

Out of the Ivy and into the Arctic: Imitation Coral Reconstruction in Cross-Cultural Contexts**

Donna Bilak*

Summary: This essay discusses imitation coral reconstruction workshops based on a recipe from a sixteenth-century “book of secrets” that took place in three different educational contexts: Columbia University, Nunavut Arctic College, and Universität Hamburg. It reflects on the utility of reconstruction and material literacy as present-day history of science methodologies in which scholarly textual interpretation meets physical research. It also considers the nature of cultural heritage in shaping material practice through an Inuit cultural context, in which the acquisition and dissemination of knowledge is not rooted in textual traditions, but bodily embedded in oral histories, craft technology, and land stewardship. The essay also presents suggestions for new collaborative practices between humanists, artisans, and scientists that can be facilitated by reconstruction methodology.

Keywords: imitation coral, wonder, reconstruction, Arctic, pedagogy, experiential learning

Introduction

Sometime during the 1580s, in or around Toulouse, a man set about the task of compiling a “book of secrets.”¹ It brought together his knowledge of different kinds of artisanal technologies gained from texts, hearsay, and first-hand experience, and by the time he finished recording all this, perhaps with publication in mind, he had filled 170 folios with hundreds of entries. The first entry in this compilation is a recipe for making imitation coral (Figure 1).

Currently, this manuscript is part of the massive “Collection de Béthune” held in the Manuscripts Department of the Bibliothèque nationale de France, identified by its shelfmark Ms. Fr. 640. Several years ago, a reference to it caught the

¹ Smith 2020.

D. Bilak, Independent Scholar and Adjunct Part-Time Faculty at New York University, Gallatin School of Individualized Study, 1 Washington Place New York, NY 10003, E-Mail: bilak@12keys.consulting

** Sincere thanks to Pamela H. Smith (Columbia University), Beata Hejnowicz (Nunavut Arctic College), and Dominik Hünniger (Universität Hamburg) for providing experimental forums. Heartfelt thanks to Marieke Hendriksen for the opportunity to process my experiences and present my ideas in this special issue.

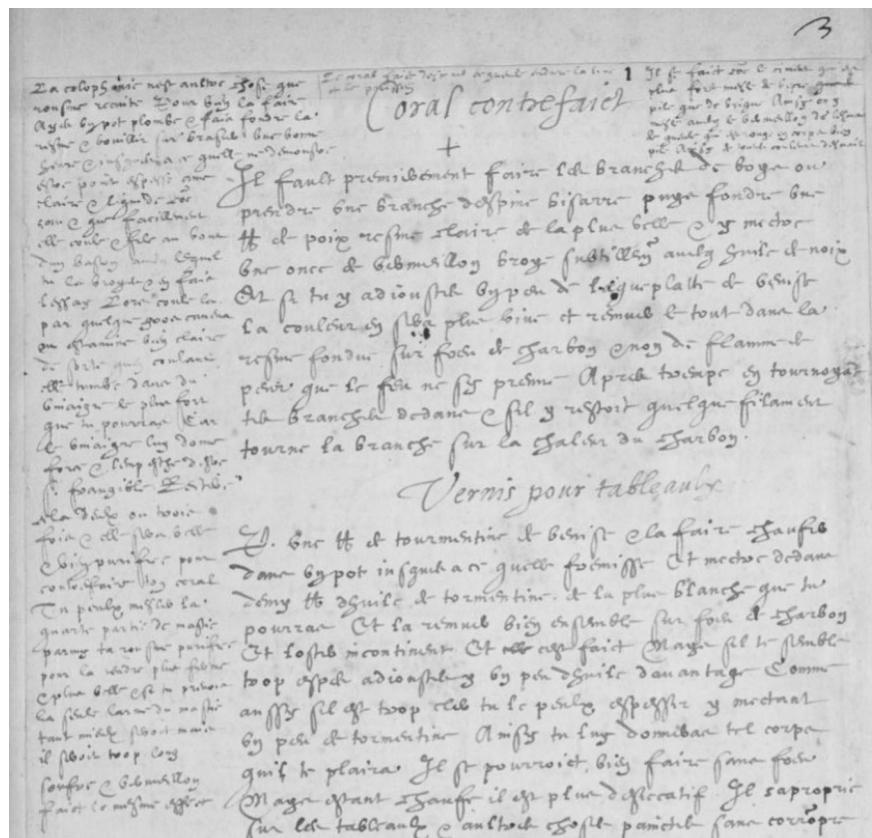


Figure 1: “Coral Contrefaict” in Ms. Fr. 640, c.1580, fol. 3r. Manuscript detail from the Making and Knowing Project, online: <https://edition640.makingandknowing.org/#/folios/3r/f/3r/tl> (accessed 13 June 2020).

eye of an historian of early modern science, Pamela Smith, in a book on the sixteenth-century Huguenot ceramicist, Bernard Palissy,² and her curiosity led to its excavation out from the archival colossus of the Béthune collection. Its subsequent investigation generated a research enterprise known as the Making and Knowing Project (M&K) under Pamela’s direction at Columbia University,³ dedicated to the material and intellectual exploration of Ms. Fr. 640 through the historical reconstruction of its entries.⁴

“Coral” was among the very first group of recipes that the M&K team reconstructed in December 2014. I have been fascinated with this recipe from the time when I was a postdoctoral scholar on M&K, from 2014 to 2017. In addition to participating in the M&K imitation coral reconstruction, I have led two other

² Amico 1996.

³ Smith et al. 2014.

⁴ Making and Knowing Project et al. 2020.

“coral”-making workshops, at a vocational school in the Canadian Arctic with Inuit Metal Arts students in May 2015, and at the Universität Hamburg with academic colleagues in February 2020. Each group worked from the same text, yet all three workshops produced distinctly different “coral” results. Why?

This essay investigates cross-cultural “coral”-making to explore what the iterations of a reconstruction can reveal about communities, practice, and the co-creation of knowledge. It presents my reflections on how reconstruction changes based on setting and people, and their knowledge sets, together with a historically inflected genealogy of coral. It is designed as a series of intersecting case studies that narrates my evolving relationship with reconstruction in how “coral”-making plays out across different audiences, in different contexts and environments. The transparency afforded by a frank personal account allows me to bring the range of reactions into focus that infuse and influence these workshops: excitement, doubt, confusion, anxiety, surprise, wonder. I also draw attention to the generative power of human error in pedagogical practice, and how its acknowledgement can facilitate agile and constructive responses to uncertainty and failure that enhance the teaching and learning process. A chronological framework does not effectively convey the experiential complex that this study aims to articulate. It begins, therefore, with the most recent workshop at the Universität Hamburg, a “coral” reconstruction that almost founded. This particular account also interweaves recollections on “coral”-making in the M&K lab at Columbia in 2014, which I drew upon during the Hamburg reconstruction in striving to counteract unexpected material reactions. The next section contextualizes the cultural understanding and use of coral in the Mediterranean region from antiquity to the early modern period. Such organization mirrors the “show-then-tell” format I adopted for the Hamburg workshop where our reconstruction session was followed by a discussion about coral and meaning-making in early modern humanist and artisanal spheres. The final part of this essay relates the imitation coral workshop that took place in the Canadian Arctic with Inuit Metal Arts students in 2015, whereby a blunder of mine concerning a key material in fact enabled the students to lay cultural claim to a reconstruction exercise around a sixteenth-century French recipe in an unexpected way.

I use the term reconstruction across these different case studies for its flexibility in conveying the sense of building something again as well as re-enactment from available evidence.⁵ This premise also invites us to consider the three imitation coral workshops as presenting a kind of ethnography of experience,⁶ illuminating the heady emotional mix of playfulness and apprehension that reconstruction work stirs up. This constitutes an important element of reconstruction methodology. Learning how to work with—and through—such feelings can be amazingly intellectually transformative. Reconstruction is not about giving or following instructions. It is about working with materials to probe the unknown to learn what

⁵ Among the growing body of scholarship on the subject of reconstruction, re-enactment, and performance, see Hagendijk 2018; Fors et al. 2016; Chang 2011; Staubermann 2011.

⁶ For learning by doing, see Ingold 2013; also Baiocchi et al. 2013.

you do not know. This experience yields understanding through self-awareness, which primes us to perceive failure as an invitation to experiment, to engage in intellectual risk-taking, and to train intuition in producing new knowledge.

2. Hamburg, February 2020

Oftentimes, the seed of a project gets planted at an informal social gathering. As it happened, the Hamburg workshop was the outcome of a lively dinner conversation where I met Dominik Hünniger, a researcher at the Universität Hamburg with the *Forschungsgruppe "Imaginarien der Kraft."*⁷ Dominik was keen to introduce his colleagues to an M&K-style reconstruction workshop, and given my experience as a former postdoc on the project, I was in. I proposed the imitation coral recipe from Ms. Fr. 640 as suitable for a one-day meeting, and Dominik assembled the requisite materials based on my itemization.⁸ However, intellectual contextualization was intentionally minimal: I pre-circulated a case study of materials and meaning-making in early modern Europe to provide a broad frame of reference for the experiment,⁹ as opposed to scholarship about M&K reconstruction.¹⁰ My rationale was simple. I did not want to give away the reconstruction experience before it happened. I take a fluid approach to reconstruction that is not tightly focused on proving/disproving a hypothesis. Rather, I use material exploration to ask: What does our thinking look like, what might we produce, when we are not trying to come up with answers?¹¹ This premise evinces the role that uncertainty plays in knowledge formation, even as it challenges trained approaches in the humanities where research emphasizes findings but not necessarily the failures or feelings that lead to them.¹² I also take certain cues from the M&K definition of reconstruction as a way of close reading. M&K essentially aims to get its students to triangulate between text, hands-on material engagement, and historical object research in order to form a mental image of where this interplay might lead, in which reconstruction acts as proof of concept.¹³ With the Hamburg "coral" workshop, I hoped for the act of real-time discovery to show the participants a different approach to historical research in which information attained

⁷ With thanks to Surekha Davies for convening this convivial occasion during the July 2019 History of Science Society conference in Utrecht.

⁸ I did not recommend specific brands and I hewed to the recipe's resin reference; M&K worked with rosin (a substance produced from the processing of resin) which is alluded to in the recipe's paratext "Colophony [rosin] is nothing other than recooked resin." The Hamburg workshop used Lienzos Levante vermilion pigment and Nabür Caravane resin. M&K and Nunavut Arctic College reconstructions used pigments from Kremer Pigments Inc. (New York City art supplier specializing in making historical pigments from minerals and organic substances); M&K 2014 email correspondence records our Amazon purchase of rosin but not the brand name.

⁹ Smith 2015a.

¹⁰ Smith and Making and Knowing Project 2016; M&K student perspectives in Kremnitzer et al. 2018.

¹¹ In this I am also inspired by the notion of "talkative things" and "unthinkable combinations" discussed in Daston 2004.

¹² On the powerful learning potential of failure see Firestein 2016; and Latour 2005 on uncertainty. See Febvre 1973 about the reconstitution of emotions in history.

¹³ See the contribution of Taape et al. in this volume.

from doing informs knowing. I was also curious to learn their response to the reconstruction experience.

On the morning of the workshop, eleven of us gathered in a multi-purpose room within the Universität Hamburg. It was large and airy with modular tables, a projection screen and plenty of power outlets, replete with a kitchenette. A protective layer of paper taped to the surface of one of the tables was all that was needed to transform it into our workbench, laden with a hotplate, a glass baking tray, assorted stainless steel palette knives, several packets of resin, a small bottle of walnut oil, and a small container of vermillion pigment. Piles of twigs lay on a nearby table (collected by the participants), alongside a box of nitrile gloves and disposable face masks. Introductions revealed that several workshop participants possessed some kind of craft skill (cooking, mixed-media art, knitting). Our group reflected different facets of academe: historians of art and of science from America and Europe, together with the director of the university's central collection office and the taxidermist for its Center of Natural History (CeNak). All expressed a deep interest in the idea of blending experiential learning with research and teaching, and eagerly awaited the experience of making imitation coral as a way to try out one version of reconstruction methodology.

I explained that we would start with a consideration of the recipe, devise a workflow, then do the experiment. Reflections and historical contextualization would follow lunch. With that, we launched full tilt into the imitation coral entry on folio 3r, working from the M&K digital edition of Ms. Fr. 640:¹⁴

One needs to first make the branches of wood or take a bizarre thorn branch, then melt a lb of the most beautiful clear pitch resin and put in one ounce of subtly ground vermillion with walnut oil, and if you add in a little Venice laque platte, the color will be more vivid, and stir everything in the resin melted over a charcoal fire and not of flame, for fear that it catches fire. Next dip in your branches while turning, & if any filaments should remain on it, turn the branch over the heat of the charcoal.

We toggled between the original French text and its English translation in trying to assess the information, and the information gaps, presented in this puzzling paragraph. Grappling with the recipe's opacity swiftly prompted questions about its ingredients, then and now. Were we in fact working with "the most beautiful clear" resin? What does this even mean? While the resin that Dominik had purchased online appeared to be suitable, nobody in our group in fact had a point of reference for knowing otherwise, including me. What is a "bizarre" branch? Or "Venice *laque platte*"? What exactly was this mixture of a lot of resin with a little pigment supposed to produce? Clearly, the recipe involved undisclosed steps and tacit knowledge, putting the onus on the group to try and fill in the blanks. Consideration of the entry's marginal notes added more layers of complication to textual interpretation. Should we factor the recipe's paratext into our reconstruction?¹⁵ Instead of illuminating a path forward, textual examination generated

¹⁴ Diplomatic French transcription in Appendix.

¹⁵ See paratext in Appendix.

debate about experimental design. Faced with multiple entry points into an ambiguously described process, where to even start with the reconstruction?

Several Hamburg participants expressed discomfort with the recipe's lack of specificity. In terms of the early modern recipe genre, the imitation coral entry in Ms. Fr. 640 is not particularly unusual for its content, or lack thereof.¹⁶ However, the kind of information we expect today from a recipe is absent from folio 3r; namely, precision instructions that walk us step by step through the process, managing our expectations at every stage with pithy descriptions aimed to instill confidence about obtaining a definitive result. The group asked for more scholarly context in order to construct a workflow. To this, I requested that we delay information delivery (a seemingly counter-intuitive approach) until the afternoon workshop debrief, having prepared a presentation that involved discussion of the M&K project together with historical images, objects, and marine-biology reports relating to coral.

This was a tough call on my part. I discerned that the group was struggling for orientation with the recipe, desiring to attain a degree of certainty with the text before starting the reconstruction process. I empathized with this. Yet I believe it is vitally important to sit with uncertainty in this kind of sense-based work.¹⁷ Doing so, I argue, encourages our intuition to activate and enter into the interpretative process. This notion stems from my work with students striving to reconstruct entries from Ms. Fr. 640 in M&K.¹⁸ My position on uncertainty as a valuable cognitive process also resonates with what Michael Polanyi has described as the tacit dimension. Polanyi contends that we possess a vast body of tacit knowledge (skills, ideas, experiences) that we are largely unaware of, which becomes legible to our perception through encounter with the unexpected and unfamiliar.¹⁹ I thus view reconstruction as a methodology with the potential to open us up to such inner connectivity when we allow perception to act as the guide through intellectual puzzles, like those posed by the information gaps and variables that characterize early modern recipes. In this, the sensation of disquiet that can accompany working with the unknown seems to be as fundamental to the reconstruction experience as is the "aha" moment, the stage when text and process finally start to make sense together.

The Hamburg group was game, even though my information deferral (quite reasonably) increased the level of anxiety around the proceedings. Going into the reconstruction process without the assurance of mastery over the text runs contrary to how we, as historians, are trained to proceed with research. Nonetheless, the group devised a workflow after some debate, which essentially followed the body text.²⁰ In its own way, the "coral" entry is relatively straightforward. Melt some kind of high-quality resin (which we were going to do with an electric hotplate, given that a charcoal fire was not an option in our work space), then somehow

¹⁶ "The Recipes Project: Food, Magic, Art, Science and Medicine" presents an excellent scholarly online resource: <https://recipes.hypotheses.org/> (accessed 13 June 2020). See also Nummedal 2019; Leong 2018; Rankin 2013.

¹⁷ For sense-based pedagogy as developed since the 17th century see Lehmann 2019.

¹⁸ Bilak [forthcoming].

¹⁹ Polanyi 1958.

²⁰ An example of this approach in Albala 2016.

combine the vermillion pigment with an undefined quantity of walnut oil, and finally dunk a twig into this mixture. So, despite not having a full picture of the steps involved or a clear sense of the recipe's outcome, we began the experiment with a mix of anticipation and trepidation. I felt the same way too, even though I could more or less envision what this recipe would produce based on my prior experience with "coral"-making. However, the one thing I did not expect was for the reconstruction to go wrong.

As we began to melt the resin, I immediately noticed it behaved differently from the previous two times I worked with this recipe. It became very thin in consistency, very fast. Also, the ounce of vermillion mixed with walnut oil called for by the recipe did not combine with the liquified resin. Instead, the vermillion-oil mixture broke up into a myriad of tiny red globules suspended in the translucent resin. We were working with a watery substance that would not color, that ran off our stirring stick instead of adhering to it—basically, the opposite of my M&K experience with this experiment. I knew that the vermillion and resin used in the Hamburg workshop were different brands from those used in the Columbia University and Nunavut Arctic College "coral" reconstructions. I suspected the presence of synthetic ingredients, either in the resin, the vermillion, or both, that interfered with their combination during the Hamburg experiment. But I am not a chemist, and I did not understand the science behind this reaction. The participants' anxiety about going into the reconstruction blind, so to speak, now morphed into anxiety around possible disappointment. What if nothing happened? I was prepared to accept failure as the outcome, but the group was emotionally invested in having a "successful" experience—that is, in seeing *something* happen, even if they did not quite know what that should be.²¹

While I processed the look and feel of this unexpected material reaction, I was also thinking back to my first "coral"-making experience in the M&K lab at Columbia, undertaken with our Science History Institute colleagues Elisabeth Berry Drago and Mariel Carr who documented it in December 2014.²² Notwithstanding the professional editing that went into producing the video, it captures our "coral"-making process in real-time—which went smoothly in that the vermillion-walnut oil mixture immediately combined with the resin, creating a rich red colour, and the coloured substance we produced readily adhered to the twigs. The entire reconstruction process (i.e., mulling, melting, dipping, and drying) took around an hour; however, overall preparation (from textual interpretation to being experiment-ready) involved weeks of consultation with artists, chemists, and Columbia University Health and Safety officers. Notwithstanding this extensive planning, just as in Hamburg, the M&K team did not know what to expect at "showtime." The M&K reconstruction experience dovetailed with the Hamburg workshop in other respects too, such as encountering barriers to textual interpretation presented by early modern terminology and tacit knowledge, questioning the historical acceptability of modern materials and equipment, and wondering what would define a successful experiment. Both groups also exhibited

²¹ A fascinating study about overcoming reconstruction challenges in Principe 2016.

²² "Making & Knowing Fake Coral," online: <https://player.vimeo.com/video/129811219> (accessed 13 June 2020).

anxiety and excitement about embarking on a process without knowing what it would yield.

As the Hamburg experiment began to unravel, I drew from my bodily memory of the M&K “coral” iteration. I took over the task of stirring the resin because I knew what to feel for in terms of consistency: a slight resistance in the heated liquid against the stir stick, like walking in shallow water. Because our hot-plate tended to rapidly heat up, and because the resin quickly liquified, I had one hand continuously fiddling with the electric control to try to maintain a steady lukewarm temperature, while maintaining a controlled, slow, figure-eight stirring tempo with the other, an action that allowed me to monitor how the resin was behaving throughout the entire pot, not just at the outer edges or in the center as a circular motion would indicate. I began describing to a participant what to feel for in making a thicker, grainier paste (more pigment, less oil). I hoped this would not only help as colourant, but also act as a thickener for the resin, like adding cornstarch to a stew. We kept up a rhythm of stirring the resin and adding the paste, using up considerably more vermillion than the recipe called for (almost two-thirds of the container of pigment). Time seemed to stand still during this activity, the group seemed to collectively hold their breath. After about ten minutes of labouring over the mixture (unsure the entire time if our efforts would yield workable material), it suddenly seemed to reach some sort of saturation point and the resin-vermillion-walnut oil combined into a thick, goopy brilliant red varnish (Figure 2). A brilliant red resin coated the twig, transforming the slender woody shoot into “coral.”

Once we got to this point, things became Zen. There was laughter, sounds of awe and exclamations of delight as we took turns dipping the twigs into the mixture, watching their transformation into “coral” as the varnish cooled and hardened, a process roughly the length of time it takes nail polish to dry. We were now caught up in the playfulness of the reconstruction, making dozens of “coral” pieces. One participant had brought in delicate sprigs of dried marjoram, which proved difficult to coat because of how thick and heavy our varnish had turned out.²³ Translucent resinous webs formed between its slender branches and the sprigs clumped together. This provoked the determination to conduct a future experiment using the marginal notes about tempering the resin with vinegar as per the marginalia,²⁴ as this participant was really invested in “petrifying” the dainty marjoram stalks with a vermillion coat. Observing, describing, experimenting, we lost track of time, something several people remarked on when, with surprise, Dominik announced it was after noon.

In contrast to the gamut of emotions that pervaded the morning’s reconstruction, our afternoon debrief was relaxed as the group unpacked the experience.²⁵ Wonder at the unfamiliar was a leitmotiv in our “coral”-making reflections, in both the senses of the term: as an expression of doubt about the ability of the text

²³ The M&K and Arctic “coral” experiments also yielded a thick goopy substance with the use of commercial rosin both reconstructions.

²⁴ I interpret the marginal note on colophony to be a recipe for making rosin. See paratext in Appendix for a colophony recipe.

²⁵ Compare with recollections of RISD glass instructors recounting their students’ first direct experience making glass in Berwick et al. 2017, on 18, 21–22. Formalized discussion in Matt 2013.



Figure 2: Hamburg “coral,” 2020; vermillion, walnut oil, resin, wood branches and marjoram sprigs.
Photo: Dominik Hünniger.

to produce an object, and as a feeling of amazement upon witnessing the woody twigs transform into red “coral.” Wonder as amazement marked a moment of sudden insight, where material transformation revealed the relationship between text and practice. The “coral” recipe in Ms. Fr. 640 blurs the boundary between nature and artifice in using natural things to create an imitation of a natural material. The coral presentation I prepared for our group also framed the imitation coral recipe as a narrative of transformation that appears in classical texts and resurfaces in the writings and objects created by their early modern interpreters. Just as with the Hamburg workshop, this study now turns to consider coral in the early modern imagination as related to blood, petrification, and transformation,²⁶ expressed through art, artifact, and natural philosophical discourse.²⁷

3. Coral: Matter and Meaning

Today, we understand coral as a polyp that can live alone or in colonies. Corals have a nervous system, they grow and reproduce, and they can cover themselves with a hard or soft exoskeleton. Coral reefs occur in global distribution and display diverse communities, and most of the coral ecosystems in existence today established their formation between 5,000 and 10,000 years ago. In the Greco-

²⁶ See Lander Johnson and Decamp 2018 for cross-cultural studies about blood in pre-modern Europe.

²⁷ See also Smith 2014.

Roman world that existed 2,000 years ago, Mediterranean coastlines and islands around south-eastern France, Corsica, Sardinia, Naples, and Genoa were ringed with coral habitats.²⁸ Coral was a valuable commodity worked into jewelry, and high-quality specimens were considered to be on par with pearls.

Yet coral as a physical entity posed a puzzle for ancient ontologies of the natural world. How to understand, and therefore classify, something that resembled a tree-like rock, or rock-like tree, that grew underwater and apparently hardened upon exposure to air? Theophrastus describes coral as a kind of stone-plant, *lithodendron*, in a brief entry in *De lapidibus*, his study of mineral substances.²⁹ Pliny's *Historia Naturalis* provides a more detailed (if cursory) account of coral, characterizing it as a kind of aquatic plant that becomes a stone. Pliny comments on its various localities, form and color, the different cultural and commercial values assigned to it as a precious material, its apotropaic power when hung as branches around the neck of infants, as well as its medicinal use. Pliny also describes coral as a substance that petrifies with human touch.³⁰ Coral's perceived ability to lapidify also occurs in Ovid's *Metamorphoses*, where the legend of Medusa, the Gorgon whose gaze possessed the power to turn living matter into stone, narrates a creation story for coral. According to the storyline, the hero Perseus decapitated the Gorgon and subsequently weaponized the severed head, which retained its petrifying powers even in death.³¹ After battling Cetus the giant sea-serpent, Perseus set the Gorgon's head upon some seaweed that he strewed on the sandy shore in order to wash the gore from his hands.³² Contact with the Gorgon's blood transformed the pliant aquatic plants into red, hard twigs, delighting nearby nymphs who scattered them into the sea currents, thusly sowing the underwater coral forests that fringed the Mediterranean region.³³ The name of the red coral genus indigenous to the Mediterranean region is known to this day as *gorgonia*.³⁴

²⁸ Plin. Nat. 32.11. English translation, see Pliny the Elder 1855, Book 32, Chap. 11 ("Coral: Forty-Three Remedies and Observations"), online: <http://www.perseus.tufts.edu/hopper/text?doc=Perseus%3Atext%3A1999.02.0137%3Abook%3D32%3Achapter%3D11> (accessed 13 June 2020). See also Oceana Report 2007.

²⁹ Caley and Richards 1956, on 24–25, 53.

³⁰ Plin. Nat. 32.11; English translation: Pliny the Elder 1855, Book 32, Chapter 11 ("Coral: Forty-Three Remedies and Observations"), online: <http://www.perseus.tufts.edu/hopper/text?doc=Perseus%3Atext%3A1999.02.0137%3Abook%3D32%3Achapter%3D11> (accessed 13 June 2020).

³¹ Ovid 4.604–622; 663–705; 753–803; and 5.149–199. An early digital version of Anthony S. Kline's English translation of the *Metamorphoses* can be found here: Book 4:604–622 ("Perseus and Atlas"), 663–705 ("Perseus Offers to Save Andromeda"), 753–803 ("Perseus tells the story of Medusa"), online: <https://ovid.lib.virginia.edu/trans/Metamorph4.htm> (accessed 13 June 2020); and Book 5:149–199 ("Perseus uses the Gorgon's head"), online: <https://ovid.lib.virginia.edu/trans/Metamorph5.htm> (accessed 13 June 2020). An evocative discussion on the conceptualization of Medusa's blood in Benvenuto Cellini's bronze casting in Cole 1999.

³² Ovid 4.740–752; English translation (Kline's version): second paragraph of Book 4:706–752 ("Perseus defeats the sea-serpent"), online: <https://ovid.lib.virginia.edu/trans/Metamorph4.htm> (accessed 13 June 2020).

³³ See also Gibson 2015.

³⁴ Discussion of *gorgonia* coral in Cole 1999, on 228–229.

These ancient commentaries formed an important part of early modern discourse among natural philosophers who also grappled with coral's classification.³⁵ Printed works by Georg Agricola, Conrad Gesner, Petro Andrea Matthioli, and Ferrante Imperato, for example, discussed the lapidifying characteristics of coral as well as its medicinal value.³⁶ Coral's perceived dual nature as marine plant and hard mineral made it a desired item in museums assembled by such collectors as Imperato, Francesco Calzolari, Ole Worm, and Gillis de Kimpe, eliciting wonder from visitors and sparking debate about its placement in the natural order.³⁷ The artist Domenico Remps used white, black, and red coral specimens to emblematize the relationship between natural history and natural philosophy in his *trompe l'œil* cabinet of curiosities. The top shelf holds a human skull to which is affixed a red coral branch, its staring eye sockets the inverse of Medusa's petrifying glare. The collector as allegorist conjoins *memento mori*, *naturalia*, and *artificialia* in creating a microcosmic world inside a simple wooden cabinet (Figure 3).³⁸

The nature of coral finds allegorical expression in Michael Maier's *Atalanta fugiens*, an alchemical retooling of another Ovidian legend about the race between the fleet-footed huntress Atalanta and her suitor Hippomenes.³⁹ Emblem XXXII in *Atalanta fugiens* depicts a coral fisherman lifting a coral branch from a lake. Half submerged, the coral's transformation from supple aquatic plant to hardened rock is implied by the artist's hatching technique in the illustration, used to convey its lapidification in contact with air.⁴⁰

The themes of blood, petrification, and transformation that cut across Pliny and Ovid mingle in the early modern artisanal imagination. Wenzel Jamnitzer exemplifies these in his material actualization of still another Ovidian legend, the nymph Daphne's transformation into a laurel bush.⁴¹ Created around 1570, Jamnitzer crafted Daphne's body in gold and silver, using red coral branches to express her metamorphosis (Figure 4). Coral bursts from her upraised arms at the wrists and shoot up out of her coiffure, its ends decorated with tiny green enamelled leaves to indicate the fast-growing greenery that will soon engulf her form. Jamnitzer's statuette seems to play with the ancients' notion of coral as a tree-like rock, or rock-like tree, even as the coral branches evoke the lapidification of blood associated with the Medusa legend.

³⁵ Ottaviani 2015; also Chessa 2020. Caley and Richards 1956, on 11 lists early modern printed editions of *De lapidibus*. See also Schmitt 1971.

³⁶ Agricola 1657, on 603; Gesner 1565; Matthioli 1598. For discussion of coral's medical properties see Rijks 2017.

³⁷ Ottaviani 2015, on 290, 311–313. On de Kimpe see Rijks 2019, on 320; compare Kimpe's "coral"-making material with paratext (right-hand margin) in Appendix. For early modern culture of wonder and collecting see Daston and Park 1998.

³⁸ The sequence of artifacts and their organization in levels in Remps' painting has parallels in printed portrayals of early modern museums; see Ottaviani 2015, on 303 and fn. 53. For early modern collecting culture, see Impey and MacGregor 1985; Findlen 1994.

³⁹ Nummedal and Bilak 2020.

⁴⁰ Maier 1618.

⁴¹ Ovid 1.525–552; English translation (Kline's version): Book 1:525–552 ("Daphne Becomes the Laurel Bough"), online: <https://ovid.lib.virginia.edu/trans/Metamorph.htm#488381109> (accessed 13 June 2020).



Figure 3: "Cabinet of Curiosities" by Domenico Remps, c.1689; oil on canvas. Dimensions 99×137 cm. Museo dell'Opificio delle Pietre Dure, Florence. Image: created 21 May 2020, source/photographer WGA on Wikimedia Commons, online: https://commons.wikimedia.org/wiki/File:Cabinet_of_Curiosities_1690s_Domenico_Remps.jpg (accessed 13 June 2020).

As a precious red stone, coral corporelizes the perceived sanctified properties of Christ's blood and its relationship with the transubstantiation of the Eucharistic elements of bread and wine into the body and blood of the Son of God in the moment of consecration. The ancient view of coral's apotropaic properties is thusly recast in early modern religious paintings of the Christ child, which relate to the contemporary vogue in portraiture for depicting infants and children adorned with coral bracelets and necklaces (Figure 5). Such jewellery in both religious and secular contexts is usually rendered as a strand of small round coral beads, sometimes with a dangling branch, fastened about the neck or wrist. However, in the Christian frame of reference, coral's perceived transformative nature assumes emblematic significance as the lapidification of blood that flowed from the wounds of Christ at his sacrifice for the redemption of humankind from the stain of original sin. Coral jewellery in portraits of Christ as child can therefore be understood in terms of transposition. The coral is not to protect Christ from externalized danger or evil (as is meant with other children). The coral he wears embodies a kind of *memento mori*, a reference to the redemption that flows our way through the blood that is spilled in Christ's sacrificial crucifixion. Nails will pierce his hands and feet, a crown of thorns will bite into his head, and a spear thrust will open a wound in his body. In portraits of the infant Jesus, it is sight, our act



Figure 4: Statuette of “Daphne” by Wenzel Jamnitzer, Nuremberg, c.1570; gold, silver, coral. Musée national de la Renaissance. Image: created 27 March 2013, author Pposchadel on Wikimedia Commons, online: [https://commons.wikimedia.org/wiki/File:%C3%89couen_\(95\)_ch%C3%A2teau,_2e_%C3%A9tage,_cabinet_d%27orf%C3%A8vrerie,_statuette_de_Daphn%C3%A9e,_Wenzel_Jamnitzer,_Nuremberg,_vers_1570.jpg](https://commons.wikimedia.org/wiki/File:%C3%89couen_(95)_ch%C3%A2teau,_2e_%C3%A9tage,_cabinet_d%27orf%C3%A8vrerie,_statuette_de_Daphn%C3%A9e,_Wenzel_Jamnitzer,_Nuremberg,_vers_1570.jpg) (accessed 13 June 2020).



Figure 5: “Virgin and Child” by Joos van Cleve and collaborator, c.1525; oil on wood. Overall dimension 28 3/8×21 1/4 in. (72.1×54 cm). Metropolitan Museum of Art, New York. Image: Public Domain, online: <https://www.metmuseum.org/art/collection/search/436795> (accessed 13 June 2020).

of looking at the coral jewellery he wears, that activates its Christological redemptive meaning.⁴²

As text and artifact, imitation coral in Ms. Fr. 640 participates in the allegorical and natural philosophical discourse of an early modern cultural history of coral. The hardening of the red, resinous varnish as it cools in the air, the action that transforms woody twigs into “coral,” recalls both ancient and early modern commentaries on coral’s dual nature and ability to lapidify. We do not know if the author of Ms. Fr. 640 had first-hand experience seeing or handling coral specimens. But he may have read about coral.⁴³ Certainly, the recipe’s fantastical branches are reminiscent of *gorgonia* coral. Was “faked” coral intended to deceive?⁴⁴ Notions of value are tied to this question. Extant contemporary inventories and recipes hint at the commercial value imitation coral may have held more generally in early modern European culture.⁴⁵ Nevertheless, the author of Ms. Fr. 640 likely viewed this recipe for its philosophical value as an exercise in creating a process that mirrored the material transformation associated with coral, which extends to our time. “Coral”-making illuminates a relationship between process and myth in how we learn about the natural world and history, even as its creation enchanting our intellect.

4. Iqaluit, 2015

The question “What is coral?” plays out differently in the reconstruction workshop I held at Nunavut Arctic College (NAC) in May 2015. Beata Hejnowicz, Senior Instructor of the Metal Arts programme at NAC, had invited me to Iqaluit to lead a hands-on jewellery history workshop with her students (Figure 6). Iqaluit, situated on Frobisher Bay, is the capital of the Canadian territory of Nunavut with a population of around 7,000 people: it is the largest Arctic community in Canada (most others are much smaller), and its designation as a city follows the 1993 Nunavut Land Claims Agreement. NAC is a vocational school in Iqaluit run by the Canadian government. Its primary focus is to serve the Inuit community in acquiring professional skills and training, although the school includes “southern” students living in Iqaluit (a common designation used “up north” for anyone, or anything, that comes from outside the Arctic).

Beata wanted me to introduce her students to practice and design from different cultures and periods as a way to expand their knowledge, skills, and creativity in jewellery making. The May 2015 visit constituted my first of a series of now annual trips to NAC to teach jewellery history. Beata and I knew each other from the Jewellery Arts programme at the George Brown College of Applied Arts and

⁴² For coral rosaries see Rijks 2015, on 66.

⁴³ Folio 1r (online: <https://edition640.makingandknowing.org/#/folios/1r/f/1r/tl>; accessed 13 June 2020) lists “Hermolaus Barbarus” among other ancient and contemporary authors. The accompanying bibliographical note in the digital edition identifies this as Ermolao Barbaro (1454–1493), Venetian humanist renowned for his edition of Pliny’s *Natural History*; see Barbaro 1493; also Barbaro and Wildenberg 1548.

⁴⁴ Rijks 2017; Bol 2014 probes the meaning of “counterfeiting.” Hendriksen 2019 offers a different perspective of artificial coral.

⁴⁵ Rijks 2019, on 321 discusses the Antwerp silversmith Hendrik Smits who may have counterfeited coral for profit. See also Smith 2015b.



Figure 6: Flying into Iqaluit, January 2020. Photo: author.

Technology in Toronto, Ontario, of which we are graduates. I had worked professionally as a wax model-maker and designer in Toronto's jewellery industry, and I came to be a historian by handling a wide range of jewellery at auctions and through estate jewellery dealers. Asking questions about these artifacts opened up a path that led me to graduate school, and my intellectual understanding of practice expanded substantially as an M&K postdoctoral scholar.

When Beata and I reconnected in 2015, I was into my second year on M&K, where my inner goldsmith had been reawakened in working with Columbia University students on their historical reconstructions of entries from Ms. Fr. 640. Beata organized a meet-and-greet in May to get me acclimated with the Metal Arts programme, and I was to return in January to lead a two-week jewellery history course.⁴⁶ The May workshop involved seven NAC students in the final year of the programme, and I planned an imitation coral reconstruction for the same reason that informed my decision five years later in Hamburg: do-ability with materials and process in a limited timeframe. Moreover, the experience of making imitation coral with the M&K team was fresh in my mind, and I was interested to see how the project's ideas about reconstruction might apply to an Arctic vocational school—so, a kind of M&K “user story” that tested out the transferability

⁴⁶ “Frozen Museum” is the 2016 NAC workshop that produced an open-access online exhibition of Inuit “cylinder seals,” which recast an ancient Mesopotamian lithic form of communication into a contemporary carrier of living Arctic stories, online: <http://frozennmuseum.cango.ca/> (accessed 13 June 2020).

of the project's pedagogy by exporting imitation "coral"-making to the Arctic.⁴⁷ I was also compelled by a deeper, personal question. Would my work as a historian of early modern science have any social relevance in a marginalized community with different kinds of educational needs and goals? In asking myself this, I was sensitive to the fact that this is also a society suffering from trauma caused by generations of governance by another culture (mine), and a place where industrial extraction by Euro-North American companies impact how the Inuit are able to reclaim their culture, which is rooted in land stewardship.⁴⁸ I had no idea what to expect.

The material preparation for the "coral" experiment was reasonably straightforward. I decided to use the same brands for the NAC workshop as were used in the M&K reconstruction at Columbia University. That said, the artists supplier Kremer Pigments was sold out of vermillion when I went to their store in New York City stock up, so I purchased cinnabar as a suitable substitute (the two pigments are chemically related, but the latter is not as brilliant a red as the former).⁴⁹ The only thing I did not pack were the "bizarre branches" called for in folio 3r, knowing that plant matter would not clear international customs. I figured we would just use branches from up north. I do not know where my head was at because there are no trees in the Arctic, as I was reminded when flying in and looking down at a vast stretch of tundra from 30,000 feet. Beata's solution turned out to be simple and effective. We would use caribou antler that she had on hand in the studio.

I organized the NAC workshop into two parts based on the "tell, then show" premise—basically the opposite format of the Hamburg workshop. The morning focused on a media-rich PowerPoint presentation of early modern images and objects. This would contextualize the reconstruction by showing how the imitation coral recipe from Ms. Fr. 640 presents a fascinating window into a bygone world of collecting practices and ideas about natural history. The afternoon would be dedicated to "coral"-making in the studio. I kicked off our morning session with Étienne Delaune's 1576 print of the goldsmith's workshop to illustrate similarities as well as differences in shop organization and practices, then and now.⁵⁰ Next, I showed different coral examples, such as a seventeenth-century spoon featuring a coral branch for a handle from the V&A collections,⁵¹ as well as Jamnitzer's statuette of Daphne, recounting the story of her transformation. I was just about to engage the students in a close-looking exercise at the details in the print of Fer-

⁴⁷ User stories are "short, simple descriptions of a feature told from the perspective of the person who desires the new capability, usually a user or customer of the system. They typically follow a simple template: As a < type of user >, I want < some goal > so that < some reason >," online: <https://www.mountaingoatsoftware.com/agile/user-stories> (accessed 13 June 2020). M&K preliminary planning for the digital edition brainstormed user stories in broadly imagining a diverse readership and what their needs might be.

⁴⁸ Heyes 2007; Wachowich 2010.

⁴⁹ Kremer Pigments 10620 Natural Cinnabar, online: <https://shop.kremerpigments.com/media/pdf/10620e.pdf> (accessed 13 June 2020). See also early modern vermillion-making in Smith 2015b.

⁵⁰ Online: https://www.britishmuseum.org/collection/object/P_1951-1120-5 (accessed 13 June 2020).

⁵¹ Online: <https://collections.vam.ac.uk/item/O294981/spoon-unknown/> (accessed 13 June 2020).

rante Imperato's 1599 museum, for historical context on the relationship between objects and collecting in the early modern study of the natural world,⁵² when a student raised his hand and asked: "What is coral?"

Full stop. How could I have made this assumption? I was mortified. When I pulled together my PowerPoint presentation back in New York, it had never occurred to me that I should preface my introduction to this Arctic imitation coral workshop with an explanation of the biology of coral and marine ecosystems. Why did I assume universal knowledge of this polyp? The next question was mine (and the one I should have led with): "Who knows what coral is?" All but one of Beata's students were from Arctic communities and had never heard about coral. This stony substance constituted a totally new thing to almost the entire class.

The student's coral question necessitated that I drop my script and go freestyle with the presentation. I used the two Mac desktops in the classroom to start pulling up interactive maps, images of coral reefs, and YouTube videos of underwater scuba footage of coral in tropical climates. As we explored this underwater world together, the NAC students widened the discussion with accounts of their lived experience of Arctic land and water. Our conversation about meaning and materials grew organically as we let websites and storytelling weave a path of discovery. A counterpoint conversation emerged with this online exploration of coral as students started sharing what it was like to go hunting and fishing (the dead ptarmigan in the lunchroom fridge served as fresh evidence in this discussion). Some students also related their observations about how the land is changing because of climate conditions.⁵³ These narratives in turn prompted my questions about traditional Inuit and modern ways of hunting. This led to more stories about life outdoors in their home communities, and explanations of how organic material from the fish, birds, and animals they harvest from the land can be transformed into art. The frame of reference that the students provided for me about the Arctic natural world enabled me to better contextualize coral as both organic matter and historical artifact for them.

This first NAC encounter made me aware that I cannot export research questions to the Arctic. The needs of the students take priority in teaching, which are unknowable until we meet and start interacting. In departing from my prepared talk and allowing the "What is coral?" question to reshape our session, the imitation coral recipe from this sixteenth-century French manuscript turned into a key that opened us up to one-another's worlds. I also believe that the acknowledgement of my erroneous assumption made the students more comfortable with me. This vulnerability, together with the use of digital technology, worked to create the social bonding that subsequently formed around our impromptu and lively discussion about biodiversity, and about materials and technologies in Inuit and Western artisanal traditions. And then it was noon.

The reconstruction began after our lunch break. I started off with a read-through of the "coral" recipe in English translation, expecting to provide considerable guidance in its interpretation as the NAC students were not trained in the

⁵² Online: <https://brbl-dl.library.yale.edu/vufind/Record/3433271> (accessed 13 June 2020).

⁵³ Four centuries after the author of Ms. Fr. 640 penned his "coral" entry, the Mediterranean coral reefs as well as reefs and atolls in other parts of the biosphere are under threat from anthropogenic environmental stressors; see Ezzat et al. 2013.

humanities. This turned out to be another assumption on my part. To my surprise, the NAC students readily conceptualized what the recipe might produce, and were unfazed by the tacit dimension of the recipe. In the studio, they easily self-organized into designated tasks—mulling the pigment with oil, melting the resin, combining the materials, and dipping the antler—all new techniques to them that they confidently handled, adapting their existing artisanal know-how to the “coral”-making process.⁵⁴ I was basically superfluous.

As the “coral”-making activity unfolded, I thought about the workshop dynamics between the M&K students at Columbia and the NAC Metal Arts students. The former was grounded in theory but not necessarily in practice. Sense-based learning required dedicated time in teaching them how to work with each other as well as with tools and materials. Conversely, the NAC group had material knowledge but were lacking in humanities training. They struggled less in coming to terms with the recipe. This response might stem from certain aspects of Inuit culture. Inuit art characteristically depicts some form of interface between humans and nature in the visualization of whole systems, expressed as scenes organized around the depiction of familial, ecological, or cosmological happenings—as well as the fusion of these different elements.⁵⁵ As well, in Arctic craft traditions the kind of *naturalia* and *artificialia* embodied by the imitation coral recipe are a natural course of making art; I discuss this more below. The Inuit also teach through storytelling: “For the Inuit, words are tools that act upon the world.”⁵⁶ This tradition of oral history, which links each generation to the next, meshes in interesting ways with the constructivist educational approach and its focus on social and emotional learning.⁵⁷ This perspective views knowledge as relative in a student-centered learning experience, the premise being that everybody put things together differently. The NAC student’s coral question marked the turnaround moment when the Arctic workshop shifted from a one-way transmission of information from teacher to student, to forming a community around knowledge exchanges. Perhaps this sense of community made the students more receptive to learning about a text in which a tree branch, or caribou antler, could transform into “coral.”

It also amazed me that the two “coral”-making campaigns produced such different objects, even though the recipe, materials, and process were essentially the same. The “coral” created by the M&K team with quince branches constitutes a more accurate representation of the text from folio 3r. The Arctic “coral” presents a wonderful kind of cultural mashup, engendered by our unexpected cross-cultural discussion around coral that morning, as well as materially through the use of caribou antler as opposed to tree branches. The caribou coral embodies a material meeting of early modern *artificialia* with Arctic *naturalia* (Figure 7).

In retrospect, the NAC students’ intuitive artisanal response to a sixteenth-century French imitation coral recipe should not have been all that surprising. Trans-

⁵⁴ Images online: <https://dbilakpraxis.com/arctic-metalarts/> (accessed 13 June 2020).

⁵⁵ “Siilavut, Nunavut (Our Environment, Our Land)”, lithograph by Kenojuak Ashevak (1999), archived online: http://www.spiritwrestler.com/catalog/index.php?products_id=7456 (accessed 13 June 2020).

⁵⁶ Wachowich 2010.

⁵⁷ Mensah 2015. See also Bennema and Lehmann 2019.



Figure 7: Left: Arctic caribou “coral”, 2015; cinnabar, walnut oil, resin, caribou antler. Right: M&K “coral,” 2014; vermillion, walnut oil, resin, quince branches. Photos: author.

formations are culturally embedded in Inuit creation stories and in shamanic practices,⁵⁸ and the Inuit are consummate artisans.⁵⁹ Intergenerational transfer of skill often begins within the family during childhood in working with stone, bone, and skin, and in visualizing the transformation of these materials into new forms with new applications (clothing, implements, ornaments). It is customary for an Inuit artisan to use material from one animal in the creative reimagining of its form into another, using physical characteristics as a guide in artistic decision-making. This interplay between form and material is exemplified in a carving that Johnny Angutikjuak, a NAC student from a later jewellery history workshop (2018) showed me, in which he had carved the shape of a diving loon that he discerned in the curve of a walrus tusk.⁶⁰ Another NAC student, Peter Nowyook, has a special affinity for walrus tusk and narwhal tusk (Figure 8), materials that he specifically employs to carve narratives “about how we use the seal,” an aspect of Inuit culture with personal significance to this artisan. As Peter explains:

There is a special bone inside the seal that holds a deep meaning for me, it is called kutina. We used to go out hunting with my family, and every time we had a meal outside, the cooked seal was shared with everyone, but this piece of seal meat from this particular bone was reserved for the women to eat. That is why I carve women’s jewellery which I design as uluk earrings and as earrings in the shape of this special seal bone.⁶¹

⁵⁸ “Bear in shamanic transformation” sculpture by David Ruben Piqtoukun (c.1991), steatite (soapstone), bone, aluminum, and paint. On exhibit at Fine Arts Museums of San Francisco, online: <https://art.famsf.org/david-ruben-piqtoukun/bear-shamanic-transformation-200721269> (accessed 13 June 2020).

⁵⁹ Images of Inuit practitioners at “Dorset Fine Arts,” online: <http://www.dorsetfinearts.com/stonectut> (accessed 13 June 2020).

⁶⁰ Angutikjuak’s artist statement online: <https://arcticmetalarts.com/guiding-hands/> (accessed 13 June 2020). For another example of artistic material transfer, see “Standing Bear” carving by Barnabus Arnasungaaq (c.1972), muskox horn, stone and graphite, in Walker’s Auctions catalogue, “Inuit & First Nations Art Auction” (May 18, Ottawa), lot 40 (p. 13 in PDF), online: <http://www.walkers-inuitart.com/assets/walker-s-inuit-art-spring-2017-complete.pdf> (accessed 13 June 2020).

⁶¹ Peter Nowyook, interview by Donna Bilak, Nunavut Arctic College, Iqaluit, Nunavut, January 2016. Quoted in Nowyook’s exhibit “Ivory Carving,” The Frozen Museum, online: <http://frozen-museum.cngo.ca/exhibits/show/peter/peters-seal.html> (accessed 13 June 2020). “Ulu” translates from Inuktitut to English as “women’s knife,” and it is a traditional tool of Inuit women.



Figure 8: Peter Nowyook, walrus tusk earrings, 2016. Left: This pair is carved in the shape of the ulu ("women's" knife). Right: This pair follows the anatomy of the seal's bone referenced in Nowyook's interview, online: <http://frozennuseum.cngo.ca/exhibits/show/peter/peters-seal.html> (accessed 13 June 2020). Photo: author.

My experiences with the students in the Arctic have led me to think deeply about shared histories and sharing histories, and how this relates to making new knowledge. The NAC students may not be trained as humanities scholars, yet they participate in a more capacious understanding of humanism as it pertains to our present time.⁶² Artforms encode their lived Arctic experience, cultural heritage, and the reality of living in two worlds defined by exposure to Euro-North American culture (industry, education, arts, socio-political systems).⁶³ The Inuit are deeply concerned with reclaiming their culture and keeping it alive (*the way we used to live is different from now*).⁶⁴ Art-making amalgamates with the different kinds of knowledge—material, technological, cultural—that socio-historical entanglement produces. On my part, I feel that what I have been doing these past several years as a teacher, researcher, and maker is a kind of humanism in real-time, and I have come to believe that humanism is a living practice. However, humanism is not just about producing new knowledge. It is fundamentally about learning how to know.

5. Outro

Collectively, the "coral" reconstructions reveal overlap and singularity. On the one hand, all three experiences share certain commonalities. Each reconstruction

⁶² Broadly stated, humanism embraces the works and workings of a particular time and place in service of the recovery of knowledge, and in devising of new methods to advance knowledge about the world guided by observation and experimental practices. Collaboration and community are hallmarks of early modern humanist practices. Modes of making and communicating knowledge were predicated upon exchanges of ideas and things, and through encounters involving scholars, artisans, merchants, and indigenous peoples. See Park and Daston 2008; Norton 2017; Bauer and Marroquín Arredondo 2019.

⁶³ Pitsiulak et al. 2018; Campbell 2017.

⁶⁴ Heyes 2007, on iv.

worked from the same text and used similar types of materials, equipment, and techniques. On the other hand, the “coral” artifacts differ with each iteration. This reflects the different kinds of knowledge brought into the reconstruction experience by the participants, and by me, derived from the kinds of skills, questions, and memories that characterized each group, and that are unique to each workshop. Failure holds an important place in the “coral” reconstructions a catalyst for curiosity and community building.⁶⁵ The pleasure that “coral”-making gives to our intellect is also revealed to be part of the process. Does reconstruction have an epistemology of playfulness? How can we examine the culture of play in its extension to the domains of learning and research? I was especially struck by the soundscape of wonder associated with “coral”-making that connected all three workshops around the moment of material transformation. It seems wonder dissolves cultural and geographical boundaries.

The afterlife of the “corals” raises interesting forward-thinking questions about experimental design and the kinds of questions we might want to probe with reconstruction. The M&K “corals” have retained a brilliant red colour over the years, but they are brittle, and the resinous coats of several objects are crazed and flaking. With object decay in mind, I advised the Hamburg participants to display their reconstruction trophies in a sealed glass jar.⁶⁶ I do not know about the state of the Arctic “coral.” What insights might “coral” decay monitored in a controlled setting yield? This kind of analysis invites a *longue durée* approach to reconstruction and highlights the necessity of creating a larger dataset. The three “coral” reconstructions have served to identify certain material limitations. Information from the imitation coral recipe’s paratext maps out new kinds of reconstruction iterations for a wider scope of material evaluation. The left-hand margin presents a detailed recipe for colophony. Would “coral” created from resin tempered with vinegar be easier to work with, or produce a more stable object?⁶⁷ An opportunity exists to explore the properties of a natural substance in a way that probes the preoccupation with material “virtues” held by early modern natural philosophers and other contemporary practitioners interested in the industrial, medical, or artisanal applications of organic matter.

A final thought about assumptions of permanence. It is surreal to me that I composed this essay in a new reality catalyzed by COVID-19 barely a month after the Hamburg workshop. Our relationship with physical and digital realms in how we interact and communicate suddenly and dramatically changed with coronavirus restrictions. Yet even as I joined much of the world in the hard pivot to remote instruction and social distancing during the spring of 2020, I was amazed by reportage about the sheer scale of hands-on culinary experimentation taking

⁶⁵ See Firestein 2016 for a thorough definition and exploration of the utility of failure in science.

⁶⁶ Vermilion is a compound of mercuric sulphide and M&K consulted with both Columbia Health and Safety as well as chemists affiliated with the Science History Institute about the possible dangers of working with this pigment and handling it as “coral.” It is inadvisable to use this Ms. Fr. 640 recipe to create objects for handling, such as jewellery for example, because of the dangers associated with prolonged skin contact with vermillion.

⁶⁷ See Appendix.

place in domestic kitchens across New York City where I live, throughout North America, and beyond. Shortages of staples in many supermarkets necessitated creative reimagining of bread-making and stews, while the Internet opened up a world of recipes to try out. This recourse to material experimentation with digital guidance on a sweeping social scale provides an unexpected case study on co-existence and naming that as a hybrid experience as we rethink how to teach and research when physical access to people, classrooms, labs, and archives is limited and uncertain. What new directions might experiential learning take going forward? If reconstruction methodology is like the scholar's Swiss Army knife, how might a virtual dimension extend our practice?

Appendix: Diplomatic French translation of body text in folio 3r, "Imitation Coral" in Ms. Fr. 640, and paratext.⁶⁸

Diplomatic French transcription

Il fault premierement faire les branches de boys ou prendre une branche despine bizarre puys fondre une lb de poix resine claire de la plus belle et y mectre une once de vermeillon broye subtillem{ent} avecq huile de noix Et si tu y adjouastes un peu de laque platte de venise la couleur en sera plus vive et remuer le tout dans la resine fondue sur fœu de charbon et non de flamme de peur que le feu ne sy prenne Apres trempe en tournoya{n}t tes branches dedans & sil y restoit quelque filament tourne la branche sur la chaleur du charbon

Paratext

Left-hand margin

Colophony is nothing other than recooked resin. To do it well, take a leaded pot & melt the resin, & boil it over the brazier a good hour, & until it appears not to be thick, but clear & liquid like water, & easily runs & flows from the tip of a stick with which you grind it, & test it. Then pour it through a coarse canvas or a very light tammy cloth, such that when pouring it falls into the strongest vinegar that you can find, for the vinegar gives it strength & prevents it from being so fragile. Reiterate this two or three times & it will be beautiful & well purified. For counterfeiting your coral, you can mix a quarter part of mastic into your purified resin to render it more firm and more beautiful, & if you were to take a single tear of mastic, it would be all the better, but it would be too long.

Sulfur & vermillion makes the same effect.

Center margin

The coral made of gules red enamel endures the file and polishing.

⁶⁸ Online: <https://edition640.makingandknowing.org/#/folios/3r/f/3r/tl> (accessed 13 June 2020).

Right-hand margin

It is made like cement that is stronger mixed with pestled than of glass rather than with brick. Thus, here one mixes well pestled gules red enamel, which is red in body, with the vermillion. Thus with all colors of enamels.

References

Agricola, Georg, "De natura fossilium, liber IV," in *De re metallica libri XII* [...] (Basil: Emanuel Koenig 1657), 594–603, online: <https://doi.org/10.3931/e-rara-15392> (accessed 13 June 2020).

Albala, Ken, "Cooking as Research Methodology: Experiments in Renaissance Cuisine," in *Renaissance Food from Rabelais to Shakespeare: Culinary Readings and Culinary Histories*, ed. Joan Fitzpatrick (London: Taylor and Francis, 2016), 73–88.

Amico, Leonard N., *Bernard Palissy: In Search of Earthly Paradise* (Paris and New York: Flammarion, 1996).

Baiocchi, Gianpaolo, Diana Graizbord, and Michael Rodríguez-Muñiz, "Actor-Network Theory and the Ethnographic Imagination: An Exercise in Translation," *Qualitative Sociology* 36, no. 4 (2013): 323–341.

Barbaro, Ermolao, *Castigationes Plinianae et Pomponii Melae* (Rome: Eucharius Silber, 1493).

Barbaro, Hermolao Iunior, and Hieronymus Wildenberg, *Naturalis scientiae totius compendium, ex Aristotele, & alliis philosophis* (Basel: Oporinus, 1548).

Bauer, Ralph, and Jaime Marroquín Arredondo, "Introduction: An Age of Translation," in *Translating Nature: Cross-Cultural Histories of Early Modern Science*, ed. Ralph Bauer and Jaime Marroquín Arredondo (Philadelphia: University of Pennsylvania Press, 2019), 1–23.

Bennema, Frederick, and Ann-Sophie Lehmann, "Teaching by Heart: Care, Education, and Art," in *To Mind Is to Care*, ed. Joke Brouwer and Sjoerd van Tuinen (Rotterdam: V2 Publishing, 2019), 190–211.

Berwick, Rachel, Denise Markonish, and Jocelyne Prince, *Wonder: 50 Years RISD Glass* (Providence: Rhode Island School of Design and RISD Shorttruns, 2017).

Bilak, Donna, "Pedagogy in the Making and Knowing Project," in Making and Knowing Project et al. 2020, online: [forthcoming].

Bol, Marjolijn, "Coloring Topaz, Crystal and Moonstone: Gems and the Imitation of Art and Nature, 300–1500," in *Fakes!?: Hoaxes, Counterfeits and Deception in Early Modern Science*, ed. Marco Beretta and Maria Conforti (Sagamore Beach, Mass.: Science History Publications, 2014), 108–129.

Caley, Earle R., and John F. Richards (eds.), *Theophrastus on Stones* (Columbus: Ohio State University, 1956).

Campbell, Nancy, *Annie Pootoogook: Cutting Ice* (Fredericton, NB: Goose Lane Editions; Kleinburg, ON: McMichael Canadian Art Collection, 2017).

Chang, Hasok, "How Historical Experiments Can Improve Scientific Knowledge and Science Education: The Cases of Boiling Water and Electrochemistry," *Science & Education* 20 (2011): 317–341.

Chessa, Maria Alessandra, "Imitation Coral_3r (2014 Fall Annotation)," in Making and Knowing Project et al. 2020, online: <http://makingandknowing-prototype.cul.columbia.edu/index.html%3Fp=1481.html> (accessed 13 June 2020).

Cole, Michael, "Cellini's Blood," *The Art Bulletin* 81, no. 2 (1999): 215–235.

Daston, Lorraine, "Introduction: Speechless," in *Things That Talk: Object Lessons from Art and Science*, ed. Lorraine Daston (New York: Zone Books, 2004), 9–24.

Daston, Lorraine, and Katharine Park, *Wonders and the Order of Nature, 1150–1750* (New York: Zone Books, 1998).

Ezzat, Leila, Pierre-Laurent Merle, Paola Furla, Alexandre Buttler, and Christine Ferrier-Pages, "The Response of the Mediterranean Gorgonian *Eunicella singularis* to Thermal Stress Is Independent of Its Nutritional Regime," *PLoS ONE* 8, no. 5 (2013), online: <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0064370> (accessed 13 June 2020).

Febvre, Lucien, "Sensibility and History: How to Reconstitute the Emotional Life of the Past," in *A New Kind of History: From the Writings of Febvre*, ed. Peter Burke (London: Routledge and Kegan Paul, 1973), 12–26.

Findlen, Paula, *Possessing Nature: Museums, Collecting, and Scientific Culture in Early Modern Italy* (Berkeley and Los Angeles: University of California Press, 1994).

Firestein, Stuart, *Failure: Why Science Is So Successful* (New York: Oxford University Press, 2016).

Fors, Hjalmar, Lawrence M. Principe, and H. Otto Sibum, "From the Library to the Laboratory and Back Again: Experiment as a Tool for the History of Science," *Ambix* 63 (2016): 85–97.

Gesner, Conrad, "De Coralis," in *De omni rerum fossilium genere, gemmis, lapidibus, metallis [...]* (Zurich: Jacob Gesner, 1565), 983–990.

Gibson, Susannah, *Animal, Vegetable, Mineral? How Eighteenth-Century Science Disrupted the Natural Order* (Oxford: Oxford University Press, 2015).

Hagendijk, Thijs, "Learning a Craft from Books: Historical Re-Enactment of Functional Reading in Gold- and Silversmithing," *Nuncius* 33 (2018): 198–123.

Hendriksen, Marieke M. A., "Casting Life, Casting Death: Connections between Early Modern Anatomical Corrosive Preparations and Artistic Materials and Techniques," *Notes and Records: The Royal Society Journal of the History of Science* 73 (2019): 369–398.

Heyes, Scott, "Inuit Knowledge and Perceptions of the Land-Water Interface" (PhD thesis, McGill University, Montreal, 2007), online: <http://hdl.handle.net/11343/39421> (accessed 13 June 2020).

Impey, Oliver, and Arthur MacGregor (eds.), *Origins of Museums: The Cabinet of Curiosities in Sixteenth- and Seventeenth-Century Europe* (Oxford: Clarendon Press, 1985).

Ingold, Tim, *Making: Anthropology, Archaeology, Art and Architecture* (London and New York: Routledge, 2013).

Kremnitzer, Kathryn, Siddhartha V. Shah, and Wenrui Zhao, "Three Recipes for Historical Reconstruction," *Common Knowledge* 24, no. 3 (2018): 389–396.

Lander Johnson, Bonnie, and Eleanor Decamp (eds.), *Blood Matters: Studies in European Literature and Thought, 1400–1700* (Philadelphia: University of Pennsylvania Press, 2018).

Latour, Bruno, *Reassembling the Social: An Introduction to Actor-Network-Theory* (Oxford and New York: Oxford University Press, 2005).

Lehmann, Ann-Sophie, "An Alphabet of Colors: Valcooch's *Rules* and the Emergence of Sense-Based Learning around 1600," in *Lessons in Art: Art, Education, and Modes of Instruction Since 1500 / Lessen in kunst: kunst, onderwijs en vormen van instructie sinds 1500*, ed. Eric Jorink, Ann-Sophie Lehmann, and Bart Ramakers (Leiden and Boston: Brill 2019), 168–203.

Leong, Elaine Yuen Tien, *Recipes and Everyday Knowledge: Medicine, Science, and the Household in Early Modern England* (Chicago; London: University of Chicago Press, 2018).

Maier, Michael, *Atalanta Fugiens* (Oppenheim: Johann-Theodor de Bry, 1618), online: <https://digital.sciencehistory.org/works/pc289j53n/viewer/zg64tm73g> (13 June 2020).

Making and Knowing Project, Pamela H. Smith, Naomi Rosenkranz, Tiana Helena Uchacz, Tillmann Taape, Clément Godbarge, Sophie Pitman, Jenny Boulboullé, Joel Klein, Donna Bilak, Marc Smith, and Terry Catapano (eds.), *Secrets of Craft and Nature in Renaissance France: A Digital Critical Edition and English Translation of BnF Ms. Fr. 640* (New York: Making and Knowing Project, 2020), online: <https://edition640.makingandknowing.org/#/> (accessed 13 June 2020).

Matt, Susan J., "Recovering the Invisible: Methods for the Historical Study of the Emotions," in *Doing Emotions History*, ed. Susan J. Matt and Peter N. Stearns (Urbana: University of Illinois Press, 2013), 41–53.

Matthioli, Pietro Andrea, "Corallium," in *Opera quae extant omnia: hoc est, commentarii in VI. libros Pedacii Dioscoridis Anazarbei de Medica materia* (Frankfurt: Nicolaus Bassaeus, 1598), 955–956, online: <https://www.biodiversitylibrary.org/item/30625> (accessed 13 June 2020).

Mensah, Emmanuel, "Exploring Constructivist Perspectives in the College Classroom," *SAGE Open* 5, no. 3 (July–Sept. 2015), online: <https://doi.org/10.1177/2158244015596208> (accessed 13 June 2020).

Norton, Marcy, "Subaltern Technologies and Early Modernity in the Atlantic World," *Colonial Latin American Review* 26, no. 1 (2017): 18–38.

Nummedal, Tara, *Anna Zieglerin and the Lion's Blood: Alchemy and End Times in Reformation Germany* (Philadelphia: University of Pennsylvania Press, 2019).

Nummedal, Tara, and Donna Bilak (eds.), *Furnace and Fugue: A Digital Edition of Michael Maier's Atalanta fugiens (1618) with Scholarly Commentary* (Charlottesville: University of Virginia Press,

2020), online: <https://www.upress.virginia.edu/content/furnace-and-fugue> (accessed 22 July 2020).

Oceana Report, "The Corals of the Mediterranean" (August 2007), online: <https://oceana.org/reports/corals-mediterranean-0> (accessed 13 June 2020).

Ottaviani, Alessandro, "The Coral of Death: *Kunst- und Wunderkammern* between Temporality and Allegory," *Nuncius* 30 (2015): 281–319.

Park, Katharine, and Lorraine Daston, "Introduction: The Age of the New," in *Early Modern Science*, Cambridge History of Science, vol. 3, ed. David C. Lindberg and Ronald L. Numbers (Cambridge: Cambridge University Press, 2006; online published in 2008), 1–18, online: <https://doi.org/10.1017/CHOL9780521572446> (accessed 13 June 2020).

Pitsiulak, Tim, Laakkuluk Williamson Bathory, Koomuatuk Curely, Taqralik Partdirge, Jocelyn Piirainen, Anna Hudson, Georgiana Uhlyarik, and Kenojuak Ashevak, *Tunirrusiangit: Kenojuak Ashevak and Tim Pitsiulak* [= catalogue of the exhibition of the same name held at Art Gallery of Ontario June 16–August 12, 2018] (Toronto, ON: Art Gallery of Ontario; Fredericton, NB: Goose Lane Editions, 2018).

Pliny the Elder, *The Natural History*, ed. and trans. John Bostock and Henry T. Riley (London: Taylor and Francis, 1855), online: <http://www.perseus.tufts.edu/hopper/text?doc=Plin.+Nat.+toc> (accessed 13 June 2020).

Polanyi, Michael, *Personal Knowledge: Towards a Post-Critical Philosophy* (Chicago: University of Chicago Press, 1958).

Principe, Lawrence M., "Chymical Exotica in the Seventeenth Century, or, How to Make the Bologna Stone," *Ambix* 63, no. 2 (2016): 118–144.

Rankin, Alisha, *Panacea's Daughters: Noblewomen as Healers in Early Modern Germany* (Chicago: University of Chicago Press, 2013).

Rijks, Marlise, "Defenders of the Image: Painted Collectors' Cabinets and the Display of Display in Counter-Reformation Antwerp," *Nederlands Kunsthistorisch Jaarboek* 65 (2015): 54–83.

Rijks, Marlise, "Unusual Excrescences of Nature: Collected Coral and the Study of Petrified Luxury in Early Modern Antwerp," *Dutch Crossing* 41 (2017): 1–29.

Rijks, Marlise, "Gems and Counterfeited Gems in Early Modern Antwerp: From Workshops to Collections," in *Gems in the Early Modern World: Materials, Knowledge and Global Trade, 1450–1800*, ed. Michael Bycroft and Sven Dupré (Cham, Switzerland: Palgrave Macmillan, 2019).

Schmitt, Charles B., "Theophrastus in the Middle Ages," *Viator* 2 (1971): 251–270.

Smith, Pamela H., "Knowledge in Motion: Following Itineraries of Matter in the Early Modern World," in *Cultures in Motion*, ed. Daniel Rogers, Bhavani Raman, and Helmut Reimitz (Princeton: Princeton University Press, 2014), 109–133.

Smith, Pamela H., "Itineraries of Materials and Knowledge in the Early Modern World," *The Global Lives of Things: The Material Culture of Connections in the Early Modern World*, ed. Anne Gerritsen and Giorgio Riello (Florence: Taylor & Francis Group, 2015a), 31–61.

Smith, Pamela H., "The Matter of Ideas in the Working of Metals in Early Modern Europe," in *The Matter of Art: Materials, Practices, Cultural Logics, c.1250–1750*, ed. Christy Anderson, Anne Dunlop, and Pamela H. Smith (Manchester: Manchester University Press, 2015b), 42–67.

Smith, Pamela H., "An Introduction to BnF Ms. Fr. 640 and its Author-Practitioner," in Making and Knowing Project et al. 2020, online: https://edition640.makingandknowing.org/#/essays/ann_300_ie_19 (accessed 13 June 2020).

Smith, Pamela H., Amy R. W. Meyers, and Harold J. Cook (eds.), *Ways of Making and Knowing: The Material Culture of Empirical Knowledge* (Ann Arbor Michigan: The University of Michigan Press, 2014).

Smith, Pamela H., and Making and Knowing Project, "Historians in the Laboratory: Reconstruction of Renaissance Art and Technology in the Making and Knowing Project," *Art History* 39 (2016): 210–233.

Stauber, Klaus (ed.), *Reconstructions: Recreating Science and Technology of the Past* (Edinburgh: NMS Enterprises, 2011).

Wachowich, Nancy, "Technologies créatives: expérimentation et pratiques sociales dans les sociétés arctiques / Creative technologies: Experimentation and Social Practice in Arctic Societies," *Études Inuit Studies* 34, no. 2 (2010): 5–19, online: <https://doi.org/10.7202/1003777ar> (accessed 13 June 2020).