Spiralling Out of a Shell: Fictioning More-Than-Machine Listening

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This article critiques the anthropocentric tendencies in machine listening practices and narratives, developing alternative concepts and methods to explore the more-than-human potential of these technologies through the framework of sonic fiction. Situating machine listening within the contemporary soundscape of dataveillance, the research examines post-anthropocentric threads that emerge at the intersection of datafication, subjectivation and animalisation. Theory and practice interweave in the composition of a music piece, The Spiral, enabling generative feedback between concept, sensation and technique. Specifically, the research investigates the figure of a mollusc bio-sensor between science fact and fable, as the (im)possible locus of musicality. This emergent methodology also offers new insights for other sound art and music practices aiming to pluralise what listening might be.

SPIRALLING OUT

> the question in music is that of a power of deterritorialization permeating nature, animals, the elements, and deserts as much as human beings. … human beings are hardly at an advantage, except in the means of overcoding, of making punctual systems. … nature opposes its power, and the power of music, to the machines of human beings, the roar of factories and bombers. (Deleuze and Guattari 2013: 360)

Today, the question of music is entangled with that of machine listening[1] within a more-than-human ecology of sound, to the extent that they are both situated in the convergence of proliferating apparatuses of datafication[2] and post-anthropocentrism. Musical experience is almost unavoidably processed by the mechanisms of surveillance capitalism, capturing the behaviour of human and non-human lives as data (including music-making/consuming) in order to produce economic surplus through feedback loops of behavioural prediction and modification (Zuboff 2019). Under these conditions, perception and datafication are co-constituted, 'troubl[ing] rigid boundaries between machine and human listening' (Amsellem 2024: 28), which in turn troubles the notion of music defined as exclusively human. At the same time, listening machines seem to be indifferent to the human as exceptional, since they are equally applied to

[1] A variety of AI methods applied on data extracted from sound or audio.
[2] Datafication is the process of sense-making through the capture and analysis of various aspects of life as digital data. For more on datafication in relation to dataveillance and the ideology of dataism, see Van Dijck (2014).

Organised Sound **29**(03) © The Author(s), 2024. Published by Cambridge University Press. doi:10.1017/S1355771824000244

datafying animal behaviour through sound (Lupton 2023: 82). In this way, they are part of a post-anthropocentric gesture which 'displaces the notion of species hierarchy and of a single, common standard for "Man" as the measure of all things' (Braidotti 2013: 67). As posthumanist philosopher Rosi Braidotti points out, today 'no animal is more equal than any other, because they are all equally inscribed in a market economy of planetary exchanges that commodifies them to a comparable degree and therefore makes them equally disposable. All other distinctions are blurred' (ibid.: 71). In this sense, Jeremy Bentham might have been right to predict a time 'when humanity will extend its mantle over everything that breathes' (Bentham cited in Cimatti 2020: 187), except that he missed the part where humanity itself (defined in terms of a double negation: non-non-human) is dismantled. The world of machines, thus, contains the possibility of dissolving the boundaries between human listening and animal hearing, allowing us to think of hybrid, more-than-human ways of being in sound.

How could we approach the question of musical listening beyond the binary of nature/culture, attending to 'animals [that] qualify as cyborgs, that is to say as creatures of mixity or vectors of posthuman relationality' (Braidotti 2013: 73)? Let us think of a real creature, half animal half machine, that motivated the research presented in the following pages: a mollusc bio-sensor (Distributed Sensing Systems Group 2020). To produce the 'best oyster' for human consumption, farmers in Tasmania have designed cyborg oysters with implants of digital sensors, aiming at optimising their production by correlating the creatures' biometric data with the environmental data (Lupton 2023: 87–8). While this method is remarkably close to the science fiction (SF) of the past – particularly the 'super-mollusc' produced by the fusion of computation and biology, imagined by Vilém Flusser in 1988 (Flusser 2011: 144–5) – it is equally relatable to today's human society, as it appears that 'a happy oyster is a big-data oyster' (Rutkin 2014). The figure of this humanised machinic mollusc is conducive to what Donna Haraway refers to as SF, a method of (un)making 'multispecies' worlds through the entanglement of speculative fabulation and science fact (Haraway 2016: 2–3). In her recent work, the scope of SF consists of 'science fiction, speculative fabulation, string figures, speculative feminism, science fact, so far' (ibid.: 2–3). The present research attempts to link Kodwo Eshun's methodology of Sonic Fiction with SF, to develop a critical, post-anthropocentric approach to machine listening.

Sonic fiction is a theoretical framework developed by Kodwo Eshun's investigation of 'an unofficial mythology' of 'the machine as a lifeform', situated in the twenty-first century 'discontinuum of AfroDiasporic Futurism', 'oppos[ing] common sense with the force of the fictional and the power of falsity' (Eshun 1998: A[179], A[189], 00[-003]). It is a potent framework for approaching the post-anthropocentric *conceptechnics*[3] of machine listening, through the method of *sonic thinking*. Traced by Holger Schulze, this way of thinking *with* and *by means of* sound works through the tripartite structure of *mixillogic*, *mythscience* and *mutantexture* (Schulze 2020: 19–22). The first term signifies the kind of logic characterised by 'joyful transgression' that is made 'out of mixtures' and 'applies steps in thinking that would not be regarded adequate in scholarly logic' (ibid.: 21). It is a logic that, contrary to common sense, is adequately equipped for the transversal terrain of the posthuman. Coined by Sun Ra, the second term is described as 'a new and apparently mythologically structured or grounded kind of scientific knowledge', with the capacity of going against reductive traditional epistemologies (ibid.: 19). In relation to the problem of control posed by contemporary networks of surveil- lance and datafication, Simon O'Sullivan develops mythscience as a practice of *fictioning*, where art is mobilised as a form of resistance against the contemporary homogenisation of subjectivity (O'Sullivan 2014, 2016). The third term describes the effect of the other two, that is, a material

[3] The term 'conceptechnics' appears in the work of Kodwo Eshun, emphasising the co-constitution of concept and technique in the realm of sonic fiction, where 'producers are already pop theorists' (Eshun 1998: 00[-004]).

doi:10.1017/S1355771824000244

sonic trace of 'a diffracted logic', productive of more expansive auralities and plural possible worlds (Schulze 2020: 21, 35–40). Thus, sonic thinking allows us to listen in the present mytho-techno-scientific reality, seeking for alternate logics as points of access to sonic (im)possibilities. What follows is a critique of the homogenising conceptechnics of machine listening through a process of fictioning, engaging with the sonic thinking that unfolds around the figure of the mollusc bio-sensor as a locus of a malacological mythscience[4]. This involves the development of a molluscan mixillogic applied in the composition of a more-than-music assemblage, productive of molluscan mutantextures.[5]

ANTHROPO-LISTENING MACHINES

The idea of a listening machine is not at all new to music.[6] Most tech-friendly artists (or even consumers) are routinely in contact with machines that are listening in one way or another, although there is little consensus among researchers and practitioners about the definition of machinic listening (Sterne 2022). A pragmatic definition of machine listening would be a digital system that involves the extraction of meaningful data from audio streams and its insertion into machine learning as input data and/or training sets. However, even though more subtle definitions diverge widely, there seems to be a consensus when we look at the presuppositions within discourses that justify various design and development trajectories.

One of the earliest uses of the term 'machine listening' appears in the work of the musician and engineer Robert Rowe (Stern et al. 2021: 25:54). In his seminal study on computer music, *Interactive Music Systems*, he states that we should 'follow the example of human cognition in building a machine listener [because] *humans provide the best, indeed the only, model of successful music listeners* [and thus, the music produced] will resonate with the human cognitive processes for which it is ultimately intended' (Rowe 1993: 119; emphasis added). This claim to human exceptionalism in relation to music recur like a refrain in various definitions of machine listening until today. For instance, Michael Casey writes in the *Oxford Handbook of Computer Music* that 'an important area of research in the last decade or so has been machine listening; the goal is to make computer systems that are capable of humanlike hearing and decision making' (Casey 2011: 450). Andrew Hugill defines them as 'models of the [human] auditory systems' adding that 'there remains a major challenge in achieving a machine listener that "understands" the causal way in which human beings hear in real time' (Hugill 2019: 26). Finally, Thor Magnusson claims that:

> with machine listening [and other relevant developments] our machines now have ears that serve as extensions of our own; ears that can hear better and more than we do, informing us in ways that can be extremely helpful. However, to hear sound and to understand sound are not the same, and we have yet to reach a stage where machines exhibit general musical perception on par with humans. (Magnusson 2019: 157–8)

[4] Malacology is the branch of zoology that studies the phyllum Mollusca.

[5] The mutantextures exist in multiple forms, including new heuristic concepts that will appear throughout the text, as well as a music composition titled *The Spiral*. The latter exists as a score for piano and a max patch. The reader may access a live recording of the piece, performed in London, at the New Lights Festival 2023 (Cury 2023).

[6] As Parker and Dockray point out, 'History is full of references to "listening machines", to describe things like ear trumpets, phonautographs, phonographs, spectrographs, and "listening typewriters," [but] the use of "machine listening" to suggest a new, specifically machinic form of listening, rooted in the techniques of information theory and digital signal processing, seems to arrive only in the 1990s, starting in computer music' (Parker and Dockray 2023).

doi:10.1017/S1355771824000244

Instead of a search for novelty, innovation and the affirmation of difference, the history of machine listening reveals a tendency to reproduce a presupposed ideal model of human listening, even though it is very hard to determine this model in the first place. The Aural Diversity project has effectively deconstructed this normative listening experience, which has been the ground of most of the acoustic design in Western societies, despite being at best a reductive and exclusive fiction (Drever and Hugill 2023), or an 'analytic fact of Nobody' (Deleuze and Guattari 2013: 123). Furthermore, Jonathan Sterne points out that a problematic and anthropocentric notion of *listening* is a common ground for most of the debates around machine listening, adding that currently 'machine listening is intimately connected to corporate attempts to enclose more and more domains of human interaction, and to state surveillance and authoritarian projects in many parts of the world [and thus] any theory of the listening in machine listening needs to also be a theory of power' (Sterne 2022: 3). This resonates with the collective research project *Machine Listening, a Curriculum*, which defines machine listening as 'much more than just a new scientific discipline or vein of technical innovation ... It is also an emergent field of knowledge-power, of data extraction and colonialism, of capital accumulation, automation and control', developing into a political field that 'demands critical and artistic attention' (Dockray et al. 2024). The present research follows precisely these lines into the discourse and practice of machine listening, by considering the 'listening machine' simultaneously as another machine: the biopolitical apparatus described by Giorgio Agamben as the *anthropological machine*.[7]

In *The Open: Man and Animal*, Agamben develops his theory of *anthropogenesis*, the production of the Western notion of the (hu)man, as the result of 'a caesura and articulation between human and animal', where 'Man suspends his animality and, in this way, opens a "free and empty" zone in which life is captured and a-bandoned {ab-bandonata} in a zone of exception' (Agamben 2004: 79). Agamben describes this process of distinction between the human and the non- human as the anthropological machine and calls for critical attention: 'We must learn instead to think of man as what results from the incongruity of [the human and animal], and investigate not the meta- physical mystery of conjunction, but rather the practical and political mystery of separation. What is man, if he is always the place – and, at the same time, the result – of a ceaseless division and caesurae?' (ibid.: 16). In short, his analysis defines the anthropo- logical machine as an evolving process of exclusion. Each iteration or assemblage of the anthropological machine produces the propriety of the human by proposing a critical characteristic for the judgement of human nature. Agamben primarily focuses on language as one of the most consistent characteristics that have been sustaining this distinction. He investigates the figures of the *Pithecanthropus Alalus* (literally translated as the 'speechless ape-man'), whose existence is demarcated right outside the evolutionary threshold of the 'speaking man' (ibid.: 34), and the *Homo Ferus*, a name given to the *enfants sauvages*, human-born children grown up among animals in the eighteenth century. Their muteness (due to their linguistic lack) and facelessness (as they may not have walked on two legs, thus concealing their head), excluded them from the species *Homo Sapiens* (ibid.: 30). This time, in reverse, we see that the anthropological machine turns into a listening machine – the *anthropo-listening machine* – as it has an ear for the silence, muteness and illegibility of bodies, only to draw an anthropogenetic line around the human through the exclusion of everything else.

[7] Giorgio Agamben is a contemporary Italian philosopher, associated with the study of biopolitics. His thesis is rooted on the distinction between bios (political 'human' life) and zōḗ (animal life) as a (or the) fundamental political question. The 'anthropological machine' – the structure that re-iterates the distinction between humanity and animality – appears in his work *The Open: Man and Animal* (Agamben 2004: 33–8, 79–80). In the context of the current research, the notion is expanded by more recent debates of the political ecology of Man; by considering that 'He has a gender, a race, a religion, a theory of property and an idea about self', and by acknowledging that 'His effects are not limited to His class, race, and gender', cascading into intersecting forms of violence on de-humanised bodies (Tsing 2016: 3).

doi:10.1017/S1355771824000244

In our times, narratives and practices of AI, including machine listening, play an important role in sustaining such mechanisms of exclusion. There are numerous cases where the 'black boxes' of neural networks have (re)enacted unacceptable biases (Hern 2018) while critical attention has been aimed at the violence and perils these biases might entail (McQuillan 2022). Following the case of language, it seems that AI easily slips into an anthropological exclusion based on Intelligence – or the kind of behaviour it is designed to simulate in each iteration – as the defining characteristic of the human. Contrary to these anthropocentric narratives of artificial intelligence, the artist, writer and technologist James Bridle sees the potential of a more-than-human and critically ecological approach to these technologies, for attending to the plurality and diversity of the planetary intelligence(s) defying anthropocentric boundaries. In *Ways of Being*, Bridle shows how 'intelligence is ecological – that is, entangled, relational, and of the world', which in turn implies that 'artificial intelligence provides a very real way for us to come to terms with all the other intelligences which populate and manifest through the planet' (Bridle 2023: 57). Could we extend this view to AI ways of listening?

Despite Rowe's assumption that 'musical listening' is exclusively human, there is a plethora of sonic artefacts and mutantextures that testify to the workings of transversal musical sensibilities and mixillogics that put to question the human exceptionalism associated with musical listening. The work of Florian Hecker, among others, exhibits machine listening's capacity for de-centring the rigid model of the human – upon which the anthropological machine relies – from the potentialities of musical listening. Iteratively moving between analysis and synthesis, Hecker interrogates state-of-the-art machine listening technologies, attempting 'to open a dialogue with these spectral operators ... in order to render audible their intelligence signature, the signal trace of their nonhuman brain-ear' (Hecker and Kronic 2021: 57–8). Through this process, described as 'synthetic listening', Hecker's work attempts to reach the aesthetic dimension of sonic phenomena that 'no human listener would ever happen upon' (ibid.: 63). The idea of the brain-ear, developed by the philosopher and Hecker's collaborator Maya B. Kronic, is premised on viewing the human sensorium as a 'patchwork' (Kronic 2015), akin to a machinic assemblage, or 'agencement', where the human is always entangled and potentially inseparable with non-human entities and events (Miyazaki 2012). Diving into Hecker's sonic fiction, the figure of the *chimera*[8] appears in a variety of pieces and forms that 'the listener must reconstruct as a unified yet impossible synthetic creature' (Kronic 2015). The impossibility of Hecker's sonic chimeras can range from the mostly unintelligible *Articulação* (2014), to the machinic 'intelligence structure' that produced *Synopsis Seriation*, which 'does away with [the former] staging of computer-generated speech [in favour of dramatising] synthetic sound in all its unnameable intensities' (Hecker 2021b). The mutantexture that emerges from Hecker's chimeras has entered the AI terminology under the label of the 'templetexture': a notion that 'calls for machine listening systems that do away with any recourse to "coarse" semantic labelling', by amplifying the humanly imperceptible incongruences between semantic machine listening, auditory neurophysiology, and sonic processes of texture synthesis (Hecker and Kronic 2022).

Apart from the audible content, the chimera can be adequately used as a metaphor for the listening subject encountering Hecker's sound-worlds – some to which 'only machines can listen' (Hecker 2021a). Given the understanding of the human sensorium as a patch- work that remains integrated enough to produce a coherent, intersubjective 'image of the world, and of the subject that inhabits it', Kronic proposes that 'it is also possible to engineer circumstances in which this

[8] A chimera is a creature found in Greek mythology, defined as having a body typically composed of lion, goat and serpent parts. It has been widely used as a metaphor for organisms consisting of 'impossibly' heterogeneous components. It is also used in biology referring to organisms containing a mixture of genetically different tissues, which can be naturally occurring or artificially produced through methods such as fusion, grafting or mutation.

doi:10.1017/S1355771824000244

integration fails' (Kronic 2015). Counter to the aesthetic ideal of disinterested pleasure, Hecker's work (re)synthesises the listener through a 'non- integrable or disintegrated experience' (ibid.) – akin to what Deleuze would call the 'transcendental exercise of the faculties' – recognising its potential to break down the Kantian myth of the unified subject through aesthetic experience (Cox 2018: 212–13). As Kronic puts it, Hecker's work replaces the *auraltypical* subjects of psychoacoustics with 'a laboratory humanity ... populated by disintegrated and hallucinating subjects' (Kronic 2015). However, this approach runs the danger of producing a mode of listening that is too abstract (or not abstract enough), in the sense that it fails to condition the continuity required for more- than-human entanglements. Instead of a lab-logic approach to listening where the first step is to be 'isolated' (ibid.), the foundation for an ecological machine listening is radical relationality.

George Lewis offers an exemplary approach to machine listening, situated as a way of resisting 'dominant discourses and research directions in the field [of strong AI, as well as computer music, that] continue to assume a Euroamerican model of human subjectivity' (Lewis 2011: 461). His research shows how the 'human' model of machine listening is far from a neutral and natural term; but rather a term constructed through racialised power relations, relying on an exnominated whiteness (Lewis 2002: 99–103), or a 'white aurality' defined through the normalising exclusion of other possible sensibilities (Thompson 2017: 273–5; Schulze 2020: 61–5). Instead of relying on prefabricated notions of listening and musicality, his revolutionary *Voyager* (Lewis 2000b; Lewis and Mitchell 2019), realised in 1988, is a sonic experiment of how radically different creative intelligence can be, and how we could make sense with it (Lewis 2000a: 38). The answer is given through the sonic persona of the 'creative machine' and the 'Afrological' notion of improvisation. While resisting the privilege of its 'Eurological' counterpart, composition, this approach grants the machine a mode of listening capable of 'dialogic imagination', thereby offering great potential for disentangling the anthropo-listening machine (ibid.). Defined as the 'bidirectional transfer of intentionality through sound', emotional transduction offers a way to conceptualise the vibrant relationalities possible in a sonic 'technology-mediated animism', and differential musical processes of interactivity where the '[human] identities are continually conditioned and reinscribed' (ibid.: 36–8). In short, by emphasising the situated agency of machinic listening assemblages by inscribing 'values such as relative autonomy, apparent subjectivity, and musical unique- ness rather than repeatability', Lewis (2018: 127) shows us how to allow creative machines to teach us how to listen otherwise. The emergence of different 'synthetic' ways of listening is generative of a diverse Synthetic Acoustic Ecology (SAC) that might promote ways of being in sound on par with non-human others. Eldridge and Kiefer view such an ecology as a potent lingua franca for bridging empirical/theoretical, cultural/biological and artistic/scientific sonic epistemologies (Eldridge and Kiefer 2018). By promoting 'sonic situatedness' and 'sonic embodiment', they view the practice of building audio-based sonic worlds of interactive agents as a way of deepening our responsiveness to the soundscape's emergence. Their proposition for such a framework is primarily intended for monitoring and prediction applications, aiming for an ecological optimisation according to the premise that the 'soundscape structure is a proxy for ecological integrity', while warning us 'to avoid projecting *added reality* onto simulated models' (ibid.: 6). However, turning SAC into a predictive system of optimisation seems to contradict the former ambitions. In the words of the feminist technoscience researcher Thao Phan, 'while ostensibly oriented towards the future, in practice, predictive models operationalise the past. At their worst, these systems don't only perpetuate inequality but foreclose alternate possibilities for futures that do not conform to previous patterns and expectations' (Phan 2022: 54:36). In the case of SAC, this should remind us of immanent bias, to the extent that it exclusively assigns ecological relevance to certain actors and actions and not others. For instance, how would it include creatures that are silently affected by sound, if the sonic data only describe vocalisations? We can find an abundance of examples in the vastness of the ocean, where, apart from the usual

doi:10.1017/S1355771824000244

suspects of like-large-brained cetaceans, there is a plethora of creaturely sonic entanglements that are deemed mute by anthropocentric onto/epistemologies (Vermeij 2010). This does not mean that they should be excluded from the scope of a possible synthetic acoustic ecology, but rather we should learn from their strangeness and amplify our efforts towards attending our ears to the inaudible. Otherwise, the anthropological machine will keep feeding on the muteness of the sonically Other. Instead of exnominating the legitimising process of *pure data*, creative practice might offer more through sonic fiction precisely by actively and critically engaging with that *added reality*, since, according to Phan, 'our legitimacy is in our excess: our failure to align with the homogeneous technical standards' (Phan 2022: 01:06:37). Thus, a truly ecological listening might emerge through diffractive mixillogics rather than synthetic logics.

(DIS)MANTLED SOFTNESS

> [F]or the vertebrate to become an Octopus or Cuttlefish, all it would have to do is fold itself in two fast enough to fuse the elements of the halves of its back together, then bring its pelvis up to the nape of its neck and gather its limbs together into one of its extremities. (Deleuze and Guattari 2013: 297–8)

Having established the genealogical entanglement between machine listening and the anthropological machine, what follows is a 'strategic alienation' (Schulze 2020), or a process of *unbecoming* through sound, seeking ways of dismantling the anthropo- listening machine. Felice Cimatti, a contemporary philosopher who explores the possibilities of such an endeavour, writes that the first step is 'to be exposed to the animal's gaze', and the second is 'to accept the possibility of a transformation, contained in the animal's gaze' (Cimatti 2020: 96–103). In this case, the gaze is far from limited to an anthropomorphic vision; it 'has nothing to do with the eyes, but with the fact that something – something nonhuman or even inhuman – is staring at us, whether or not it has eyes' (ibid.: 96–100). In fact, the more surprising the gaze, the more effective the rerouting of the anthropological machine into *becoming-animal*.[9]

In Matthew Calarco's work on critical animal studies, becoming-animal is defined as 'a refusal to enact the ideals and subjectivity that the dominant culture associates with being a full human subject and to enter into a relation with the various minor, or non-dominant modes of existence that are commonly viewed as being "other" than human', while 'the animal often serves as the chief limit against which human propriety is instituted' (Calarco 2015: 57). The conditions capable of setting forth such a process are often described as 'zones of indiscernibility' (Deleuze 2017: 15–19), 'zones of intensity or proximity' (Deleuze and Guattari 2013: 319), 'zones of exception' (Agamben 2004: 79), or 'zones of indistinction' (Calarco 2015: 57). The latter is fundamental in Calarco's theory of 'indistinction' (ibid.: 48–69), where he explains how such zones produce a space for dismantling the anthropological machine, while challenging anthropocentric structures of power and amplifying the 'more-' that has been excluded from the

[9] (I found myself seated at a marble-like white table in a crimson-yellow lit space in the centre of London. The soft hum of conversation provided a soothing backdrop to the infinite reflections in the tilted mirrors that diligently covered the bare walls. In front of me lay a plate adorned with twelve oysters, their shells glistening in the dim light. After slowly manoeuvring the last plump mollusc through my mouth, all that remained was a strange landscape of ice, squeezed lemons, and rough, grey curvatures. I began exploring the textures of the shells with my fingers.
Upon the lush bed of ice, within the smooth and striated rhythms of a fully grown oyster shell, I was stunned to discover a baby oyster clinging patiently – still alive. Its miniature form, almost translucent, must have had escaped the chef's gaze, perfectly camouflaged in the fractal geometry. Intrigued, I carefully scooped it up with my finger, feeling the tiny creature attach itself to my skin with a tingly sensation. Now what? Freezing a stream of thoughts and questions about this slippery life-world, I awkwardly googled on my phone, my index finger too busy being gripped by the unexpected guest, searching for a method to rescue the little critter – needless to say, a failed attempt.)

doi:10.1017/S1355771824000244

notion of the human as described earlier (ibid.: 62–3). The capacity of listening, machinic or not, for opening such zones of indistinction is illustrated in Espen Sommer Eide's 'Exercises in Non-human Listening' (Eide 2019), where he speculates on music as becoming- mosquito. Fascinated by the way of hearing practised by the mosquitos he encounters in northern Norway, he envisions a musical instrument that can simulate the way mosquitos listen to each other.[10] Furthermore, he draws inspiration from the animism of the Yukaghir people, whose hunters 'lose themselves and become the animal completely', entering 'an in-between state, between the animal and the human' by embodying an 'imperfect copy' of that animal (ibid.: 30). More accurately, Deleuze and Guattari stress how this imperfect copy should not follow a logic of imitation or representation (Deleuze and Guattari 2013: 319), but one enters a zone of indiscernibility by allowing their body to 'enter into composition with *something else'*, and further, that 'this something else can be quite varied, and be more or less directly related to the animal in question', referring to the examples of the 'animal's natural food', its 'relations with other animals', or an 'an apparatus or prosthesis to which a person subjects the animal ... in question' (ibid.). In the case of becoming-mosquito, that something else is the 'distorted ghost tone' that enables the mating mosquitos to relate with each other into a 'tuning duet' (Eide 2019: 29). Such a process would reroute the anthropo-listening machine through which 'we pick out tonal signals and discard the noise' by composing as 'the mosquito tunes into the noise and discards the signal' (ibid.: 30). So, the third step for dismantling the anthropo-listening machine appears to be a matter of selection, of picking up and following the thread of difference (or 'something else') in relation to an animal.

In Gerard Raunig's work, *softness* is framed as a thread leading out of an exclusive, masculine subjectivity characterised by domination, appropriation and possession (Raunig 2024: 86–90). He develops softness as a way of relating through affections 'with all kinds of critters, with plants and animals, with technical apparatuses and thing-worlds', capable of producing subjectivities that go 'beyond anthropocentric perspectives' forming what he terms the 'human-machinic soft-ware' (ibid.: 90, 79). As he shows in a letter to Suely Rolnik, this notion of softness was already articulated by Felix Guattari in the question of becoming-animal, when the latter envisions a 'multiplicity of mutant becomings ... as so many ways of inventing, of "machining" new sensibilities, new intelligences of existence, a new softness' (Guattari 2011, cited with a slightly altered translation in Raunig 2022: 79) – or, a new softness between humanity and animality. Thus, the question of becoming-animal is already entangled with the properly *(malaco)logical* question of becoming-soft.[11] Could we then dismantle the anthropo-listening machine by composing with the 'gaze' of animals defined by their softness (molluscs)?

MEMORIES OF QFWFQ

In the work of Deleuze and Guattari, the question of becoming-animal is intimately linked with literary fiction, which offers methodologies for building routes of escape from exclusively 'human' ways of living (Burrows and O'Sullivan 2019: 25). In fact, an encounter with a fictional mollusc was the pretext for applying these questions in practical experimentation. During Italo Calvino's centenary (2023), I was asked by pianist Carolina Cury to compose a piece for piano

[10] 'The unique aspect of this is that these antennae do not pick up frequencies in the same way as our human ears do, by analysing the fundamental tones. Recent research shows that they are actually specialised in picking up what is called "intermodulation distortion", also called "subjective tones". These are distortions between tones that are introduced by the hearing organ itself' (Eide 2019: 29).

[11] Consisting of the Greek prefix 'malaco-', meaning 'soft', malacology refers to the study of the soft-bodied animals classified as molluscs. The added brackets represent the shell that often contains the soft molluscan body, creating the neologism (malaco)logic through a molluscan mixillogic.

doi:10.1017/S1355771824000244

and machine listening/synthesis,[12] based on Italo Calvino's *Cosmicomics* (2010). This collection of short stories, originally published in Italian in 1965 and in English in 1968, weaves a SF[13] cosmology propelled by the constant metamorphoses of the main character, Qfwfq. Each story starts with the presentation of a scientific factoid which is extrapolated into (im)possible worlds of more-than-human becomings. The music composition is titled *The Spiral*, after Calvino's homonymous story, which begins with the following passage:

> For the majority of molluscs, the visible organic form has little importance in the life of the members of a species, since they cannot see one another and have, at most, only a vague perception of other individuals and of their surroundings. This does not prevent brightly coloured stripping and forms which seem very beautiful to our eyes (as in many gastropod shells) from existing independently of any relationship to visibility. (Calvino 2010: 137)

Immersing myself in Qfwfq's molluscan experience, I was drawn to the paradoxical process where the molluscs produce sensations that are imperceptible to them, but nevertheless enable them to enter into meaningful and aesthetic relations with totally other entities. The metaphor employs the sensation of the image appearing on the mollusc shell and the sense of vision, which is not granted to molluscs by the scientific factoid. This process is an essential part of becoming-animal, described by Deleuze and Guattari in the parable of the orchid and the wasp, where the former forms an image of the latter capable of deceiving the male wasp into spreading the flower's pollen (Deleuze and Guattari 2013: 9, 278, 342). It is possible to interpret the 'image' in these two cases as a form of fiction that creates the conditions for a multispecies entanglement to enfold. Could we infer that the same is possible with sonic fiction?

This process is at work throughout the *Cosmicomics*, triggered by the unpronounceable name of the main character: Qfwfq. The SF novelist and critic Ursula K. Le Guin, unexpectedly [14]comments that 'one fault in [Calvino's] prose is its joky or satirical convention of unpronounceable names ... reducing [language] to the literally *unspeakable* symbology of mathematics' (Le Guin 2016: 161; emphasis added). Furthermore, she considers it as a flaw when 'that [language] game gets *chancy'* in the way that the reader articulates the sound and the text (ibid.; emphasis added). This gesture and the aesthetic judgement implied here can be read as an example of the anthropological machine: it appears caged in the binary of legibility/muteness, turning away from the zone of indiscernibility that threatens to disassemble the linguistic structure into creative *non-sense*, while it is this *non* that allows the reading body to momentarily escape the anthropological machine (Cimatti 2020: 177). Thinking back to the work of George Lewis which was discussed earlier (2002: 99), approaching the phonetically provocative name as 'chancy' recalls how 'aleatory and indeterminism' are words and ideas often used to bypass the word 'improvisation', by defining the possibility of other logics in terms of a lack (e.g., of structure, of sound, of meaning). On the contrary, the unpronounceable name amplifies the interactivity of reading and the role of the reader as an improviser. For that reason, unpronounceable writing was central to the notation of *The Spiral*. This will be discussed in section 6, after a deviation through another molluscan figure.

[12] It was premiered in London as part of Carolina Cury's Cosmicomic Suite in New Lights Festival 2023 (Cury 2023).

[13] Even though Haraway does not engage with Calvino's work, the *Cosmicomic* stories could be read as such posthuman threads, leading to hybrid, queer, multispecies becomings (Iovino 2014).

[14] In her novel *Always Coming Home* (1985), Le Guin has also made use of invented language that intentionally breaks with common articulations of text and voice. She re-articulated the two through a complementary album of music which allowed her to 'hear the people she'd imagined' (Le Guin and Barton 2018).

doi:10.1017/S1355771824000244

MEMORIES OF A VAMPYROTEUTHIS

Influenced by the 'cultural revolution' of the 'Information Age' in the 1980s in the wake of AI and genetic technology (Flusser and Bec 2012: 66, 74), Vilém Flusser (1920–1991) started writing a fable about the vampire squid (*vampyroteuthis infernalis*) in the form of an unusual scientific report, partly 'written by' *vampyroteuthis infernalis* itself and illustrated by the biologist, zoosystematician and artist Louis Bec (1936– 2018). Lured by the paradoxical relationship of the vampire squid and the human, Flusser studied the creature as our existential 'antipode' (Flusser 2011: 36) attempting 'to critique our vertebrate existence from the molluscan point of view' (ibid.: 27). *Vampyroteuthis Infernalis* was the first work of what he saw as a new discipline of 'Philosophy of Fantasy' (ibid.: 146). He describes part of his research methodology in a letter he wrote to Dora Ferreira da Silva:

> I am working on [*Vampyroteuthis Infernalis*] with varied methods: I read biology, neurophysiology, psychology and the Encyclopaedia Britannica. I constantly translate parts written in German to French, English and Portuguese. I discuss it with everyone that shows up on my horizon, I go to visit aquariums, I watch films about submarine life, I seek to intuit the vertebrate, mammalian and primate foundation of my own behaviour, and I seek to read the newspaper *as if I were a mollusc*. (Ibid.: 142; emphasis added)

By inhabiting a molluscan perspective, the author intended to produce a new mode of philosophical writing that is 'simultaneously scientifically exact and mad fantasy' (ibid: 142). More recently, it has been adopted in posthumanist discourse as an epistemologically potent 'media fable', capable of questioning the 'universally applicable' human perspective, enacting a mode of 'self-critique' of the author's *anthroposition* (Jue 2020). In this way, it can inform the way we might approach more-than-human ways of listening. Even though in *Vampyroteuthis Infernalis* Flusser does not elaborate on sonic media, he was interested in the 'vampyroteuthian' turn in the development of artificial intelligence and the shift towards software-based art, claiming that 'there can be no doubt that "soft" [in *software* processing] alludes to molluscs ("soft animals")' (Flusser and Bec 2012: 67). In this sense, he hints towards a potential space of (im)possibility, or sonic fiction, where machine listening was always already molluscan.[15]
Machine listening is intimately linked with a machine of subjectivity, capable of rendering inoperative the anthropological machine of listening. In *More Brilliant than the Sun: Adventures in Sonic Fiction*, Kodwo Eshun develops a theory of sonic fiction emerging from the 'intersections of sound and science fiction' in the 'coevolution of machines and humans in the late 20th C Black Atlantic Futurism' (Eshun 1998: 00[-002]). It operates by transversal 'sensation transference' where 'concept feeds back into sensation, acting as a subjectivity engine, a machine of subjectivity that peoples the world with audio hallucinations' (ibid.: 7[121]). In sonic fiction, the boundaries of the human are often blurry, with various escape routes to animality. For instance, Eshun considers how the vocoder '[turns] the voice into a synthetic spectrum of perverse voco-imps [letting] you talk with cartoons, become cartoon, become animal, become supercomputer' (ibid.: 06[080]). This idea could be traced back to John C. Lilly's s(f)cientific experiments during the Cold War, who attempted to study human–alien communication through cetaceans 'using the vocoders to translate dolphin vocalisation into human speech' (Gerspacher

[15] A Flusserian analysis of machine listening, focused on the theme of predatory deception explored in *Vampyroteuthis Infernalis*, deserves a dedicated study in the context of the 'Predator' spyware ecosystem which has caused political turmoil throughout the globe in the past few years (Naber et al. 2023). However, the focus of the current study is on the more positive aspects of the molluscan fable.

doi:10.1017/S1355771824000244

2022: 50). This ambition still resonates today, although the vocoder is replaced by more complex listening assemblages, involving robotics, linguistic models and machine learning (Andreas et al. 2022). Even though Eshun does not directly consider sonic fiction in relation to machine listening, we could view the work of George Lewis as the articulation of the two, especially in his discussions on the notions of emotional transduction in relation to Eshun's sensation transference mentioned earlier, and technology-mediated animism in relation to Eshun's notion of machine life.[16]

If sonic fiction is a subjectivity engine (Eshun 1998: 02[014], 03[034], 07[121], A[186]), what sonic engine could produce the sonic fiction of a molluscan subjectivity? Applying Flusser's molluscan dialectics in the interaction design of the music composition, it might be possible to conceive of machine listening as an *(anim)algorithm* enabling this task. Flusser describes his method of SF speculation, which I refer to as *(malaco)logic*, in a letter to his friend, the engineer and philosopher Milton Vargas:

> So there we have two 'dialectical' terms occupied by biological research: that of 'homology' and that of 'analogy'. 'Homology' refers to the genotype: birds' wings are homologue to our arms. 'Analogy' refers to the phenotype: the wings of birds are analogue with the wings of bats. And this is an epistemological problem of first order: if the octopus brain is 'analogue' with ours and 'homologue' with, let's say, our medulla, then how do octopi 'think'? (Flusser 2011: 134)

The syllogisms of *Vampyroteuthis Infernalis* gain momentum through this oscillation between analogues or homologues of the human/vampyroteuthis pair. For instance, Flusser's theory of 'vampyroteuthian art' unfolds like a spiral around the analogy of ink, gradually amplifying the differences between the human use of ink for writing as objective inscription and the vampyroteuthian use of ink for hiding as subjective deception (Flusser 2011: 105–16). Thus, he goes as far as to define an 'intersubjective society' as 'a society of Vampyroteuthes' (ibid.: 114). In order to transcode this kind of molluscan subjectivity into a sonic engine, it might be suitable to apply Flusser's (malaco)logics to the model of animal subjectivity developed by Jacob von Uexküll, now recognised as the pioneer of biosemiotics.[17] Contrary to most of the traditional conceptions of the animal, Uexküll approached it as 'a living being with its own *subjectivity'* (Cimatti 2020: 28). He developed the theory of the *umwelt*, or the animal's perceptual life-world (Uexküll 2010: 1–34), which considers animal subjectivity as a closed unit consisting of the organism's 'perceptual world' and 'effect world', where the former triggers a series of reactions or 'adaptive behaviours' that make up the latter (Cimatti 2020: 29). Illustrated in the diagram of the 'functional cycle' (Uexküll 2010: 49), the resonance between the two 'worlds' is what produces the behavioural complexity of living beings according to the theory of *umwelt*.

The machinic *umwelt* encountered by the performer of *The Spiral* is an example of (malaco)logic applied in machine listening: a neural network enables the resonance between the human/molluscan sonic analogy of a molluscan perceptual world and a human's musical effect world. The former was modelled on recent biological studies of molluscan hearing. The data

[16] 'So there's a whole thing about machine life that already exists with musicians anyway. Producers have already started working out a theory of machine life. As soon as you look at what they've been saying – magnify it, and start to use it – you realise that there's this series of Sonic Fictions and scientific fabulations, all of which I just call Sonic Fictions. There's 20 years of speculation on the machine as a lifeform' (Eshun 1998: A[189]).

[17] Jakob von Uexküll (1864–1944) contributed significantly to our understanding of animal perception and behaviour. His ideas laid the groundwork for contemporary discussions on animal subjectivity and agency, influencing a wide range of philosophical discourses. Uexküll's work is a common reference in Gilles Deleuze's explorations of affect and becoming, Giorgio Agamben's inquiries into the 'open' nature of animal existence, Matthew Calarco's critiques of anthropocentric perspectives in his philosophy of animality, as well as in the field of robotics and the perceptual world of AI.

doi:10.1017/S1355771824000244

produced through lab experimentation in a study of the hearing of the bivalve mollusc Magallana Gigas (Charifi et al. 2017) was used to emulate the intensity and delay of the oyster's capacity to be affected by a spectrum of acoustic vibrations through a patchwork of digital filters and delays. The processed sound is then quantised, normalised and used as the input for machine learning. Since the oysters proved to be highly sensitive to frequencies between 10 and 80 Hz, a geophone [18]is used instead of a conventional micro- phone, as it is more sensitive to the low register and the infrasound that affect the molluscan body most.

The machine 'listens' through a fuzzy Adaptive Resonance Theory (ART) model for unsupervised machine learning, producing a flux of constantly updating clusters of identifiable percepts. The version used is implemented into a Max object[19] by Benjamin D. Smith, who envisioned its potential to be used 'as an intelligent partner, listening to the musical development and making informed choices and mappings as the *improvisation unfolds*' (Smith and Garnett 2012). *The Spiral* works in a similar way. Every time a new cluster is detected, the percept that triggered it is associated with a set of data making up the 'effect world', consisting of parameters for sound synthesis that are pre-composed as 'optional' material to be used throughout the piece (that are almost never reproduced accurately). The association is done using another neural network, a multilayered perceptron extending the clustering process into a continuous micro-temporal capacity for reactive behaviour. This behaviour is expressed through 'musical' sound by modulating the granulation parameters that re-synthesise the live input of the human performer into radically different and often surprising gestures. This hybrid *umwelt* – half human, half molluscan – makes up an (anim)algorithm with a functional cycle that opens a zone of indistinction for becoming-animal to unfold.

MEMORIES OF AN AURIFORM

The unpronounceable notation of The Spiral was attained through a (malaco)logic of hearing emerging around the notion of the *auriform*.[20] This malacological term, which is used to classify molluscs 'having the shape and form of a human ear', sets up a Flusserian dialectic oscillation between the human hearing apparatus and the molluscan image. Inverting the terms of the analogy, instead of the auriform molluscs having the shape and form of a human ear, one could look at the human ear as having the shape and form of a mollusc. Subsequently, the plurality of molluscan visual forms can be viewed as a space of (im)possibility for imagining (post)human ears and ways of hearing.

In this sense, the method of notation explored in *The Spiral* engages with the sonic fictions of our *molli*form ears[21] by tracing forms of molluscs on systems of musical staff. This technique draws on the work of eco-acoustic composer Matthew Burtner. Part of his composition *Cloudprints* (2007) is composed by digitally superimposing a linear grid system on pictures of clouds to sonify their intricate morphology. However, in *The Spiral*, the linear grid is substituted by groups of concentric circles that, according to Calvino and Flusser, would be more adequate for accessing a molluscan existence. For instance, Flusser infers that 'whereas we think linearly ("rightly"), [the vampyroteuthis] thinks circularly ("eccentrically")' (Flusser and Bec 2012: 42).

18 Geophones are originally designed to sense subtle seismic vibrations in the earth. For this reason, they are very sensitive in the low frequency registers and are adopted for creative use in field recording or sound art.

19 The object 'ml.art' can be found in the 'ml.star' package.

20 The word's etymological origin, *auris*, is the latin word for 'ear' or hearing'. The word 'auriform' is used in zoological taxonomy to classify molluscs that resemble human ears, like the species *haliotis diversicolor* (Pain 1964: 2). The auriform abalone molluscs have also been used as bio-sensors, thus embodying the image of a cyborg human ear without a body (Distributed Sensing Systems Group 2020).

21 The latin word for 'soft', *mollis*, is the etymological root of 'mollusc'.

doi:10.1017/S1355771824000244

The theme of circularity reappears consistently in molluscan SF, which Qfwfq explains in terms of radial symmetry:

> Form? I didn't have any; that is, I didn't know I had one, or rather I didn't know you could have one. I grew more or less on all sides, at random; if this is what you call radial symmetry, I suppose I had radial symmetry, but to tell you the truth I never paid any attention to it. (Calvino 2010: 137)

It is worth mentioning how this circularity refrain echoes in the SF film, *Arrival* (Villeneuve 2016).[22] Appearing as the foundation of the cephalopod-like aliens' tentacular existence, circularity is visually illustrated through the language of these creatures, in which they 'write' by manipulating an ink-like substance into complex, circular floating formations. As the narrative unfolds, we understand that the circularity of this language determines the temporal structure of the writing subjectivity, which eventually explains the time-warping visions of the protagonist, Dr Louise Banks. In his book *The Owls Are Not What They Seem: Artist as Ethologist*, Arnaud Gerspacher interprets the film in tandem with Derrida's parable of the cuttlefish, where the mollusc's ink 'would have the power of attesting to cephalopod interiority', or the ability to *be* or *do* (prior to *saying*) 'I' (2022: 48). For him, both stories are illustrations of what he calls the 'ethogrammatological reversal' – a hypothesis that questions the exceptionalism traditionally attributed to human language, considering it to be only one communicative medium among a plurality of semantic possibilities grounded on animal behaviour (ibid.: 45). By following this hypothesis from mythology to ethology, one might indeed extend a meaningful (musical) 'I' beyond anthropocentrism through the study of animal behaviour and trace structures.

Contrary to the popular imaginary, molluscs do not have radial symmetry, but bilateral symmetry like humans (Flusser and Bec 2012: 12). However, Flusser points out that they 'resign half of their body in favour of the other to become "half animals"', or 'ek-centric animals whose bodies incline towards coiling both as a whole and in all their details' (ibid.: 12–14). This ambiguity between bilaterality and radiality might explain his observation that the 'spiral symmetry is the fundamental theme of the mollusc body' (ibid.: 14), a theme that is also visible in the image used for the second section of the composition (Figure 1). The photograph captures the trace of a nudibranch mollusc, signifying the mollusc's absence within the presence of the spiral articulation of its eggs. During the performance, the spiral trace re-emerges in the zone of indiscernibility between the circular writing informed by the molluscan morphology and the linear reading typically imposed by Eurocentric music culture.

Figure 1: Nudibranch eggs in a spiral arrangement. This image was used in the composition of the second movement of The Spiral, titled 'Ova Nudibranchiorum'. Photo: Alexandros Patakis.

[22] Based on Ted Chiang's 'The Story of Your Life' (1998), *Arrival* (2016) has received critical attention for exceptionally depicting the possibility of soft, non-aggressive exchanges with radical otherness, in contrast to the tropes of mainstream alien-themed SF (Sanchez-Taylor 2024).

doi:10.1017/S1355771824000244

The Spiral consists of seven sections, each based on a picture of a different mollusc, or other aquatic creatures found in a molluscan milieu.[23] The morphology of each creature was then inscribed on the circular system using conventional Western music notation, which is warped into unreadable formations at several points of 'dissonance' between the linear languages and the circular structure. The performer is asked to play each of the seven sections starting from the inner circular system, gradually proceeding outwards ad lib before transitioning between circles. At each circle, the gaze of the performer starts at the imploded graphics at the circle's centre before spiralling outwards. The circularity of the inscription method pushed the score to the limits of legibility from a human point of view. It demands the constant spiralling of vision while it occasionally warps the familiar symbols to extremes (Figure 2). In this way, the (malaco)logical traces turn the composition into an unpronounceable improvisation unfolding as the auriform music meets the plurality of molliform ears.

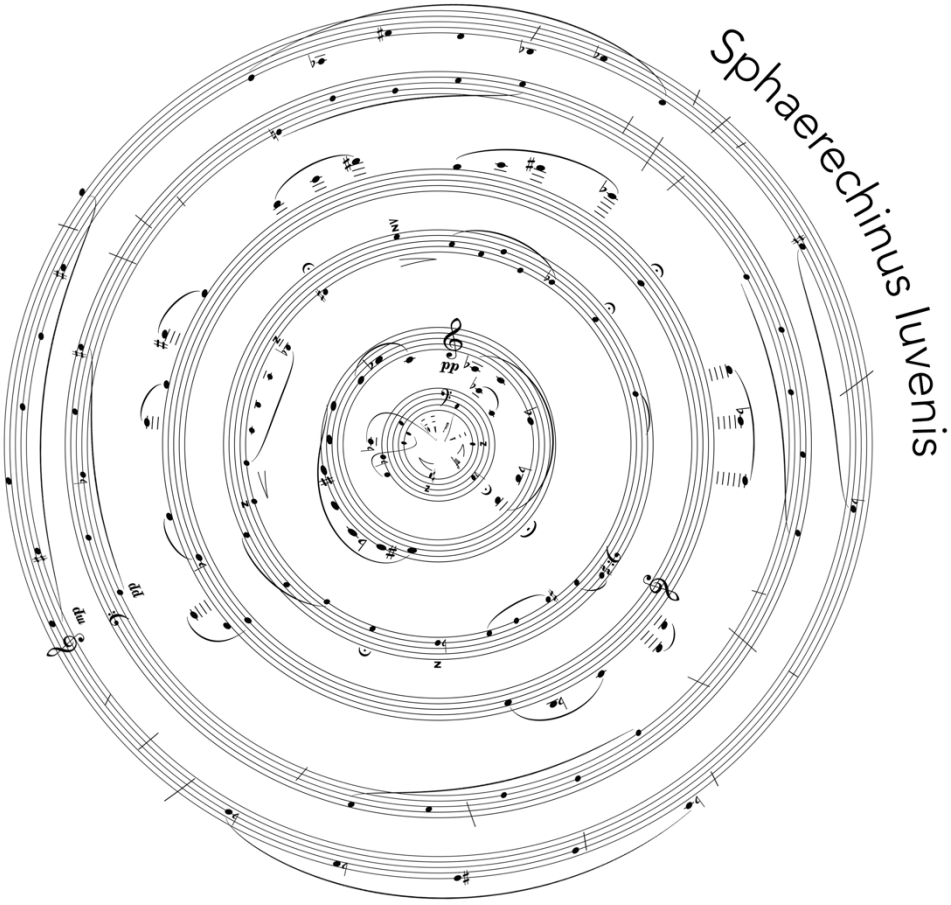

Figure 2: The third movement of The Spiral, where the legibility of the notation collapses as it approaches the centre of the circular structure.

[23] The seven pictures were provided by the author's (aquatic) uncle, Alexandros Patakis. They were captured during his scuba dives in the Mediterranean Sea. The molluscs included *Peltodoris Atromaculata*, eggs of *Nudibranchia*, *Flabellina Babai*, *Flabellina Affinis* and *Janolus Cristatus*, while their non-mollusc cohabitants included two *Sphaerechinus Granularis*.

doi:10.1017/S1355771824000244

ACKNOWLEDGEMENTS

The invaluable guidance and support of Professor John Levack Drever and Dr Jol Thoms throughout this research, along with creative dialogues with Carolina Cury, are deeply appreciated. I extend my gratitude to the anonymous reviewers and the editorial team of Organised Sound for their insightful feedback and meticulous attention to detail. Finally, thanks to Alexandros Patakis for providing permission to reproduce his photograph in this article.

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