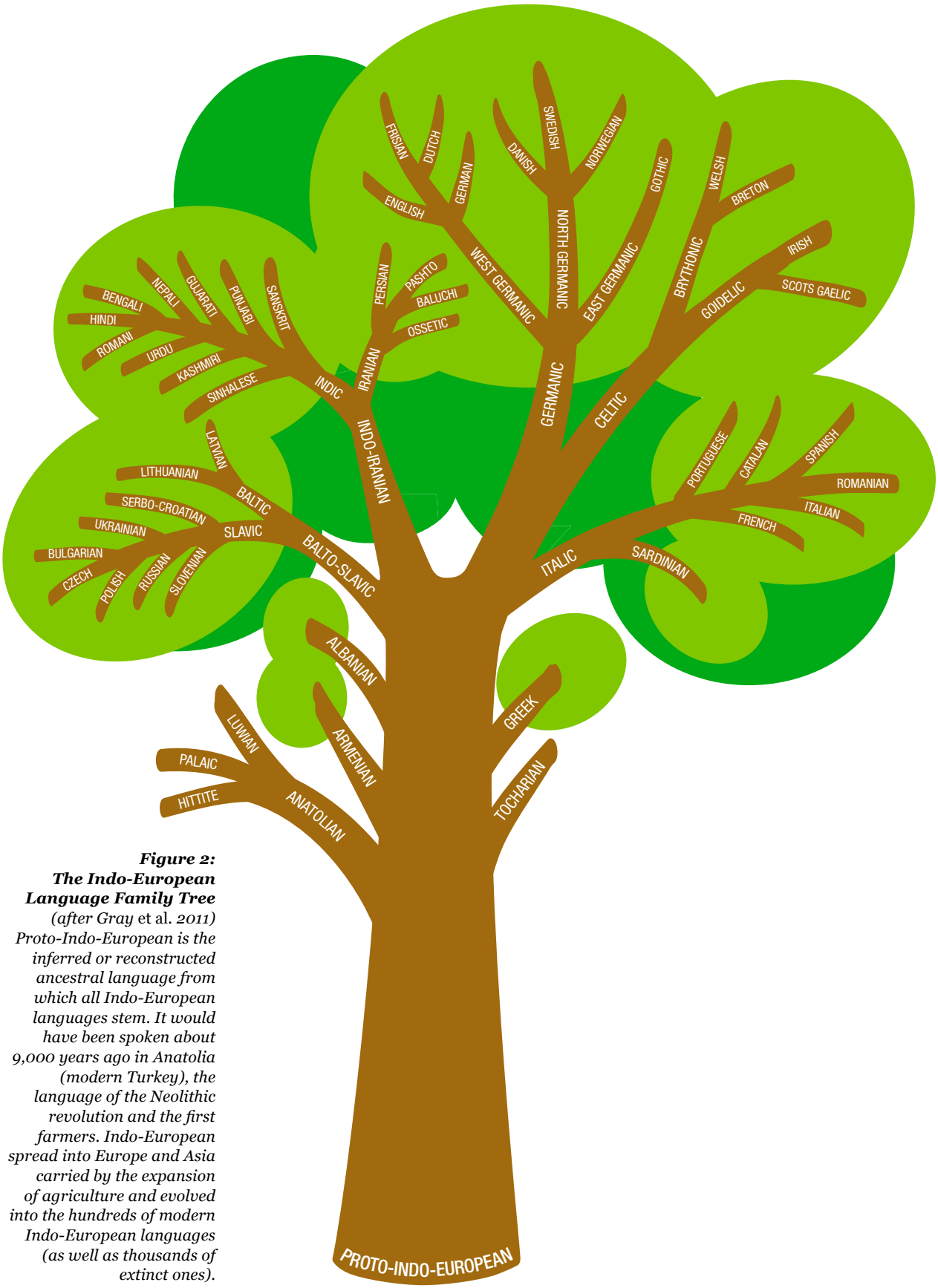


Figure 2:
The Indo-European Language Family Tree
(after Gray et al. *2011)*
Proto-Indo-European is the inferred or reconstructed ancestral language from which all Indo-European languages stem. It would have been spoken about 9,000 years ago in Anatolia (modern Turkey), the language of the Neolithic revolution and the first farmers. Indo-European spread into Europe and Asia carried by the expansion of agriculture and evolved into the hundreds of modern Indo-European languages (as well as thousands of extinct ones).

So who were the original Proto-Indo-Europeans and where did they come from? One of the most surprising findings of the comparative linguists was that some extinct languages spoken in Bronze Age Anatolia (modern Turkey) such as Hittite belonged to the Indo-European family, even though modern Turkish, a member of the Altaic language family, does not. The Hittite language was known only from cuneiform inscriptions on clay tablets dating from the second millennium BCE and deciphered by the Czech linguist Bedrich Hrozný in the early 20th century (Hrozný 1917). The key breakthrough came when Hrozný found the word *watar* in a sentence alongside an ideogram, or symbol, known to mean 'bread' in Sumerian. The similarity of *watar* to water, or Wasser in German, and the similarities of another word in the sentence to eat or essen, and of another to aqua in Latin, led him to guess the meaning was something like eat bread, drink water. But the shock was that this finding placed Hittite in the Indo-European family, not with the Altaic family of central Asian languages, or the Afro-Asiatic family along with other Middle Eastern languages such as Arabic (see figure 9).

A great many theories have been proposed to locate the homeland and time of the Proto-Indo-Europeans. Recently, scientists have re-examined the linguistic evidence using computational methods developed to determine the evolutionary relationships between species based on their DNA. Instead of comparing DNA, Gray and Atkinson (2003) compared a list of 200 words in 87 languages to reconstruct the Indo-European family tree (see Figure 2). They were able to date its origin to about 8-9,000 years ago (Gray and Atkinson 2003, Gray *et al.* 2011), supporting the theory proposed by the archaeologist Colin Renfrew that the Indo-European languages were carried from Anatolia into Europe and South Asia on a cultural tsunami caused by the greatest seismic event in prehistory – the Neolithic revolution, or the adoption and spread of agriculture (Renfrew 1987).

A number of comparative linguists such as Joseph Greenberg have attempted to construct higher-order language families, which unite several families into a single grouping, equivalent to a class or phylum in zoology (Greenberg 2000). Indo-European has been combined with several other families including Uralic (which covers Finland and western Russian Arctic), Altaic (Siberia, Mongolia, Central Asia and Turkey) and Eskimo-Aleut (North American Arctic) languages into a phylum called Nostratic or Eurasiatic. Greenberg also proposed a super-family called Amerind to include all but two indigenous American languages families. These proposals are not widely accepted among linguists, but there is some support for Eurasiatic, based on quantitative techniques used by evolutionary biologists, who estimate the date of the proposed ancestral language, proto-Eurasiatic, would have been around 15,000 years ago, close to the end of the last ice age (Pagel *et al.* 2013).

Some experts have even attempted to link languages as far apart geographically as Basque and Navajo, along with a few northern Caucasian and Siberian languages, into a phylum called Dene-Caucasian.[9] Such heroic attempts at reconstructing deep historical links between languages are highly controversial among linguists. If such a language as proto Dene-Caucasian ever existed, or more likely but still highly controversially, if not a language then at least some proto-Dene-Caucasian words existed, they would have been spoken right back at the height of the last ice age, by Palaeolithic hunter-gatherers living alongside mammoths and woolly rhinoceroses somewhere in Siberia. However remote this possibility may sound, there is some genetic evidence that could support this theory, from the 24,000-year-old remains of a young boy buried under a stone slab in the village of Mal'ta near Lake Baikal (Raghavan *et al.* 2014). Analysis of his genome revealed European ancestry which suggests that there had been an eastward migration of people into Siberia from Europe.

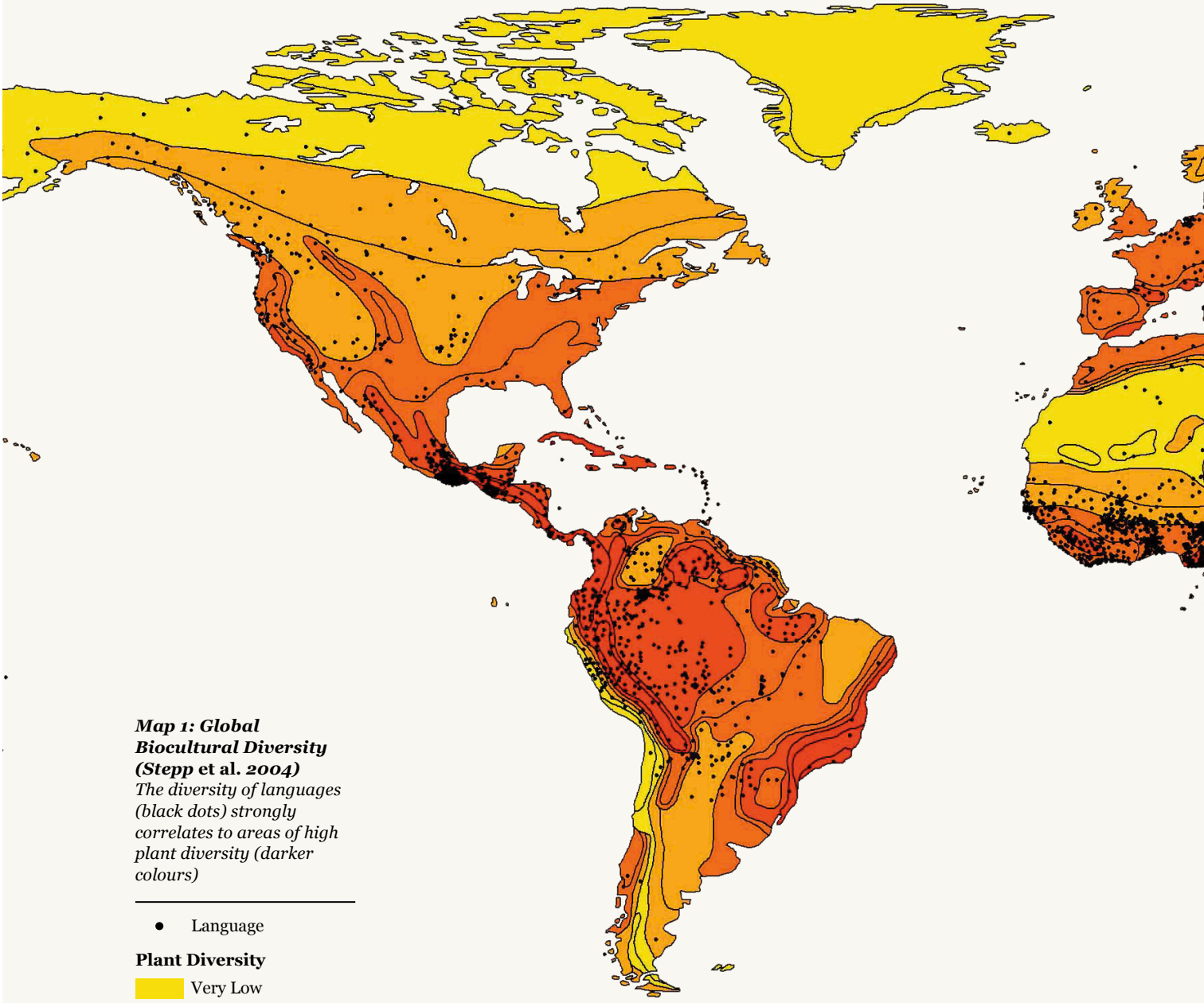
But more surprisingly, his DNA showed he is also ancestral to modern Native Americans, which suggest that some descendants of the Mal'ta population interbred with East Asians in Siberia who then migrated across the Beringian land bridge to the Americas around 15,000 years ago. Is it possible that the Basque and Navajo languages retain some residual cultural imprint from those times?

Basque is one of the few remaining languages left in Europe that is not Indo-European in origin. Genetically, the Basque people also show some differences from other European populations (Cavalli-Sforza 2000). Interestingly, places with Basque-derived names and sites of Palaeolithic cave art overlap geographically in southwest France and northern Spain. The earliest cave paintings date back 30-40,000 years, marking the beginning of western art, and coinciding with the arrival of modern *Homo sapiens* in Europe (long after the arrival of the Neanderthals, who soon disappeared). The cave artists continued to produce their work for another 20,000 years, achieving their *magnum opus* in the extraordinary paintings of horses, bison, aurochs, reindeer, as well as more abstract images of humans, at Lascaux in France and Altamira in Spain, around the time of the last glacial maximum around 17-18,000 years ago. Is it possible that these artists spoke a language that was the ancestor of Basque? Indo-European languages spread into Europe from Anatolia alongside the adoption of agriculture, as settled farming replaced nomadic hunter-gathering as the primary way of life, and the original languages spoken by the first modern humans in Europe fell like dominoes. Basque, for reasons that are unknown, is the last domino standing, a language isolate descended from Palaeolithic hunter-gatherer-artists.

SOME LINGUISTS HAVE ATTEMPTED TO CONSTRUCT HIGHER-ORDER LANGUAGE FAMILIES, WHICH UNITE SEVERAL FAMILIES INTO A SINGLE GROUPING, EQUIVALENT TO A CLASS OR PHYLUM IN ZOOLOGY

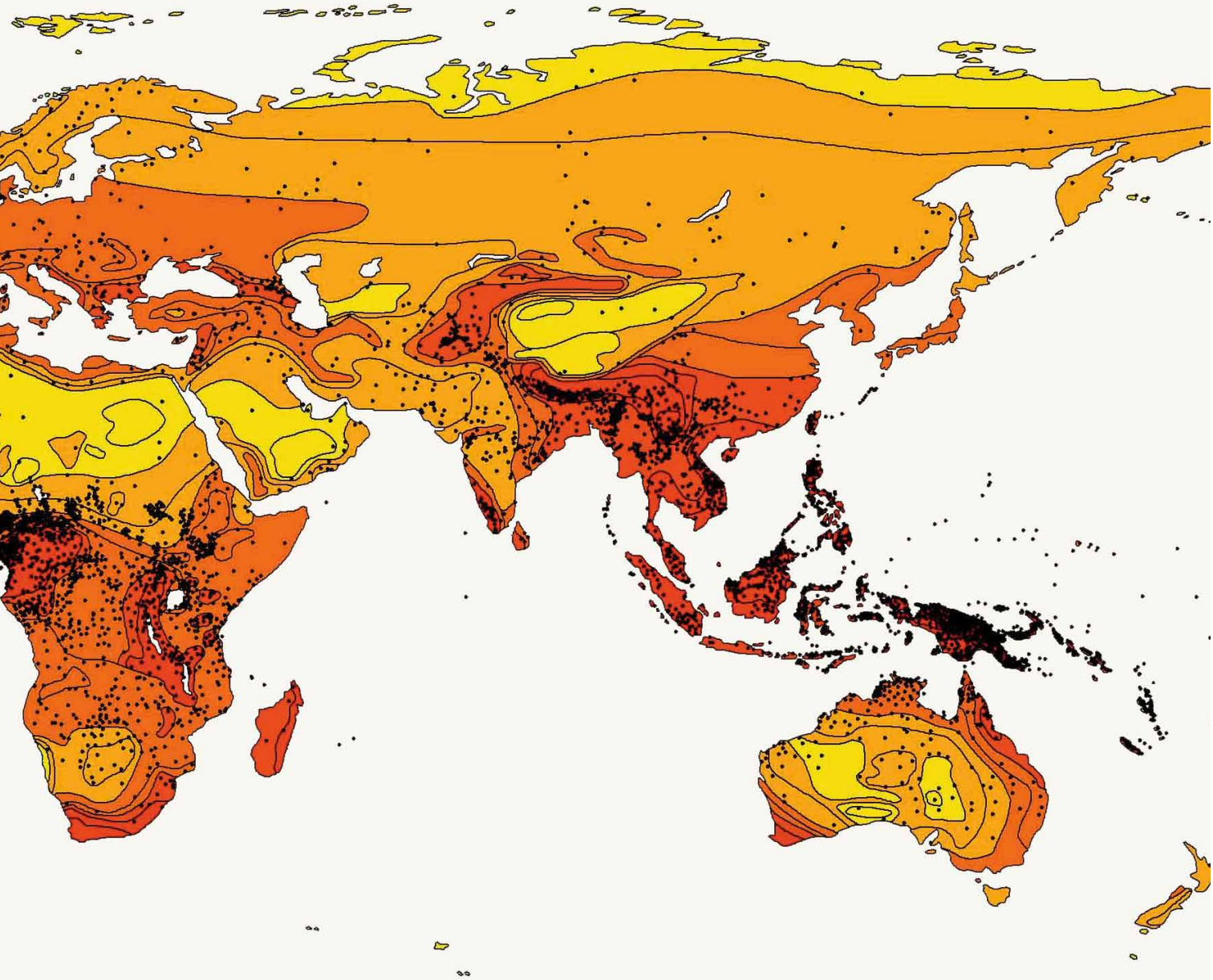
A big coincidence

There is another way in which the evolution of languages mirrors the evolution of species: the similarity in the geographic distributions of languages and of species around the world. Places with high species diversity, especially tropical forests, tend to have high linguistic diversity, and areas of low species diversity, such as tundra and deserts, have low linguistic diversity (Mace & Pagel 1995, Nettle & Romaine 2000, Moore *et al.* 2002, Sutherland 2003, Stepp *et al.* 2004, Loh & Harmon 2005). The island of New Guinea which makes up less than one percent of the Earth's habitable surface, apart from being one of world's biodiversity hotspots with endemic species such as birds of paradise and tree kangaroos, supports around



Map 1: Global Biocultural Diversity (Stepp* et al. *2004)
The diversity of languages (black dots) strongly correlates to areas of high plant diversity (darker colours)

1,000 languages, one seventh of the total. A glance at Map 1 confirms this view, and that it is not just that places with greater population density have greater language density. It is well known to biologists that species density per unit area is highest in equatorial regions and declines towards the poles – a pattern known as Rapaport's rule – and languages obey it too. It is possible that the one causes the other, that in some way higher biodiversity is capable of supporting greater cultural diversity, but the explanation seems to be that both biological and cultural diversity depend on the same environmental factors such as temperature and rainfall (Nettle 1999, Moore *et al*. 2002, Sutherland 2003).



San hunters, speakers of a Khoi-San language, Namibia. Unlike other language families, Khoi-San languages use clicks made by the tongue and sharp intakes of air. The Hadza people (front cover), 2,500 km away in Tanzania, also speak a click language (see figure 9). Genetic evidence suggests that the most recent common ancestor of these two peoples lived as long as 50-70,000 years ago, around the time that modern humans left Africa. It is possible that the very first languages ever spoken were click languages, and that clicks evolved before vocal words as a means of communicating without scaring animals when hunting (Pennisi 2004).

DECLINE OF BIOCULTURAL DIVERSITY

The extinction crises facing both species and languages as consequences of similar processes

Until now, the story has been about evolution and diversification. There is another side to the story, decline and extinction. Most species that ever existed have gone extinct. They are the inner branches and twigs of the tree that stopped growing (or evolved into another species) before reaching the outermost edge. Over and above the background extinction rate, there have been at least five biological mass extinction events since the Cambrian explosion, in which global species diversity was suddenly reduced.

The third event was the greatest, 245 million years ago, in which 96% of species went extinct, and the fifth, 65 million years ago, marked the demise of the dinosaurs. Following each mass extinction event, however, biodiversity recovered to or exceeded its previous high level. The present rate of species loss may be in the region of 100-200 times higher than the background rate found in the fossil record (Groombridge and Jenkins 2002), which puts us in the midst of a sixth mass extinction. But this extinction event is cultural as well as biological (Nettle and Romaine 2000).

According to Ethnologue (Lewis *et al.* 2013), a periodic publication dating back to the 1950s which compiles data on the world's languages and speaker numbers, half of the world's population speaks one of only 24 languages, the top ten being Mandarin Chinese, Spanish, English, Hindi, Portuguese, Bengali, Russian, Japanese, Javanese and German.[10] These two dozen languages have speakers numbering in tens or hundreds of millions. The other half of the world's population speak the remaining 7,000 languages (see Figure 3).

The Ethnologue data describe an enormously skewed distribution of speakers among the world's languages. Figure 4 shows that the frequency of languages of different sizes forms a normal, bell-shaped curve, but on a log scale – each category along the horizontal axis of the graph is ten times the size of the previous one. Around half of the world's languages has fewer than 10,000 speakers, and the other half has more than 10,000. But 95% of the world's population are found in the three size classes at the right-hand end of the bell curve, they speak languages spoken by millions, tens of millions or hundreds of millions of people. Forty percent of us occupy the tiny group of languages with 100 million-plus speakers. At the other end of the distribution, just over one percent of the world's population are responsible for maintaining over 5,000 languages, those with fewer than 100,000 speakers. Astonishingly, only about 0.1% of the world population or about 8 million people, equivalent to a city about the size of London, are responsible for keeping one half, or about 3,500, of the world's languages alive.

Figure 3:
World languages
More than half the world's population speaks one of just two dozen languages (source: Lewis et al. *2013).*

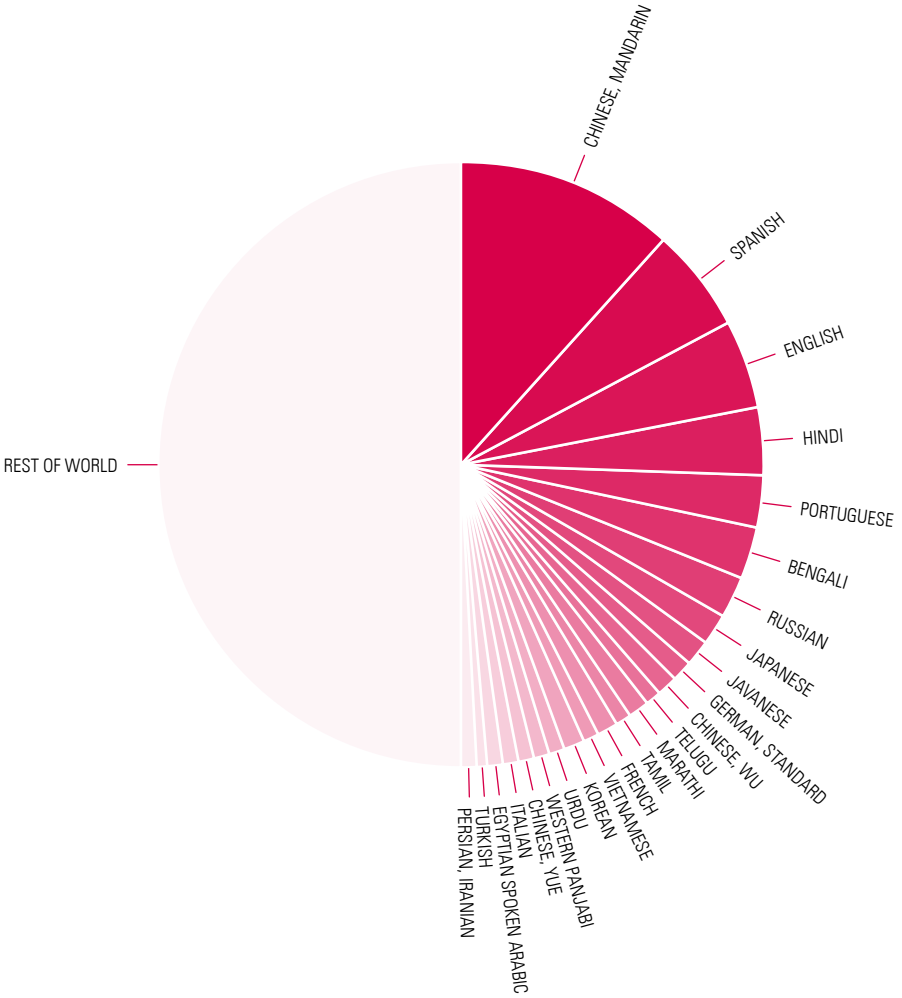
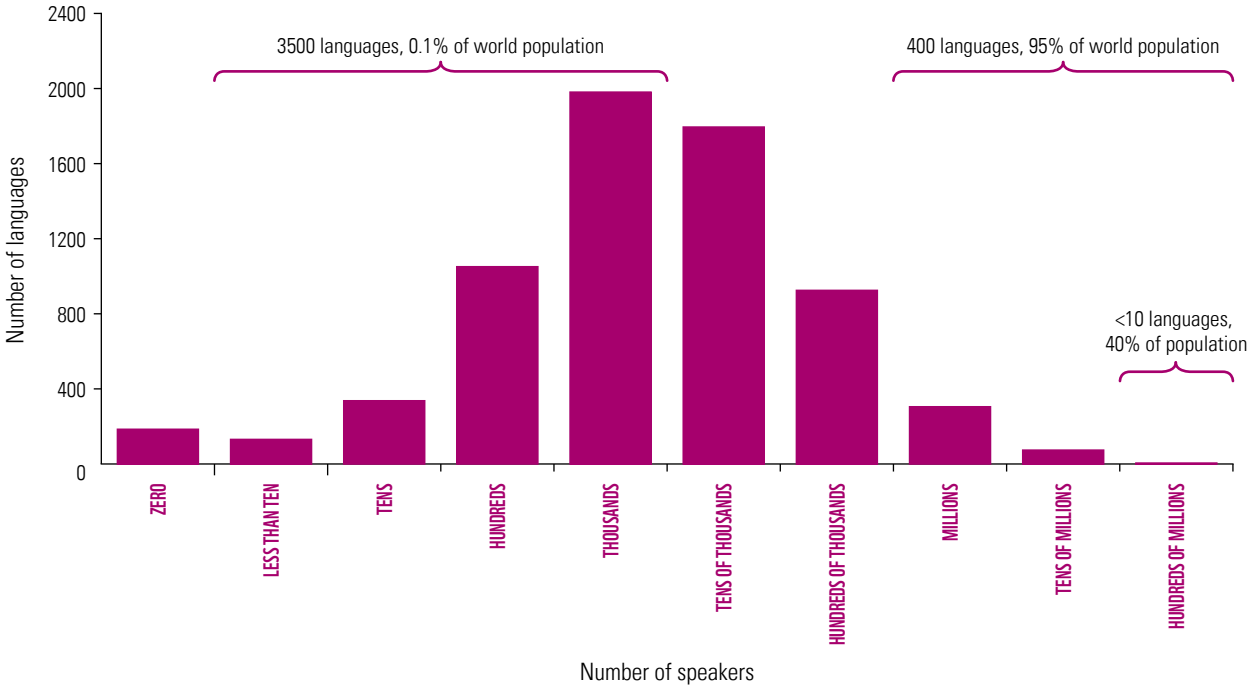


Figure 4:
Sizes of languages
Number of languages by size class (after Harmon 1995, 2002; data source: Lewis et al. *2013).*



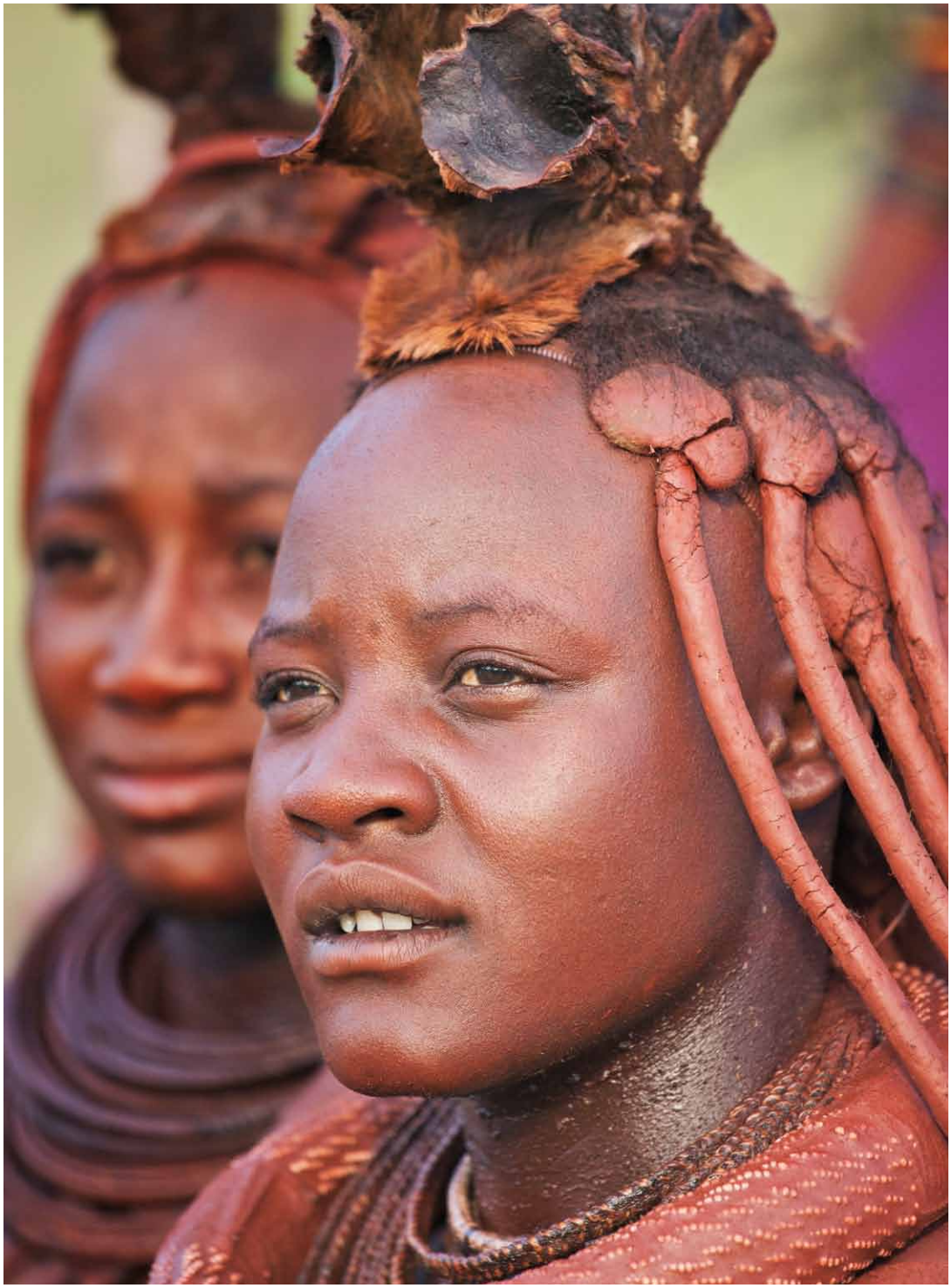
LANGUAGES GO EXTINCT EITHER BECAUSE THE ENTIRE POPULATION OF SPEAKERS DIES OUT OR, MORE USUALLY, BECAUSE THE SPEAKERS SHIFT TO A DIFFERENT LANGUAGE AND, TYPICALLY WITHIN A FEW GENERATIONS, FORGET THEIR MOTHER TONGUE

A comparison with the distribution of language sizes two decades ago (Harmon 1995) reveals that, while the world's population has grown by about 25%, the number of million-plus languages has expanded but small languages have dwindled away. The distribution is gradually shifting to the right like a wave and becoming even more skewed. The only group on the left of the graph that has grown is the zero (extinct) class. Some linguists predict that 90% of the world's languages will die out this century (Nettle 1999, Nettle & Romaine 2000). Why is this happening?

Languages can go extinct either because the entire population of speakers dies out or, more usually, because the speakers shift to a different language and, typically within a few generations, forget their mother tongue. This can happen for social or economic reasons, such as commerce or migration, or through a deliberate policy of linguistic unification by a dominant group (see box: Linguistic Ecology). The globalization of trade and media, and technological progress in transport and communication, have accelerated the process of language shift, as have nationalization policies that favour a small number of languages, increasing the pressure on languages with thousands or fewer speakers, and boosting the dominance of those with millions. As language is the primary medium of cultural transmission, linguistic diversity and cultural diversity are being diminished simultaneously.

Most of the languages threatened with extinction are evolutionarily quite distinct from the few dominant world languages, and so they also represent very different cultures. Nearly all are spoken by indigenous people, some still living in traditional ways on their ancestral lands, although these are becoming rare. Along with the languages, the traditional knowledge of these indigenous cultures is being forgotten. The names, uses and preparation of medicinal and food species, both plant and animal, and traditional methods of farming, fishing, hunting and natural resource management are disappearing, not to mention the vast array of spiritual and religious beliefs and practices that are often associated with traditional land use and resource management, which are as diverse and numerous as the languages themselves. This vast store of knowledge that has evolved and accumulated over tens of thousands of years could be lost in the course of just two centuries, the 20th and the 21st. While linguists have made great efforts to document, record and archive as many of the endangered languages as possible, and ethnobiologists have attempted to record the traditional uses of plants and animals by indigenous peoples, the most important conservation takes place on the ground, as part of a living culture.

Conserving linguistic and cultural diversity presents a quite different ethical problem compared with the conservation of biodiversity. There are very strong utilitarian and economic arguments for protecting species and maintaining natural ecosystems, but there is also a moral argument that no species should be extirpated for human purposes. Cultures and languages on the other hand can only be maintained by people who choose to, usually but not necessarily the ethnic group with which the culture evolved, nobody should be forced to speak a language or practise a culture if they do not want to. Most indigenous peoples, of course, do want to keep their language and culture alive, but they may not have the opportunities or means or numbers to sustain it.



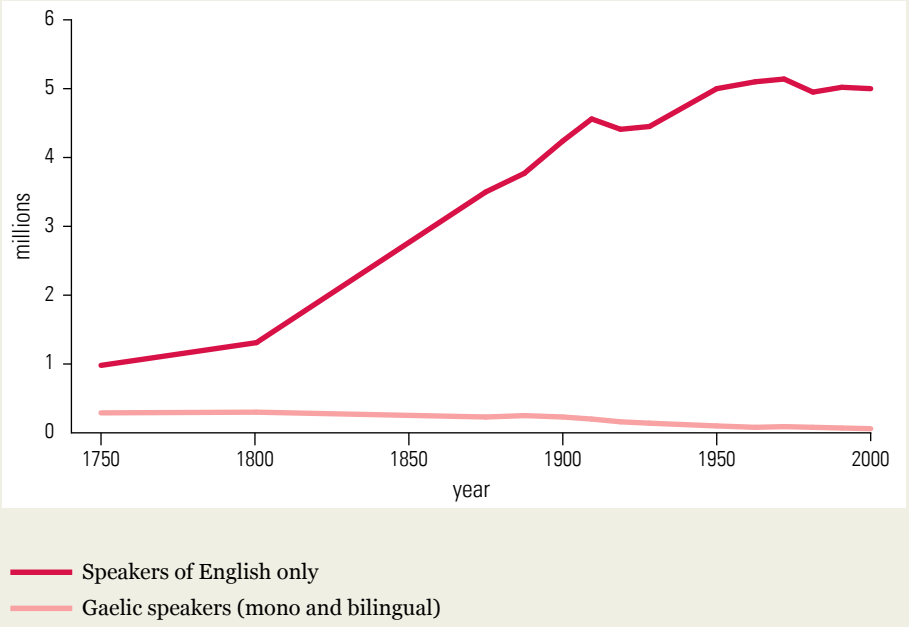
Himba woman, a speaker of a Niger-Congo language. The Himba are semi-nomadic pastoralists who, unlike many indigenous groups in Africa, have managed to maintain much of their traditional lifestyle. Kunene Region, Namibia.

Linguistic Ecology

When linguists discuss the ecology of a region or a country they are not thinking of the relationships between its species and their environment. They are talking about the languages spoken in an area and the dynamics of the interactions between them and the social and political context in which they exist. One of the dominant forces in linguistic ecology is language shift. Language shift occurs when a population of speakers adopts a new language at the expense of their mother tongue, generally over the course of a few generations, and is the biggest driver of language extinction.

A well-documented, on-going example of the process of language shift comes from Britain, where Scottish Gaelic[11] has been losing speakers to English over the last 200 years (MacAulay 1992).[12] In the mid-18th century the population of Scotland was around 1.25 million, consisting of about 300,000 Gaelic speakers, concentrated in the Highlands and Islands, and nearly one million English speakers, concentrated in the Lowlands. The Highland clearances, a programme of removing small-scale farmers from their land to make room for large-scale sheep farmers, and the consequent migration of Gaelic speakers to the Lowlands or away from Scotland altogether led to a steady decline in their number. By the end of the 19th century, monolingual Gaelic speakers had mostly disappeared, and nearly all the remaining Gaelic speakers were bilingual. Today the population of Scotland is around five million, with about 58,000 Gaelic speakers, just above one percent of the total (note that Scottish Gaelic is still above the world median language size, and therefore one of the worlds' larger languages). The Scottish government has made efforts to promote primary education in Gaelic and, although the number of Gaelic speakers continued to decline between 2001 and 2011, the number of speakers aged under 20 remained stable.

Figure 5: Language Shift in Scotland *(MacAulay 1992)*



Of the other Celtic languages, Irish, the closely-related sibling of Scottish Gaelic, is declining alongside it, and Breton (spoken mainly in Brittany, France) is declining faster. The last mother tongue Cornish[13] speaker died in 1777 and the last Manx[14] speaker in 1974, although attempts are being made to keep them alive as second languages.

Welsh is the only Celtic language with a strong speaker base owing to decades of support from the educational system and government policy. Celtic languages have been struggling along beside far larger, socially and politically dominant languages, English and French, for more than a thousand years. The British Isles had an entirely Celtic-speaking population up until the time of the Roman invasion, and remained predominantly Celtic-speaking until the arrival of the Anglo-Saxons in the 5th century. Gradually the Celtic languages were pushed to the western fringes where they survive today. Language shift, to be very clear, does not mean that one population replaces another, but that one language is displaced by another within the same population. The peoples who spoke Celtic languages are still there, genetically the population is still largely Celtic, even in England.

Nenets reindeer herdswoman, a speaker of a Uralic language, eating reindeer meat, Kánin Peninsula, Russia, Arctic.

© Staffan Widstrand / WWF

STATUS OF SPECIES AND LANGUAGES

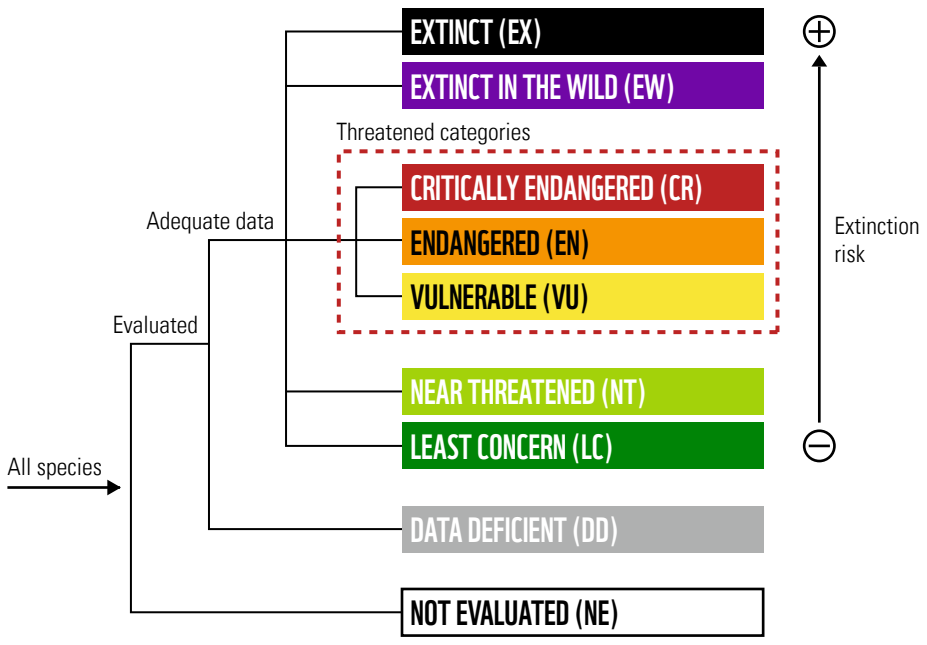
Global similarities and regional differences in the state of biological and linguistic diversity

Because species and languages are alike in terms of their evolution, diversity, and distribution around the world, it is appropriate and feasible to assess their current status in similar ways, and compare the two. We have adapted and applied two methods developed for assessing the state of biodiversity to measure the state of linguistic diversity. The first is the IUCN Red List system which is used to assess the extinction risk to species (IUCN 2013); the second is the WWF/ZSL Living Planet Index which measures the rate at which biodiversity is declining (Loh *et al.* 2005, Collen *et al.* 2009).

Threat Status of Species – Red Listing

The IUCN Red List is a system used by biologists to assess the conservation status of plant and animal species. It is based on a set of categories for ranking species according to their risk of extinction. There are seven categories ranging from Least Concern to Extinct. There is an eighth category for species which have been evaluated but for which there are insufficient data to assess their status. Those species which are categorised as vulnerable, endangered or critically endangered are considered to be threatened.

Figure 6:
IUCN Red List categories
(IUCN 2013)



Only a fraction of all species have been evaluated, but a few taxa (species groups) have been completely evaluated and some have had a random sample of 1500 species evaluated. Among the vertebrates, all mammals (5,501 species known and described to date), birds (10,064 species) and amphibians (6,771 species) and a random sample of 1,500 species of all reptiles (approximately 9,000 species) have been recently assessed. More than 10,000 fish species have been assessed, but as the sample is not random, and the total number of fish species is very large but uncertain (about 32,000 known to date), no firm conclusions can be reached about the status of fish as a group. These assessments are used here to compare the threat status of vertebrate species with the status of languages, based on a random sample of 1500 languages. For the purposes of these comparisons, we combine the category extinct in the wild (EW) with extinct (EX), and the category near threatened (NT) with least concern (LC).

The criteria used to categorise the conservation status of a species into one of the Red List categories include a species' population size, its rate of reduction (if in decline), its range size and rate of decline or fragmentation, existing and future threats, or a combination of these. It is possible to apply some of these criteria to languages and assess their threat status according to either the number of mother-tongue speakers, their rate of decline, or a combination of the two. Range size is harder to apply to languages and therefore was ignored in this analysis, as was existing or projected threat. Because biologists use a wider range of criteria to assess species than has been applied here to languages, the threat status of languages should be considered more conservative.

Threat Status of Languages – UNESCO and Ethnologue

Linguists consider a language to be endangered if it is not being transmitted successfully from one generation of speakers to the next. This is very good reasoning, but it means that the criteria used by linguists to assess the threat status of a language are quite different to the IUCN criteria used by biologists. Ultimately the two sets of criteria, linguistic and biological, are designed to assess extinction risk. Table 3 compares the Red List criteria we have applied to a random sample of 1,500 languages with the criteria used in two systems designed to assess threatened languages, UNESCO's Language Vitality and Endangerment system (UNESCO 2010) and Ethnologue's Expanded Graded Intergenerational Disruption Scale or EGIDS system (Lewis and Simons 2010) The systems are not correlated: critically endangered in the Red List system does not necessarily correspond to critically endangered in the UNESCO system for example; the only category that means the same in all three systems is extinct.

Table 3: Definitions of categories under three systems of assessing the status of languages

Red List (as applied here)	UNESCO	Ethnologue (EGIDS)
Extinct (EX): No speakers remain.	**Extinct:** No one can speak the language.	**Extinct:** The language is no longer used.
Extinct in the Wild (EW): Not applicable.		**Dormant:** The language serves as a reminder of ethnic identity but no proficient speakers remain.
Critically Endangered (CR): Either the number of speakers is observed or projected to decline by 80% or more in three generations (75 years); or speakers number less than 250 and declining by 25% or more in one generation (25 years); or speakers number less than 50.	**Critically endangered:** Youngest speakers are great-grandparents; language not used on a regular basis; language only partially remembered.	**Nearly Extinct:** Only spoken by great-grandparent's generation who have little opportunity to use the language.
Endangered (EN): Either no. speakers observed or projected to decline by 50% or more in three generations (75 years); or no. speakers less than 2,500 and declining by 20% or more in two generations (50 years); or no. speakers less than 250.	**Severely endangered:** Language spoken only by grandparents' and older generations; parents understand but do use it to speak to their children or each other.	**Moribund:** Only speakers are grandparents' generation.
	Definitely endangered: Youngest speakers are parents' generation; children are not using the language at home.	**Shifting:** Parents' generation use the language among themselves but it is not being transmitted to their children.
Vulnerable (VU): Either no. speakers observed or projected to decline by 30% or more in three generations (75 years); or speakers number less than 10,000 and declining by 10% or more in three generations (75 years); or speakers number less than 1,000.	**Vulnerable:** Most children speak their parental language as their mother first language, but usage is restricted to the home or particular social situations.	**Threatened:** The language is used by all generations, but it is losing users.
Near Threatened (NT): The language does not meet the criteria for CR, EN, or VU but is likely to do so in the near future (this category has not been used in this assessment).	**Stable yet Threatened:** The language is spoken by all generations in most contexts, but multilingualism is common and a more dominant language is taking over in some contexts.	
Least Concern (LC): The language does not fall into any of the categories above; speakers are widespread and abundant.	**Safe:** The language is spoken by all generations; inter-generational transmission is uninterrupted.	**Vigorous:** The language is used by all generations, and the situation is sustainable.

Ethnologue further defines a number of higher categories for languages in vigorous use: namely where standardized literature is in use but not widespread (Developing); standardization and literature are in widespread use in education (Educational); the language is used at work and in mass media but without official status as a national or regional language (Wider communication); used in education, work, mass media and government at provincial or national level (Provincial, National); used internationally for trade, knowledge exchange or policy (International).

The UNESCO and Ethnologue EGIDS systems use inter-generational transmission as the principal criterion in assessing a language's vitality, defined according to the number of generations that speak the language: great-grandparents only, grandparents and older, parents and older, or all including children. While there is an undeniable logic to

these systems, there are some good reasons for using the IUCN Red List system developed by biologists to assess the status of a language. Firstly, if children are no longer speaking their parental language, unless there is great effort to revitalize the mother tongue, it is inevitable that the language will move up through the categories towards extinction. However, if a language that is close to extinction were to undergo a massive revitalization effort, it would not move back down through the categories as first the grandparents, then parents and finally children learn to speak the language once again. The linguistic categories assume there is one way traffic up the ladder to extinction. But it should be possible to track a reversal in the fortunes of a language dropping back down the categories, which is the case if the Red List criteria are applied. Secondly, the status of a language may change from location to location, or even from family to family, as children could be speaking their mother tongue in some places, while only parents or grandparents use the language in others. The Red List criteria are not concerned with the age of the speakers, only the total numbers. Of course, the end result of a breakdown in inter-generational transmission will be a decline in speaker numbers, so the Red List criteria are focusing on the ultimate effect rather than the direct causes of endangerment.

The linguistic criteria recognize that a language may be safe or vigorous even if it is only spoken by a very small population, as long as inter-generational transmission is uninterrupted. The biological criteria conversely consider a language to be threatened simply if the number of speakers is below a critical threshold (1,000 for vulnerable, 250 for endangered, 50 for critically endangered), even if there is no decline through the generations. This is justifiable as it is precisely when the mass of speakers is small that a language could be threatened by a shift away from the mother tongue towards a more dominant language by means of unforeseen events extraneous to the process of intergenerational language transmission.

Comparison of Conservation Status of Languages and Species

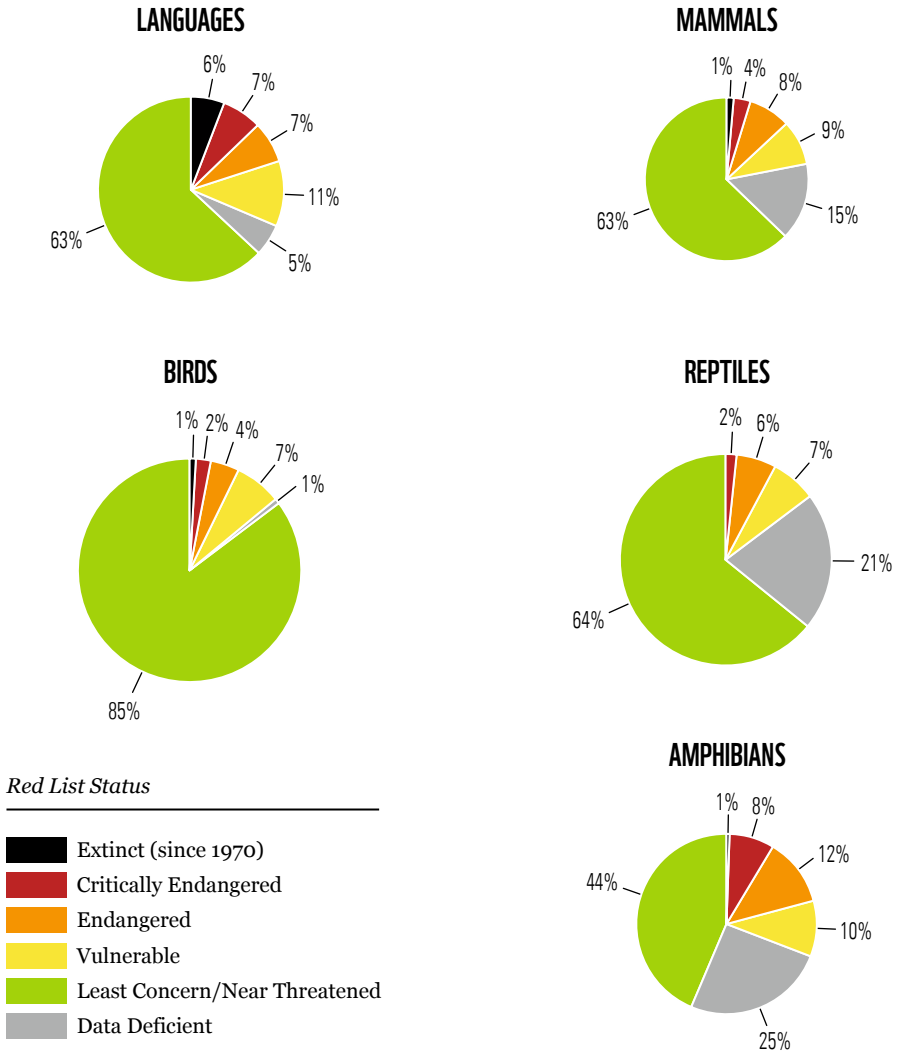
Most importantly for our present purposes, applying the IUCN Red List criteria to languages allows us to assess their threat status on the same basis as species, and make comparisons on a quantified basis. This has been done previously by the ecologist William Sutherland (2003), who used a limited set of the Red List criteria to compare languages with birds and mammals. Sutherland found that a higher percentage of languages was either threatened or recently extinct (32%) than either birds (13%) or mammals (28%). Here we compare the status of languages with that of mammals, birds, reptiles and amphibians, and compare the status of languages between regions of the world and between different language families, using selected Red List criteria. The data on numbers of speakers of languages come from editions of Ethnologue dating from 1951 to 2009, although most of the data come from the 1990s and 2000s (see Table 4).

Table 4: Number of data points on speaker numbers

Period	Data points
1900-1949	19
1950-1959	107
1960-1969	350
1970-1979	601
1980-1989	634
1990-1999	854
2000-2009	1008
Total	3573

Past data are sometimes unreliable, especially in the earlier decades, and therefore the first Red List criterion – rate of decline observed or projected over three generations – has not been used in this analysis. Trends in speaker numbers have only been used in combination with total number of speakers (the second criterion). Therefore the assessment of languages is very much more conservative than that of species groups. The results are shown in Figure 7.

Figure 7:
Red List conservation status of languages and four vertebrate classes
Size of each pie is proportional to the number of languages or species in each group Mammal, bird and amphibian data from IUCN (2013), reptile data from Bohm et al. *(2013).*



The analysis indicates that at least a quarter of the world's languages are threatened with extinction (CR, EN or VU), assuming that no data deficient (DD) language is threatened, compared with at least 21% of mammals, 13% of birds, 15% of reptiles and 30% of amphibians, the most threatened class of vertebrate. Furthermore, about 6% of languages have been reported as recently extinct, as opposed to about 1% of vertebrate species. If sufficient data on all the criteria used to evaluate animals were available to assess languages, then the status of languages could be worse than it appears here.

Ethnologue reports figures for the numbers of languages in each EGIDS category except for Extinct. They are Dormant 2.9%, Nearly Extinct 6.0%, Moribund 4.1%, Shifting 6.5%, Threatened 14.8%, Vigorous or better 65.7% (Lewis *et al.* 2013). If the EGIDS categories were translated into Red List categories as in Table 3, the percentages would be quite similar to those given in Figure 7.

Threat Status of Language Families and Regions

Just as the world's population is not evenly distributed among the world's languages, with half the world speaking one of just 24 languages, so the world's languages are not evenly distributed among language families. Figures 8a and 8b show the dominance of a few major language families such as Afro-Asiatic, Austronesian, Indo-European, Niger-Congo and Sino-Tibetan.

Figure 8a:
The largest language families by number of languages
(source: Lewis et al. *2013)*

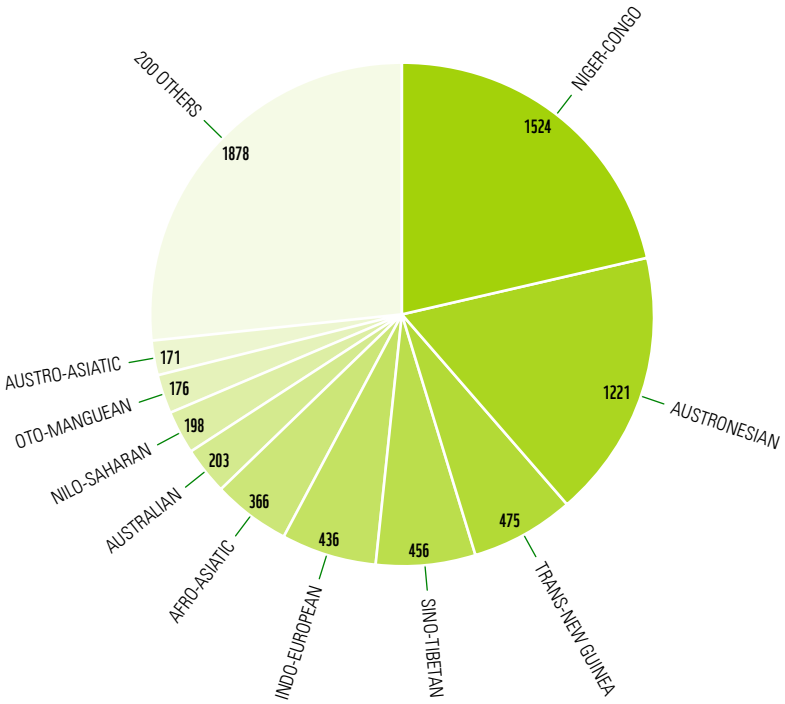
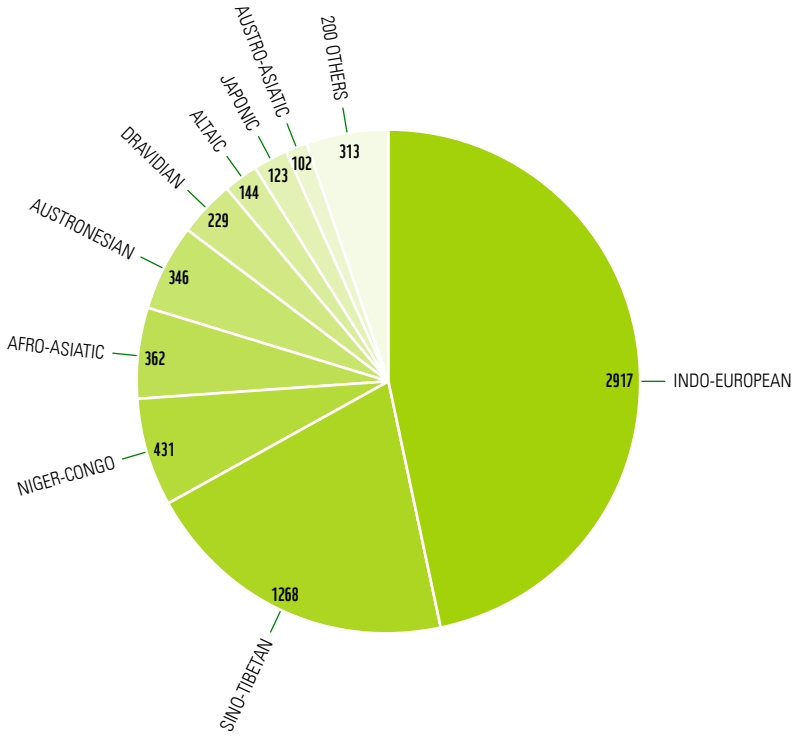


Figure 8b:
The largest language families by number of speakers (millions)
(source: Lewis et al. *2013)*



Status of Language Families

Some of the larger language families from different regions of the world have been assessed to compare their conservation status, in exactly the same way as all languages were assessed as a whole. Figure 9 shows the percentage of languages in each Red List category. The status of languages in each family can be compared by looking at the percentage of languages in the extinct (EX) and threatened categories (CR, EN, VU). Note that this assumes that all data deficient (DD) languages are not threatened, so it is a conservative estimate of threat status.

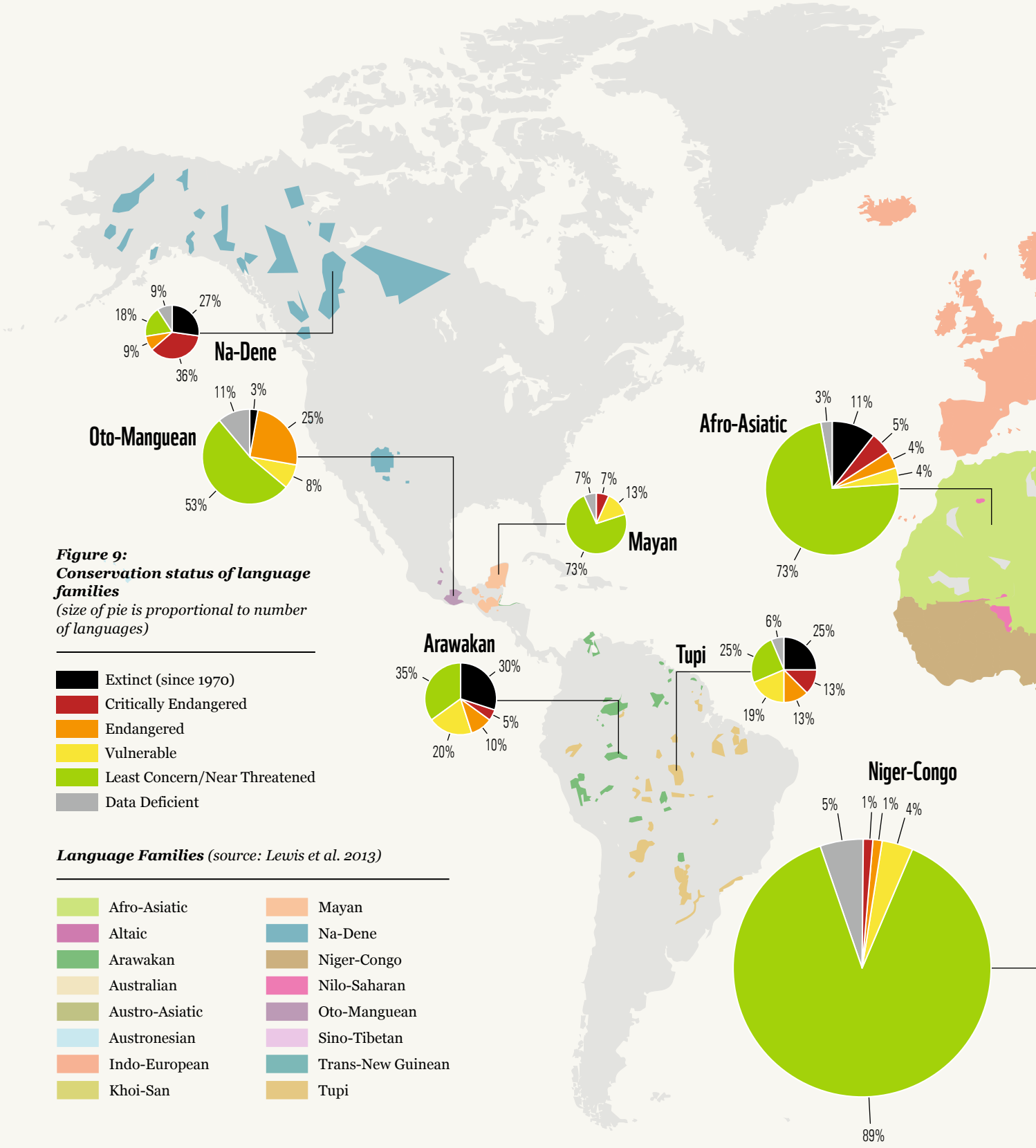


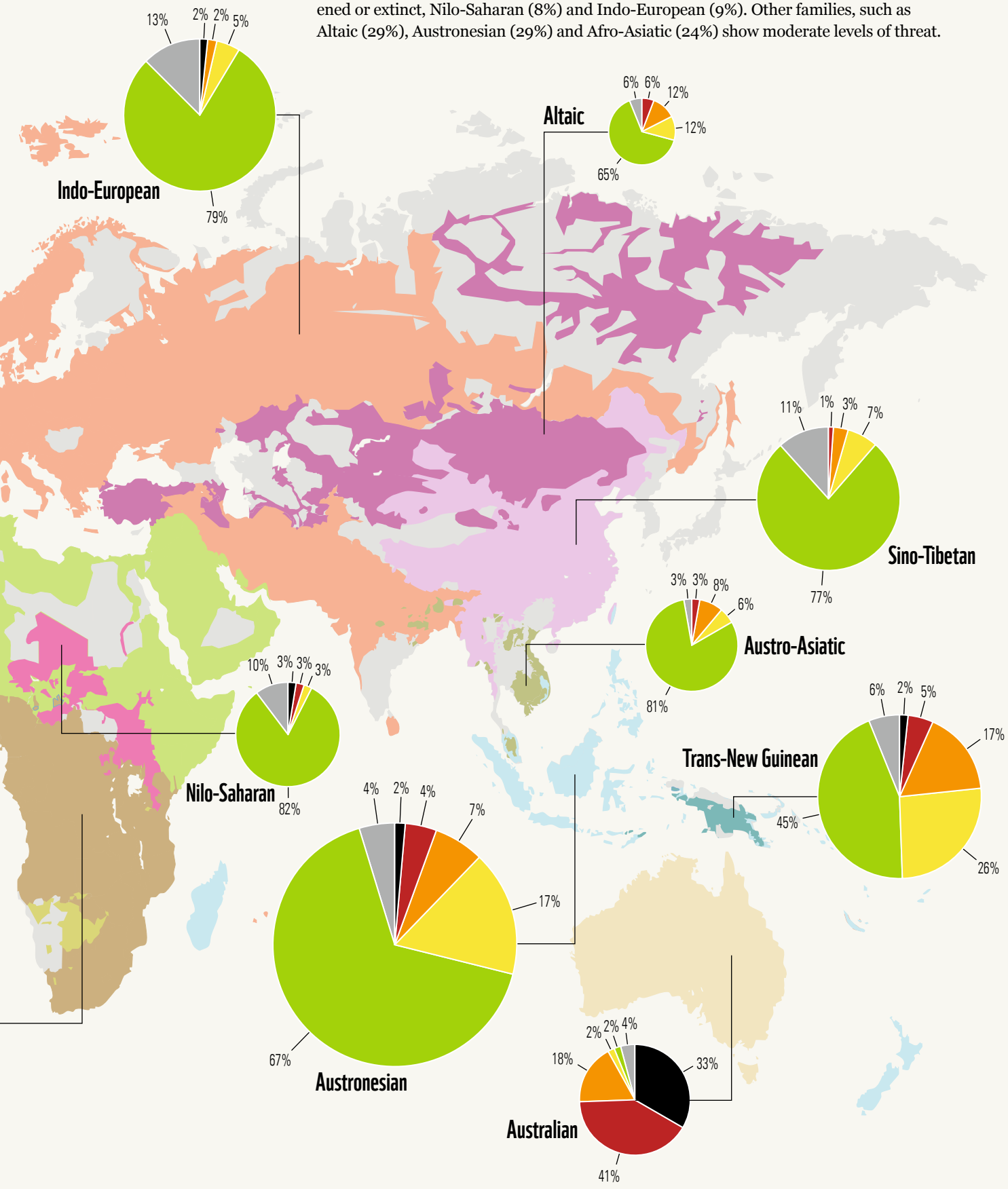
Figure 9:
Conservation status of language families
(size of pie is proportional to number of languages)

- Extinct (since 1970)
- Critically Endangered
- Endangered
- Vulnerable
- Least Concern/Near Threatened
- Data Deficient

Language Families *(source: Lewis et al. 2013)*

- Afro-Asiatic
- Altaic
- Arawakan
- Australian
- Austro-Asiatic
- Austronesian
- Indo-European
- Khoi-San
- Mayan
- Na-Dene
- Niger-Congo
- Nilo-Saharan
- Oto-Manguean
- Sino-Tibetan
- Trans-New Guinean
- Tupi

It is clear that languages in the Australian family are the most severely endangered, with 94% of languages threatened with extinction or extinct (since 1970), followed by some of the American language families such as Na-Dene (73%), Tupian (69%) and Arawakan (65%). The least endangered families are Niger-Congo, with only 6% of languages threatened or extinct, Nilo-Saharan (8%) and Indo-European (9%). Other families, such as Altaic (29%), Austronesian (29%) and Afro-Asiatic (24%) show moderate levels of threat.



Status of Regions

A clear pattern emerges if the data are analysed by region rather than family. Figure 10 show the percentage of languages in each Red List category. The status of regions can be compared by adding up the percentage of languages in the extinct (EX) and threatened (CR, EN, VU) categories. As with families, this assumes that all data deficient (DD) languages are not threatened, so it is a conservative estimate of threat status of each region.

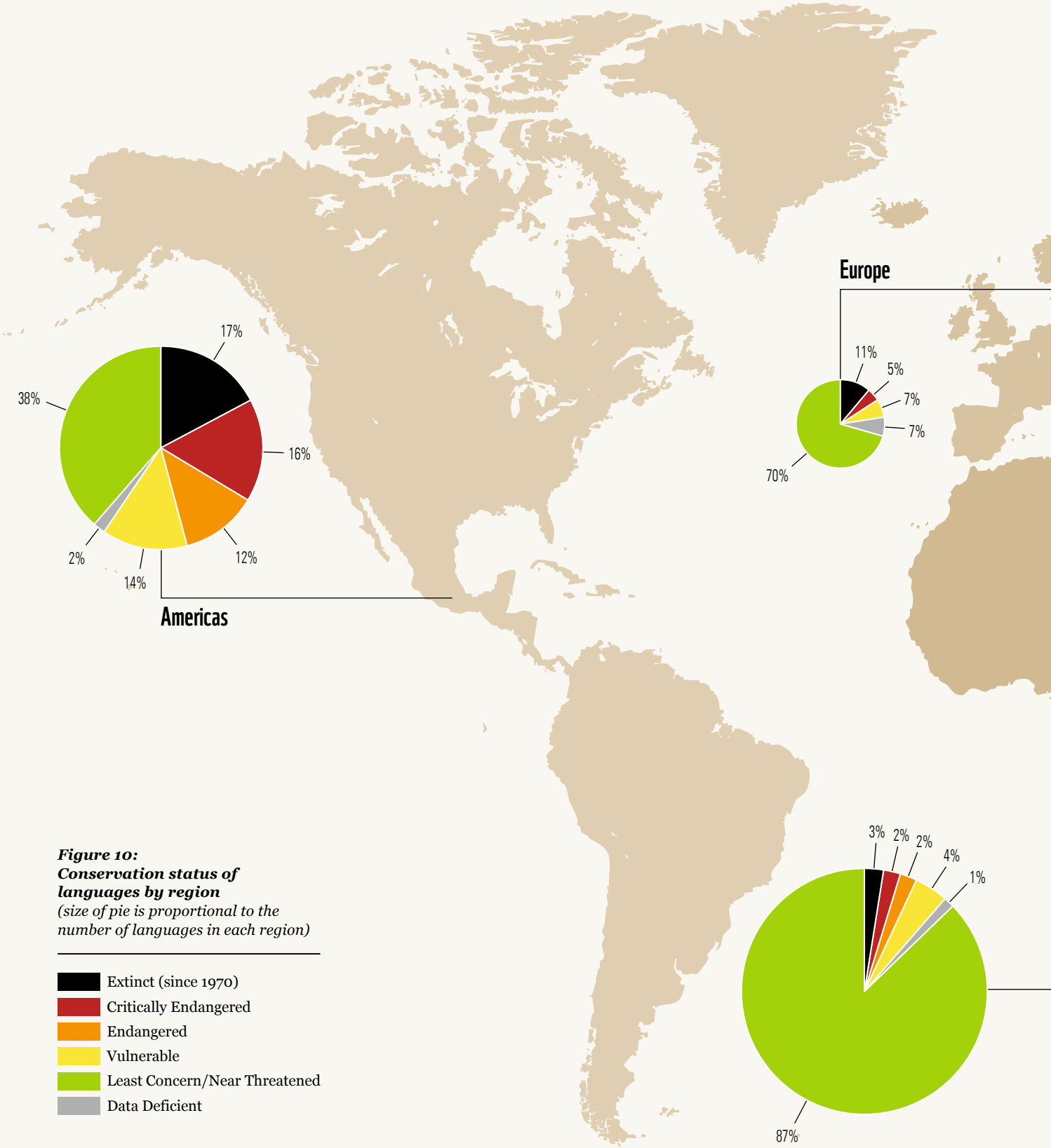
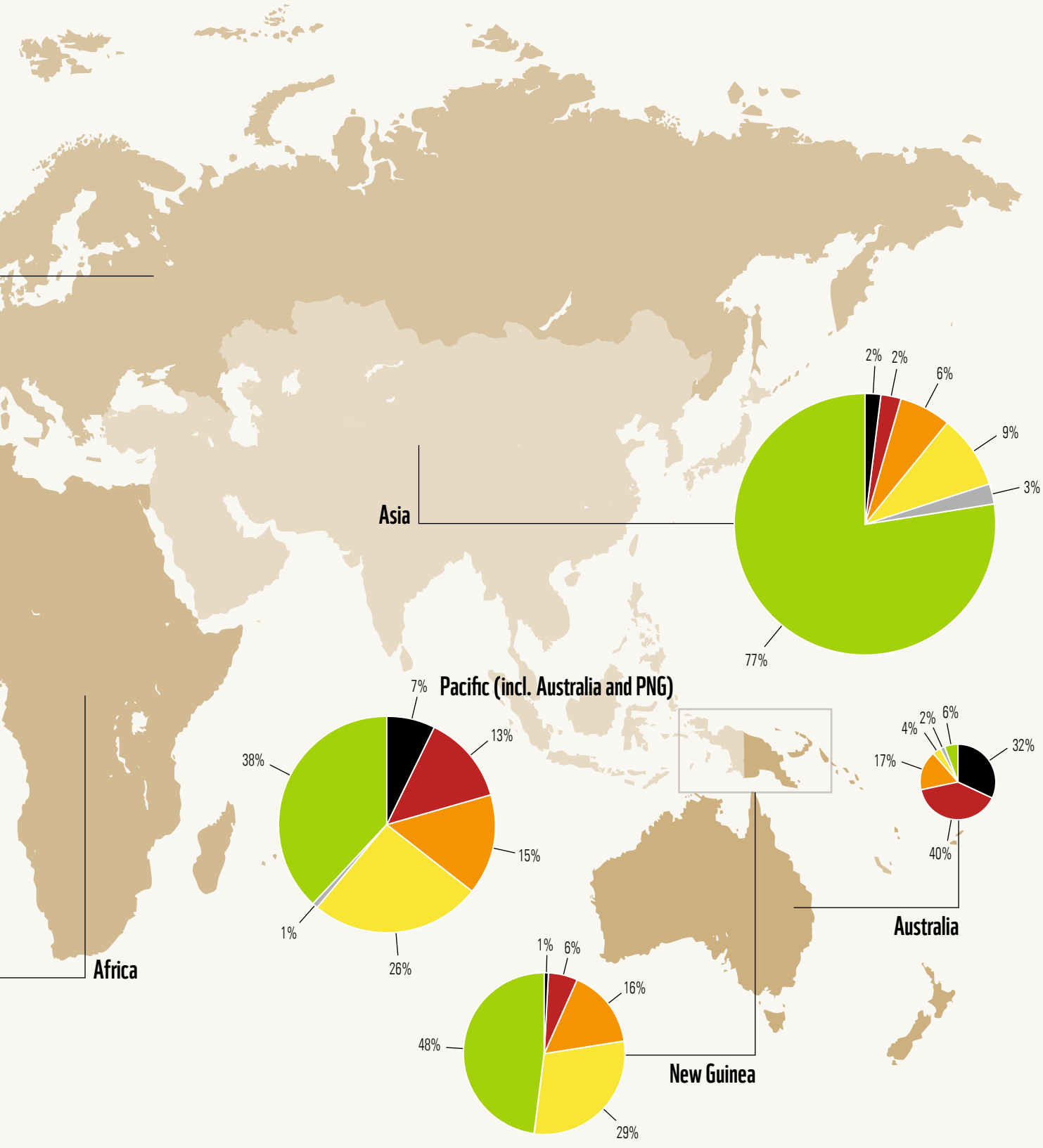


Figure 10:
Conservation status of languages by region
(size of pie is proportional to the number of languages in each region)

Languages of the Pacific and the Americas are the most severely endangered, both regions with about 60% of their languages threatened with extinction or extinct (since 1970). The regions with the lowest level of extinction risk are Africa (11%) and Asia (20%). If Australia is separated from the rest of the Pacific region, it is once more apparent that Australia's languages are the most severely endangered in the world (92%).[15]



Trends in Languages and Species

Another way that biologists assess the state of biodiversity is to use indices based on average trends in the populations of a selection of species, such as the WWF/ZSL Living Planet Index (LPI). Species population indices are essentially like stock market indices such as the Dow Jones or Financial Times Stock Exchange (FTSE) which track trends in market capitalization of a number of companies. The LPI is based on time-series data for approximately 9,000 vertebrate species populations (of about 2,600 different species) from around the world. The index has been published biannually by WWF and ZSL since 1998 (WWF 2012).

In previous work, the authors adapted the LPI method to create an index called the Index of Linguistic Diversity (ILD) (Harmon and Loh 2010) which can be compared with trends in biodiversity as measured by the LPI. The ILD uses trends in the numbers of speakers across a sample of languages to calculate average trends. The same sample of 1,500 languages used in the Red List analysis of languages was also used to calculate the ILD. Data on numbers of mother tongue speakers for each language going back to 1900 were extracted from editions of Ethnologue. After removing all languages with data from only a single point in time (412 languages), and then filtering the data to remove anomalous data points or time series,[16] the remaining dataset contained time series for 985 languages. The ILD calculates the average trend of those languages in the sample. The ILD results for all 985 languages is a measure of trends in linguistic diversity for all languages in the world, and may be compared with the global LPI to see relative trends in linguistic diversity and biodiversity. To facilitate regional comparisons between the two indices, we also calculated the ILD by biogeographic realm to match up with the way the LPI is calculated regionally.

The biogeographic realms used in the analysis are the Afrotropical, the Indo-Pacific, the Nearctic, the Neotropical and the Palearctic realms. These are regions of the world defined according to the shared evolutionary history of their biota. It is a useful way to compare trends with languages, as language families tend to conform approximately to the same biogeographic patterns. Table 5 below shows which families belong to which biogeographic realms.

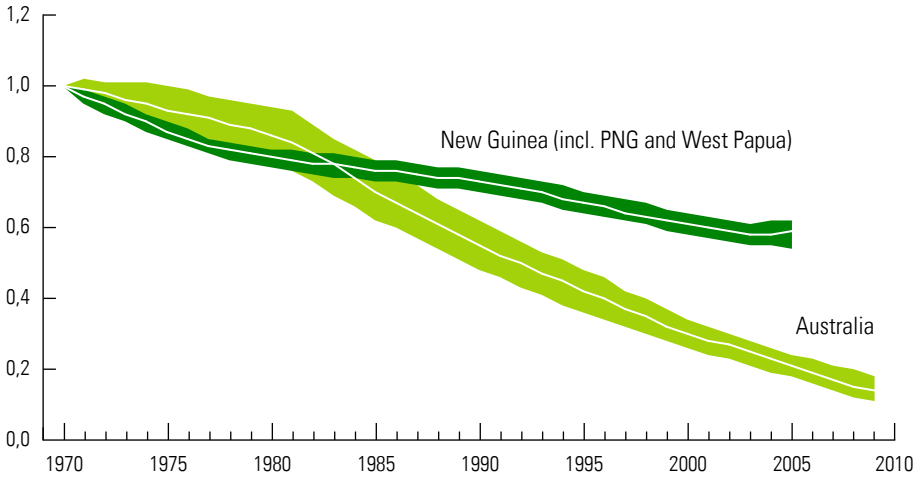
Table 5: Distribution of some language families among biogeographic realms

Biogeographic Realm	Location	Language families analyzed in this report
Afro-tropical	Sub-Saharan Africa	Niger-Congo, Nilo-Saharan
Indo-Pacific	South and Southeast Asia including southern China, Australasia and Oceania	Australian, Austro-Asiatic, Austronesian, Trans-New Guinea
Nearctic	North America and a part of northern Mexico	Na-Dene
Neotropical	Latin America and the Caribbean	Arawakan, Mayan, Oto-Manguean, Tupi
Palearctic	Eurasia, northern Africa and the Middle East, Central Asia, northern China and Japan	Afro-Asiatic, Altaic, Indo-European, Sino-Tibetan

The major difference between the LPI and ILD methodology is that the ILD has been corrected for overall human population growth. Within the period covered by the index, the human population has more than doubled, whereas there is no comparable overall growth in global wildlife populations. Therefore all of the ILD graphs presented here have been corrected for overall population growth. The biogeographic realm ILDs have been corrected for human population growth within the realm boundaries. The ILD therefore is not an index of population trends in quite the same way as the LPI; what the ILD measures is trends in the fraction of the total population belonging to each language.[17] To use another economic analogy, it is like an index of average market share of languages. If the average market share declines, it means that a few languages are increasing their market share at the expense of a greater number of others. This is exactly what we would expect to see if language shift is taking place: as speakers shift away from many small languages to fewer larger languages, then the average market share index falls.

The ILDs and LPIs for each biogeographic realm are shown in figure 12, plotted on the same axes for comparison, as are the global indices. Because the Indo-Pacific realm includes two islands which are particularly important in terms of linguistic diversity, Australia and New Guinea, additional ILDs for the two are shown separately in figure 11. Australia shows the fastest decline in linguistic diversity of any country, with a fall of about 85% in its ILD from 1970 to 2009. The ILD for New Guinea, the number one hotspot for linguistic diversity, which includes the Indonesian half of the island plus the half that is Papua New Guinea (PNG), shows a decline of about 40% between 1970 and 2005. This is a faster decline than the global average ILD, and reflects the Red List status of the island which shows that over 50% of New Guinea's 1000 or more languages are threatened.

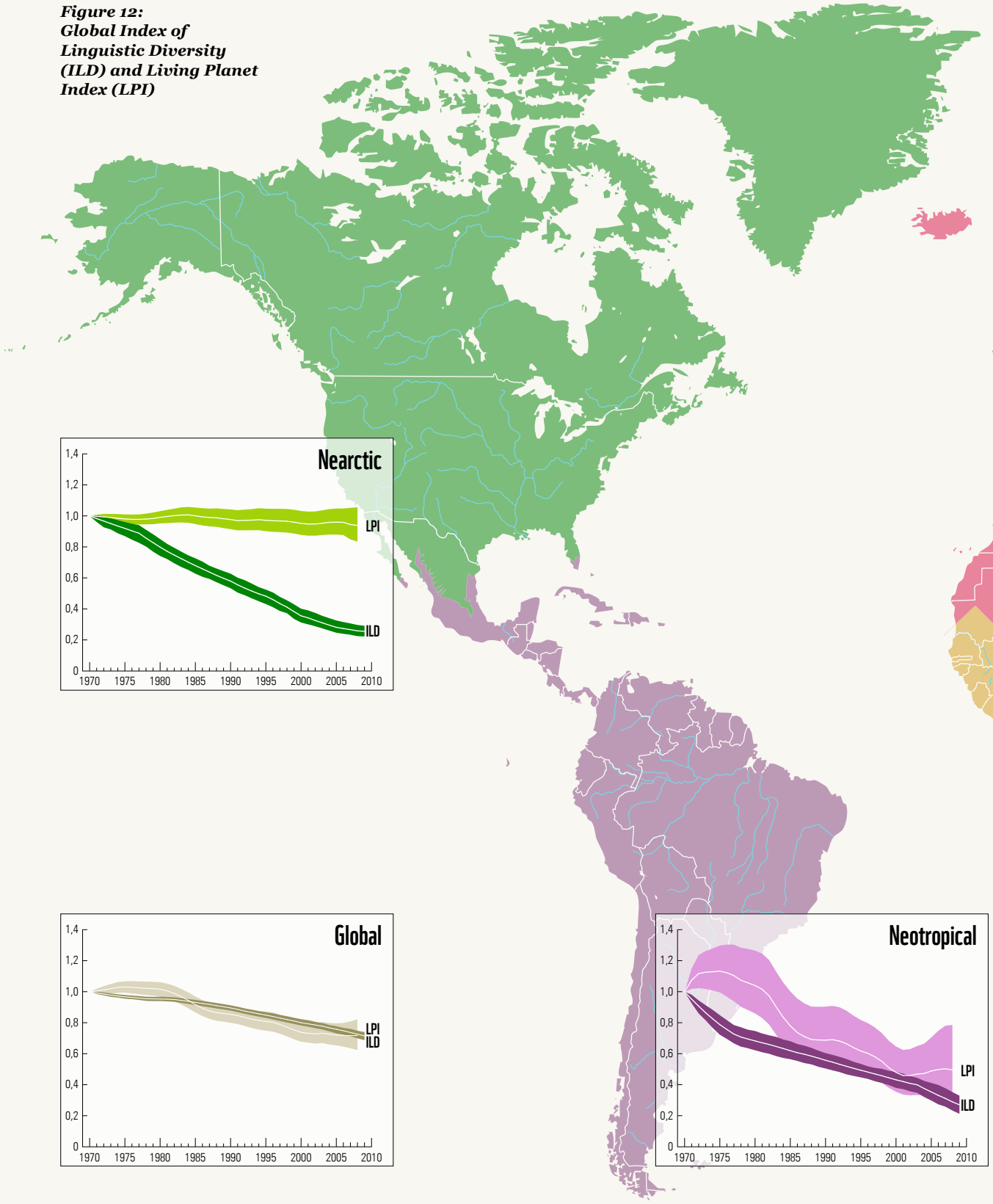
Figure 11: Index of Linguistic Diversity. Australia and New Guinea



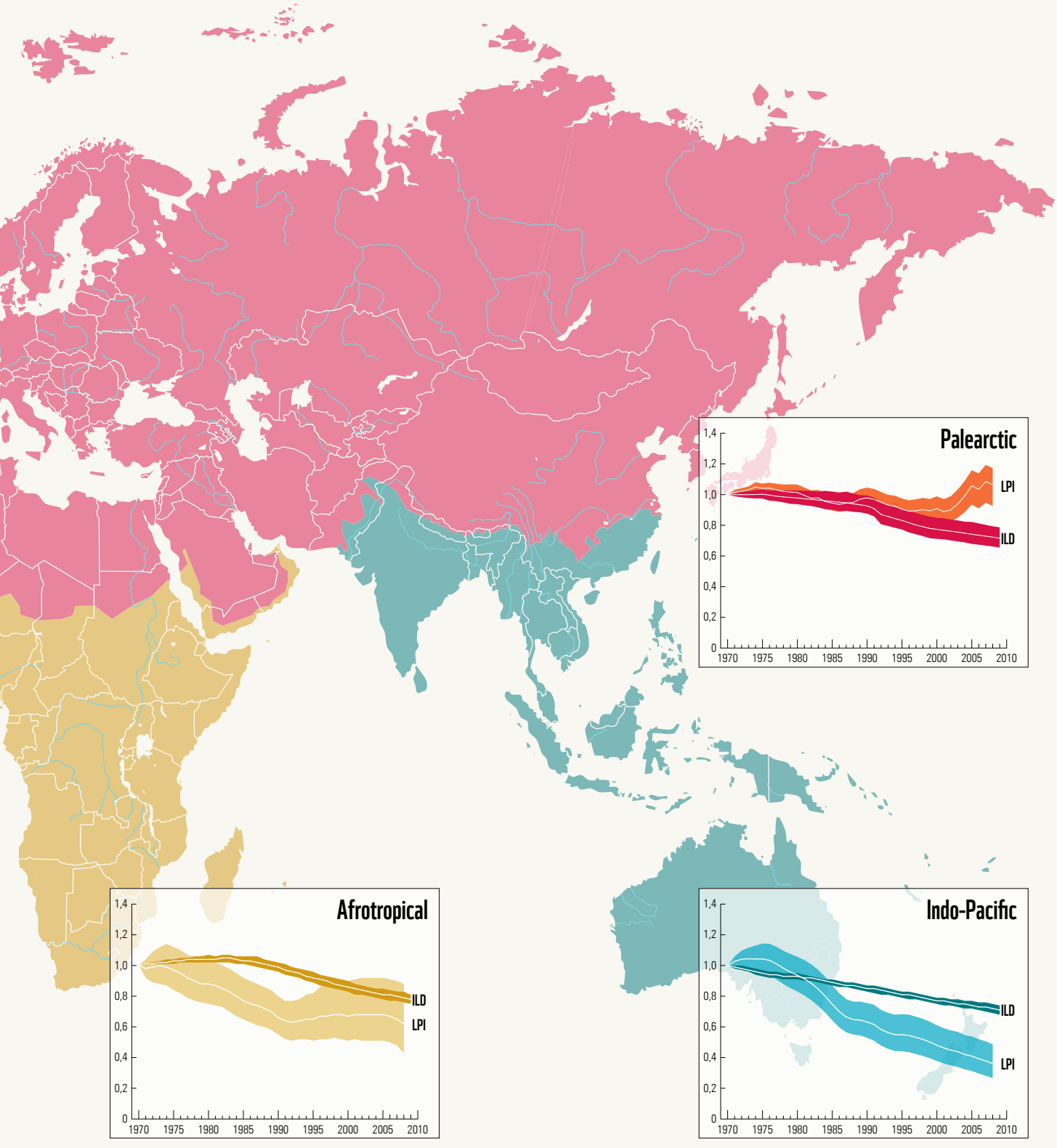
Trends in the LPI and ILD

Globally, the indices of both species populations (LPI) and speakers of languages (ILD) are declining at similar rates, about 30% in 40 years. The most rapid declines in species since 1970 have occurred in the Afrotropics (about 40%), Indo-Pacific (about 65%) and Neotropics (about 50%), whereas the Nearctic and Palearctic have shown little overall change. For languages, the most rapid declines since 1970 have taken

Figure 12:
Global Index of Linguistic Diversity (ILD) and Living Planet Index (LPI)



place in the Nearctic and Neotropical realms (both about 75%), whereas the rate of decline in the Afrotropical (about 20%), Indo-Pacific (about 30%) and Palearctic (about 30%) realms has been slower. In summary, biodiversity has declined rapidly in the tropics, but remained steady in temperate realms; linguistic diversity on the other hand has declined rapidly in the new world, but more slowly in the old world.



CONCLUSIONS

It is striking that biodiversity and cultural diversity in general, and species and languages in particular, show extraordinary parallels both in terms of their evolution and the threats they face. Both species and languages have evolutionary histories which can be traced back in time to earlier, ancestral species and languages; both languages and species can be classified in such a way as to show the phylogenetic relationships between those related by descent from a common ancestor. Species may be defined by the ability to interbreed; language may be defined by mutual intelligibility.
By these definitions, subspecies are analogous to dialects. The process of formation of new species, speciation, has its linguistic equivalent. It may even be argued that the evolutionary mechanisms that give rise to both species diversity and linguistic diversity are similar. Biological evolution and, it can be argued, cultural evolution are the result of the action of replication, variation and selection working on hereditary material.
As well as the genetic relationships between languages, linguists talk about the ecology of a region or country, which has nothing to do with flora or fauna.
The global distribution of languages and species show remarkable similarity, with diversity highest in the tropics and declining toward the poles.

Two results are immediately apparent when comparing the status and trends in biodiversity and linguistic diversity. Firstly, at the global level, the trends are very similar, both the LPI (species) and ILD (languages) declined by about 30% since 1970, which suggests that biodiversity and linguistic diversity are being lost at similar rates. This supports the conclusion of the Red List analysis comparing the conservation status of languages and species: globally, linguistic diversity is at least as threatened as biodiversity.

THE DIFFERENCE IN REGIONAL TRENDS BETWEEN THE SPECIES AND LANGUAGES CAN BE EXPLAINED BY THE DIFFERENT DIRECT PRESSURES FACED BY BIODIVERSITY AND LINGUISTIC DIVERSITY

The second result is that, while both biodiversity and linguistic diversity are threatened globally, they are declining at different rates in different regions of the world. By far the most rapid losses in linguistic diversity have occurred in the Americas where, according to the Red List analysis, 60% of languages are threatened or have gone extinct since 1970. The ILD plummeted by over 75% between 1970 and 2009 in both the Nearctic and the Neotropical biogeographic realms. The LPI, however, shows that while species populations have fallen in the Neotropics (although with high uncertainty limits), they were almost completely flat in the Nearctic. The LPI fell by more than 60% in the Indo-Pacific, whereas the ILD declined by about 30%, a similar rate to the global average. Of course this masks the catastrophic decline of more than 80% in the ILD of Australia (and more than 40% in New Guinea). The ILDs for the Afrotropical and Palearctic realms both show declines of around 20-30%.

The difference in regional trends between the LPI and the ILD can be explained by the different direct pressures faced by biodiversity and linguistic diversity. Biodiversity decline is the usually the result of one of five main direct threats or pressures: habitat loss and destruction, direct over-exploitation of species from hunting and fishing, competition or predation by invasive alien species, climate change, or pollution. Habitat loss and over-exploitation of species remain the greatest threats for most of the world's biodiversity, and over the last 40 years the strongest pressure has been felt in the tropics, especially in Asia.

THE GROWING FOOTPRINT OF RICH COUNTIES AS WELL AS POPULATION GROWTH IN POOR COUNTRIES ARE DRIVING THE LOSS OF TROPICAL BIODIVERSITY IN AFRICA, ASIA AND LATIN AMERICA

In Europe and North America most of the biodiversity loss from habitat destruction occurred before 1970 and so does not register on the LPI. However, the footprint of natural resource consumption by the developed world is felt increasingly in the developing tropics, and all the more so as China's demand for natural resources grows; so it is the growing consumption by rich counties as well as population growth in poor countries that are driving the loss of tropical biodiversity in Africa, Asia and Latin America.

The decline in linguistic diversity is normally a result of the process of language shift away from small indigenous languages toward larger, national or regional languages. Language shift is driven by a number of social, political and economic factors including migration, urbanization, national unification, colonization, and the globalization of trade and communications. Migrant communities often undergo a process of language shift, whether moving from one country to another, or from a rural to an urban area within the same country. Governments in many developed and developing countries actively promote a single national language at the expense of other, usually minority, languages for political reasons. This has been the case with Mandarin in China, French in France and Amharic in Ethiopia for example. Migration, urbanization and political nationalization have been the primary drivers in Africa, Asia and Europe, where language shift has tended to occur between languages within the region. In the Americas and the Pacific, especially Australia, the primary driver has also been migration, but the migrants, mainly European, vastly outnumbered the indigenous populations, and so it was the migrants' languages, primarily English, Spanish and Portuguese, that became politically and economically dominant. It is in these regions where indigenous languages are most highly threatened.

Australia and the island of New Guinea deserve particularly close attention: Australia because its indigenous languages are the most highly threatened in the world, and New Guinea because it is the most linguistically diverse place on Earth. Most of the 1,000 or so languages of New Guinea are threatened, but their decline is not as rapid as in Australia where more than 90% are threatened with extinction. The difference between the two islands is of course due to the fact that the vast majority of the Australian population is of European descent, whereas the population of New Guinea is largely indigenous. Australian languages are spoken by minority indigenous communities, and among these communities English is taking over, or has taken over, as the first language. In New Guinea indigenous languages are faring better, although the English-derived lingua-franca Tok Pisin is gaining ground at their expense.

MIGRATION, URBANIZATION AND POLITICAL NATIONALIZATION HAVE BEEN THE PRIMARY DRIVERS OF LANGUAGE LOSS IN AFRICA, ASIA AND EUROPE. IN THE AMERICAS AND AUSTRALIA, THE PRIMARY DRIVER HAS ALSO BEEN MIGRATION, BUT THERE THE MIGRANTS, MAINLY EUROPEAN, VASTLY OUTNUMBERED THE INDIGENOUS POPULATIONS.

A Bajau (“sea gypsy”) woman and children, speakers of an Austronesian language, Kusungan Island, Sabah, Malaysia. Bajau people originated from the Philippines and traditionally lived on boats, making their living from the sea, but most are now settled.

EPILOGUE

A future for biocultural diversity?

Ultimately, both linguistic diversity and biodiversity are diminishing as a result of human population growth, increasing consumption, and globalization which erodes differences between one part of the world and another. At the regional level, these fundamental drivers of diversity loss are manifest in different ways. For biodiversity, the biggest threat in modern times has been and still is habitat destruction, followed by over-exploitation (fishing and hunting) and invasive species. Since 1970, habitat loss has been most rapid in the developing world, particularly in Asia, whereas habitat loss in Europe and North America has slowed down and levelled off. Consequently the most rapid decline in biodiversity is now happening in the tropics, the part of the world with the greatest diversity.

LINGUISTIC DIVERSITY AND BIODIVERSITY ARE DIMINISHING AS A RESULT OF HUMAN POPULATION GROWTH, INCREASING RESOURCE AND ENERGY CONSUMPTION, AND ECONOMIC GLOBALIZATION WHICH ERODES DIFFERENCES BETWEEN ONE PART OF THE WORLD AND ANOTHER

For languages and culture, 'habitat' means the human population, which has doubled since 1970, so habitat loss is not the problem. Nor does direct 'consumption' threaten culture (there is no equivalent of cultural over-consumption). It is the cultural analogue to alien invasive species – language shift – that is the greatest threat to linguistic and cultural diversity. It is not that one human population replaces another population, as is the case with invasive species, it is that one language displaces another language within the same population. When an indigenous language goes extinct, often the indigenous culture follows. This process has been happening for the last two hundred years or more in the linguistic ecology of the Americas, Australia and parts of the Pacific, where indigenous languages have been severely threatened by the dominance of European languages, particularly English, Spanish and Portuguese. In Africa, Asia and Europe, where the main drivers of language shift have been migration, urbanization and political unification policies, language shift has tended to occur between languages of those regions, and diversity is being lost, but not as rapidly.

Why do we need so much diversity? Would it not be better for the sake of world peace and the global economy, it is sometimes argued, if we spoke fewer languages in the world? Are languages or cultural diversity really worth conserving as much as species or biological diversity? The logical conclusion of this type of argument is that, ideally, we should speak just one world language. But then we would all become more similar, and the differences between one part of the world and another, or between one culture and another, would rapidly erode away. In the end, we would speak the same language, wear the same clothes, eat the same food, listen to the same music, consume the same brands and hold the same beliefs. One city would look much the same as another. The world would become homogenized. This counter-argument may sound absurd, but it is already happening: the world is already losing its extraordinary biocultural diversity, as the findings of this report demonstrate. No doubt the global economy would continue to grow just as well, or even better, with just a few world languages and cultures. It is even possible that global ecosystems could continue to provide basic life support functions – although probably not as well – with less biodiversity, and humanity would still survive. But this is not just a question of survival, or even global economic productivity. A diverse world is a culturally and naturally richer world. With less diversity, humanity is poorer. It is a question of the kind of world we want to live in.

The science of biocultural diversity is in its infancy, and more research is needed to examine and understand the processes and mechanisms that underpin and unite biological and cultural evolution and ecology. Most importantly, we need a better understanding of how to slow down and reverse the loss of diversity. While the outlook is not bright for many of the world's smaller languages, especially those no longer being learned by children, there is plenty of scope to improve, develop and promote biocultural conservation. There is an opportunity for biodiversity conservation and the conservation of indigenous languages and cultures to go hand in hand. Most of the world's linguistic diversity is found in areas of high species richness and endemism. If biodiversity conservation organizations on the ground in areas of high biocultural diversity were to invest resources in the conservation of indigenous languages and traditional knowledge there would be a double pay-off. Field linguists working on indigenous languages often lack the ecological knowledge needed in order to understand and translate the vast lexicon of terms for species and natural phenomena. Field biologists could benefit from the immense wealth of traditional ecological knowledge of indigenous people. Not only would biological and cultural diversity be conserved together in the environment in which they both evolved, so protecting the full range of living biocultural diversity, but also the traditional resource management systems, a fundamental component of the cultural identities that are now in retreat, could be applied to conserving the landscape, its component species and its languages.

But it is not only the rarest languages and species that we should conserve. Relatively common languages, spoken by tens of thousands of people, and common species are in decline too. Maintaining diversity is not just a question of protecting endangered languages and species in remote hotspots of biocultural diversity such as the Amazon or New Guinea, vitally important though that is, conservation is also a matter of allowing diversity to thrive in those parts of the world where humans have already had a profound impact on the biological and cultural landscape, in the more densely populated parts of the planet. Recognizing and exploring the parallels between nature and culture, and understanding the processes that underlie their evolution, ecology and extinction, is a first step towards ensuring that we can continue to inhabit a world of incredible diversity.

Mongolian herder, speaker of an Altaic language, Baga Lake, Khar Us Nuur National Park, Mongolia.

END NOTES

[1] It is possible for a person to speak more than one language, of course, whereas an individual animal or plant cannot belong to more than one species. In this report, we refer to mother-tongue speakers of a language only. This means one's native language, or the language one most strongly identifies with as a native speaker, which is usually, although not necessarily, the language one learned first. When we report the numbers of speakers of a language, we mean mother-tongue speakers, so each speaker is only counted once.

[2] There are actually quite a number of different definitions of "species" and "languages," and multiple processes of speciation and language genesis. For details, see Harmon 2002.

[3] This description of the evolution of biocultural diversity builds on JL's contribution "The third flowering of the Tree of Life" to Jorgen Randers, 2052 - A Global Forecast for the Next Forty Years (2012).

[4] Ours is not the only species to have culture – many species of songbird, for example, show regional and local variations in their repertoire of songs which are not inherited genetically but learned from other individuals of the same species, and some species of primate even have a limited repertoire of calls with specific meanings such as "snake" or "leopard" – but we are the only species to have language.

[5] French belongs to the Italic branch, which is also part of the Indo-European family.

[6] There is still controversy surrounding the exact dates and routes of the human diaspora out of Africa. The description here is based on Oppenheimer (2004).

[7] It is likely that proto-language, consisting of sounds, gestures and expressions, had begun evolving long before that time.

[8] Strictly speaking, this is West Frisian, as there are two other Frisian languages spoken in northern Germany.

[9] Basque is a language isolate (in a family of its own) in northern Spain and southwest France, while Navajo is a language in the indigenous Na-Dene family spoken in the southwest United States.

[10] Arabic is not included in the top ten as it is classified as many different languages, such as Algerian spoken Arabic, Egyptian spoken Arabic, etc. If all speakers of Arabic languages were counted together, Arabic would appear in the top ten.

[11] Scottish Gaelic, a Celtic language related to Irish, should not be confused with Scots, a Germanic language related to English.

[12] Native Scots Gaelic speakers and bilingual English-Gaelic speakers are counted together in this example.

[13] Cornish, a Celtic language related to Welsh and Breton, spoken in Cornwall.

[14] Manx, a Celtic language related to Irish and Scottish Gaelic, spoken on the Isle of Man.

[15] A few of Australia's languages are not in the Australian language family, hence the difference between the percentage of Australia's languages that are extinct or threatened with extinction and that for Australian languages.

[16] Languages with 1,000 or more speakers which grew or declined at a rate greater than 10% per year.

[17] For more detailed discussion of the ILD, see Harmon and Loh (2010).

DATA TABLES

Table 6: Conservation status of languages and species
Data for mammal, bird and amphibian species from IUCN 2013, data for reptiles from Bohm et al. *2013, percentage in each Red List category.*

Language or Species Group	EX	CR	EN	VU	LC	DD	Total assessed
Languages (sample of 1500)	6%	7%	7%	11%	63%	5%	1.500
Mammals (all)	1%	4%	8%	9%	63%	15%	5.506
Birds (all)	1%	2%	4%	7%	85%	1%	10.065
Reptiles (sample of 1500)	0%	2%	6%	7%	64%	21%	1.500
Amphibians (all)	1%	8%	12%	10%	44%	25%	6.409

Table 7: Conservation status of selected language families
Percentage of languages in each Red List category.

Language Family	EX	CR	EN	VU	LC	DD	Total assessed
Afro-Asiatic	11%	5%	4%	4%	73%	3%	75
Altaic	0%	6%	12%	12%	65%	6%	17
Australian	33%	41%	18%	2%	2%	4%	51
Austro-Asiatic	0%	3%	8%	6%	81%	3%	36
Austronesian	2%	4%	7%	17%	67%	4%	245
Indo-European	2%	0%	2%	5%	79%	13%	104
Niger-Congo	0%	1%	1%	4%	89%	5%	296
Nilo-Saharan	3%	3%	0%	3%	82%	10%	39
Sino-Tibetan	0%	1%	3%	7%	77%	11%	87
Trans-New Guinean	2%	5%	17%	26%	45%	6%	119
Arawakan	30%	5%	10%	20%	35%	0%	20
Mayan	0%	7%	0%	13%	73%	7%	15
Na-Dene	27%	36%	9%	0%	18%	9%	11
Oto-Manguean	3%	0%	25%	8%	53%	11%	36
Tupi	25%	13%	13%	19%	25%	6%	16

Table 8: Conservation status of languages by region
Percentage of languages in each Red List category.

Region	EX	CR	EN	VU	LC	DD	Total assessed
Africa	3%	2%	2%	4%	87%	1%	402
Americas	17%	16%	12%	14%	38%	2%	255
Asia	2%	2%	6%	9%	77%	3%	464
Europe	11%	5%	0%	7%	70%	7%	44
Pacific (incl. Australia and PNG)	7%	13%	15%	26%	38%	1%	282
Australia	32%	40%	17%	4%	6%	2%	53
New Guinea (incl. PNG and West Papua)	1%	6%	16%	29%	48%	0%	220

Table 9: Index of Linguistic Diversity global and by biogeographic realm
Percentage decline 1970-2009.

Biogeographic Realm	Index	Lower confidence limit	Upper confidence limit
Global	28%	31%	26%
Afrotropical realm	22%	25%	19%
Indo-Pacific realm	29%	32%	26%
Nearctic realm	74%	78%	71%
Neotropical realm	73%	79%	67%
Palearctic realm	28%	34%	21%
Australia	86%	89%	82%
New Guinea (1970-2005)	41%	46%	38%

REFERENCES

Böhm, M., B. Collen, J.E.M. Baillie, *et al.* 2013. The conservation status of the world's reptiles. *Biological Conservation*, **157**, 372–385

Cavalli-Sforza, L.L. 2000. *Genes, People and Languages*. Penguin, London.

Collen, B., J. Loh, S. Holbrook, L. McRae, R. Amin & J.E.M. Baillie. 2009. Monitoring Change in Vertebrate Abundance. *Conservation Biology*, **23** (2), 317-327.

Darwin, C. 1874. *The Descent of Man, and Selection in Relation to Sex. Second edition*. John Murray, London. Downloaded 12 February 2014 from van Wyhe, J. (ed.) 2002. The Complete Work of Charles Darwin Online http://darwin-online.org.uk

Dawkins, R. 2006. *The Selfish Gene*. 30th Anniversary Edition. Oxford University Press, Oxford.

Dennett, D. 2002. The New Replicators. In: M. Pagel (ed.-in-chief) *Encyclopedia of Evolution*, 1, E83-92. Oxford University Press, Oxford.

Gray, R.D. & Q.D. Atkinson. 2003. Language-tree divergence times support the Anatolian theory of Indo-European origin. *Nature*, **426**, 435-439.

Gray, R.D., Q.D. Atkinson & S.J. Greenhill. 2011. Language evolution and human history: what a difference a date makes. *Phil. Trans. R. Soc. B*, **366**, 1090-1100.

Greenberg, J. 2000. *The Eurasiatic Language Family: Indo-European and its Closest Relations. Volume 1: Grammar*. Stanford Univ. Press, Stanford, California.

Groombridge, B. & Jenkins, M.D. 2002. World Atlas of Biodiversity. Prepared by UNEP World Conservation Monitoring Centre. Univ. California Press, Berkeley.

Harmon, D. 1995. The Status of the World's Languages as Reported in Ethnologue. *Southwest Journal of Linguistics*, **14** (1-2), 1-28.

Harmon, D. 1996. Losing Species, Losing Languages: Connections between Biological and Linguistic Diversity. *Southwest Journal of Linguistics*, **15** (1-2), 89-108.

Harmon, D. 2002. *In Light of Our Differences: how diversity in nature and culture makes us human*. Smithsonian Institution Press, Washington and London.

Harmon, D. & J. Loh. 2010. The Index of Linguistic Diversity: A New Quantitative Measure of Trends in the Status of the World's Languages. *Language Documentation and Conservation*, **4**, 97-151. Available online http://nflrc.hawaii.edu/ldc/2010/

Hrozný, B. 1917. *Die Sprache der Hethiter: ihr Bau und ihre Zugehörigkeit zum indogermanischen Sprachstamm: ein Entzifferungsversuch* (The Language of the Hittites: its Structure and its Membership in the Indo-European Linguistic Family). J.C. Hinrichs, Leipzig, Germany.

Huffman, S. no date. *Mapping the Genetic Relationships of the World's Languages*. http://www.worldgeodatasets.com/language/huffman/ Downloaded 22 February 2012.

IUCN 2013. *The IUCN Red List of Threatened Species*. Version 2013.2. http://www.iucnredlist.org. Downloaded 25 February 2014.

Jones, W. 1824. *Discourses delivered before the Asiatic Society: and miscellaneous papers, on the religion, poetry, literature, etc., of the nations of India*. C. S. Arnold. p.28.

Lewis, M. P. & G. F. Simons. 2010. Assessing endangerment: Expanding Fishman's GIDS. *Revue Roumaine de Linguistique,* **55** (2), 103-120

Lewis, M.P., G.F. Simons & C.D. Fennig (eds.). 2013. *Ethnologue: Languages of the World, Seventeenth edition*. SIL International, Dallas, Texas. Online version: http://www.ethnologue.com.

Loh, J., R.E. Green, T. Ricketts, J. Lamoreux, M. Jenkins, V. Kapos & J. Randers. 2005. The Living Planet Index: using species population time series to track trends in biodiversity. *Phil. Trans. R. Soc. B*, **360**, 289-295.

Loh, J. & D. Harmon. 2005. A global index of biocultural diversity. *Ecological Indicators*, **5**, 231-241.

MacAulay, D. 1992. *The Celtic Languages*. Cambridge University Press, Cambridge.

Mace, R. & M. Pagel. 1995. A latitudinal gradient in the density of human languages in North America. *Proc. R. Soc. Lond. B*, **261**, 117-121.

Moore, J.L., L. Manne, T. Brooks, N.D. Burgess, R. Davies, C. Rahbek, P. Williams & A. Balmford. 2002. The distribution of cultural and biological diversity in Africa. *Proc. R. Soc. Lond. B,* **269**, 1645-1653.

Nettle, D. 1999. *Linguistic Diversity*. Oxford University Press, Oxford.

Nettle, D. & S. Romaine. 2000. *Vanishing Voices: The Extinction of the World's Languages*. Oxford University Press, Oxford.

OED Online. Oxford University Press, March 2014.

Oppenheimer, S. 2004. *Out of Africa's Eden. The peopling of the world*. Jonathan Ball, Jeppestown.

Pagel, M., Q.D. Atkinson, A.S. Calude & A. Meade. 2013. Ultraconserved words point to deep language ancestry across Eurasia. *Proc. Nat. Ac. Sci.*, **110** (21), 8471-8476.

Pagel, M. & R. Mace. 2004. The cultural wealth of nations. *Nature*, **428**, 275-278.

Pennisi, E. 2004. The First Language? Science, 303, 1319-1320.

Raghavan, M., P. Skoglund, K.E. Graf, M. Metspalu, A. Albrechtsen, I. Moltke, S. Rasmussen, T.W. Stafford Jr, L. Orlando, E. Metspalu, M. Karmin, K. Tambets, S. Rootsi, R. Mägi, P.F. Campos, E. Balanovska, O. Balanovsky, E. Khusnutdinova, S. Litvinov, L.P. Osipova, S.A. Fedorova, M.I. Voevoda, M. DeGiorgio, T. Sicheritz-Ponten, S. Brunak, S. Demeshchenko, T. Kivisild, R. Villems, R. Nielsen, M. Jakobsson & E. Willerslev. 2014. Upper Palaeolithic Siberian genome reveals dual ancestry of Native Americans. *Nature*, **505**, 87–91.

Randers, J. 2012. *2052 - A Global Forecast for the Next Forty Years*. Chelsea Green, Vermont.

Renfrew, C. 1987. *Archaeology and Language: the Puzzle of Indo-European Origins*. Cape, London.

Stepp, J.R. *et al.* 2004. Development of a GIS for Global Biocultural Diversity. *Policy Matters*, **13**, 267-171.

Sutherland, W.J. 2003. Parallel extinction risk and global distribution of languages and species. *Nature*, **423**, 276-279.

UNESCO. 2010. *Atlas of the World's Languages in Danger. Third edition.* (C. Mosely, ed.-in-chief). 11-12.

Walker, G. 2003. *Snowball Earth*. Bloomsbury, London.

WWF. 2012. *Living Planet Report 2012* (M. Grooten, ed.-in-chief). WWF International, Gland, Switzerland.

Cashinahua girl, a speaker of a Panoan language with around 1,000 speakers, her face painted with dye from huito fruit. Near the Alto Purus Reserved Zone, Ucayali, Peru.

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