

RESEARCH

The Anthropocene Eel: Emergent Knowledge, Ontological Politics and New Propositions for an Age of Extinctions

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This paper explores how the Anthropocene, a scene of ontological transformation, reconfigures disciplinary knowledge-making and challenges conventional forms of critique in the social sciences. I examine these interrelated questions by considering the emergent relations between eels, researchers and their knowledge practices, and global environmental change, over the last century. The argument unfolds in two acts. The first centres on the Danish scientist Johannes Schmidt, whose obsession with eels was pursued over three decades and 65,000 kilometres of ocean expeditions. In many ways pioneering, Schmidt's exclusive focus on the domain of 'nature' exemplifies what the sociologist of science Andrew Pickering terms 'disciplinary dualism.' The second act focuses on the recent emergence of the Anthropocene eel. Characterised by coupled becomings and multispecies entanglements, this hybrid eel is threatened with extinction. Eel populations and disciplinary dualism, it appears, are both collapsing. This dramatic situation raises important questions about theory and politics in the Anthropocene. Confronted with catastrophically entangled and ontologically slippery objects like the Anthropocene eel, the epistemological practice of critique faces significant challenges. In conclusion, I argue that navigating the Anthropocene requires experimentation with ontological propositions adequate to the increasingly critical states of the world.

Keywords: Anthropocene; becoming; critique; eels; ontology; propositions

More than a decade ago, the sociologist of science Andrew Pickering (2005) brought together two stories, of eels and of global warming. At some point, small Asian eels had been imported to the US as exotic additions to home aquariums. However, they grew large fairly quickly, and moreover they began escaping their tanks. When owners dumped the eels in local ponds they thrived at the cost of local fish. Complaints to the authorities led civil engineers to drain the ponds, but while most other fish died, the eels buried themselves in the mud and survived. Concrete barriers were then built around the affected ponds, but the eels climbed out.

Pickering used the story of the escaping eels to develop a contrast between a posthuman perspective on the environment with an understanding premised on disciplinary dualism. Rather than defining two extant domains—society and nature—each operating according to its own principles, the relations between eels and people had to be understood as a process of temporal emergence and coupled becomings. Rather than reifying each agent, the emphasis would be on mutual modifications, unpredictably unfolding in time.

Disciplinary dualism, Pickering suggested, could also be observed in the context of scientific efforts to model

global warming. Rather than dealing with coupled becomings of humans and nonhumans—relating, for example, to concrete practices of oil extraction or modern consumption—climate models embed dualism, as they rely exclusively on quantitative measurements and estimates of carbon dioxide emissions as a mere 'attenuated proxy for the human world' (2005: 40).

In this paper I examine how the Anthropocene, as a scene of ontological transformation, reconfigures disciplinary knowledge-making and challenges conventional forms of critique in the social sciences. The exploration proceeds via an examination of the changing relations between eels, researchers and their knowledge practices, and global environmental change, over the last century. While early eel research, exemplified by the pioneering efforts of Johannes Schmidt, offers illustration of the 'disciplinary dualism' identified by Andrew Pickering, the recent emergence of what I call the Anthropocene eel, defined in terms of coupled becomings and multispecies entanglements, testifies to the slow-motion collapse—not only of eel populations but also of dualism.

The point is not, however, that periods like the Holocene and the Anthropocene have different ontological configurations that inherently match with particular forms of knowledge. STS (science and technology studies) scholarship has described many cases of becoming and hybridity before the emergence of the Anthropocene, and early ecologists like Aldo Leopold (1949) famously argued

for learning to think like a mountain (Bonneuil and Fressoz 2016: 42). Further, as described by anthropologists (e.g. de la Cadena 2015), environmental historians (e.g. Cruikshank 2010), and indigenous scholars (e.g. Whyte 2018), many people have always had distinctly non-dual relations with earth-beings, glaciers, landscapes and ancestors. Despite important differences,¹ these studies make clear that the situation cannot be understood in terms of a general contrast between the Holocene and dualist knowledge formations and the Anthropocene and entangled ones. This point is, of course, also brought home by the converse fact that far from all knowledge today is non-dualist.

Hence, rather than assuming a single, epochal epistemic-ontological difference, I take the contrast between Schmidt's disciplinary dualism (in the Holocene) and its unfolding collapse among eel researchers (in the Anthropocene) as indicative of a growing recognition of ontological entanglements as relevant units of analysis, which relates to the increasing prominence and visibility of *dangerous and accelerating* climatic, ecological and environmental effects.

This situation has several important implications for current modes of theorisation and politics, extending to and including the question of the appropriateness of the concept of the Anthropocene itself (Blok and Jensen 2019). As is well known, this term is widely criticised as universalising, homogenising and Western-centric. Numerous alternatives are currently in circulation (e.g. Malm and Hornborg 2014; Bonneuil and Fressoz 2016). Despite the importance of these objections, however, it is noticeable that the alternatives tend to perpetuate the distinction of ontologically separate social and natural domains and thus develop from *within* the horizon of dualism.

Just as conventional notions of critique face new challenges as they confront catastrophically entangled and ontologically slippery objects like the Anthropocene eel, critiques of the Anthropocene remain on thin ice as long as they are premised on disciplinary dualism. Nomenclature aside, they are constitutively unable to adequately analyse the coupled becomings and ontological transformations characteristic of climate disruption. In conclusion, I argue that navigating this changing ontological landscape requires experiments with making propositions adequate to the increasingly critical states of the world.

Slippery Objects of Critique

Andrew Pickering's (1995, 2008) posthuman perspective, also known as 'the mangle of practice,' offered an alternative to the idea that either people or things provide a static unit of analysis. The stories of escaping eels and global warming both illustrate the centrality of temporal emergence and the mutual tuning that occurs as humans and nonhumans act together. The mangle of practice thus offered an alternative to the social construction prevalent in STS in the 80s and early 90s. It also offered provocations to critical theory, and to critique in general. These questions return to haunt the Anthropocene.

What is critique? Wendy Brown (2005: 14) notes that the word comes from the Greek *krisis*, which entailed 'the art of making distinctions, an art considered essential to judging and rectifying an alleged disorder in or of the democracy' (2005: 18). In its Marxist form, critique 'posits a more comprehensive means to grasp social reality and diagnose social pathologies' (Thompson 2017: 1). For Foucault (1984: 45–6), critique was no longer 'to be practiced in the search for formal structures with universal value, but rather as a historical investigation into the events that have led us to constitute ourselves and to recognise ourselves as subjects of what we are doing, thinking, saying.' At issue is examining particular discourses and institutions in a way that 'exposes the limits of [the] epistemological horizon itself' (Butler 2001: 1). As Judith Butler (2001) observed, critique thus requires a specific object and target—a practice, discourse or episteme—to operate efficiently. But it is precisely such relatively stable units that vanish in Pickering's mangle, where temporal emergence dissolves fixed identities, reconfigures boundaries and loosens structures.

With the advent of the Anthropocene, characterised by the breakdown of categorical certainties and the ontological modifications of actors—like eels—that no longer appear either social or natural but rather hybrid and entangled, Pickering's characterisation appears freshly relevant. Yet, given that the Anthropocene is also a time of violent climate disruption and mass extinctions, questions of critique arguably also reappear with intensified urgency. This extends to the question of what the Anthropocene names and whether that name is appropriate. While the term evokes a universal humanity, critics rightly observe that the fossil fuel economy driving climate disruption was, after all, created by a small subset of culprits (Malm and Hornborg 2014). In a wide-ranging critical discussion, Christophe Bonneuil and Jean-Baptiste Fressoz (2016) point to additional problems. Among them are that the Anthropocene assumes a perspective of the Earth from nowhere, that it evokes a technocratic ideal of planetary governance and that it naturalises and depoliticises geohistory. And Kyle P. Whyte (2018) shows that the Anthropocene imagination can easily lead to the erasure of colonial violence and of indigenous perspectives. Meanwhile, others take the Anthropocene as a starting point for exploring emergent ontological configurations and multispecies entanglements.

The political theorist David Chandler has drawn the frontlines of this complicated situation in his detailed examination of *Ontopolitics in the Anthropocene* (2018). This book recognises the difficulties conventional social theory encounters when facing the new objects and concerns of the Anthropocene. It engages a range of theories, from Bruno Latour and Isabelle Stengers' studies of Gaia to new materialism and object-oriented ontologies that now pose questions about how to operate 'without the certainties and signposts of modernity' (Chandler 2018: 7). Similar to others (e.g. Malm and Hornborg 2014: 62; Swyngedouw and Ernstson 2018: 4), however, Chandler worries that the emphasis on fluidity and hybridity characteristic of (most of) these approaches

undermines the capacity for principled critique of the (modern, capitalist) structures, causes and agents that led to the Anthropocene in the first place.

Taking the anthropologist Anna Tsing's (2015) studies of multispecies encounters in capitalist ruins as emblematic of the 'ontopolitical' orientation, Chandler notes that its emphasis on entanglements displaces human designs and intentions from the centre stage of politics. Foucault and an earlier generation of scholars had brilliantly delineated and critiqued the epistemological horizon of modernity, but Tsing and other 'ontopoliticians' step into the ring after the collapse of that horizon. The problem is that they enter these ruins not in search of improved critical weapons guided by a sense of indignation or outrage, but rather with a 'feel good' (Chandler 2018: xiii) attitude, in search of new possibilities. 'What was it,' Chandler asks, 'about contemporary life in the ruins or the promise of extinction that apparently offered such a wonderful opportunity for profound political creativity?' (2018: xiv, citing Mitchell 2017: 23).

Formulating an adequate reply to this question is difficult because the category of ontopolitics covers many approaches, several of which were developed before the Anthropocene. Embedded in the objections, however, is a conflation of the descriptive, diagnostic and conceptual aspects of these studies and their (only sometimes articulated) prescriptive, normative or political dimensions. Pickering's focus on temporal emergence, for example, is not due to the conviction that it is inherently wonderful that humans and nonhumans engage in coupled becomings. It is, rather, a consequence of studies—of particle physics, cybernetics and ecologies, among others—that make it manifest that they do so. Anna Tsing's call to pay attention to lively encounters in the debris of modernity, similarly, is not celebratory but ethnographic. Nevertheless, the *tension* detected by Chandler and others is significant. If human-centered critical perspectives face real challenges dealing with Anthropocene entanglements, and mere documentation of hybrid encounters in a collapsing world is unsatisfying, what other options are available?

Below, I argue that the situation calls for experimenting with ontological propositions about the critical states of the Anthropocene world. I take the notion of propositions from the process philosopher A. N. Whitehead (1929: 184) who thought that the primary function of theories is not to capture reality, but rather to act as 'lures for feeling,' which make it possible to think, feel or act, in new ways (see Stengers 2011). Rather than representing matters of fact, propositions are thus hybrids situated halfway between potentiality and actuality (Whitehead 1929: 185–6), perhaps not too unlike Kyle P. Whyte's (2018) 'counterfactual dialogues' and 'indigenous futurisms.' They may slip out of existence without notice, or they may be actively ignored. But when they gain a foothold, they have the potential to introduce novelty into the world (Whitehead 1929: 187).

I explore these ideas by considering the changing relations between eels, researchers and their knowledge infrastructures, and planetary environments, over the last

century. In contrast to Pickering's treatment of eels and global warming as empirically separate but conceptually similar, the fate of eels is now fully entangled with global environmental change.

I tell the story in two acts, with a conceptual intermezzo. The first centres on the pioneering Danish scientist Johannes Schmidt, whose obsession with eels was pursued over three decades and 65,000 kilometres of ocean expeditions. While his efforts exhibit striking forms of temporal emergence and copious coupled becomings of humans and nonhumans, the interest of Schmidt and his research collaborators' interests were more or less exclusively 'natural.' In this sense, the early eel research conforms to Pickering's depiction of disciplinary dualism. So, too, do later social science examinations of marine research expeditions, like Schmidt's, only from the other side. While illuminating topics like scientific entrepreneurship, communication and the changing contexts of postcolonial science, these studies remain distanced from zones of coupled becomings and ontological entanglements.

As the 'great acceleration' (Steffen et al. 2005) proceeds apace, such couplings and entanglements proliferate. The second act fast-forwards to the present, where researchers depict ontologically transformed worlds in which eels are threatened by overfishing, habitat destruction, dam cascades and changing ocean conditions. Connecting the rapid decline of eel populations with a variety of global environmental changes, these studies articulate an Anthropocene eel, fully and catastrophically entangled. This is happening at the same moment at which several strands of social science have begun to exhibit more-than-human 'ontopolitical' characteristics. Eel populations and disciplinary dualisms seem to be collapsing in tandem.

At one level, the following is thus a fascinating albeit depressing story about the ontological misfortunes of the eel. At another, it is a story about the coupled becoming of knowledges, the breakdown of disciplinary dualism and about the need for developing new propositions for a world in crisis.

But let me start with the eel, and the lifelong fascination it came to hold over one Danish scientist at the end of the nineteenth century.

Johannes Schmidt: Ahab of the Eel

In 1899, the young Danish botanist Johannes Schmidt went on an expedition to Siam to study plant and animal life.² The destination was the island of Koh Chang on the eastern side of Siam Bay (now the Gulf of Thailand). Accompanied by the zoologist Ole Theodor Mortensen and provisioned by the government and the Carlsberg Foundation, Schmidt left Copenhagen on an East Asiatic Company vessel. After stopovers in Antwerp, Southampton, Port Said and Singapore, they continued on to Bangkok. A week later, they set off on the small steamer *Chamroen*, and finally disembarked at Koh Chang just before Christmas.

On the island, the two men set to work connecting samples from the mangrove. Schmidt was fascinated by enormous dipterocarps; Mortensen absorbed by fiddler crabs and mudskippers capable of climbing trees. Four

months later, the two returned to Denmark and Schmidt went on to publish 'The Flora of Koh Chang' in *Botanisk tidsskrift* (The Botanical Journal), and take up a position as assistant at the Biological Station.³ Among his tasks were sailing the seas in search of data about fish populations, water salinity, temperatures, currents and other topics relevant to Danish fisheries.

Schmidt had been born into a family of scientists—and beer. After the death of his parents when he was seven, he had moved in with his uncle, the chemist Johan Kjeldahl, then head of the Chemistry department at the Carlsberg Brewery laboratories in Copenhagen. After the trip to Siam, family relations with the brewery were cemented through marriage to Ingeborg van der Kühle, daughter of the administrative director of the Old Carlsberg Brewery.

At the time, the northern European countries had recently agreed to conduct international explorations of the sea. In Denmark, this led to the establishment of a commission and acquisition of the steamer *Thor* in order to carry out maritime scientific expeditions. In 1903, Schmidt joined *Thor's* first trip north to the Faroe Islands and Iceland, which aimed to learn about important food fishes such as cod, flounder, haddock, herring, plaice and eel. West of the Faroe Islands, the vessel captured a single larva of the European eel (*Anguilla Anguilla*). This tiny find profoundly shaped Schmidt's life.

The development of the eel had long been a mystery. Aristotle thought that it emerged fully formed from the muddy ocean floor. Around 1780, parallel Italian and Danish discoveries of eel ovaries had put this idea to rest, but most details were missing. It was known that grown eels left the European rivers, disappearing into the Atlantic and that younger eels returned. But where the former went and from where the latter returned was unknown.

In 1896, the Italian scientists Grassi and Calandruccio captured a few eel larvae and studied their metamorphosis in an aquarium. Since the Italian specimens had been caught in the Strait of Messina, between Sicily and Calabria, they believed the spawning ground to be somewhere off the coast of Italy. Schmidt's catch of a freely flowing larva in the Northern Atlantic challenged this theory.

But where might the spawning grounds be? Results from the *Thor* expedition suggested that each fish species thrived under specific hydrographic conditions including water depth, temperature, salinity and currents. It seemed necessary to search larger areas of the North Atlantic, and Schmidt did so with great perseverance between 1905 and 1908. Preliminary calculations suggested a location somewhere west of the British Isles but there were other possibilities. And so, the search continued from the Bay of Biscay to Ireland.

Despite compiling large amounts of data, and collecting more than 500 eel larvae, it proved impossible to find the spawning grounds. In a letter from 5 June 1906, written off the coast of Ireland, Schmidt expressed bewilderment: 'But now the problem is that we find eel larvae all the places where, if there was any sense to it, they should not be' (quoted in Tåning 1947a: 42). Two days later, he observed that 'the eels' spawning area seems to be considerably larger than I had thought, and obviously this

makes things significantly more difficult.' As his colleague, the ichthyologist Å. Vedel Tåning (1947a: 43) remarked, 'one notices in his letters from these days that the problem increasingly captures and enamours Professor Schmidt, depriving him of peace of soul [*sjælefred*].' Like Herman Melville's Captain Ahab always driven further by the enigmatic white whale, Johannes Schmidt would spare no effort in pursuit of the tiny, elusive eel. After three more months of futile efforts, however, *Thor* headed home.

By the winter of 1908, Schmidt drew the conclusion that eel metamorphosis was seasonal, and that eggs would therefore only be found if one arrived at the right place at the right time. The likelihood that a single ship would chance upon the correct location in the huge Atlantic was, of course, slim. Accordingly, Schmidt spent several years convincing Danish trading ships sailing these waters to equip themselves with pelagic nets and to collect samples. In the meantime, he took up the prestigious position as director of Carlsberg's Physiological Laboratory, a post he kept from 1910 until his death. That did not diminish his obsession with the eel.

Dana Expeditions and the World Tour

After the calamity of World War I had stalled the attempts to solve the riddle of eels, Schmidt continued the pursuit on the two '*Dana* expeditions' between 1920 and 1922. The first trip went west, eventually to the Sargasso Sea, where nights were spent fishing for eel spawn and other species. It was discovered that American and European eels both spawned in this area, which raised questions about the mingling of these populations and why they went their separate ways.

Though a leakage brought these studies to an abrupt halt, the results were substantial. In Schmidt's words, 'Given the many difficulties we have faced, there is every reason to be pleased with the accomplishment, which, to put it in English "ends every discussion about the breeding place of the Eel"' (Jespersen 1947: 85). After 17 years, it had at long last been firmly established that a small area of the western Atlantic was both cradle and grave of the eels.⁴ After spawning, they embarked on their long journey back to the European coast, returning years later to breed and die in the same area. Still, the elusive eel egg had not been found, nor had any of the old breeding eels been captured. Further oceanic detective work was required.

In 1921, a new *Dana* vessel stopped in Gibraltar to study the inflow of glass eels from the Atlantic. It went past Madeira, where the travellers briefly visited *Quest*, Shackleton's vessel, then en route to its ill-fated Antarctic adventure. After continuing past French Guiana, *Dana* tracked back and forth between Barbados, St. Vincent, St. Lucia, Guadeloupe and Martinique, conducting several months of pelagic and hydrographic research. There were forays into the very deep waters of the Gulf of Panama, where specimens were hauled up using a pulley of steel wire from depths of 10,000 metres. The combined harvest by the two *Dana* expeditions added up to 1,807 American and 6,597 European larvae.

In 1924, Schmidt was inducted to the prestigious French Académie des Sciences and declared his ambition

to extend the eel studies to the Indo-Pacific. After three years of lobbying, the Carlsberg Foundation agreed to pay for the largest privately funded ocean expedition ever seen: *The Carlsberg Foundation's Oceanographical Expedition round the World 1928–30* (Sandbeck 1998: 125). And so, Schmidt, though troubled by bad health, was set to pursue the somewhat megalomaniac task of conducting comparative studies of the animal- and plant-life in Atlantic, Indian and Pacific Oceans. Samples would be collected from the deepest areas of the sea, with the assistance of cutting-edge echolocation technology. (As a curiosum, this also enabled the identification of the Carlsberg Ridge in the Indian Ocean).

After departing from Europe, the expedition crossed the Panama Canal and continued to Tahiti, the Cook Islands, Samoa, Fiji, New Caledonia and New Zealand. Via the Torres Strait, it entered the East Indian seas in the spring of 1929. *Dana* stopped at Galathea Bay, named after an earlier Danish expedition, sailed up the Mekong to Saigon, made a brief, nostalgic return to Koh Chang, and went on to Shanghai (Sandbeck 1998: 127). Back in Plymouth, *Dana* was congratulated by the president of the International Council for the Exploration of the Sea, Henry Maurice, and, in Boulogne sur Mer, French government representatives were present to celebrate the expedition. Eventually, *Dana* reached Helsingør, setting of Shakespeare's *Hamlet*. The ship had crossed the equator twelve times and covered a distance of 65,000 sea miles. The crew was greeted by thousands of celebrants, and the Danish newspapers overflowed with praise: 'Denmark is No. 1 in Sea-exploration' (*Ringkøbing Amts Dagblad*, 30 June, 1930, as quoted by Poulsen 2013: 55).

On the one hand, then, a dogged pursuit of the elusive eel. On the other, a national celebration of scientific achievement. What to make of this story?

Eels and Dualisms: A Double Collapse

To get a handle on Schmidt's expeditions and the eels, it is instructive to consider the situation in terms of Pickering's 'disciplinary dualism.'

At the centre of Schmidt's research was a fundamental appreciation of the importance of hydrographic factors for understanding the life history and distribution of fish populations. The fact that the 'same' eel is found everywhere between Iceland and Egypt and that it lives in both fresh and salt water would be explained with reference to temperature gradients, salinity and currents. This, then, was oceanic science, fully embedded in the natural world. Evidently, eel research was funded due to the importance of the species for Danish fisheries, and it was hardly displeasing to Schmidt to be showered with media attention. Nevertheless, these dimensions were clearly separated from the research core. Carlsberg funding enabled the research, fame followed, perhaps alongside practical implications for maintaining viable eel fisheries but, at the level of scientific questions, such 'social dimensions' played no significant role.

Disciplinary dualism is plainly evident in popular descriptions and celebrations of Schmidt's scientific life, written by students and colleagues. His privileged social

position within the Carlsberg dynasty is simply a fortunate backdrop, not remarked upon. Instead, the story centres on the serendipitous catch of a single glass eel, which set the scene for a lifelong and worldwide scientific pursuit. The vastness of this quest is dramatised through comparison with the tininess of its object, as in Anton Bruun's (1947: 160) comparison of the search for eel eggs in the world's largest oceans with finding a needle in a haystack.⁵ After three decades of sampling 5,000 locations from the Faroe Islands to Samoa, Schmidt had collected 20,000 specimens though still no eggs. His unparalleled determination, clear vision and scientific acumen had, however, enabled him to solve many of the eels' mysteries. As for those mysteries themselves, they were, again, plainly 'natural' ones.

Among numerous accomplishments, Schmidt had traced the voyages and development of the eels from the Sargasso to the European rivers and back, and he had identified hydrographic parameters crucial for eel survival. His comparative studies of eel populations' genetics showed as the sole representative of marine biology in Ernst Mayr's (1942) 'modern synthesis' of evolutionary theory (Sinclair 2010). And when the German geologist and polar explorer Alfred Wegener developed his controversial theory of continental drift, he used Schmidt's research to tie together the movements of eels with those of tectonic plates (Poulsen 2016: 419). Eels had originally bred close to the shore, Wegener extrapolated, but their journeys had very slowly lengthened as the continents separated.

Not surprisingly, this 'natural' emphasis contrasts starkly with the image of maritime research expeditions emerging out of social science. For the marine historian Bo Poulsen (2013, 2016), Johannes Schmidt is important because he was one of Denmark's earliest and most successful fundraisers. Prior to the Oceanographic Expedition around the World 1926–1930, Schmidt went on trips to the United States in search of potential benefactors (Poulsen 2013: 58), and he obtained 600,000 Danish crowns, the equivalent of 60 years of his own salary, from Carlsberg. His expeditions are thus a precursor of today's big science, and Schmidt himself prefigures an emergent type of scientific subject situated halfway between researcher and entrepreneur. From this perspective, Schmidt's privileged social position within the Carlsberg family is evidently central rather than peripheral.

Poulsen also emphasised Schmidt's role as an innovator in scientific communication. For the 1920–21 *Dana* expeditions, he brought along a camera to share footage with funders and the public. He often appeared on the radio and willingly featured in Danish periodicals. For the world expedition, he used a wireless telegraph to send updates and greetings back to the Danish public, and *Dana* organised public screenings of Danish life and the work of the expedition in harbour cities across the world. The expeditions thus exemplify evolving forms of scientific nation-building mediated by communication technologies (see also Nielsen 2010: 95). It is not coincidental that so many excited Danes turned out when *Dana* returned to Helsingør as 'no. 1 in sea exploration.'

More broadly, social scientists observe that the Second World War, maritime expeditions took place in a changing

postcolonial context (Nielsen 2010). Schmidt's first trip to Koh Chang had been enabled by the Danish military presence in Thailand. Years later, he strenuously opposed the sale of the Danish West Indian islands to the US, since they provided a unique workspace for Danish natural historians. Meanwhile, local people encountered across the planet, if mentioned at all, are described as passive facilitators, cooks of weird dishes, or clumsy helpers (Bruun 1961; Winge and Tåning 1947). Ahead of their time in terms of creative resource mobilisation, media strategies and the use of new technologies, the maritime scientists were evidently very much of their time when it came to social relations and imaginaries.

These social studies are pertinent and raise many important questions about science in a quickly changing world. It is clear, however, that their points of emphasis are, precisely, 'social.' In a more or less direct reversal, the 'natural' questions that mattered to the maritime scientists and their biographers are backgrounded as a different set of interest take front stage. As the ocean world becomes the canvas *upon which* new socio-political and technological conditions for conducting maritime science emerge, disciplinary dualism is firmly maintained.

Since the *Dana* expeditions a great many things have changed. While coupled becomings have been with us all along, Schmidt obviously had no way of predicting that the hydrographic factors he so carefully described would start changing rapidly in the 1970s. While the eel had successfully adapted to ever-longer journeys to their spawning grounds (on account of continental drift), they presently seem unable to cope with much faster human-induced changes. Across the planet, eel populations are in free fall, threatened with extinction. Current understandings of the mutual interlocking causes of this changing ontological situation are a consequence of gradually transformed and infrastructurally expanded horizons of knowledge.

If one harbours any lingering doubts about the limitations of disciplinary dualism, they ought to be dispelled by the 'great acceleration' (Steffen et al. 2015). Long ago, Wegener made the then surprising conjecture that the lives of eels may be related to plate tectonics. In the Anthropocene, eels are still tied to geology. Humans, alas, have become geological forces. While critics of the Anthropocene rightly insist on the destruction wrought by capitalist and colonial projects, the dualist premise upon which their critiques rest appears increasingly dubious.

It is relevant, at this point, to ask how scientists—social scientists included—came to *know*, and to practically unanimously *agree*—that the momentous changes referred to as 'the Anthropocene' have, and are, occurring. The answer is that knowledge about such things as planetary thresholds, changing ocean patterns and the global situation of eels, has been enabled by the gradual build up of planetary scientific infrastructures, physical as well as virtual. Over the last century, the gradual construction of what can be called Anthropocene knowledge infrastructures made it possible to bring together dispersed bodies of data, and thus to gradually elicit the coupled becomings driving global change, as

well as their nefarious consequences. In his own small way, Schmidt, too, contributed to the toolbox of Anthropocene infrastructure through his advocacy for 'large-scale multidisciplinary surveys to investigate population dynamics of fish species' (Sinclair 2010: 4).⁶

Today, the disjunctive relation between eels and global warming assumed by Pickering has thus been replaced with a conjunctive relation, in which eels and many forms of global environmental change—warming included—are ontologically entangled. As disciplinary dualisms collapse, it is possible to detect emerging figurations of the Anthropocene eel.

The Anthropocene Eel

In 2006, *Galathea 3* set out from Danish shores. In the national media, scientists described the expedition as following in Schmidt's footsteps. Hopefully some of the eels' remaining riddles would be solved. The context, however, had changed radically. While eels, in Schmidt's time, had been plentiful—and a mainstay of Danish cuisine—they had become rare and expensive. While *Galathea 3* was depicted as epistemologically continuous with earlier endeavours, the significance of the expedition was thrown into stark relief by ontological discontinuity. Its populations having declined by more than 90 per cent since the 1970s, the eel has landed on the International Union for Conservation of Nature (IUCN)'s list of critically endangered species.⁷

Using cutting-edge equipment, *Galathea* researchers would collect eel larvae and analyse their distribution relative to currents, salinity, temperature and depth—the hydrographic factors identified by Schmidt. Eel eggs would be collected. Lurking in the background, as always, was the hope of capturing mature spawning eels. The expedition would also contribute to a large-scale database of eel DNA sequences, and larger specimens would be tagged with experimental pop-up marks capable of registering light, depth and temperature. They would be released at a set time, drift to the surface, and start transmitting data to satellites.⁸

Galathea 3 did indeed generate knowledge about a variety of topics including oceanic spawning migration (Aarestrup et al. 2009) and panmixia in the Sargasso Sea (Als et al. 2011). The expedition did not, alas, find the eel egg. It also did not directly connect with the changing ontological configuration of the eel. Fomenting among the community of eel researchers, however, various studies and ideas now coalesce around what can be called an Anthropocene eel.

The steep decline of worldwide eel populations has been explained by a range of interlocking factors and processes, from declining water quality and habitat loss to new diseases, large-scale river modifications and changing ocean conditions. Researchers have identified a whole series of ramifying ecological consequences. The collapse of freshwater mussels in the Susquehanna River basin, for example, is explained by the fact that the mussels have become unable to distribute along the river, since a cascade of hydroelectric dams prevents the eels on which they attach to swim freely. The disappearance of the

mussels, in turn, adversely affects water quality, as well as the ospreys, raccoons, herons and striped bass that feed on them (Prosek 2010). Traversing the supposed division between society and nature in multiple directions, these situations offer a vivid illustration of coupled becomings and multispecies entanglements.

In 2008, Bonhommeau et al. (2008) argued that an unintended consequence of the well-established fact of *direct* human harm to eels—via overfishing and habitat destruction—was that too little attention had been paid to *indirect* anthropogenic damage due to changing climatic and oceanic conditions. Recent studies, however, make explicit connections between the fate of the eel and climate change. In 2012, Daverat et al. (2012) examined the detrimental effects of global warming on eel growth over the last century. The evocatively subtitled ‘Survival of the Fattest’, Belpaire et al. (2009) invoked the relation between eel populations and food availability in spawning areas. Since global eel populations have dwindled in tandem with changing Pacific and Atlantic temperature regimes over the last decades, however, it now appears that food availability is linked to changing climatic conditions. The eel decline emerges as an effect of heterogeneous and massively distributed processes and relations.

Indeed, a 2018 paper subtitled ‘Freshwater eels as a symbol of the effects of global change,’ pointedly depicts eel decline as an Anthropocene syndrome, resulting from several interlocking causal series (Drouineau et al. 2018). Changes in oceanic conditions negatively impact larval survival, as does the fragmentation and loss of habitat. These issues intersect with threats due to the impact of commercial and recreational fisheries at all stages of eels’ lives. Ocean pollutants make matters worse, as the fatty tissues eels need to survive their long journeys (survival of the fattest, remember) now store contaminants, and weakened eels lose out against parasitic nematodes. Each of these ‘coupled becomings’ are described as emergent consequences of the Anthropocene ‘great acceleration’ (Steffen et al. 2015). The interlocking series of elements join in a destructive assemblage, which threatens to overwhelm the adaptive capacity of eels.

As befits a publication in *Fish and Fisheries*, the article by Drouineau et al. (2018) concludes with practical management implications. Further improvements in knowledge infrastructures and monitoring systems will be crucial, and coordinated international responses are necessary to act ‘act on each source of anthropogenic pressure’ (Drouineau et al. 2018: 14). Since some problems, like changing climate regimes, are basically impossible to mitigate, even stronger compensatory efforts are needed in other areas like overfishing, pollution and river modifications.

However, the authors do not seem to invest too much hope in these proposals. While the eel has survived enormous changes over millions of years—from ice ages to continental drift—it is depicted as unable to cope with the disruptions of five decades of ‘great acceleration.’ The ‘cumulative effects of global change,’ they conclude, ‘can lead to the collapse of species, even in species that have amazingly high adaptive capacities’ (Drouineau et al. 2018: 1). Temporal emergence indeed.

Genres bend and blur as elements of requiem vie with scientific findings and practical recommendations in the conclusion. Confronted with the observation that ‘the rate of change during the Great Acceleration in the second half of the twentieth century was too fast for the adaptive capacity of the eel’ (16), the reader experiences a sense of jumbled temporalities, as if the still-living eel is *already*, virtually gone. As conventional forms of detached exposition appear increasingly unable to express the magnitudes of destruction, and unsatisfying for expressing their affective charge, the emergence of new forms of scientific writing may be another Anthropocene syndrome.

We are brought back to urgent questions of response, critique and propositions.

New Propositions for an Age of Extinctions

This story has covered a century of obsessions with eels, their fortunes and their elusive eggs. Due to a complex series of coupled becomings, eels that used to be so plentiful that they were seen as vermin (Drouineau et al. 2018: 16) are now on the verge of extinction. In consequence of global environmental change there are far fewer eggs to search for. The story thus illustrates a distinctive Anthropocene effect: the acceleration of coupled becomings and temporal emergence with uncontrollable, but generally destructive, consequences. It also raises difficult questions about the relation between emergent knowledges, ontological politics and slippery objects of critique.

Today, the contours of climate trajectories are generally known. This knowledge has been enabled by painstakingly constructed global scientific infrastructures conjoined with innumerable forms of scientific practices over several decades. Current maritime expeditions hook up with entities inconceivable at the time of Johannes Schmidt: global databases of DNA sequences, a vast range of advanced technologies and satellites circling the planet.

Globally distributed infrastructures and knowledge practices articulate the decline of eels as resulting from vastly heterogeneous coupled becomings—involving everything from parasites to dam cascades and the global spread of sushi—and unfolding at multiple spatial and temporal scales. Meanwhile natural scientists have also become increasingly cognisant of, and interested in, the diversely articulated socio-cultural and cosmological importance of the eel for many people across the planet (Tsukamoto and Kuroki 2014, see also Prosek 2010). Here, arguably, are openings to extend Kyle P. Whyte’s (2018: 7ff) indigenous science fictions and counterfactual dialogues into the natural sciences, making them integral to the creation of new propositions. Disciplinary dualism, in any case, seems increasingly untenable.

It also shows signs of collapse from within the social sciences. Prior to the advent of the Anthropocene, Andrew Pickering’s (1995) mangle of practice and actor-network theory both illustrated this tendency. Today, their pioneering efforts have been complemented by a range of approaches—from multispecies anthropology and various ontological turns (Jensen 2017) to new materialisms and speculative realism that, significant differences aside, all

orient to the non- or more-than human. These approaches, however, are in no way unquestioned. As exemplified by Chandler's engagement with 'ontopolitics,' many scholars fear that social science is recklessly abandoning its critical spirit at the very threshold of climate catastrophe when it will be most needed.

Confronted with the likelihood of terminal eel decline, it is indeed hard not to feel that something has gone badly wrong. Marvelling at temporal emergence, obviously, will not ameliorate the loss of extinction. Yet, the story of the eels also indicates that the capacities of critique may be waning.

As noted by Judith Butler (2001: 1), critique requires a specific target: a practice, discourse or episteme. From within the modern horizon of disciplinary dualism it has proven relatively easy to identify such targets. While numerous sciences busily document unfolding Anthropocene trajectories and events, critical social science has taken aim at the agents and processes that caused them. And indeed, their specification of the causes of climate disruption in socio-political and economic terms makes plainly evident several of the Anthropocene's blind spots (or, as the critics argue, fundamental flaws). Conversely, however, a deeply embedded disciplinary dualism makes the same critiques unable to conceive of their own objects and categories—like the modern corporation, the Western state, or the neoliberal subject—as *themselves* contingent and still changing effects of coupled becomings. Meanwhile, paradoxically, the same reliance on disciplinary dualism disables critical approaches from fully grappling with the very ontological entanglements that presently threaten so many entities. The critical targets are turning out to be as slippery as the catastrophically entangled eel.

Critique, for Foucault, was about exposing the unnoticed limits of an epistemological horizon in order to open new possibilities for an 'arts of existence.' At this moment, when climate disruptions make daily headlines it is necessary to relocate this still tantalising idea from epistemological to ontological territory. For eels, after all, are not only changing as objects of knowledge. If the probability that they will experience a new art of existence presently seems so slim, it is because the very grounds and conditions of that existence—the oceans, rivers and, indeed, their bodies—have been *ontologically* modified. To make sense of the weird, dangerous entanglements that threaten species and ecologies, Anthropocene knowledge practices will have to locate themselves firmly *in the zone* of coupled becomings. Thus, we find ourselves in a new situation, even if only relatively so. Ontological entanglements have been with us all along, but their presence is now more keenly felt, and their consequences more threatening. The Anthropocene requires new propositions: lures for feeling that take care of what may still be possible, even against the background of increasingly likely catastrophe.

It might be said that scholars attuned to hybridity and coupled becomings—like Pickering and Latour—were early developers of propositions that enabled social researchers to tune in to such situations in the first place. Yet, these controversial propositions were often oriented

inwards, towards or against other social theories, from social construction to critical theory. At this moment, it is necessary to experiment with turning propositions *outwards*: to engage in the difficult task of imagining and constructing different entanglements. If that aim is not critical in any conventional sense, it is certainly also not celebratory. Precisely *because* propositions increasingly have to be articulated in grim contexts with catastrophic potentials, however, the aim of new propositions has to be the making of space for creating livable multispecies practices and futures.

Here it becomes possible to envisage a relation to critique in its original form, which, as Wendy Brown (2005: 19) noted, was concerned with making distinctions in a context of crisis. A time when entities, like eels, for example, are in a *critical condition*. Such threshold situations and conditions emit, Brown argued, an 'urgent call for knowledge, deliberation, judgment, and action to stave off catastrophe' (2005: 20). Perhaps not unlike the silent screams of eel researchers, as they gradually move from the comfort zone of disciplinary dualism into discomfiting spaces characterised by the unpredictability of ontological becomings.

New propositions, then, give tentative form to things still amorously becoming, indistinct, perhaps barely thinkable, but in decidedly, ontologically critical, states. Lures for feeling in a threatened, threatening world. To keep open possibilities for multispecies arts of existence. Even in the Anthropocene.

Notes

¹ Thus, there are crucial differences between the by now conventional notion that social and environmental factors—conceived as belonging to fundamentally different domains—must be *linked* or *brought together*, and the emphasis on coupled becomings, which views entities as *constitutively composite* and thus neither natural or social/cultural. At the same time, there are evident differences between *forms* of non-dualist analysis that examine how diverse people understand their relations with nonhuman entities, on the one hand, and from those concerned with how such entities are mutually transformed over time, on the other. While the latter distinction does not, in my view, entail any necessary incompatibility, and these studies are often resonant, their specific emphases and orientations are often significantly different (see also Jensen 2015).

² The following descriptions are primarily drawn from secondary sources, centrally the 1947 volume *Naturforskeren Johannes Schmidt: Hans liv og ekspeditioner—skildret af venner og medarbejdere* [The natural scientist Johannes Schmidt: His life and expeditions—portrayed by friends and colleagues] (Winge and Tåning 1947). They also rely on descriptions by his younger colleague Anton Bruun (1961) and later characterisations by scientists (e.g. Sinclair 2010) and historians (Poulsen 2013, 2016).

³ Biologisk Station was a marine biological research station established in 1889 to produce knowledge useful for Danish fisheries.

- ⁴ Later eel researchers argue, however, that Schmidt's data was insufficient to draw this conclusion (Prosek 2010).
- ⁵ Not to be outdone, the project description of the Danish *Galathea 3* expedition compared the task of finding an eel egg in the Sargasso to finding 'a hundredth of a needle in a haystack.' The availability of improved equipment, it was hoped, would make the task feasible. Still, no eggs were found in 2007 either. See <http://www.galathea3.dk/dk/Menu/Forskning/Den%2Beuropæiske%2Bål/Projektbeskrivelse/Fiske%2Befter%2Bgydende%2Bål%2Bi%2BSargassohavete8ac.html?Print=Article> (Consulted 7/1/2019).
- ⁶ Meanwhile, it is notable that Å. Vedel Tåning, who edited the memorial to Schmidt's life and work, described Schmidt himself as 'an endangered species'. His freely roving interests and regularly changing self-definitions (botanist, zoologist, physiologist, geneticist, oceanographer), Tåning (1947b: 174) wrote, were becoming rarer due to scientific over-specialisation. From this perspective, Schmidt's career appears analogous to that of Alexander von Humboldt, who simultaneously embodied an earlier mode of scientific knowledge production (the individual scientific explorer of natural history) and helped render it obsolete through the scientific infrastructure he built (Morita 2017).
- ⁷ See <https://www.iucnredlist.org/species/60344/45833138>.
- ⁸ See <http://www.galathea3.dk/dk/Menu/Forskning/Den%2Beurop%C3%A6iske%2B%C3%A5l/Projektbeskrivelse/Opklaring%2Baf%2B%C3%A5lens%2Bvandringsrute%2Bog%2Bgydepladsen%2Bved%2Bhj%C3%A6lp%2Baf%2Bpop-up%2Bsatellit%2Bm%C3%A6rker.html>.

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The author has no competing interests to declare.

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