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Extinction

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Abstract. A significant proportion of conservationists' work is directed towards efforts to save disappearing species. This relies upon the belief that species extinction is undesirable. When justifications are offered for this belief, they very often rest upon the assumption that extinction brought about by humans is different in kind from other forms of extinction. This paper examines this assumption and reveals that there is indeed good reason to suppose current anthropogenic extinctions to be different in kind from extinctions brought about at other times or by other factors. Having considered – and rejected – quantity and rate of extinction as useful distinguishing factors, four alternative arguments are offered, each identifying a way in which anthropogenic extinction is significantly different from other forms of extinction, even mass extinction: (1) Humans are a different kind of natural cause from other causes of extinction; (2) Extinctions brought about by humans are uniquely persistent; (3) Anthropogenic extinctions are effectively random whereas past mass extinctions are rule-bound; (4) The impact of the current anthropogenic extinction event differs from the impact of other extinction events of the past, such that future recovery may not follow past patterns. Together, these four arguments suggest that the present-day extinction event brought about by humans may be unprecedented and that we cannot clearly extrapolate from past to present recovery from extinctions. Although insufficient as justification for the claim that present-day extinctions are undesirable, the arguments provide some ammunition for conservationists' conviction that species extinction – in which humans play an accelerating role – ought to be prevented.

Key words: anthropogenic, extinction, species, speciation

Introduction

The extinction of species is of fundamental concern to conservation bodies. For example, it is made clear that there is a correlation between "those animal species known to IUCN to be threatened with extinction" and those included in the IUCN Red Data Book series "which contains detailed information on the status of species and of the measures needed to conserve them". Analyses of the data are said to "stimulate conservation activities, the results of which are then fed back into the system to determine new conservation priorities" (IUCN, 1988).

There is a clear message here, which is that certain forms of species extinction are undesirable. This belief – which is implicit in the work of all conservation bodies – is infrequently questioned and rarely justified. When justifications are offered, anthropogenic extinction is usually assumed to be significantly different in kind from extinction caused by other means, this being seen as one reason to condemn it. (Condemnation does not, of course, necessarily follow even if significant differences are found; this would require further argument.) The assumption that the two kinds of extinction differ is, however, even less likely to be argued for, and where arguments are found, they are usually unsatisfactory and often appear confused. The point of this paper is to offer arguments in support of this assumption, thereby strengthening the conservation rationale.

Placing anthropogenic extinction

Before one can tackle the question of why current species extinction is thought to be undesirable, it is necessary to address the more fundamental question of whether extinction caused by humans really differs in kind from other forms of extinction. The other forms of extinction fall into two camps: background extinction – a low-grade continuous form that includes the modification of one species into another as well as the replacement of species with better-adapted competitors – and mass extinction – a rapid, wide-ranging and catastrophic form that takes no account of a species' adaptations.

Our first line of approach is to determine whether the current anthropogenic extinction event can be aligned with either of these other forms of extinction in terms of scale or rapidity. In order to do so, we need to make use of the available data on extinction rates. This presents us with a potential problem, for there are substantial discrepancies in the data. Some of these discrepancies are merely apparent. Since there seems to be no standard way to describe extinction rate, one source might base its figures solely on mammal extinction, while another might consider the extinction of mammals and birds. There are, however, real discrepancies which arise as a result of our limited knowledge in this area and the need for estimates. Nevertheless, despite the often quite substantial discrepancies, it is clear that, in terms of rapidity, the current anthropogenic extinction event is sufficiently dissimilar to background extinction to justify a different judgement about its significance. Its rate is, however, sufficiently close to that of past mass extinction events to justify a similar judgement.

Primack (1993), for instance, estimates (on the assumption that there are around 10 million species on Earth today) that we would expect to lose between one and ten species a year through natural background extinction, but notes that the current observed rate (based on birds and mammals) is 100 to 1000 times greater. Not only is the current rate of extinction many times greater than background extinction, it is also increasing. The United Nations Environment Programme's estimate of 1995 confirms that "[n]early three times as many birds and mammals (112 in all) became extinct between 1810 and today than were lost between 1600 and 1810 (38 species)" (Porritt, 1996). This represents "an extinction rate of 50 to 100 times the expected natural rate" which, while rather more conservative than Primack's, is still surprisingly high. According to a 1992 estimate of the rate of (total) species extinction from the World Conservation Monitoring Centre (Groombridge, 1992), one hundred species are lost a year. This works out as 273 species a day or 4 species an hour.

Current anthropogenic extinction, then, is of a quite different order to background extinction; even on a conservative estimate it is on a much greater scale. It fits more easily into the mould of 'mass extinction' such as occurred at the end of the Permian period (250 million years ago) when, as Primack (1993) tells us, "50% of animal families, including over 95% of marine species" disappeared. Although these percentages are much higher than current losses, numbers of species lost, according to Norton (1986), are thought to be similar, presumably because of today's greatly increased diversity. If, then, the current extinction event resembles past mass extinction events in terms of scale and rapidity, these features cannot be upheld as evidence of a difference between them. Anthropogenic extinction conforms, in these particulars, to a familiar pattern of extinction. If rate of extinction is unhelpful as a distinguishing feature, might there, then, be other factors that would indicate a difference between the current extinction event brought about by humans and past mass extinction events?

Are anthropogenic extinctions unnatural?

It would not do to talk about possible differences between forms of extinction and neglect to mention the distinction between natural and unnatural occurrences, an area covered by authors as diverse as Elliot (1994) and Evernden (1985). In our present context, Wilcox (1988) notes that "[t]he argument is frequently made that extinction is natural". The point of such an observation is that if extinction is natural, and if one values what is natural (as conservationists appear to do) one ought to find extinction, if not *valuable*, then at least acceptable. And within the idea that natural processes ought to be acceptable there lurks a feeling of inevitability: that to try to resist the outcome of such events would be quite pointless.

The argument that one ought to accept extinction if one values what is natural is, at best, unhelpful. The belief that some extinction is natural does not commit us to a belief that *all* extinction is necessarily natural. Indeed, the reason that is usually given for the former belief is that extinction occurs in the absence of human agency.[1] It would thus be nonsense to argue that anthropogenic extinction is natural on the grounds that non-anthropogenic extinction is natural. And if anthropogenic extinction is natural, it would not necessarily follow that it should be found acceptable. There is no necessary connection between the two. Furthermore, if events that occur as a result of human agency are natural, it is difficult to see what might be excluded from the natural category. And thus the observation that anthropogenic extinction is natural would be claiming nothing of interest.

It may prove worthwhile to pursue the 'natural' question in a clear-headed way, with respect to seeking a difference between past and present extinction events. However, the purpose of this paper is to take a somewhat different approach. Whether the current anthropogenic extinction event is natural or not, the question to be asked is whether it is *unprecedented*.

The significance of extinction rates

One stance – and that taken by those we may call the traditionalists – is to argue that whilst the current extinction rate is clearly too rapid to belong to "background extinction", its very great rapidity also puts it beyond the realms of past mass extinctions; it is of a greater order of magnitude again. Primack (1993) writes that "the current rate of extinction of species is greater now than at any time in the past", and Norton (1986), talking of past mass extinctions, is convinced that "[w]hile these events may have approached currently expected species losses in total numbers, they were spread over much longer periods of time, measured in millennia".

Most biologists seem to adhere to this model for the majority of past mass extinctions. However, there is now an alternative theory for (at least) one of the extinction events: the mass extinction marking the end of the Cretaceous period 65 million years ago, when the dinosaurs (and other less well known species) disappeared. This alternative theory suggests a much more rapid demise for the dinosaurs, a demise resulting from a "nuclear winter" brought about by an asteroid or comet hitting the earth.

Opinion amongst scientists is divided. Many earth scientists, according to Bowler (1992), dispute the evidence for such impacts. Other scientists, as in the case of Campbell (1987), accept the occurrence of impacts but claim that such an impact would merely have added the finishing touches to an extinction which was already in full swing. Yet other scientists seem to accept the theory. Primack (1993), for instance, says that a collision with an asteroid resulting in climate change and extinction was quite likely. And Gould (1989) believes that "mass extinctions are *more frequent, rapid, devastating in magnitude,* *and distinctively different in effect* than we formerly imagined." The crucial point is that if the theory is correct, dinosaur extinction "may have taken less than a year" (Begon et al, 1990). And if this is so, then there is at least one mass extinction event of the past that may not be able to be distinguished in effect from current anthropogenic extinction in terms of rapidity; it may even have occurred more quickly.

It would be valid to point out here that current rates of extinction are almost certainly vastly underrated and this is because many species are as yet unknown and unrecorded. Estimates of the number of species currently in existence range from five million in total, (Primack, 1993), to 30 million species of insects alone in tropical moist forests (Wilcox, 1988). Wilcox notes that "[w]hen the tropical moist forest tallies start coming in, the documented extinctions will undoubtedly take another order of magnitude jump over the historic rate" but that for the moment, "for every species listed as endangered or extinct at least a hundred more will probably disappear unrecorded".

Nevertheless, it is generally accepted that there are gaps in the fossil record – that some past extinctions remain unrecorded too. Since our current level of knowledge is so very sketchy about past and present species numbers, and since we are unable to do more than guess about extinction rates (factors which must be at the root of the discrepancies in the literature), then we cannot base any conclusions about similarities or differences between past and present mass extinctions upon extinction *rates.* We must look elsewhere.

In what follows it will be argued that there are significant differences between the present anthropogenic mass extinction event and past mass extinction events which are unrelated to quantity or rate. Four such differences are identified. The differences relate to (i) kinds, (ii) persistence, (iii) extinction models, and (iv) modes of impact. Their significance lies in the fact that, together they lead us to question the validity of extrapolating from past mass extinctions to the present extinction event. In particular, they call into question the validity of predicting a similar post-extinction recovery.

Grounds of distinction

(i) *A difference in kind*

Current anthropogenic extinctions and past mass extinctions are different in *kind.* The grounds for affirming such a difference are as follows:

(a) Suppose we take the asteroid theory – as an explanation for the dinosaur extinction – to be the right one. Given that we have not ruled out the possibility of anthropogenic extinctions as natural, or even assuming that they are, it must be noted that humans and asteroids are quite different kinds of natural cause. The latter, though clearly natural in that they are 'of the universe' are nevertheless alien, extraterrestrial and non-living. Humans, on the other hand, are thought of as natural (at least in part) in that they are familiar, terrestrial and living. Asteroids do not belong to the subset of 'the natural' that constitutes the system of our natural world which is undergoing evolutionary change. In that respect they are different, even, from the (extraterrestrial) sun whose input is, of course, integral to the system.

(b) The thrust of the above argument can be used in a weaker form to argue for differences between extinction events caused by humans and past mass extinctions excluding those brought about by asteroids. The major causes of past mass extinctions – plate tectonics, climate change (and to a lesser extent volcanic eruptions) – although neither alien nor extraterrestrial, are clearly non-living. They are, of course, a part of our natural world in one sense, but they belong to a category that is separate and distinct from the category to which humans belong: while humans are organic, these other causes of extinction are inorganic. They have not, then, as humans and other organic things clearly have, evolved through a process of natural selection. And, although connected to the process of evolution by way of cause and effect, these inorganic factors are not bound up with the evolutionary process in the same way as are organic ones. Indeed, in that they constitute *events*, the inorganic factors act upon and are moulded by evolution, but organic entities are the very stuff of evolution. There is a sense, then, of the organic as internal to the system and the inorganic as external to it. We could say, therefore, that anthropogenic extinction, as the only organic cause of extinction, is quite distinct – in being internal to the system – from the other, inorganic, external causes of extinction.[2] Indeed, it is further set apart in being the only extinction event that has been brought about, not only by a species but by a single species.

(c) Assuming that a meaningful distinction can be made between that which is internal and that which is external to the system, a further difference in kind can be noted, relating to the different natures of the forces. Humans, as internal to the system, can be seen as a single species gradually expanding its niche, colonising all habitats, driving out other species and eventually engulfing all other niches. This is quite different in nature to the external force that rips through habitats, devastates them and then is gone. One might see the difference as analogous to external injury and internal disease.[3]

Given that anthropogenic extinctions are different in kind from past mass extinctions, there are grounds to question the validity of extrapolating from past extinction events to the present extinction event. The argument would not be that different causes necessarily guarantee different effects, but rather that given different causes it would not be safe to infer the same effects. The outcome of the current extinction event cannot be assumed to resemble that of past mass extinction events.

(ii) *Persistence is unprecedented*

Anthropogenic mass extinctions differ – *or will have differed if we don't change our ways* – from past mass extinctions in their *persistence*, a persistence that is unprecedented. For as long as human populations increase (or even remain constant) and we continue to behave as we do, we will continue to destroy and fragment other species' habitats for our own use, and thus species will continue to become extinct (habitat fragmentation and loss being the main cause of species extinction today). Extinctions will continue without limit, then, until either our species is itself made extinct, or we come to see that our behaviour must change. Furthermore, even if human pressures on the environment ceased, many species would still be at risk of extinction for some time, as they have been reduced to such small and thus vulnerable populations (Primack, 1993). In comparison, past mass extinctions had finite life-spans, the causes of which devastated and then left the biota to recover (if not to reach the same level or range of biodiversity, then to develop an alternative but equally viable level and range of biodiversity).

The current anthropogenic extinction event is clearly unprecedented in respect of this new persistence. Its different nature leads us, once again, to question the validity of extrapolating from past extinction events to the present extinction event. For instance, we could not merely *assume* that recovery from this new, persistent event (whether with or without humans on the scene) would resemble post-extinction recoveries of the past. Since the events themselves differ, their after-effects cannot be assumed to be the same.

(iii) *The random model undermines Darwinian fitness*

Anthropogenic extinctions fit random model

One difference between the current anthropogenic extinction event and past mass extinctions could be the mode of species survival. In order to explore this possibility, we will first determine the likely mode of species survival in past mass extinctions.

There are those who argue that all species survival is random, in which case no difference is to be found between modes of survival in any of the extinction events. Acceptance of the random model, however, depends on a rejection of the truly explanatory nature of Darwin's "survival of the fittest".

If this is seen as a mere tautology – where all who are fit survive and all who survive are fit – then survival will necessarily be random.

Others, however, accept Darwin's "survival of the fittest" to be truly explanatory, not in a fully predictive sense but in the sense that fitness can be attributed to an individual's particular traits. Gould (1977) is of this opinion; he argues that "certain morphological, physiological, and behavioural traits should be superior a priori as designs for living in new environments. These traits confer fitness by an engineer's criterion of good design, not by the empirical fact of their survival and spread. It got colder before the woolly mammoth evolved its shaggy coat". So, for those who accept that Darwinian fitness (of which background extinction is a concomitant) is meaningful, species survive because of certain traits of their members that confer fitness.[4]

Yet if fitness is recognised as having an explanatory role in background extinction, it is largely rejected as playing a part in mass extinction events. Gould (1989) argues that mass extinctions are different from background extinctions in that they are random, that mass extinction operates like a lottery, "with each group holding a ticket unrelated to its anatomical virtues". Interestingly, though, Gould believes that background extinctions and mass extinctions have more in common than this model suggests. Although he accepts that there is a random element to species survival in mass extinction events, he rejects the truly random model of extinction in favour of "the different-rules model". He believes that during mass extinctions "most survivors get through for specific reasons . . . [but] the traits that enhance survival during an extinction do so in ways that are incidental and unrelated to the causes of their evolution in the first place". Mass extinctions bring along with them "different rules" for survival such that: "the very best of your traits, the source of your previous flourishing, may now be your death knell. A trait with no previous significance . . . may now hold the key to your survival. There can be no causal correlation in principle between the reasons for evolving a feature and its role in survival under the new rules". The key point here, is that although they are subjected to different rules, the species that survive, do so because of specific traits that their members have.[5] Can anthropogenic extinctions be seen to fit in with this model or are they different?

At first sight, they seem to fit the model. As a result of habitat fragmentation, for instance, the species that survive are those whose members have specific traits that will fit in with the new rules: having small ranges, good dispersal abilities, rapid reproductive rates and so on. However, unlike past mass extinctions where the causes – and thus the different rules – were relatively regular in form (usually shifting land masses and/or climate change) extinctions caused by humans take a variety of (often simultaneously acting) forms. Seven are suggested by Diamond (1984): "overkill; habitat destruction by logging, fire, introduced browsing and grazing animals, and draining; introduction of predators; introduction of competitors; introduction of diseases . . . extinctions secondary to other extinctions [and] chemical extinctions". The resultant "different rules" have become increasingly complex. It is as if present-day species are being attacked from all sides, with nowhere to run.

A closer look, however, reveals not that the new rules are varied and complex, but that *there are no rules at all.* With past mass extinctions, if a species survived because its members possessed a particular trait – for example small size – one could expect to find other (at least similar) small species also surviving. That is, *reasons for survival were generalisable*. Today, however, that is not always the case. This is because species survival or extinction is ultimately dictated by human preferences, goals and objectives (hereafter referred to as preferences), the effects of which are random in a way that past factors never have been. Anthropogenic extinctions may be said to have a truly random pattern of occurrence such that rules cannot operate.

Human inconsistency dictates random survival

Human preferences cannot be governed by rules because of the variety in such preferences within and between individual humans, and between human communities or cultures. This applies both in the present and across time. But not only is there great variety in human preferences, there is remarkable inconsistency. Consider, for instance, the fact that we hunted the passenger pigeon to extinction because it was small and docile, while we may yet hunt the wolf to extinction because it is large and fierce. It may be argued that this is not odd since the wolf is a danger to us whilst the passenger pigeon was (presumably) good to eat. However, this is not satisfactory, for the wolf is also revered,[6] and although pigeons are plentiful in Western cities, they are generally not eaten, even by the poor. We seem to value species' traits in a haphazard, somewhat capricious manner. And the claim that human preferences are inconsistent, even whimsical, is no less valid when we consider plant species. Rhododendron, once the popular plant of British Victorian country estates, is now the scourge of conservationists.

However, although the direct targeting of species (overkill) is an important cause of extinction, it is generally agreed that the main cause of species extinction today is habitat loss. It is quite clear, though, that the arguments about the randomness of species extinction will apply just as readily to human/habitat relationships since we have preferences for habitats just as we do for species. We are more likely, for instance, to plunder forests than deserts; we have neither the desire nor the ability to destroy (or indeed protect) all habitats equally. Even similar habitats are often treated differently, perhaps for economic, religious or cultural reasons. When decisions to protect or destroy habitats are influenced by such diverse factors as human need, greed and ignorance, one cannot avoid great inconsistency.

The main point of the argument is this: climate change or asteroids landing on the earth were a *consistent* pressure on the species that encountered them; the reason for their survival or extinction (which was to do with the traits their members possessed) *was a transferable or generalisable reason*. Small size was thought to be a generalisable reason for mammal survival during the postulated "nuclear winter" of the Cretaceous mass extinction. Conversely, human preferences, which today so often dictate species survival or extinction are an inconsistent pressure on species. They cannot be understood within a context of generalisable rules. Since this is the case, the "different rules" model breaks down, for rules can only come into being if the reasons for survival can be generalised. Human preference is a contingent fact rather than a biological rule.

Human pressures preclude rules for survival

At this point, an objection might be raised. It could be suggested that one example of a rule in human-affected environments is: "species that threaten human food supply are in danger of extinction". However, this will not do. Whilst the statement is in general true, *it is not a rule for survival.* A rule would be required to *differentiate* the chances of species survival/non-survival. All the above statement tells us is about *one* reason for species *non-survival.*

The objection that some species – rats, cockroaches and urban foxes, for instance – seem to have learned the rules for survival in the human-affected environment fares no better. If we consider those various species that are thriving alongside us, we can find no characteristic or trait (such as resourcefulness), the possession of which leads (in most cases) to survival. The nearest we might come to a rule for survival is "the ability to survive alongside humans". However, as we have seen, rules can only come into being if the reasons are generalisable. Yet the fickleness of humans precludes this possibility. Our "rule" for survival thus becomes "the ability to survive alongside *fickle* humans". But to describe human fickleness as a consistent pressure (which is neccessary for the formation of a rule) makes no sense at all. By the very *nature* of fickleness, *consistency is ruled out.* The idea of a species becoming adapted to fickleness is incomprehensible. And the one adaptive option that might have been open to species – an avoidance of human pressures – is increasingly not an option at all, for humans are now a pervasive influence throughout the globe.

An example will illustrate the point. In Australia, the rabbit (which was introduced there by humans) has adapted perfectly to its new, human-affected environment. Thus, it would seem to have learned the new rules for survival.

However, as the recent situation in Australia reveals, the rules are apparent rather than real. If Australians have their way – and it seems as if they might – the rabbit may be exterminated (Anon, 1995). It will not do to object that this is merely an example of the rules having changed – just as they would have after an asteroid hit the earth in the past. The point about rules is that they are generalisable. Yet the rabbit alone has been targeted for extermination; the reason for the rabbit's demise is too *specific*. Human preferences are too fickle to allow for rules. Consistency, generalisations and rules have no place in human-affected environments.

Nor does it help to argue that scientific rationality – employed for much of our conservation decision-making – can come to the rescue. As Shrader-Frechette and McCoy (1994) argue, decision-making in conservation is very much based upon human preferences, whether scientific rationality is employed or not. They point out that even apparently objective judgements – such as that of economic efficiency – embrace all sorts of hidden value judgements and assumptions, such as "the comparative value of biological importance, aesthetic interests, popular demand, anthropogenic needs, and so on". Objective judgements in a conservation context are usually complex and situational, rendering them little more generalisable than judgements that more explicitly acknowledge preferences.

Similarly, if we consider the survival ability of species that are not deliberately targeted by humans – that is those *incidentally* affected – little more sense can be made of the idea of consistency. In human-affected environments, species are required to adapt to pressures as diverse as pollution, the motor car, introduced predators and loss of habitat to name but a few. Clearly, some species do manage to survive. But whether they do or not is nothing short of a lottery. Yet even if it were possible to make some sense of the idea of 'rules for survival' in this limited category, our argument remains unchallenged. It requires only that human preferences – and thus human fickleness – play an important part in determining the survival or otherwise of species today, not that they determine *all* survival or extinction.

Implications of the random model

The argument so far raises the question of whether species that survive despite the whims of humans can be said to be "fitted" – or adapted – to their environment, for adaptedness, it is argued, requires a consistent selection pressure. And if (at least some) surviving species cannot be said to be "fitted" to their environment, clearly "fitness" cannot be passed on to offspring and thus the concept of evolution is fundamentally changed. To give an example of how this might come about – *even in conservation decision-making* – consider the following scenario. We saw that when conservation decisions have to be made about whether to save this species over that one, many different factors – often specific to the case – must be taken into account. It could be that due to insufficient finances, popular concern (or a multitude of other possible reasons), the species chosen to be conserved happens to be less well-adapted than other species to the non-human biotic, and abiotic environment.[7] Because of a combination of human pressures and lack of help, the species that is better-adapted to its non-human environment may subsequently become extinct. Thus, even our well-meaning actions could result in a better-adapted species becoming extinct before its less-well-adapted counterpart.

The charge that humans may be undermining Darwinian fitness need not rest on the foregoing argument alone. There is another reason why it may be argued that human impact results in maladapted species and this is to do with the *nature* of (many) human pressures on species. Technology drives much change in the human-dominated world. These changes translate into new pressures to which species must attempt to adapt. Yet because of the very nature of certain technological pressures, they rule out the possibility of species adaptation. Take, for example, the motor car: there seems nothing that a species such as the hedgehog could do to take on the might of such an enemy. For a hedgehog, the car may be something that *cannot be adapted to*; it cannot outrun the car and its usual defence of rolling into a ball is clearly no more successful. And as discussed earlier, an avoidance strategy is not really an option at all.[8]

Given that, in human-dominated environments the adaptation of species appears to suffer, one might legitimately worry about the possible repercussions on the ecosystem. If the concept of "health" has any purchase in the natural world (as J. Baird Callicott (1995) thinks it does) then we might have cause to worry, for a healthy ecosystem must arguably be – at least in part – about the adaptedness of the species therein. This point connects with the earlier idea that anthropogenic extinction – as internal to the system – is analogous to disease, which is seen as a failure within the (immune) system. We may have good reason to question the speed, degree, or nature of post-extinction recovery in an ecosystem such as the one that is taking shape under our control. The health issue aside, if adaptiveness is being adversely affected by the current anthropogenic extinction event, then this in itself is a significant difference from past mass extinctions since adaptiveness has been the driving force of evolution since life on Earth first began. Any change after 3.5 billion years must be worthy of note.

(iv) *Character of impact*

Past mass extinctions have all coincided with and been followed by, speciation events. Even though large percentages of species were lost at each mass extinction event in the past, (and after the Permo-Triassic extinction, according to Gould (1989) diversity plummeted to 4 percent of its former value), the diversity lost was always regained and indeed went on to increase. Thus the fact that "humanity has already raised the rate of species extinction far above the historic rates of species formation" (Ehrlich and Ehrlich, 1981), cannot, in itself, suggest that the anthropogenic extinction event is unprecedented, for this was the case during past mass extinctions. It may take a very long time for diversity to be replaced, for it "took the process of evolution about 50 million years to regain the number of families lost during the Permian mass extinction", (Primack, 1993). Or, as the authors of *Biodiversity; The UK Action Plan* (HMSO, 1994) put it, "there is reason to believe it might take some twenty times longer for the biosphere to recover from the current rate of mass extinctions than humankind has existed on the planet". Nevertheless, the fact that diversity has increased in a step-wise fashion throughout the history of the Earth despite past mass extinctions must surely be indicative of nature's resilience.

There is, however, a problem with the assumption that diversity will be replaced this time around, and the problem lies in the nature of current anthropogenic extinctions. Ehrlich and Ehrlich (1993) draw our attention to the fact that: "the same human activities that are causing extinctions today are also beginning to shut down the process by which diversity could be regenerated. Entire new groups of organisms are unlikely to evolve as replacements for those lost if Earth's flora and fauna are decimated now".

The authors do not expand on this point but the theme is taken up by Vermeij (1986) who gives a speculative explanation. His argument rests upon the claim that current habitat fragmentation, although not a new phenomenon, is fundamentally different from past fluctuations in habitat size, which, he acknowledges, were also responsible for mass extinctions. He notes that according to the classical – and popular – view, speciation is promoted by "geographical isolation coupled with a distinctive regime of selection", drawing our attention to the paradox that both speciation and extinction are favoured by the same conditions.

Although it may seem that human habitat fragmentation should favour speciation, Vermeij argues that it may not. The reason, he suggests, is that unlike the aftermath of past mass extinctions, current populations of species are unable to expand because of continued pressure on their habitats. As we have already seen, current human pressures on habitats are persistent; arguably uniquely so. Vermeij argues that: "Because more genetic variation is preserved in an expanding population than in a declining one, the successful incorporation of favourable genetic alterations is more likely in an expanding population than in one which is stable or contracting. Population expansion may be impossible in most instances unless the population's habitat is expanding". This statement immediately rings alarm bells, for in most cases protected natural areas are decreasing rather than increasing in size; in some cases whole areas are de-designated, while in others, protected areas are being bisected by roads, or encroached upon from the edges, thus fragmenting them or whittling them down little by little. Indeed, it seems that for certain organisms there is a minimum area that is necessary for the process of speciation to take place. For example, "for small mammals, the smallest islands (Cuba and Luzon) on which a single species is known to have given rise to two species are 100,000 km^2", (Primack, 1993). But not only are habitats now small and either remaining so or decreasing in size, resulting in (at the very least) reduced speciation, speciation is still further reduced by the fact that we have lost vast stretches of habitat to human settlement. This use – which is increasing apace – is largely incompatible with the evolution of new species. These two factors reduce *total* diversity, the variety of species in a geographic area (as opposed to within-habitat or between-habitat diversity) the importance of which is emphasised by Norton (1986). However, the sort of speciation we have been talking about – allopatric speciation – in which speciation occurs as a result of a geographical barrier, is not the only kind of speciation. Other kinds include polyploidy (a common form of – particularly plant – speciation) and sympatric speciation – that which occurs in the same place as the parent species among, for example, insects. Neither of these types of speciation requires expanding habitats. They can also occur very rapidly. The question arises, then, why worry about decreasing habitats or indeed extinction?

While it may be true that species could, theoretically, continue to be replaced through these kinds of speciation despite reduction of natural habitat, this would be unlikely to placate conservationists. To begin with, although speciation of this kind does not require expanding habitat, it does require *some* habitat. If we continue in the direction we are heading, we may not one day be able to accommodate even this meagre requirement. At the very least we are in the process of reducing habitat in which such speciation can take place. Further, although new species may be formed, they will not – for many of us – be adequate replacements for those lost. They will consist mainly of plants, insects and other small species; there will be no replacements for the elephants of this world through these systems of speciation. Further elucidation is best left to E. O. Wilson (1992) who writes that "new species are usually cheap species. They may be very different in outward traits, but they are still genetically similar to the ancestral forms and to the sister species that surround them . . . Pairs of newly created sister species are often so close in their diet, nest preference, susceptibility to particular diseases, and other biological traits that they cannot coexist . . . local communities are not enriched by the presence of both". Theoretically, new "cheap" species could, of course, evolve over time, moving genetically further apart from one another. However, such evolution would be severely limited by the reduction of suitable habitats as explained above. At best, we may still see some genetically diverse species evolve but these will be restricted to plants and very small animal species such as insects. The evolution of something like a panda not only requires luck, trial and error and a vast amount of time, it also requires suitable habitat. If we are concerned about the *sort* of speciation that will take place in the future, then the reduction of habitats is relevant.

The fact that there is a relationship between the size of a habitat and speciation is sufficient to explain the tension between the idea that speciation is unlikely to occur in artificial reserves and the fact that speciation is particularly rapid on islands, given that, in the words of Primack (1993), "reserves can be viewed as **habitat islands** in an inhospitable "sea" of unsuitable habitat". There is, however, a further point which helps to show how nature reserves cannot hope to produce new species in the way that islands do and it centres on our habit of species introduction. Vermeij (1986) argues that on true islands, the biota were insular and had relaxed biological selective regimes whereby species evolved interesting and unique adaptations. Introduced species have, however, "rendered the selective regime . . . more like that of continents". Vermeij sees us as "homogenizing the selectional environment of organisms and inhibiting the evolution of novelty". If species introductions are having this effect on existing islands, it seems unlikely – given the greater ease with which this can take place across land, and the probable continuation of this practice – that refuges can ever really become established as true islands. And further, if species introductions have a homogenizing effect, then colonisation – which must occur to replace those species which will naturally become extinct – will be of species more similar to those which already exist on the refuges than would have been the case on true islands. And this is so, not only because of introductions, but also because habitat fragmentation and species extinction continue unabated, reducing the pool of diversity all the while. If colonising species resemble (or are the same as) those species already there or recently lost, then they do not represent "new stock" from which divergence can take place. Colonisation will, of course, be particularly important in island-like reserves for it has been shown that the smaller the island the greater the extinction.

It may be, then, that anthropogenic extinctions are quite different from past mass extinctions in that subsequent speciation will be of a very limited kind, if it occurs at all. A further difference follows from this and that is the reversal of a general (step-wise) trend towards increasing diversity. It looks as if it is indeed the case, as was suggested earlier, that we cannot extrapolate from past to present mass extinctions in terms of recovery.

Conclusion

Four arguments have been put forward to support the claim that there are important differences between the current anthropogenic mass extinction and past mass extinctions. They lead us to the conclusion that the current extinction event is, indeed, unprecedented. Recovery from this extinction event cannot be assumed on the basis of recovery from past extinction events.

The four arguments have been offered individually – and can certainly be seen as distinct from each other – yet they are not entirely separate in their significance. Together, they have a cumulative effect that serves to formulate a robust position. Each argument plays its part, both individually and collectively, in bringing us closer to the conclusion that the current extinction event being brought about by humans is significantly different from other mass extinctions. And it is the idea that recovery is in question – in terms of diversity alone or even any recognisable form of recovery at all – that is the ultimate focus of concern. This may be an anthropocentric concern (we wish to continue as a species and fear this may not be possible in a radically different world), but it may equally be an ecocentric concern (we recognise that other species, mountains, rivers and so on ought to exist in their own right).

There would seem to be sufficient evidence to conclude that anthropogenic mass extinctions are sufficiently different in kind to other mass extinctions to warrant different judgement about their significance (although in order for this differing judgement to have normative impact one must first value a diverse and thriving ecosystem). One may be justified in believing this even if anthropogenic extinctions are natural, for the arguments are independent of the natural/unnatural distinction.

The natural/unnatural question has been deliberately avoided. This is partly because the whole debate hinges upon the definition of ‘natural’ and it seemed important to find arguments that did not depend upon definitions. Indeed, even if ‘the natural’ could be clearly defined, we would be no further forward in determining the desirability – or otherwise – of the current anthropogenic extinction event, for natural is not synonymous with right.

By taking an alternative approach, this paper has shown that the current anthropogenic extinction event is unprecedented. Conservationists, it would seem, are justified in viewing this event as significantly different from mass extinctions brought about by other means. Although the arguments themselves do not lead directly to any normative conclusions, by revealing the true nature of the current extinction event, they lay the groundwork for the belief that it is undesirable. The gut-feeling expressed by conservationists – that extinction is wrong because it destroys beautiful and interesting kinds of lives – is open to the criticism that sometimes such destruction will be viewed as a *good* thing (e.g. in the case of the smallpox or AIDS virus). This leads to the necessity for a highly problematic explanation of where to draw the line between those kinds of lives that are, or are not, of value. The arguments in this paper will help those who value species diversity to see, not why every single extinction is necessarily bad, but why the current anthropogenic extinction event is so unwelcome. Clearly, there remains the need to show why species diversity is valued before conservationists' overriding concern for species preservation can be justified. However, the preceding arguments lend credibility to the conservationist who, in claiming that species extinction is undesirable, makes the assumption that extinction brought about by humans is different in kind from other forms of extinction.

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Notes

[1] There are, in fact, two separate stances: that humans, belonging as they do to culture, cannot be said to be natural beings, and that human agency is unnatural.

[2] This distinction may be challenged by, for example, proponents of the Gaia hypothesis who maintain that there is a two-way evolutionary interaction between the organic and inorganic (with, presumably, a loss of differentiation between that which is internal and that which is external to the system).

[3] It may be, of course, that humans are not unique in their capacity as aggressive colonisers; it is possible (though not, perhaps, very feasible) that another species might be capable of engulfing all other niches. In that case, we might view the event with similar alarm. However, as far as is known, humans are the only species to have behaved in this way.

[4] The arguments in this paper follow those of authors who accept that the Darwinian concept of fitness means something quite distinct from mere survival. See Gould (1977); Ruse (1982); Sober (1984); and Dawkins (1986). It is acknowledged that there are those who reject such a claim, arguing that one can only determine fitness by survival. Lack of space prevents articulation of the arguments here, but sophisticated variations of this claim can be found in Waters (1986); Shimony (1989); and Ollason (1991).

[5] It does not matter, here, whether one accepts Darwin's "survival of the fittest" as truly explanatory; one need only acknowledge the fact that when a species survives (or not), the outcome may be shown to have come about by pointing to the possession (or not) of particular traits. That is, there can be a *retrospective* explanation.

[6] Native American Indians reputedly said that when all the wolves had gone, humans would die of loneliness.
[7] It is not that fitness is only being considered in habitats unaffected by humans; rather, it is suggested that fitness only truly makes sense where the selection pressures are consistent. As has been shown, there is no consistency in modern-day, human-affected environments.
[8] Humans are not necessarily alone in ruling out the possibility of some species' adaptations; other species may be capable of this too. When domestic cats are introduced to islands where the resident species have evolved without ground predators, the latter are sometimes exterminated as they are unable to adapt quickly enough. Such unevenness between predator and prey could only arise, however, through human intervention that draws on technology. This is not to deny that in the absence of humans some species will cause the demise of other species. It is, however, to assert that there could not be such gross disparity between the survival strategies of two species as to rule out the possibility of adaptation.

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