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Austria and Switzerland

Basic and Applied Ecology 35 (2019) 13–17

Basic and
Applied Ecology

www.elsevier.com/locate/baae

BOOK REVIEW

Inheritors of the Earth: How Nature is Thriving in an Age of Extinction, Chris D. Thomas. PublicAffairs, New York, NY, USA (2017). 320 pp., US\$ 16.99, Hardcover, 9781610397285 (eBook), ISBN: 9781610397278

Nature conservation and ecology live through a phase of intensive debates about the core principles of conservation science and practice. Should an anthropocentric valuation of nature replace an ecocentric one? In other words: Should nature primarily be conserved for its production of ecosystem services as part of human land use? Can pristine nature untouched by humans still serve as an ideal for conservation, or are disturbed novel ecosystems the new normal? Should we combat alien species or embrace them as nature's response to human-induced global change? Can we still save all or most species from extinction, or should we prioritise our species conservation efforts? In recent years, these debates have reached the public through a number of popular science books. One of the most recent ones is 'Inheritors of the Earth' by Chris D. Thomas. The author is Professor of Conservation at the University of York (UK). He is best known for his work on the effect of climate change on biodiversity. In recent years he engaged in debates about new conservation strategies for the Anthropocene, including through an opinion article in *Nature* entitled 'The Anthropocene could raise biological diversity' where he argued against the "irrational dislike of invading species" and proposed that at local spatial scales the number of terrestrial species is generally increasing thanks to the establishment of alien species and speciation by hybridization (Thomas, C.D. 2013. *Nature*, 502, 7). The reviewed book is essentially a long version of the *Nature* article targeted at a general audience.

In the first part of the book with two chapters entitled 'gains and losses' and 'biogenesis', the author introduces his core arguments. First, nature conservation should assume as null hypothesis that the impacts of humans on biodiversity in the Anthropocene can lead to gains as well as losses. According to the author, this is a more neutral standpoint than the assumption that the impacts of humans are by default negative that he attributes to traditional conservationists. Second, nature conservation should view current ecological changes "in their appropriate historical context, which involves time spans much longer than we are used to in our everyday lives"

(p. 5). He defines these time spans as millennia to millions of years. Third, he wants readers to appreciate the formation of new species either through hybridization or rapid evolution and adaptation to anthropogenic habitats (which he calls biogenesis) as a defining process of the Anthropocene. "In fact, the formation of new hybrid plant species in Europe and North America would appear to be faster already than the rate at which previously existing plants are becoming extinct. Furthermore, animals and plants which we have transported around the world are acquiring characteristics that make them less and less like their ancestors. Eventually, they will become separate species. The Earth is poised for a massive acceleration in the formation of new species – come back in a million years and we might be looking at several million additional species whose existence can be attributed to the activities of humans" (p. 8).

In the second part of the book entitled 'New Pangea', he reviews the different types of evidence for biodiversity loss through four major causes of extinction from his declared more neutral position of seeing both the gains and losses: killing of animals (chapter 2), habitat destruction (chapter 3), climate change (chapter 4), and biological invasions (chapter 5). In chapter 2 he acknowledges the extinction of most or all big animals in most world regions where they previously reigned. And he characterises the Anthropocene as an era in which a major part of primary production is appropriated by humans and the total biomass of domestic animals has become far greater than that of wild mammals. He then argues that on the positive side many wild populations of large mammals are bouncing back. He attributes this to reduced hunting pressure thanks to a sufficient provision of nutritional energy to humans through efficient agricultural production systems: "[...] the rise of domestic animals mean[s] that hunting is no longer required for our sustenance. Nor is it feasible. [...] If it were not for domestic animals, the 7-plus billion of us alive today might be expected to polish off all remaining large wild mammals in about a month" (p. 47–48). In chapter 3 he argues that human land use leads to biodiverse anthropogenic landscapes characterised by high habitat diversity and as a result high local species numbers. He acknowledges that this is due to the fact that some species – especially ecological generalists – become more widespread and abundant while others disappear. In chapter 4 he accepts that climate change can be a driver of extinctions (e.g. in mountains and coral reefs), but he puts it into perspective by stressing that

species were always on the move and that over long enough time spans new species communities will adapt to the new climates. He also makes the argument that warming will help species from the species-rich subtropics and tropics to expand to the less diverse higher-latitude zones resulting in these places in an increase in biodiversity. “If we consider the entire world’s land surface, climate change is liable to increase plant diversity across much of it. Given how many species live in the hottest parts of the world, it is not surprising that the average biological diversity per square kilometre of the world goes up when the climate warms” (p. 93). In chapter 5 he argues that the problem of biological invasions has been greatly overstated and that the arrival of alien species generally leads to a substantial increase of local biodiversity. Overall, the argument that Thomas presents in chapters 2–5 is that – although total global biodiversity will decline – locally biodiversity will increase in the coming decades and centuries because winners of anthropogenic environmental change become more widespread.

In the third part of the book, Thomas expands on his argument that the Anthropocene will be an era of accelerating speciation rates. The title of the book section – ‘Genesis six’ – is meant to say that every one of the past five mass extinctions was followed by a phase of new speciation, and that therefore we might not only face a sixth mass extinction but also be “on the brink of a sixth major genesis of new life” (p. 117). He thinks of a mass extinction as a grand-scale natural selection event that separates the species that will be successful under the new environmental conditions from loser species that will (rightly) die out. In the words of Thomas: “Birds and mammals were successful, whereas the much larger dinosaurs died out at the end of the Cretaceous period. This represents evolutionary change on the grandest of scales” (p. 117–118).

The concluding part entitled ‘Anthropocene Park’ introduces four principles that Thomas considers the overarching principles of conservation in the Anthropocene. The first principle is that we should accept change. “Deviations from the past state are not all ‘worse’. We must recognize that the diversity of life on Earth is determined by the balance between gains and losses, and it is just as legitimate to maximize gains as it is to minimize the rate of loss” (p. 229). The second principle is that we should maintain flexibility for future change. “Thinking beyond the direct and current needs of people who are alive today, any human-oriented conservation strategy must be about maintaining opportunities within the biological world of which we are a part. To be able to take full advantage of the world’s biological potential in future, we should keep alive the building blocks of the biological world. By building blocks, I mean those populations and species that will form tomorrow’s ecosystems” (p. 233). The third principle is that “humans are natural within the Earth system, and so it follows that anything we do, or do not do, is a perfectly natural consequence of the evolution of a bipedal ape. We can intervene in ways that old-thinking would define as ‘unnatural’. We can be proactive rather than bowed over with

regret that things are no longer as they were” (p. 234). And the fourth principle is that we should live within the planetary boundaries of the Earth. “We should aim for maximum efficiency, by which I mean that we should pursue strategies that fulfil all human needs – and, where possible, desires – of every citizen on Earth while generating the least possible collateral damage to the global environment” (p. 230). While the first three parts of the book are a provocation to many conservationists, this fourth part largely repeats what probably many conservationists today will agree on.

In a general sense the argumentation developed in Chris Thomas’ book is congruent with my own thinking. In my publications, many similar ideas can be found. Not surprisingly therefore, the book is full of material that I found interesting and that helped me to refine my understanding of the issues. However, I do also think that the book has problematic sides. Although the book is framed as an outlook into the future, I felt that it was too often a product of old battles. It is a rebuttal of preservationists’ thinking, and foremost of invasion biology. In its attempt to deconstruct old thinking, it uses the same rhetorical strategies that were employed by preservationists – and in particular invasion biologists – and which made invasion biology a divisive force within the nature conservation community. I fear that this book might have a similarly divisive effect. I have three types of concerns: over-simplification of the ecological understanding of the issues, a lack of transparency of implicit values and worldviews, and the use of hyperbolic language.

The book oversimplifies too often and in ways that misrepresent basic knowledge in nature conservation and ecology. Of course, the author does know the facts, and I do not think that he purposefully distorts them, but – as did invasion biologists – he sells his story instead of helping non-experts to form their own opinion. Although he acknowledges in occasional sentences that things are more complex, his overall arguments dominate. A first simplification is that he equals biodiversity with species numbers. A second one is that he uses observational data of current patterns to derive broad generalisations and make far-reaching extrapolations in time and space.

One core argument of the book is that local biodiversity increases through the arrival of new species and speciation that has “gone in overdrive”. The problem of this view is that Thomas equals biological diversity with the number of species in a local area and neglects all the other dimensions of biodiversity. Certainly, new species are being formed through rapid evolution, human-driven admixture and then separation of gene pools, and hybridization, but these processes generate hardly any new genetic and functional diversity and therefore will not balance the extinction of thousands of populations and species, whole branches of the phylogenetic tree and whole functional groups of species. He thus directly contradicts his second principle to save the world’s biological potentials for the future. To maximize flexibility for the future, we must save genetic, phylogenetic and functional diversity – not species numbers. Thomas calls

species the “building blocks of the biological world” and thereby uses an engineering-inspired metaphor that is also widely used in synthetic biology where genes are called building blocks. Seeing species as building blocks promotes an understanding that neglects the systems-level properties of an ecosystem (e.g. plant-soil feedbacks, alternative stable ecosystem states, species interactions and local (co-)adaptation including through epigenetics and learning). His understanding of nature conservation as an endeavour of conserving species as separate building blocks leads Thomas to favour conservation strategies such as assisted migration (transporting species to places where their preferred climate will be found in the future with climate change), de-extinction (the resurrection of extinct species such as the mammoth with the technologies of modern biology) or re-wilding (e.g. re-releasing rhinoceroses in Europe). In contrast to other re-wilding proponents, he proposes introductions of species to the wild in new places explicitly not primarily for an ecological reason (e.g. to replace lost ecological functions in an ecosystem) but to save species that lost their original habitat. I missed the perspectives of community and ecosystem ecology as well as an appreciation of the relationships between local human cultures and livelihoods with their specific local biodiversity.

A second simplification that characterizes this book is to derive broad generalisations and make far-reaching extrapolations in time and space from often spatially coarse and short-term observational data. Thomas concludes several times that an observed increase of total native and alien species numbers at a regional scale, including on oceanic islands, implies that alien species do generally not drive native species to extinction. I agree that alien species have sometimes been overstated as main driver of extinctions and also that alien species can be a valuable compound of regional biodiversity. But such data do not demonstrate that invasive alien species do not pose a major threat to endemic island biodiversity. It is not true that the native flora and fauna of islands survive amidst these alien species. Some native species do. But many survive only in last pockets of natural habitat that are protected from invasions and other disturbances. If alien species numbers currently increase without a decline of native species on islands then this is not a sign of coexistence of the two groups of species – they mostly do not occupy the same places – and it will be a transient phenomenon. Many native species are living dead and will die out (e.g. trees that are represented only by a few old non-reproductive individuals). When thickets of alien plants, or populations of alien species such as rats, are removed from an island habitat typically many native plant and animal species bounce back (including species that were thought to be extinct). It might be that habitat loss (or other threats) were the main culprit that brought many island species to the brink of extinction instead of invasive species. But that is a futile discussion. What matters is how now island floras and faunas that often represent unique phylogenetic lineages and functional traits and often are important to local livelihoods and cultures can

be saved – and if possible in the wild. Sometimes removing aliens is effective, sometimes other strategies are better suited. This does of course not contradict an appreciation of novel ecosystems composed of mixtures of alien and native species as part of island biodiversity.

Such extrapolations underlie also one of the other central statements of the book, namely that the upcoming extinctions of the early Anthropocene can be seen as a grand-scale natural selection event after which the winners of anthropogenic change will survive and live happily ever after without need of human assistance. It might be true that there is a set of traits that tend to characterise generalist species that are better able to survive in anthropogenic landscapes, but often different threats affect different species, and threats change in time. Large mammals were driven to extinction through hunting and returned after hunting stopped (as Thomas himself acknowledges). DDT brought many species of bird of prey to the edge of extinction, and many of these species are, after DDT use ended, common again. At present it might be bees that suffer from exposure to glyphosate. If land use further intensifies – as we must expect – then many of the ‘winner’ species will also be threatened. On the other hand, if we enter a more sustainable trajectory of land use, species that are at present losers might become winners again (e.g. of multifunctional agroecological landscapes). Equally the argument that climate warming will benefit species from low latitudes is too simplistic. Climate change will in particular lead to more frequent and pronounced climate extremes, higher year-to-year variability of climatic conditions and an increase of other disturbances (e.g. wildfires). Tropical species are adapted to a stable climate and will therefore likely suffer. Many tropical species also depend on specialised species interactions, and asynchronous species migrations will separate mutualists. More generally, it is dangerous to extrapolate from the current impacts of climate change on biodiversity to the future (as is done in chapter 4). Climate change will accelerate which will lead to non-linear changes of the effects on biodiversity (especially when considering that many other factors such as nitrogen deposition continue to change, too).

A second type of problem I see with the arguments in the book is that value-laden worldviews are presented as the logical consequence of ‘neutral’ scientific analyses. Thomas’ statements that we should accept change and “regard all human actions as natural, and thus legitimate options” (p. 239) are not more neutral than the principles of preservationists that we should protect nature of the past and consider impacts of humans by default as problematic in line with the precautionary principle. Consider this sentence: “It is time for the conservation and environmental movement to shed its self-imposed restraints and fear of change” (p. 242). This is clearly a normative statement. Thomas makes the same mistake that he criticizes. He uses descriptive observations about how the world is to make normative statements about how the world should be (philosophers call this the ‘is-ought problem’). For instance, he writes that something is “the norm” in nature in arguments that are about how we should do con-

servation. More generally, he aims in this book to redefine what we mean by ‘natural’ but he does not make explicit that this notion has different dimensions: we use it to talk about how nature works (in the sense of causal relationships), but we also use it to talk about what nature means to us.

One consequence of mixing different types of argumentation (about genes and species versus about values and worldviews) is that Thomas’ own normative stance remains elusive. In some places he sounds like an ecocentric thinker, for instance when he argues that we should appreciate nature without imposing our human preferences or that we should work with instead of against nature. In other places his arguments resonate with the rhetoric of deniers of climate change or environmental degradation; especially when he argues that nothing that humans do in nature is new. The longest such argument starts on page 211 as follows: “Not only did we evolve naturally, but it is self-evident that the laws of physics, chemistry and biology were not revoked when humans turned up – we are simply using them to our own ends. Think of some of the changes which might lead people to conclude that our impacts are unnatural. Yes, we drove many of the largest land animals to extinction, but this is not new. Many large animals became extinct when North and South America came into contact with one another, long before humans were around” (p. 211). He continues by stating that long-distance dispersal across oceans is not new because it happened before, that the climate changed before, that “when humans harvest fields of wheat and corn, it is not fundamentally different from the activities of leaf-cutter ants” (p. 212), that beavers built dams before we came up with the idea to build houses and other infrastructure, and that genetic technologies are no different than hybridization. In a time when ‘natural’ is an important value-laden concept in discourses about the role of humans in nature, any framing of it is a value-laden position. This is evident in the paragraph cited above. Thomas argues that no useful analytical distinctions can be made between pre-human and anthropogenic nature and thereby delegitimizes attempts to differentiate between high- and low-quality nature as a result of human impacts. But doing so is one of our jobs as conservation scientists. We must analyse how causal relationships in nature have changed through our evolving activities in nature (and it seems obvious that fundamental differences can be pinned down between the pre-human and human-driven extinction of large animals etc.). And we must help to make transparent different possible normative positions, their inner logic and cultural roots, and how they affect our thinking about nature. I do not think that Thomas shares in any way the views of climate change deniers. But as natural scientists we must be aware of a dangerous trap. If we do not clearly separate statements about how nature works from statements about how nature should be, we can inadvertently express normative positions. The statement that nothing is new in nature sounds like coming from a climate change denier because it frames patterns and processes as inevitable. This plays into the hands of those that prefer to keep the technological, economic and political status quo. Similarly,

to say that we should contemplate the impact of humanity on life on Earth from the distance of a million years from now implies that there is no value in articulating what type of nature we want today. To say that we should accept the ongoing changes in nature can mean that we should accept the political, social, economic and cultural status quo that leads to these changes.

Thomas’ arguments resonate in several places also with a movement in environmentalism that is sometimes labelled as eco-modernism – another value-laden mental model about the role of humans in nature. The core idea of eco-modernists is to divide up the planet into large tracts of wilderness and highly efficient land-use on the remaining land. Thomas argues along such lines in particular in chapter 2 where he states that intensive agricultural production can save wildlife through reduction of hunting pressure. I do not question that land separation and efficient land use might potentially help to solve our environmental problems, but we have to be careful once again. ‘Efficiency’ (and equally ‘rational management’) is a notion that can make something look self-evident and an obvious improvement of the past. Thereby it can hinder us to ask critical questions and to consider the possibility that we have to rethink our way of life more fundamentally (instead of ‘only’ optimising it). From a more critical position one might, for instance, wonder whether saving wildlife through efficient agriculture works when considering all side-effects of current intensive agriculture. Would it work for an agriculture that does not deplete soils and water, not negatively affect surrounding areas through the spill-over of artificial fertilizers and pesticides, and maybe most importantly that would follow the ethical principles of labour rights, human justice and animal welfare? It is particularly important to think about human justice when reading sentences such as these: “Where hunting large wild mammals for food persists, it is usually unsustainable. Bushmeat hunting in Africa, for example, is continuing to drive numbers down and the rational management of the oceans is still some way off. There is not enough wild meat to feed us. However, habits can be hard to break, especially when traditions become luxuries or are linked to particular beliefs. The Japanese do not need to eat whale meat to survive, and large wild animals continue to be hunted towards extinction for their ivory, horn, as pets [...], traditional medicines, spiritual pick-me-ups and due to cultural tradition, rather than because we need their essential nutrients” (p. 48). We should be careful with such statements in the North. Our demand for land in the South (beef, soy, palm oil, coffee, etc.) is one of the main drivers of over-exploitation of wildlife there. We have recurrently imposed our conservation strategies (rooted in our values) on local livelihoods in the global South while exploiting our own land. Cases where indigenous people were replaced from their land to form national parks are among the darkest chapters in the history of the international conservation movement. The idea of a strict separation of nature and culture is a paradoxical argument in Thomas’ book because he

argues in many other places that we should see humans as part of nature.

A third type of problem is that the book often builds on a hyperbolic language that uses vivid metaphors, strong narratives and frequent religious references. The subtitle of the book promises to explain “how nature is *thriving* in an age of extinction” (italics added). It is recurrently said that “the biological processes of evolutionary divergence and speciation [...] have gone into *overdrive*” (italics added). The individual chapters have titles such as “never had it so good”, “steaming ahead”, “genesis six”, “evolution never gives up” or “Noah’s Earth”. In invasion biology the use of such hyperbolic language has contributed to the opposition to the field of some experts and in parts of the public.

I think that this is a useful book insofar as it develops a thought experiment: What would happen if we would stop those interventions in nature that are aimed at saving qualities of the nature of the past? How would a future nature dominated of the winner species of the Anthropocene look like? Would the future be as bleak as many think? We have to thank Thomas for this provocation because it will in many places become the reality. Across major parts of the planet, we will not have the capacity to intervene substantially in the new ecological and evolutionary processes that we started. The wilderness areas of the future might indeed have many of the qualities that Thomas sketches out. A first limitation

of the book that I see, however, is that it lacks the perspectives of functional, community and ecosystem ecology that would have enriched the arguments and might have led to different conclusions. A second limitation is a lack of consideration of alternative land-use scenarios. Depending on future land use, the winner species and the fate of biodiversity will substantially differ. One reason why this perspective is missing might be that the book neglects socioecological perspectives such as from social, cultural and political ecology, anthropology (e.g. ethnobotany), environmental humanities, or agroecological and green cities research. An ecology of the Anthropocene will necessarily have to bridge between ecology, social sciences, humanities, indigenous knowledge and diverse fields of planning and design. A third limitation is that we natural scientists have to better learn that any science is embedded in a cultural and historical context, and that values and worldviews always influence our scientific thinking. We have to learn from the humanities how to better recognize the cultural roots inherent in our scientific work and ‘objective’ analyses. *Homo sapiens* is part of nature, but how we think about nature is part of culture.

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