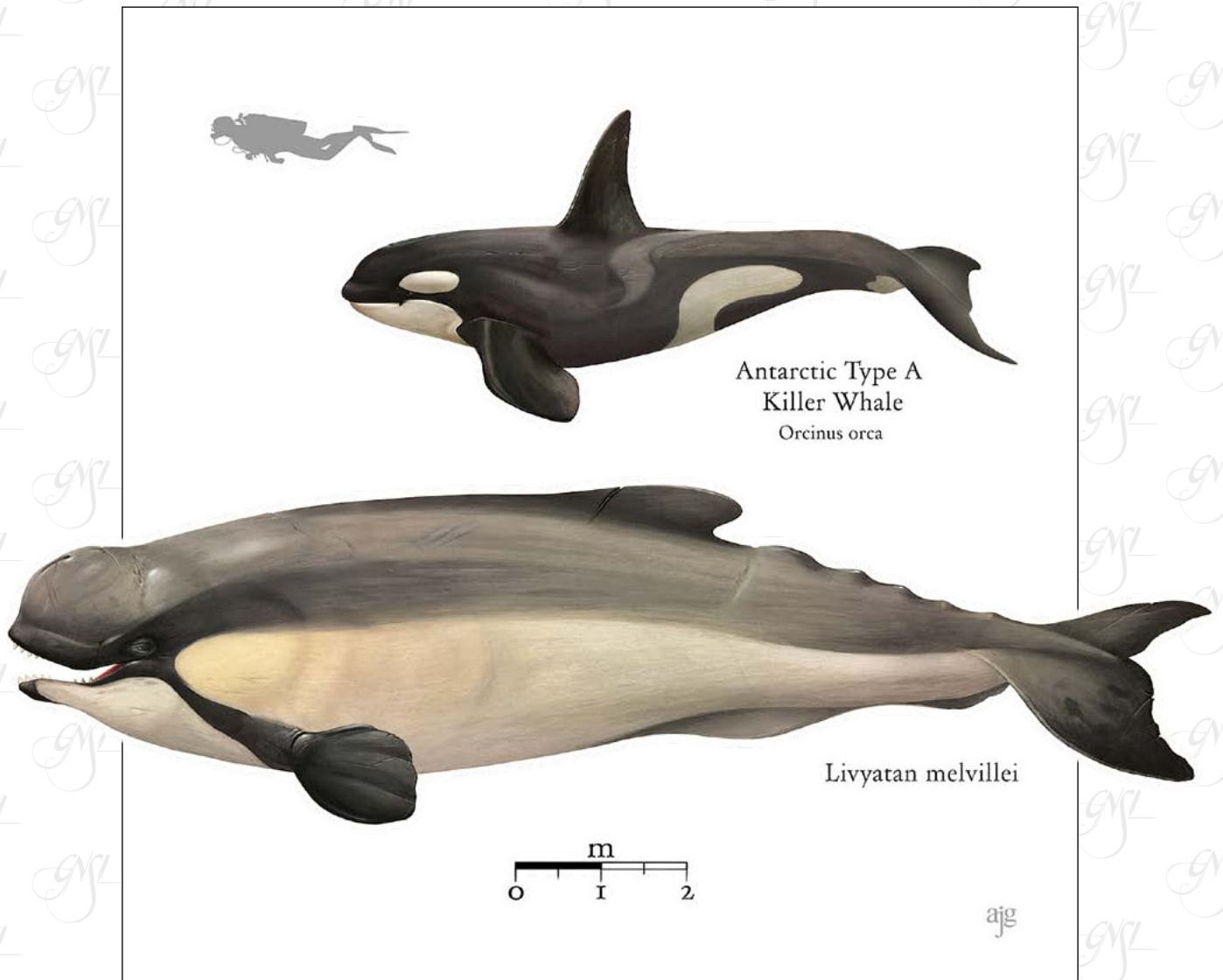


Journal of NATURAL SCIENCE ILLUSTRATION

GUILD OF NATURAL SCIENCE ILLUSTRATORS



A Note From...

Fiona Martin, JNSI Layout Manager

In the milieu of today's news, from COVID-19 numbers to contested political debates, one young protester's sign outside of the 2021 United Nations Climate Change Conference remains etched in my memory. It read, "Every disaster movie starts with ignoring a scientist." How true, I thought, as I recalled movies watched during formative years. I later discovered the original quote was tweeted by Neil deGrasse Tyson in April 2020.

As I'm part scientist, part artist, Neil's quote really resonates with me. It's a powerful reminder of how important our roles are as Visual Science Communicators. There's a movement among scientists and #AcademicTwitter for better science communication as a way to solve some of the world's biggest problems, including climate change, public health, and more. Well, I'm here to shout from the mountaintops—*hire a science illustrator!* We are translators: we visualize research connections, reveal hidden processes, and make complex concepts easier to understand. As visual storytellers, we bring science into the public consciousness.

This issue of JNSI showcases a diversity of visual communication methods, ranging from abstract to cartoon to realistic. Jane Zen experiments with flowing alcohol inks to render cellular immune responses to antibiotics and antimicrobial peptides. A. James Gustafson's reconstructions of almost mythological, prehistoric mammals offer nuggets of wisdom for aspiring paleoartists. Melissa Clarkson describes her work creating reusable, codifiable vector image libraries. A book review, written by C. Olivia Carlisle, reminds us of the dichotomy of Edward Lear's work—humorous cartoon sketches and limericks appear alongside elegant, detailed illustrations of birds and mammals.

Our GNSI president, Kalliopi Monoyios, provides a gallant summary of our second virtual conference, which had more people in attendance than any before, in-person or online! Also included is a summary of the 2021 Annual Business Meeting, and a link to the replay (in case you missed it). Kapi reminds us that volunteers are the heart of the GNSI, and we are grateful to all who have lent an extra hand to help keep the wheels turning.

As the year draws to a close, I wish you a very happy and creative holiday season!

—Fiona Martin, JNSI Layout Manager

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Cover: *Livytan* comparison. Colored pencil and ink. © 2020 A. James Gustafson

NATURAL SCIENCE ILLUSTRATORS



The Guild of Natural Science Illustrators is a nonprofit organization devoted to providing information about and encouraging high standards of competence in the field of natural science illustration. The Guild offers membership to those employed or genuinely interested in natural scientific illustration.

GNSI GENERAL INFORMATION

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CONTACT

P.O. Box 42410 Washington, DC 20015

General Inquiries: info@gnsi.org

Membership Questions: membership@gnsi.org

WEB & SOCIAL:

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GNSI JOURNAL

Volume 53, Number 3/2021 • © 2021

JOURNAL OF NATURAL SCIENCE ILLUSTRATION (JNSI) (ISSN 01995464) is published at 2201 Wisconsin Ave., NW, Suite 320, Washington, DC 20007, by the Guild of Natural Science Illustrators, Inc.

This paper meets the requirements of ANSI/NISO Z39.48-1992 (Permanence of Paper).

POSTMASTER: CHANGE OF ADDRESS

Send notices to:

GNSI Membership Secretary

P.O. Box 42410

Washington, DC 20015

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Insights from GNSI's 2021 Visual SciComm Conference

—Kalliopi Monoyios, GNSI President



Our second online conference is in the books and it was another successful demonstration of visual scicomm excellence, accessibility, and inclusion! Building on last year's successes, Conference Chair Christie Newman and her team took advantage of the ability of the online format to reach far and wide.

All said, we attracted a total of 279 registrants from 20 countries: Australia, Canada, Chile, Finland, Germany, Granada, India, Ireland, Israel, Japan, Kuwait, Netherlands, Philippines, Portugal, Saudi Arabia, Singapore, Spain, Taiwan, the United Kingdom, and the United States. Despite what we've all come to recognize as "Zoom burnout", our attendance numbers exceeded last year's virtual crowd of 262 as well as every one of our in-person conferences. Our presenters were beamed in from seven time zones on three continents, cementing our conference as a truly international event.

By following the same basic format that we pioneered last year, we hosted two days of lectures: July 18th and 19th in four sessions. Sessions were themed and covered ways visual science communication can serve society (*SciComm for the Public Good*), the challenges of communicating the nuance and complexity of science topics to nonexperts (*Communicating Complex Topics to a Broad Audience*), a panel discussion titled *Career Pathways in Visual Science Communication*, and a chance to hear behind the scenes "shop talk" from accomplished professionals in the field (*Advanced Visual Techniques*). Once again, we got great feedback on the interest and utility of watching these presentations, and the vast majority of people who registered watched the entire conference start-to-finish, either live or in replay.

If we heard one piece of constructive feedback from last year, it was that people missed workshops. So, our main upgrade included adding a consecutive weekend to the conference for workshops, held July 24th and 25th. To keep it simple and manageable

from an organizational standpoint, we chose four presenters who would cover a broad array of topics from digital sculpting, to business practices, to field sketching techniques. The majority of the workshops were half-day events. One workshop, Scott Rawlins' *Dry Media for Field Sketching*, took advantage of the entire day to allow for independent working time. In all, the workshops received rave reviews, so we will continue to hone this model for future events.

Other innovations included an animated logo, drawn by Fiona Martin and animated by Bricelyn Strauch, and a series of six Member Spotlights compiled and edited by Bricelyn Strauch. The Member Spotlights were inspired by last year's "shorts" where members like Scott Rawlins and Marla Coppolino shared ideas about field trips with us in short, prerecorded video clips. This year, since we did not have a good substitute for the Technique Showcase, we decided

Above: Five-part conference logo. Courtesy of Fiona Martin, Visualizing Science

Below: GNSI member Scott Rawlins demonstrates how to use a new camera lucida app in a pre-recorded video clip.





Screenshots: (Top) Erin Hunter demonstrated extraordinary skill in watercolor painting. (Middle) Brandon Holt generously shared 3D modeling tips. (Bottom) Mesa Schumacher showed us how she renders quick custom drop shadows in Photoshop. Art © 2021 by individual artists.

it might be interesting to pre-record tips and techniques from membership that would feel a bit like the in-person showcase event. Initial feedback indicated these, too, were well-received. At least one participant exclaimed that this format beats out the in-person Tech Showcase because everyone gets an unobstructed view of the demonstrations in digital format!

As with any year, in person or online, the conference allowed us to showcase the incredible talent we have in our ranks. The juried 2021 Annual Members' Exhibition is available to view online at https://www.gnsi.org/2021vconf_exhibition and features 196 works selected from a pool of 318 entries. Our esteemed jurors for this event included Jane Kim (Founder, Ink Dwell Studio), Paul Mirocha

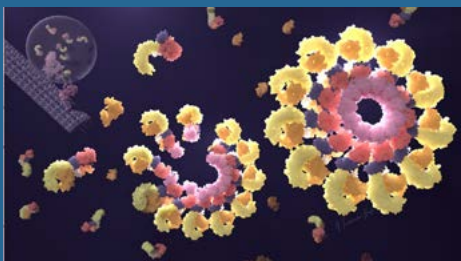
(Independent Illustrator), and Neil Shubin (Paleontologist and author of *Your Inner Fish*).

Our Social Media Director, Jenn Deutscher, also continued the wildly successful online portfolio sharing events we pioneered last year. The Facebook event leading up to the conference showcased portfolio pieces from 30 members. This event allowed for a broader swath of styles and techniques to be displayed than we typically see in our juried exhibition. It also allows members at any stage in their career to showcase their work and get meaningful feedback on it, albeit in the form of "likes" and comments. Jenn also led the open-to-anyone Twitter portfolio sharing event again using the hashtag [#SciArtPortfolioWeek](https://twitter.com/SciArtPortfolioWeek). It's difficult to get a handle on exactly how many people participated during the week, but we do have indications that these

events are increasing our visibility. That week, we watched our followers grow at a rate three times our weekly average for the year, and overall we increased our audience by 39% from 2020 to 2021. This is particularly significant since most of our new Twitter followers are scientists, according to their bios. In fact, this was a key strategic decision for us, as we want to be where our clients are most active. Twitter seems to be the place at the moment.

Once again, our conference also highlighted the generosity of our membership. We pulled off a successful online auction, raising \$3,383 for the Guild Operating Budget and the Education Fund. And we're proud to say that with the help of GNSI's generous donors we funded twelve \$50 grants to make the conference more accessible. In addition, the Great Plains Chapter sponsored one full ride for a student in their region. Again, our presence on Twitter helped in this regard, as we attracted attention in circles where we are less known. A good portion of our nonmember grantees heard about us via Twitter.

On behalf of the GNSI, we'd like to thank each and every one of the 26 volunteers who gave their valuable time to make this conference happen and make it a fantastic experience for attendees. Likewise, the Conference Oversight Committee, led by Joel Floyd, was invaluable in the process. We couldn't continue to offer the inspiring events that we do without your contributions and dedication to our community. We won't be abandoning in-person conferences any time soon, but we hope you agree that our online gatherings have proven to be their own joyous and inspiring events. Thanks, everyone!



2021 ANNUAL MEMBERS' EXHIBITION
This year's GNSI exhibit is available to view online at www.gnsi.org/2021vconf_exhibition. Please share widely on social media!

Image: NLRP3 inflammasome assembly, rendered in Cinema 4D. © 2021 Veronica Falconeiri Hays.

IN CASE YOU MISSED IT...

A Review of the 2021 Annual Business Meeting

—Kalliopi Monoyios, GNSI President

Fifty-some people attended the online Annual Business Meeting on August 4th, 2021. Generally, this event is held during the annual conference over lunch and includes presentations by each of the Board members on what's happened over the past year. This year's format was adapted to internet attention spans and was hosted on Crowdcast, the online presentation platform we've been enjoying for the conferences, so it was a bit different. But different can be good, and we had a lively and productive session.

In a departure from previous years, I divided the presentation into two parts. First, an overview of all the working parts that somehow (miraculously!) come together to keep the GNSI rolling year over year over year. We have changed much since our inception in 1968, but there is no doubt that the dedication and hard work of our volunteers (45 by my count in 2021) has sustained this vibrant organization throughout. I encourage you to watch the [replay](https://www.crowdcast.io/e/2021open-board-mtg), if only to get a sense of how we are currently structured and the many ways our wonderful volunteers regularly pull rabbits out of hats to bring you inspiring stories, events, and professional development opportunities.

If you'd like to watch the replay, you can do so by going here: <https://www.crowdcast.io/e/2021open-board-mtg>

We also discussed how we prioritized programming when suddenly faced with a pandemic and what we'll be focusing on for the coming year. When I agreed to run for president, I had no idea I would be leading this organization through some of the toughest economic times any of us have experienced. But thanks to the hard work and foresight of previous Boards, we have a rock-solid mission I was able to fall back on to help prioritize where we would spend our energy and precious volunteer hours.

As I see it, our mission outlines three areas in which we serve. We bring together individuals working at the intersection of science and art—we create

community. We provide networking opportunities that naturally grow from that community interaction. And we are a perpetual source of critical professional development through the workshops, lectures, and conferences we offer, but also via volunteer positions that build skills and resumes.

THE GUILD OF NATURAL SCIENCE ILLUSTRATORS

is an association of individuals who communicate science visually and clarify scientific ideas. GNSI brings together these individuals and provides networking and professional development opportunities.

Taking stock of all the events and products we offer, I assessed how each one serves these three arms of our mission: community, networking, and professional development. Anticipating that we might face a temporary lull in membership as people tightened their finances, I made it a priority to strengthen the community and professional development areas. I reasoned that if we could keep community members engaged, we

could provide a valuable connection in a time of extreme isolation, and that alone would be worth the price of membership. Additionally, if people were indeed experiencing loss of work, it felt like a positive and proactive time to invest in professional development that might help future job prospects when the economy kicked back into gear.

You know the next part of the story: we pivoted quickly to adapt our in-person conference format to one that translated online. More than that, we busted our chops to take advantage of the online format to the fullest: rather than recreate in-person conferences verbatim, we were motivated to discover how online conferencing could expand and excel over in-person conferences. Likewise, we harnessed the power of online gathering to revamp the Education Fund Workshops and launched the GNSI Symposia Series. Soon, we'll be adding online "Meet and Greet" events for new members. All

of these events were crafted with community and professional development in mind.

Rather than see our membership decrease, we were thrilled to see it swell from 675 to 820 over the course of the year. This is still a tiny fraction of the larger visual science communication practitioner community, but we'll take a 24% increase in membership over the year and call it a win. At this point, it should be clear that the next big step for us is to bolster our networking offerings as an organization.

Traditionally, we have been largely inward-facing. By that, I mean we have been an organization that collects people who do what we do, and the networking and information exchange we facilitated was largely among these peers. People might find great mentors and teachers, friends, and perhaps occasional collaborators, but GNSI has not been a vital job lead generator for most of its history. Now as staff positions grow scarce, we have received consistent feedback that people want networking opportunities with potential clients. The creation of our job board this year is a small step in that direction, but it's become clear that we also need to renew our commitment to "putting ourselves out there" as an organization and helping our members do so in the process as individuals.

We bring together individuals working at the intersection of science and art—we create community.

Our open Board Meeting sparked a great conversation on ways we can look outward and approach this next hurdle. I encourage you to listen to the replay and chime in with thoughts on how we might begin to tackle this outreach/connection issue. Fair warning, if your ideas hold water, I may ask you to volunteer to help make them happen!

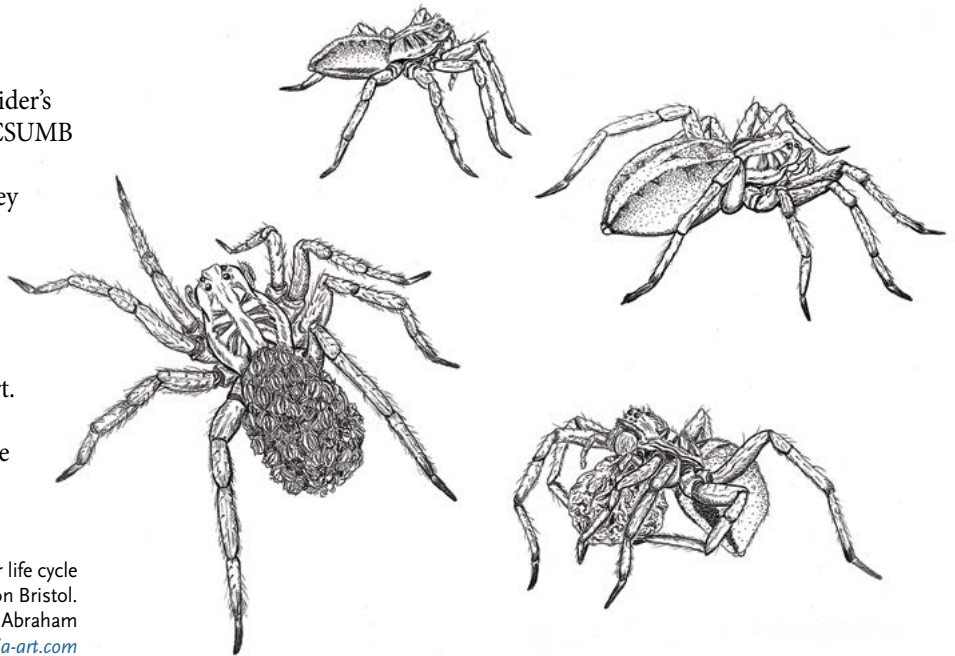
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Our Apologies...

Zia Abraham's lovely illustration of the wolf spider's life cycle was inadvertently omitted from the CSUMB article in our last issue. This illustration was part of the California State University, Monterey Bay's scientific illustration class of 2021's graduate exhibition.

We are always happy to highlight the program graduates' beautiful work, and extend our apologies to Zia for omitting her art.

The digital copy of the last issue that is available online has been updated to include Zia's work.



Right: Wolf spider life cycle (Lycosidae). Ink on Bristol.
© 2021 Zia Abraham
Website: www.zia-art.com

Font Follies — Gail Guth

Every font in this title will be unsupported by the end of 2023 in ALL new-release Adobe products.

You may consider that a good thing—after all, the dreaded Papyrus is in there! But, if you have been doing graphic design for the past few decades, you probably have a fairly large collection of these Type 1 fonts (also known as PostScript, PS1, T1, Adobe Type 1, Multiple Master, or MM) in your arsenal, and you have used them numerous times over the years. Be aware that the Type 1 technology is outdated and has been replaced by Open Type; over the next few years, Adobe will no longer support these fonts in any of their platforms. Photoshop® has already dropped support and other programs will follow suit gradually by 2023. Mobile platforms already do not recognize Type 1 fonts.

What does this mean? Adobe applications will not recognize the presence of Type 1 fonts, even if you have Type 1 fonts installed in your desktop operating system:

- Type 1 fonts will not appear in the fonts menu.
- There will be no way to use previously installed Type 1 fonts.
- Existing Type 1 fonts will appear as “missing fonts” in the document and are uneditable as is.

Embedded fonts in EPS or PDF documents will still be viewable, but you will not be able to edit the documents. Now if they will just make it so we can easily toggle unused fonts on and off...



For more detailed information, read the Adobe articles here: <https://helpx.adobe.com/fonts/kb/postscript-type-1-fonts-end-of-support.html> and here: <https://community.adobe.com/t5/type-typography-discussions/announcement-adobe-ends-support-for-type-1-fonts-for-content-editing-amp-creation/m-p/11807973>

MacWorld has an informative article as well, including information on how to examine your font library and decide what to do next, and where to find substitute Open Type fonts: <https://www.macworld.com/article/344971/adobe-drops-postscript-type1.html>

Fonts used in the title: Aftershock ITC, AINeuland, Bermuda LP Squiggle, CarnivaleDisplayCapsSSi, Cooper Black, Dorchester Script MT, PapyrusCG, Pompeia Inline, RubinoSansICG, Spumoni LP. If you still have programs that can use these outdated fonts, you can do what I did here: set the headline and convert to outlines. At least, you can do this until other platforms follow Adobe's lead and drop support altogether. — Gail

Figure 1: Synergistic Mechanism 3. Alcohol inks on translucent YUPO paper, 11 in x 14 in.

All artwork © 2021 Jane L. Zen, unless otherwise noted



Rendering the Unseeable

—Jane L. Zen, with Dr. Daniela Rivera, Department of Art, and Dr. Donald E. Elmore, Department of Chemistry, Wellesley College

My art explores the intersection of science and art, ultimately acting as visual supplementation to the lab research I have been conducting in college. As part of my thesis project, my goal was to elucidate the molecular mechanisms by which antimicrobial peptides and antibiotics interact to create synergy in killing bacteria. Although significant to both medicine and science, this project is limited by our ability to see these mechanisms in action. My artworks aim to render these mechanisms in ways that are visually engaging and informative to the viewer.

RESEARCH

Antibiotic resistance continues to be a major threat to global health. With the rapid emergence of new drug-resistant bacteria in recent years, many conventional antibiotics have become ineffective, thereby

necessitating the development of new drugs and therapeutic strategies. Dr. Daniel Elmore's lab researches the chemical properties of antimicrobial peptides (AMPs), or short protein sequences that all organisms produce as part of their innate immune

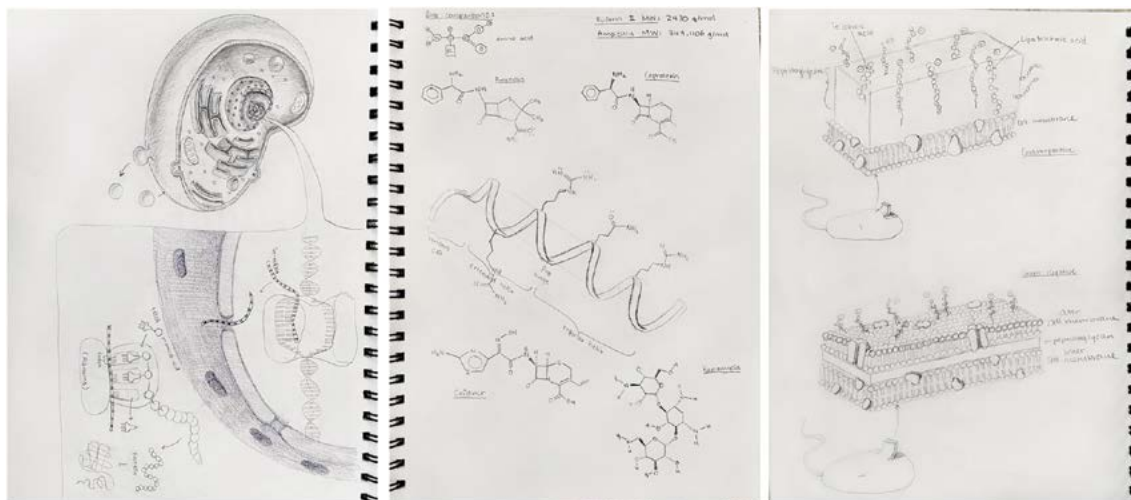


Figure 2: Preliminary sketches. Graphite on paper, 9 in x 12 in each.

systems to ward off disease-causing microbes, such as bacteria and fungi.

AMPs have become an attractive alternative due to the particular advantages they exhibit over conventional drugs, including their ability to avoid microbial resistance. Most bacteria develop resistance to drugs by modifying their surface membranes so that drugs can no longer penetrate them. AMPs, however, possess positive net charges on their surfaces, which enables them to bind directly to and interact with the inherently negatively charged membrane surfaces of bacteria. Through this electrostatic binding, AMPs can disrupt the membrane or penetrate it, leading to bacterial death through either lysis or by the targeting of intracellular components.

THESIS

The experience of studying AMPs was incredibly rewarding for me. My studies in Dr. Elmore's lab enabled me to grow as a researcher, think critically in addressing a question, and learn new experimental techniques at the bench. And as a Studio Art Major, I was able to utilize my artistic interests and skills to address the scientific questions visually, under the guidance of my art advisor, Dr. Daniela Rivera.

My initial goal was to simply identify any patterns of synergy based on specific mechanisms of action for each antimicrobial agent. Afterward, I used biophysical tools such as fluorescence labeling, absorbance spectroscopy, and microscopy to visualize the mechanism of synergy, all of which have been previously used in the Elmore lab to observe AMPs interacting with the bacteria in real time.

DYNAMIC IMAGES

My thesis became an opportunity for me to incorporate artistic elements into my research.

The goal of the "art" side of my thesis was to create illustrations that portray my experimental data and findings in ways that are visually engaging and informative. This trajectory in my thesis—scientific illustration—ultimately became another area of interest for me, and it became an ideal opportunity for me to bridge my interests in art and science.

I started out with rough pencil sketches of general concepts and images, such as the structures of peptides, bacteria, and known antibiotics (*Fig. 2*). This process gave me the chance to think carefully about the information I was handling while planning the



Figure 3: Synergistic Mechanism 2. Alcohol inks on 2 pieces of YUPO paper, 11 in x 14 in and 9 in x 12 in, 2021.

composition of my final pieces, giving great thought to proportion and scientific accuracy.

I then started to consider the more aesthetic aspects such as texture and color. I explored a range of mediums, beginning with dry mediums such as charcoal, graphite, and colored pencils, and then progressed to wet media like watercolor, oil paint, acrylic paint, and alcohol inks. Dr. Rivera introduced me to alcohol inks, and, as a member of my thesis committee, she worked with me tirelessly to examine my pieces and provide feedback on a weekly basis.

Alcohol inks captivated me, and inevitably became the prominent medium in most of my pieces. They dry fast and work well on hard, nonporous surfaces such as glass, plastic, or metal. The alcohol evaporates once applied, leaving behind the dye on the surface that can only be mixed again or removed using an alcohol-based blending solution (90% isopropyl alcohol mixed with a few drops of glycerol). Alcohol inks are noteworthy for their vibrant colors and the diffusive patterns generated when they spread across the surface. The extent of diffusion can be controlled by the blending solution, which works similarly to paper chromatography by interacting with the dyes and carrying them across the paper.

As I explored different mediums, I began learning the unique visual effects each generates and their particular advantages and disadvantages. The alcohol inks were effective in rendering lifelike cellular processes. One can equate the diffusive effects of the inks to the explosive effects of a cell as it breaks down. Compared to mediums such as graphite or watercolors, the effects of the alcohol inks appear more organic and spread more easily, enabling one to create the dynamic effects seen in a cell (*Figs. 1 and 3, previous pages*).

I then explored different combinations of mediums to see if I could create more enhanced visual and textural effects. For some pieces, I used a combination of graphite, pen, and alcohol inks on glass and translucent paper, which succeeded in preserving the cilia and anatomical minutiae of the cell while bringing out the dynamic sensation of cellular breakdown. The use of glass enabled light to illuminate the colors and underlying layers, giving the whole piece the effect of being under a light microscope (*Fig. 4*). The use of translucent sheets on top of more opaque layers created a sense of space and depth one would expect to see if gazing into a three-dimensional bacterium. For some pieces, “happy accidents” occurred when ink or other

Figure 4: Bacterial Destruction. Alcohol inks on translucent yupo paper in glass with light, 11 x 14 in.





Figure 5: Degradation of the cell. Watercolor and accidental spill of india ink, two pieces that are 11 in x 14 in (YUPO paper).

liquid-based mediums spilled onto paper accidentally and created intricate patterns that happened to illustrate something interesting about the cell (Fig. 5).

For other pieces, I combined digital and traditional mediums. I explored several programs, including BioRender® and Molecular Dynamics®, but the protein structures and phospholipid bilayer membranes appeared two-dimensional and lacked the same organic quality as in hand-drawn images. Yet the advantage of these programs is the ability to render illustrations quickly and abundantly, as well as allowing one to fix any mistakes.

I then created several images that combined the two approaches. This involved printing the digitally rendered image on YUPO® paper¹ and using graphite or paint to create additional visual effects (Fig. 6). I found this approach effective and innovative in combining the advantages of both digital and traditional mediums, rather than needing to choose one medium over another.

The use of alcohol inks and combinations of different mediums enabled me to create new visual effects in hopes that the viewer could experience the phenomenon of cells interacting with the peptides—feeling the membrane explosion, the fluidic mess, the

bacterial destruction, and yet the rich aesthetic beauty of the event. I wanted to avoid a textbook schematic or diagram that's sterile and purely analytical. Instead, I wanted to create images that were scientifically correct yet visually dynamic at the same time.

More information: <https://bit.ly/3zZdT6A>



Figure 6: Lysing of the bacterial membrane. Printed black-and-white image of a Molecular Dynamics membrane model, graphite and colored pencils, alcohol inks, glass. 11 x 14 in.



¹ YUPO paper is a synthetic, waterproof, recyclable paper that is ideal for ink adhesion.

Codifying Composable Graphic Libraries

—By Melissa Clarkson, Ph.D., M.Des.

The author describes research into the process of making images understandable to a computer as a system of images that can be combined and repurposed for multiple needs.

Whether we are working in pencil, acrylic, watercolor, or digitally, the work of natural science illustrators serves to describe parts of the world. By communicating knowledge of the natural world one image at a time, we represent knowledge in ways that cannot be captured in words alone. When illustrations are combined with text, this pairing creates a robust mechanism for representing and communicating knowledge.

Computers and the internet have changed how illustrations are created, used, and accessed. Even illustrations rendered in traditional media are no longer confined to the tangible world, but are captured, edited, and distributed as digital images. But one thing that has not changed is the need to

how people interact with information by displaying text, image, or both, based on context and user needs.

My work focuses on the representation of anatomy, which is a subject that requires visual representation for effective communication. I will first describe methods for text-based representations of anatomy, then my approach to creating visual representations of anatomy, and finally my research in integrating the two.

STRUCTURED TEXT

We often use the word “term” to refer to a word (or short phrase) that has a specific meaning in a field of study or practice. But to build for computerized information systems we must be more specific about

what a term is and how a collection of terms relates to one another. Figure 1 shows three levels of organization. A *controlled vocabulary* is a list of terms within a specific domain. A *taxonomy* is a controlled vocabulary with hierarchical relationships among terms (represented by indentations in the figure). An *ontology* is a taxonomy with additional relationships between terms, such as “has part”. Ontologies provide a way to structure knowledge about the world so that it can be used by computers.

A well-constructed vocabulary, taxonomy, or ontology will include definitions for terms. These definitions help to clarify what the authors of the terminology intend for a term to represent. This is necessary when a term is unfamiliar or could be interpreted in multiple ways. For example, “arm” in popular usage refers to the structure from the shoulder to the hand. But the medical definition refers only to the segment between the shoulder and elbow.

One other function of terminologies is to establish synonyms for terms. The terms “oviduct”, “Fallopian tube”, and “uterine tube” all have the same meaning. In addition, different terminologies may refer to the same thing using either the same term or different terms. It is also possible for the same term to have different meaning in different terminologies.

Controlled vocabulary

Hindlimb
Right hindlimb
Left hindlimb
Forelimb
Right forelimb
Left forelimb
Hand
Right hand
Left hand
Foot
Right foot
Left foot

Taxonomy

Anatomical structure
Hindlimb
 Right hindlimb
 Left hindlimb
Forelimb
 Right forelimb
 Left forelimb
Hand
 Right hand
 Left hand
Foot
 Right foot
 Left foot

Ontology

Anatomical structure
Hindlimb
 Right hindlimb
 Left hindlimb
Forelimb
 Right forelimb
 Left forelimb
Hand
 Right hand
 Left hand
Foot
 Right foot
 Left foot

has part

Figure 1: Three levels of organization of terminologies. Examples describing animal anatomy.

support communication by relying on a combination of visual representations and textual representations.

In my research at the University of Kentucky, I am exploring how visual and textual representations can be designed so that computer systems “understand” that an image of an object and the name of that object represent the same thing. Humans quickly learn the equivalence between images and words. If computerized information systems could make the same connection between equivalent images and text, then designers could create interfaces that optimize

All figures © 2021
Melissa Clarkson, unless
otherwise noted.

In the context of information systems that combine information and data from different sources (which may use different terminologies), it is a challenge to preserve meaning if we rely on terms alone. Therefore, standard practice when working with collections of data annotated with terms is to use the term's ID, which uniquely identifies a term, rather than the term itself. For example, in the domain of human anatomy, the Foundational Model of Anatomy (FMA) ontology assigns the identifier 11344 to "Left foot". This is equivalent to "Entire left foot", with code 239919000, in the SNOMED CT medical terminology. The full identifiers for these terms are formatted as URLs that point to information on the web about the term. For these two examples, the URLs are <http://purl.org/sig/ont/fma/fma11344> and <http://purl.bioontology.org/ontology/SNOMEDCT/239919000>.

STRUCTURED IMAGES

The anatomy of most organisms is incredibly complex—particularly the anatomy of humans and other vertebrates. As illustrated in Figure 2, a complete description of an organism's anatomy describes anatomical structures at scales from gross to histological to molecular anatomy throughout the time of development and aging.

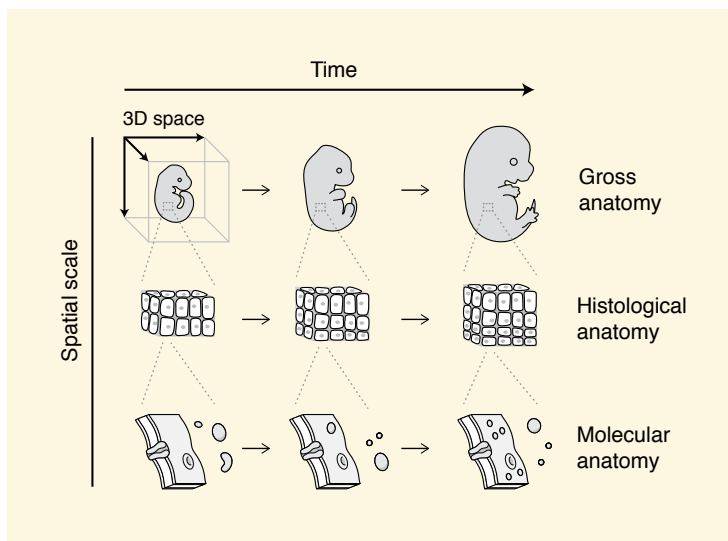


Figure 2: A complete description of anatomy accounts for different spatial scales and development over time. Development of a mouse embryo is shown.

Anatomical atlases use large collections of photos and illustrations, supplemented with a small amount of text, to convey anatomical information. Atlases serve as references for specific types of anatomy. For example, an atlas may describe anatomy of a certain species or a single region of the body. A well-designed atlas has visual consistency across the images as well as relationships among the images. Images might depict sequential stages of embryonic development, represent the same structure at different levels of magnification, or pair

a photograph with an interpretive line drawing. If images designed for an atlas are repurposed for use outside of the atlas, they may lose some of their meaning because they have lost their context.

Anatomical atlases highlight two fundamental needs when representing anatomy for the purpose of documenting anatomical knowledge: the need for systems of images and large numbers of images. This challenge can be framed as the need to create graphic libraries. In the context of graphic design, graphic libraries have been developed to meet challenges in public communication. Examples from two libraries are shown in Figure 3. But unlike the stylized, iconic graphics in these libraries, representation of anatomy requires a different style—one that preserves spatial properties of anatomical structures.

My research focuses on creating graphic libraries for anatomy. My team is developing an approach to creating systems of graphics and large numbers of graphics in ways that will optimize their use in information systems. We use simple, scalable vector graphics (SVGs) that are created in a modular fashion. As shown in Figures 4 and 5 (*next page*), we compose graphics from individual paths, and those paths are reused in different graphics when possible. This allows us to make variations of graphics by drawing new paths for only the parts that are different.

Our system also allows us to create large graphics that reuse smaller graphics. For example, the graphic of the lateral view of a human ear is reused in the lateral view of a human head. Figure 6 (*next page*) shows our method of composing these scenes.

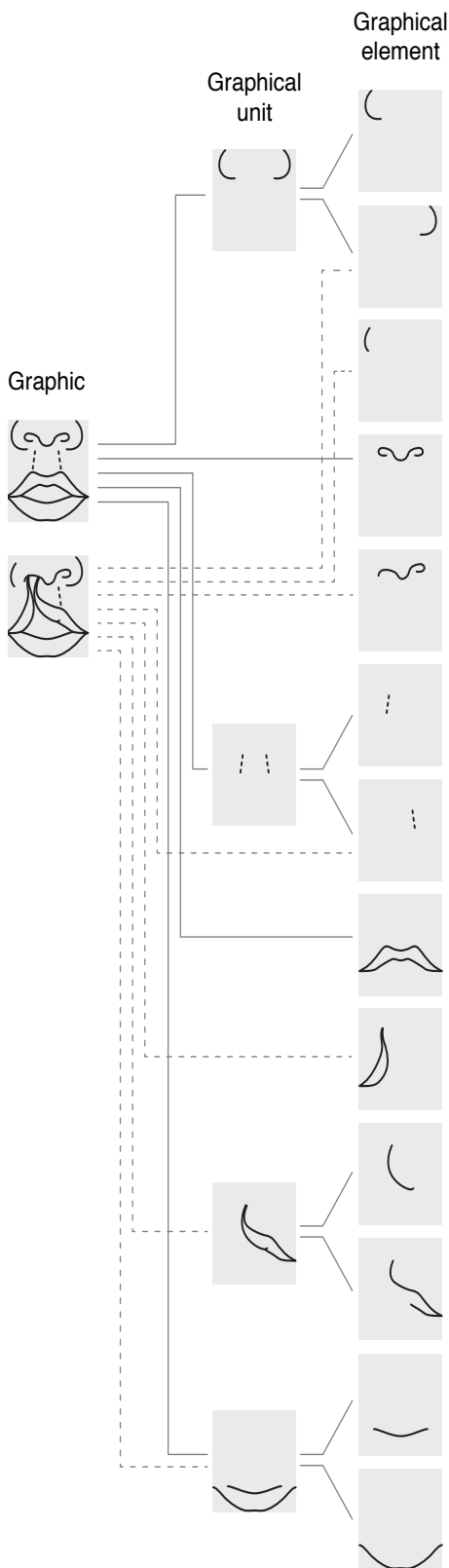
Because the libraries will have many thousands of paths, our process for producing the graphics is a combination of manual design and computer-assisted assembly.

The work begins by drawing the paths in Adobe Illustrator®. Because we are designing systems of graphics, this requires simultaneously designing collections of graphics that will be composed from a common set of paths on the canvas, as well as anticipating how the graphics can be used as part of



Figure 3: Examples of graphics libraries. International transportation symbols created in the 1970s through a partnership between the American Institute of Graphic Arts and the U.S. Department of Transportation (*top row*). Map and recreation symbols from the U.S. National Park Service (*bottom row*).

Figure 4 (below): Graphics depicting canonical anatomy of the nose and mouth and a phenotype of unilateral complete cleft lip. Graphics are composed of graphical units (sets of paths designed to be used together) and graphical elements (individual paths).



scenes on larger canvases. This requires a great deal of small adjustments to the paths so that they will be perfectly aligned when assembled.

Once a set of paths is ready, they are exported as an SVG file and imported into the software my team is building to support this project. The software extracts individual SVG paths from the file and stores them in a database, along with the dimensions of the canvas each path belongs to. We then provide instructions to the software for how to assemble graphics using the collection of paths.

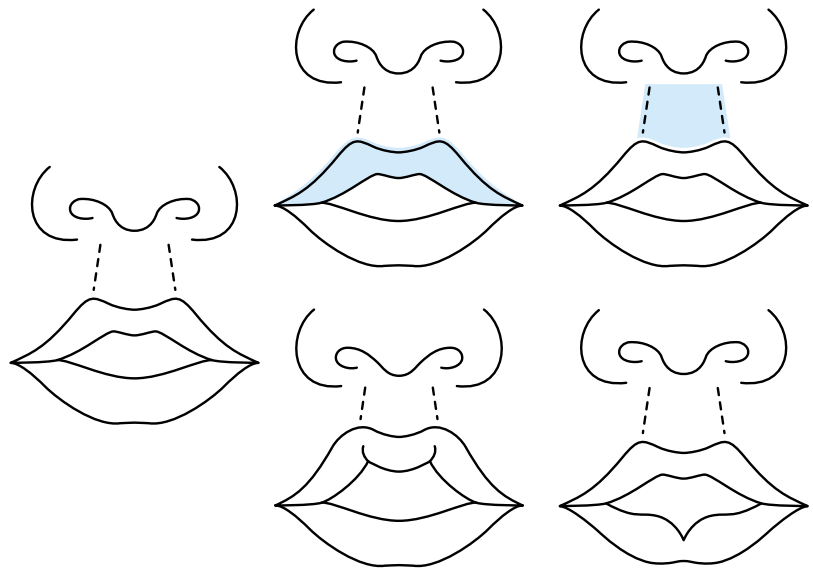


Figure 5 (above): Variations of a graphic depicting regions of the vermillion of upper lip and philtrum (*top row*) and two phenotypes of cleft lip (*bottom row*).

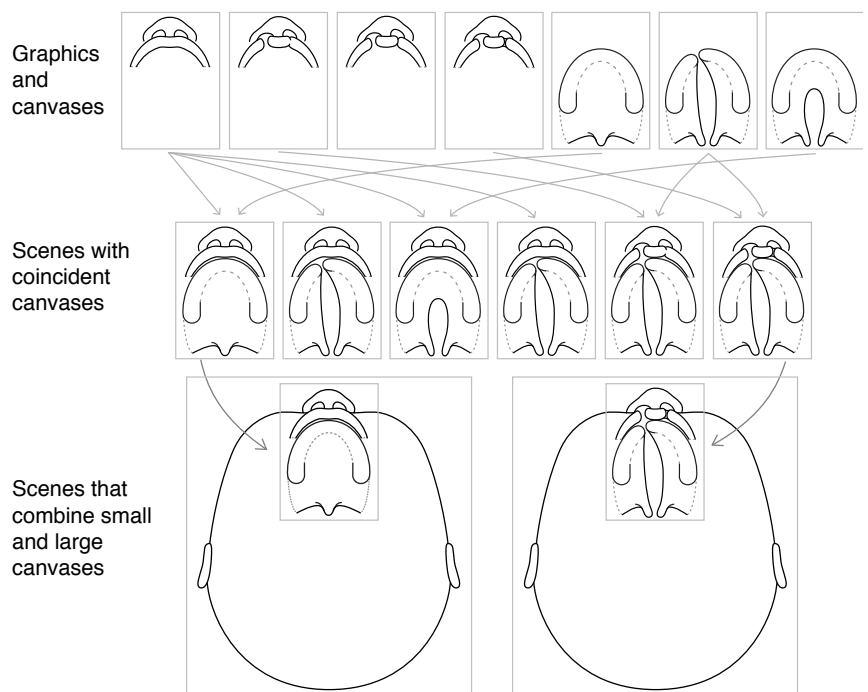


Figure 6 (above): Scenes can be composed by overlaying graphics designed for the same canvas (*middle row*) or by positioning graphics from different canvases (*bottom row*).

INTEGRATING TEXTUAL AND VISUAL REPRESENTATIONS

Each graphic, graphical unit, and graphical element is assigned a unique identifier by our software. These identifiers have a form used internally by our system (such as cfac001323) and a form that identifies them uniquely on the web (<https://endlessforms.info/cfac/cfac001323>). The graphics themselves can be accessed by adding “.svg” to the identifier (<https://endlessforms.info/cfac/cfac001323.svg>).

Recall that terminologies are textual representations, and our graphics serve as visual representations. To link these together, we create mappings between our graphics and terms. These mappings can link a single graphic to terms in multiple terminologies. They may also link a single term to multiple graphics (such as different views of the same structure). Because the mappings will be in a computer-readable format, and the terms and the graphics have unique identifiers, information systems will be able to associate our anatomical graphics with anatomical terms. This will allow designers of information systems to integrate textual and visual representations for anatomy.

FURTHER WORK

This work has recently been funded by the National Institutes of Health. Over the next four years we will be developing graphic libraries for craniofacial anatomy for both children and adults, as well as *in utero* development. We will depict not only surface anatomy, but also muscles, bone, nerves, and blood vessels. Our graphics will include a range of phenotypes and malformations, such as facial clefting.

In addition to creating a very large number of graphics, this project includes research in the representation of computer-readable information. One type of information we will represent is the meanings of the paths that compose the graphics. For example, Figure 5 uses dashed lines to represent the ridges of the philtrum. Other lines in the graphics represent occluding contours or discontinuity of color. Our graphics will encode this information in computer-readable form so that paths can be displayed differently based on their meaning. We will also represent relationships among graphics in the libraries. Some graphics will depict the same structure from different views, others will show the same structure at different stages of development or different severities of the same phenotype. By representing these relationships in computer-readable format, information systems will be able to find graphics within the library that are related.

We are working with anatomical experts and clinicians to ensure that the graphics are accurate

and will support communication and documentation in healthcare settings. For example, if the graphics were incorporated into medical record systems then healthcare providers could select a graphic and add marks to it to help document clinical findings, and the annotated graphic would become part of the patient's record. Graphics of the surface of the body could be used to build patient-facing applications for documenting sites of pain or skin conditions and changes over time. In addition to using the graphics to capture information, they could also be used to display information—such as the sites of lesions or tumors in a population of patients. The graphics could also be used to support personalized communication with patients and families by creating patient-specific brochures for conditions that have variation among patients, as with facial clefting.



This research is supported by the National Institute of Dental & Craniofacial Research of the National Institutes of Health under Award Number R01DE030100. The content is solely the responsibility of the author.

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our progress in creating these libraries on our website: <https://endlessforms.info>



Melissa Clarkson

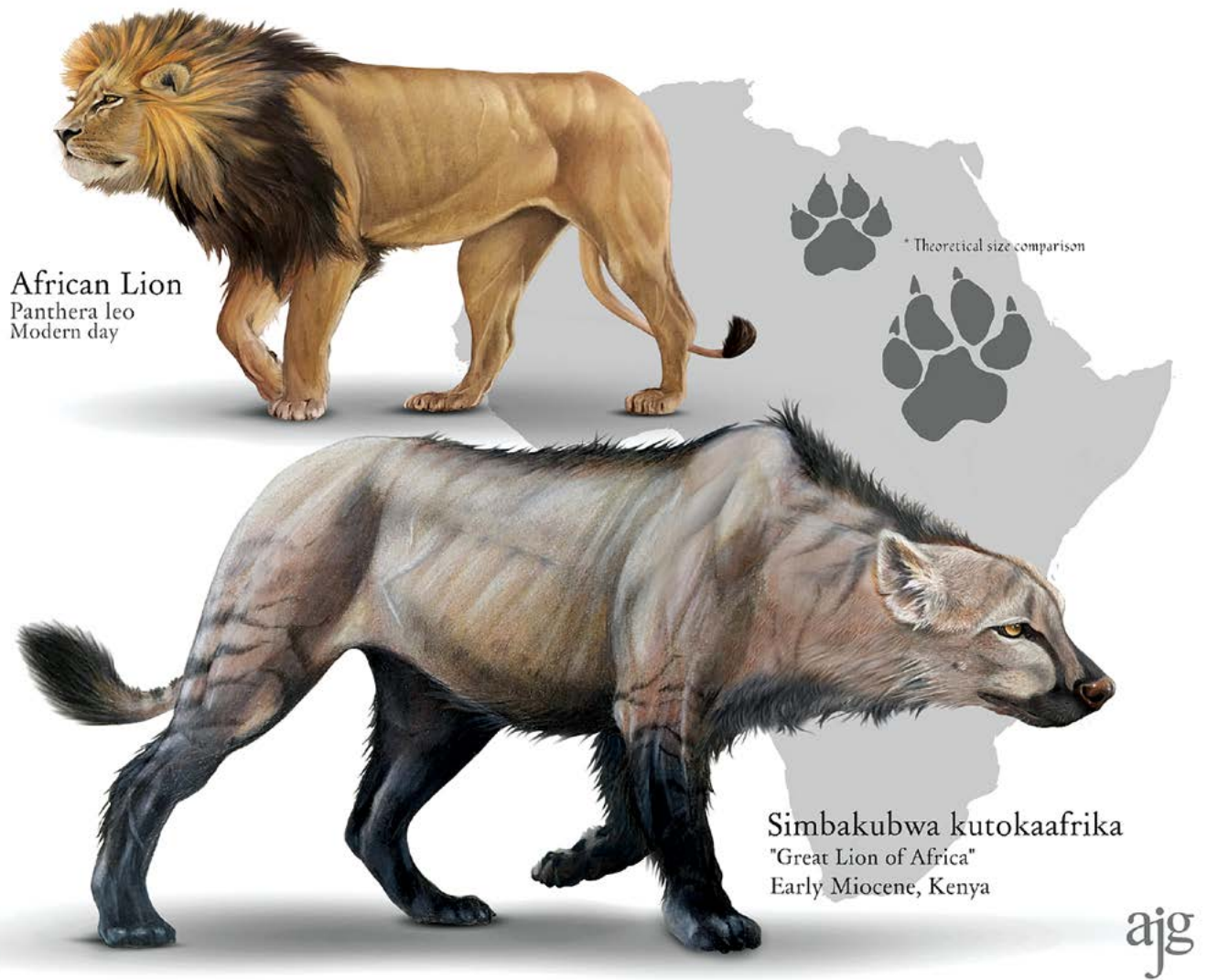
Melissa Clarkson, Ph.D., M.Des., is an Assistant Professor of Biomedical Informatics at the University of Kentucky. She works at the intersection of informatics, design, and life sciences. The overarching goal of her work is to increase the understanding of data and knowledge generated within the life sciences.

Her research has two areas of emphasis. First, understanding and addressing the gap between complex information and the needs of researchers and clinicians, then designing visualizations and interfaces, and evaluating the designs. Her

second area of emphasis is the representation of information within systems—how biomedical ontologies can be used to structure information and provide semantic consistency, as well as the role ontologies can play in making interfaces more useful and usable.

She also has interests in (a) teaching communication skills to scientists and engineers (including visual communication of data, poster design, presentation design), (b) reproducible research and responsible conduct of research, and (c) safety and transparency in the healthcare system.

Contact: mclarkson@uky.edu



RESTORATION OF

Extinct Species

—Anthony James Gustafson

Our ancient ancestors told stories of great prehistoric beasts in the form of drawings on the walls of caves. These animals played a significant role in their daily lives, and they clearly felt their stories were worth telling. And whether they realized it or not, the stories themselves would long outlive those who wrote them. So, in effect, they've been able to tell those stories to us thousands of years later.

I've always been drawn (no pun intended) to art that informs. When I made the choice to pursue art as a career, it was clear to me that the most fulfilling path would be one that allowed me to combine my creative passion with my love of both learning and teaching. I chose a path that would afford me the opportunity to immerse myself in and make contributions to the worlds of science and natural history. It was a chance for me to utilize the talents that I have been given (and have spent a lifetime cultivating) to teach others what I have learned and hopefully instill that same passion in someone else. While my portfolio consists of a wide range of subject matter including everything from biology and natural conservation to medical illustration—prehistoric restoration is without question my greatest artistic passion. And it is in this pursuit that my work has garnered more of a response from viewers than perhaps anything else I do.

New avenues such as social media have provided artists of every stripe with a new and unique opportunity to share their work with a larger audience than ever before. Platforms such as Instagram have allowed me to do the same, all while engaging with followers and social media users—answering questions, participating in discussions, and even spirited debates. There is truly no greater sense of satisfaction for me than when someone says something to the effect of “I had never even heard of this species until now,” or “wow, just imagine how beautiful this animal must have been!” Or, “I want to learn more about this.” These are the moments where I feel I have truly served my purpose as a natural history illustrator. Just as important, however, are the interactions in which someone will push back against my work, question the science behind my choices, or just flat-out refute the accuracy of a particular piece. It is in these moments that I'm able to put my own work to the test, and ultimately prove whether or not it can stand up to the rigors of scientific scrutiny. I am often asked about the process behind creating an illustrated reconstruction of an animal that neither I, nor anyone else, have ever seen in the flesh. However, that process is typically a little more involved than can be summarized within the comment section of a social media post or articulated in 280 characters or less.

I tend to approach restoration much as a portrait artist would. But as you might imagine, the biggest difference lies in the fact that a portrait artist has the luxury of having his or her subject sit for them, or at the very least has access to photographic references of the subject from which to draw. Neither of these are luxuries afforded to a paleoartist.

Unlike our ancestors, these animals are no longer a part of our daily lives. Quite simply, our subjects are

long gone. A good majority of them lived thousands, if not millions of years before the advent of cameras, and sadly man has yet to invent time travel. So, with first-hand viewing not being an option, my initial priority is to create a visual reference of my subject using whatever concrete, scientific evidence is at my disposal, combined with a knowledge of today's living animals. This part of the process begins with research. Lots and lots of research.

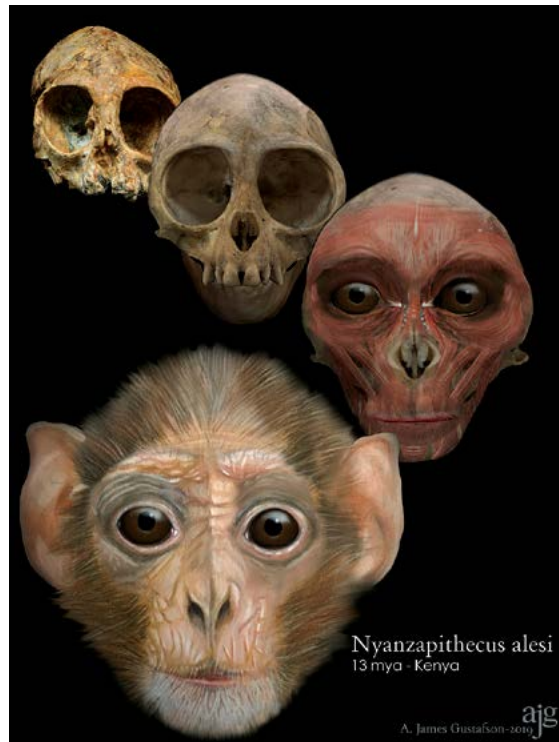
The research process typically begins by consulting the fossil record. Fossilized remains give us the most clues as to what an extinct species may have looked like. Aside from informing us of the animal's classification, be it mammal, reptile, bird, etc.—they also tell us about the animal's basic structure, how it was built, and how it may have moved. It goes without saying that a more complete fossil record lends itself to a more complete understanding of a given species. However, at times, an extinct animal's very existence might be known only from one or two isolated bones, or a portion of its dentition. A few years ago, I was given the task of reconstructing a recently described human ancestor of the late Miocene, for whom the only known evidence is a small section of jawbone and a few scattered teeth. I, of course, informed the author who commissioned the work that the result would be largely speculative. In fact, one professor of anthropology I consulted with essentially told me not to even bother. But, as was my charge, bother I did. Both my collaborator and I were happy with the outcome from an aesthetic standpoint, but if pressed, I wouldn't necessarily defend its scientific merits with the full extent of my conviction. With regards to reconstructing animals for which there are vast amounts of evidence, whenever possible, I prefer to have actual specimens in my hand to observe. This allows me to study them, take measurements, and record observations about any noteworthy features they may display. When this isn't possible, the internet becomes an invaluable tool. There is a wealth of photographic information available online. Several universities and other educational institutions often make databases of their collections available to the public.

While I try to collect as much fossil evidence as possible, bones only tell a portion of the story. They give you a general idea of an animal's physical form, but there will always be things that a skeleton can't tell you. Take, for example, the elephant. Let's pretend for a moment that you had never seen an elephant. If I were to show you a photograph of an elephant's

Previous page: *Simbakubwa* comparison. African Lion (*Panther leo*) and reconstructed *Simbakubwa kutokaafrika*. Colored pencil and ink.
© 2020 A. James Gustafson

Today, one of my main foci... is to challenge viewers' preconceptions of what they believe they already know about the animals of times gone by.

Right: Ape facial reconstruction (*Nyanzapithecus alesi*). Adobe Photoshop®, colored pencil, and ink.
© 2019 A. James Gustafson.
Original photo: Fred Spoor.



skeleton and asked you to draw what you think that animal may have looked like, it is highly unlikely that the final result would truly resemble what an elephant looks like in life. How would you know to include a long trunk where a more common nose would usually appear? Would you observe anything about its skull to indicate large, floppy ears? Being that an elephant is a mammal, you may even be inclined to cover it in fur. As the saying goes, “you can’t know what you don’t know.” And so, once I have gathered a sufficient amount of skeletal references, the research process moves on to hunting for clues elsewhere.

I have found that prehistoric animals have a way of becoming almost like mythological creatures.

In order to get a fuller picture of what a prehistoric creature may have looked like, I want to learn as much about it as I can, beyond the physical. I want to know when it lived, where it lived, and how it lived. What was its environment like? What was the climate like? What did it eat? Did it hunt? Was it hunted? Does it have any living relatives? If not, does it share any common ancestors with any animals of today? All of this information is useful in the restoration process because the answers to these and other questions all play a role in how animals look and why they look that way. An animal’s physical appearance is the result of countless adaptations it has evolved over the course of eras and eons. In nature, physical form usually serves a practical function. A zebra’s stripes help to make it easily identifiable to other zebras, but it also aids in body temperature regulation. A

male lion’s mane never stops growing and becomes darker with age. Territorial by nature, his thick, black headdress broadcasts to potential mates that he is a survivor and excels at defending what is his. It’s these understandings and the inclusion of these types of details that, while never undeniable proof of accuracy, can lend credibility to the educated guesses behind an artist’s hypotheses.

Many of the reconstructions I illustrate are commissioned by authors, publishers, or researchers. But still, there are examples in my portfolio that are self-initiated. These tend to be projects pertaining to subject matter about which I am most fascinated; central among those being human evolution. In 2017, findings were published about a 13-million-year-old infant ape skull unearthed in Kenya. It belonged to a previously unknown species named *Nyanzapithecus alesi*, and was discovered by a team led by Dr. Isaiah Nengo of Stony Brook University and the Leakey Foundation. A fine illustrated rendering of *Nyanzapithecus alesi* accompanied the findings in all of the major publications of the day. However, intrigued by this discovery, I felt inclined to try my hand at my own, independent work on the subject. As a relatively unknown illustrator (as I admittedly was at the time, and perhaps only slightly less known than I am today), one seldom knows whether a discovering scientist would or would not agree with the science behind your reconstruction. But in 2019, I was fortunate enough to find out when I was contacted by Dr. Nengo himself. He had come across my work and was kind enough to reach out to let me know that he was pleased with it. So much so, that he asked to use my reconstruction in his lectures on the subject. It is my hope that this validation is a testament to the careful process by which I went about rendering this particular species.

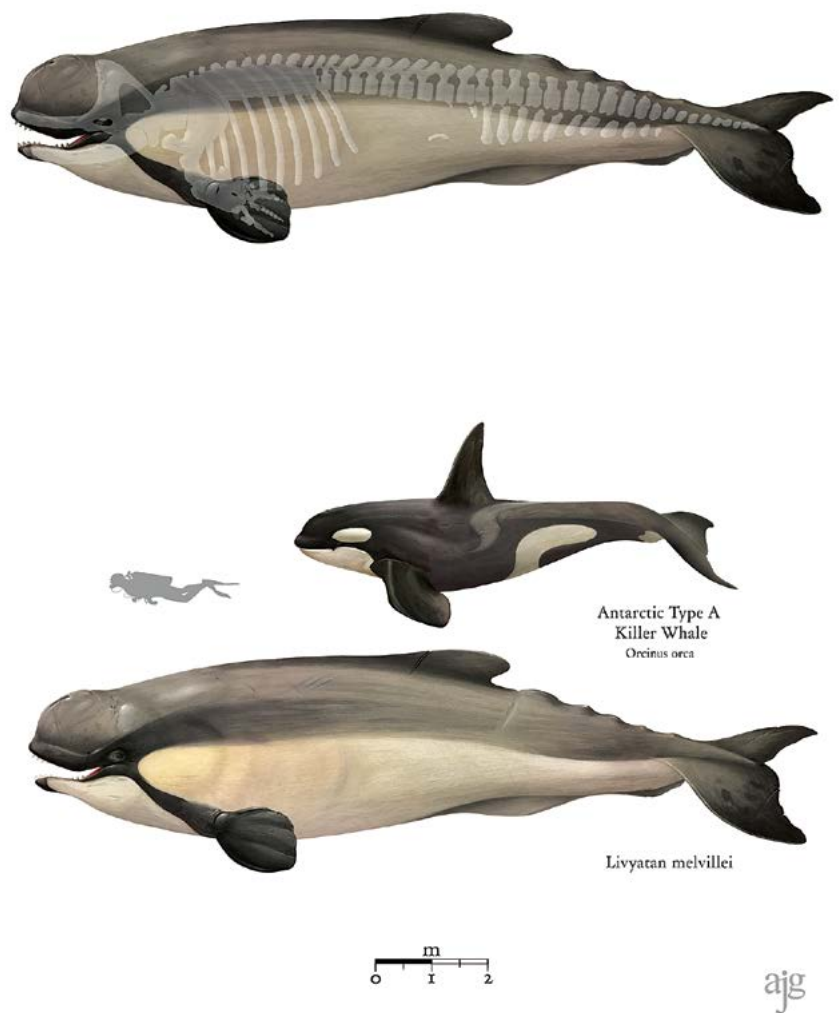
A *Nyanzapithecus alesi* skull, about the size of a lemon, had been catalogued with 360°, three-dimensional images. I began by using these images, along with those of modern day apes, to create a photographic composite model of the complete, intact skull as it may have appeared in life. From there, I reconstructed the musculature and fleshed out the face of a two-year-old primate, using proportions and features seen in juvenile Old World monkeys and gibbons—thought to be their closest living relatives. I believe the result is an image that allows the viewer to gaze into the eyes of an animal that is relatable, which is one of my ultimate goals when approaching any reconstruction.

I have found that prehistoric animals have a way of becoming almost like mythological creatures. Many of them lived in a time that is so distant from

our own, that it's easy to lose sight of the fact that these were living, breathing beings. Many of the restorations I saw during my childhood years seemed generic, almost lifeless. I found it difficult to imagine myself standing before the animals depicted in the books and magazines that I spent time poring over. Today, one of my main foci—apart from creating a depiction that adheres as closely to the available evidence as possible—is to challenge viewers' preconceptions of what they believe they already know about the animals of times gone by.

As an example, I recently undertook a reconstruction of the extinct whale, *Livyatan melvillei*. Many wonderful reconstructions of this great beast have been done. I usually tend to shy away from retracing ground that has been so aptly covered, but there was an angle that I had not previously seen represented in other *Livyatan melvillei* restorations. As a general rule, I do my best not to let existing work influence my own. *Livyatan melvillei* is a distant relative of the modern-day sperm whale. Accordingly, most reconstructions depict him as such. But when I would look at the skull, something much different would come to mind. And so, I set out to reconstruct this ancient cetacean, not as a colorless, vaguely sperm whale-shaped monster reminiscent of Moby Dick himself. Instead, using what I know of the similar skull features exhibited in modern-day orcas and pilot whales, such as the size and shape of the maxillae and supracranial basin, my aim was to create an animal that offers the viewer a slightly different perspective, while not deviating from all that is widely accepted as fact. Because of this, I sought to straddle the line between sperm whales and a more delphinian body shape and markings, blending those physical attributes with that of Pygmy and Dwarf sperm whales—such as the presence of caudal humps and a low-profile dorsal fin. Reaction to my interpretation was mixed, but I was pleasantly surprised to find that most, including some well-known paleontologists specializing in the study of prehistoric cetaceans, were appreciative of my take on this legendary marine mammal.

At times, deviating from what is commonly accepted as the prototypical representation of a prehistoric species can be met with skepticism, even antipathy. This notion underscores the importance of strict adherence to concrete science. I base my reconstructions solely on what is available to me in the form of evidentiary proof. However, illustrations do require artistic choices. But I believe that as a natural history illustrator, it is imperative that making choices does not cross over into taking liberties.



The restoration in my portfolio that has garnered more reaction than any other is an illustration I did in 2020 of *Simbakubwa kutokaafrika*. (shown on [page 16](#)). If you're not acquainted with this species, you're not alone. I discovered through sharing my illustration online that most of my audience was unfamiliar with this Miocene Hyaenodont. A paper describing this African carnivore had only been published about a year prior, after a paleontologist working at the Nairobi National Museum happened upon a previously unidentified mandible in the depths of the museum's collections. The accompanying artwork was crafted by the incomparable Mauricio Anton, and elegantly depicted the terrestrial predator—quite possibly the largest ever—in his natural surroundings. But as paleoartists are often wont to do, I couldn't resist the urge to add an original restoration of *Simbakubwa kutokaafrika* to my own portfolio. I intended to produce an illustrated study that compared him to Africa's modern-day apex predator, the lion; an animal from which the

Above: (Top) *Livyatan* skeletal. Adobe Photoshop, colored pencil, and ink. © 2019 A. James Gustafson. (Bottom) *Livyatan* comparison. Colored pencil and ink. © 2020 A. James Gustafson.

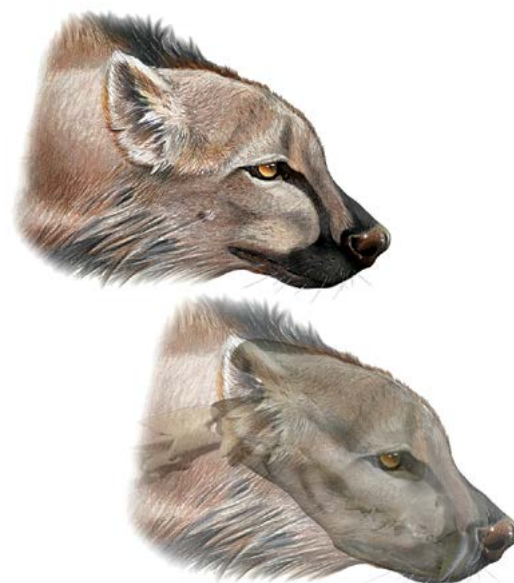
Right: *Simbakubwa* skull reconstruction. Adobe Photoshop. © 2020 A. James Gustafson. Original photo: Matthew Borths.

name of *Simbakubwa kutokaafrika* is derived but shares no familial relation. And, as is my practice, I began by disregarding existing artistic interpretations and started from scratch. I studied the photos and writings describing the known fossil specimens, which are scant to say the least. And, much as I did when tackling *Nyanzapithecus alesi*, I sought to first reconstruct the skull using the existing mandible and partial maxilla as a guide. Determining the proportions and overall size was a bit more complex, as there are very few known postcranial remains. I arrived at his scale by comparing my skull model and the existing calcaneum (heel bone) to that of other Hyaenodonts as well as their extinct and extant descendants. I worked on my restoration of *Simbakubwa kutokaafrika*, on and off, for the better part of a year. I went through several rough drafts. Again, I wanted a final reconstruction that was relatable; one that took cues from that which would be familiar to the viewer, but still represented something unique.



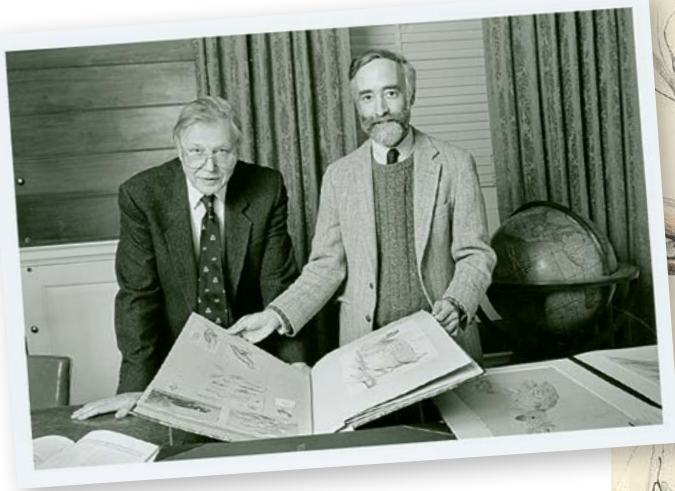
Right: *Simbakubwa* head reconstruction. Adobe Photoshop, colored pencil, and ink. © 2020 A. James Gustafson.

When we look at the apex predators of today—lions, tigers, orcas, and even the emblematic bald eagle—they each have a distinct, striking appearance that is exclusive to them. And so, I believe it is logical to deduce that *Simbakubwa kutokaafrika* would have as well. The final illustration (shown on [page 16](#)) depicts a skulking animal, ears back, and head lowered—perhaps stalking distant prey or warily approaching a potential rival. He sports a dark, wiry mane running down the length of his back that, when fully grown, will not only advertise his virility, but also protect his neck and throat during inevitable battles for dominance and supremacy among his own kind. His short fur is emblazoned with faint stripes and spots at the legs, neck, head, and tail, helping to break up his shape in the spotty forests in which he may have hunted. His steady, piercing eyes are shown leering from behind a black mask designed to shield his vision from the glaring African sun. Speaking frankly, I'm proud of the final result. And as I mentioned, it received quite a response once I did finally share it for public consumption. Much of that response has been positive. Some of it has been skeptical. But it has since been talked about, shared, “liked,” and “disliked” more times than I can count. But what matters most to me is that it has started conversations. It has introduced this largely unknown animal to people who might have otherwise never learned of it.



As I've stated time and again, that is my goal. Sharing what I learn, through the abilities that I have. In fact, that is really the goal of all scientific communication. But unlike other scientific art forms, the aim of prehistoric restoration is to reintroduce creatures, big and small, that once inhabited the landscapes

of our world and now occupy the landscapes of our imagination. The challenge exists in doing so while maintaining a balance between what I can imagine and what I can prove. My job is to help tell their stories. And my responsibility is to tell them as accurately as I can. Because much like our ancient ancestors, I believe theirs are stories are worth telling.



Book Review

Natural History of Edward Lear, New Edition, by Robert McCracken Peck

FOREWORD BY DAVID
ATTENBOROUGH

—C. Olivia Carlisle

Edward Lear (1812–1888) is best known for his witty limericks and nonsense verse. But the celebrated author of *The Owl and the Pussy-Cat* also created some of the most stunning paintings of birds and mammals during an age when many species were just being discovered and brought to private menageries and zoos throughout Europe.

In the *Natural History of Edward Lear*, New Edition, author Robert McCracken Peck, an authority on ornithological illustration in the United States, sheds light on Lear's creativity, productivity, attention to natural science detail, and success as an artist. Through Peck's extensive 20-year research in the Houghton Library at Harvard University, this book contains more than 200 of Lear's beautiful and detailed illustrations of animals, plants, and landscapes.



Peck, Robert McCracken (2021). Foreword by David Attenborough. *The Natural History of Edward Lear*. New Edition. Princeton University Press. 240 pgs. ISBN (paperback): 978-0691-21723-9

Above: Blue and yellow macaw, *Macrocerus ararauna*, now known as *Ara ararauna*, dated December 1831. Hand-colored lithograph, plate 8 from Edward Lear's *Illustrations of the Family of Psittacidae, or Parrots* (1830–1832). Featured on the cover of the new paperback edition.

Left: Edward Lear stamps, author's collection.

Top left: Sir David Attenborough and Robert McCracken Peck re-examining Edward Lear watercolors at the Houghton Library, Cambridge, Massachusetts.





Above Left: Study for Lear's plate of the red and yellow macaw (*Macrocerus aracanga*), now known as the scarlet macaw (*Ara macao*). Watercolor over graphite.

Above Right: Red and yellow macaw. Hand-colored lithograph from Lear's *Illustrations of the Family of Psittacidae, or Parrots* (1830-1832).



EARLY YEARS AND CONTINUING ARTISTIC AND LITERARY EXPERIENCES

During a challenging early childhood, Edward Lear, through his intense curiosity of the natural world, created detailed illustrations with guidance and encouragement from his two older sisters, Ann and Sarah. From these early experiences, Lear developed his artistic skills, ingenuity, and work ethic capturing the essence of life in all of his natural subjects.

As Lear continued his artistic pursuits, he visited the London Zoo as well as the Royal Menagerie at the Tower of London, where he sketched animals and birds from life. Edward T. Bennett, one of the founders and long-time officer of London's Zoological Society, was among the first to enlist Lear's help in depicting the zoo's residents. Bennett, a surgeon with a London hospital and with a private practice, may have been one of the practitioners for whom Lear produced some medical illustrations.

At age 18, after studying lithography, Lear produced an extensive scientific monograph with watercolor overlays titled *The Illustrations of the Family of Psittacidae, or Parrots* (1830-1832). This was the first English natural history book to focus on a single family of birds. Through this publication, Lear established his reputation as the artist of choice for

The author writes of Lear's humor, extensive travels, and his important place in the history of science. He explains how Lear influenced other 19th and 20th century artists such as Beatrix Potter, Maurice Sendak, James Prosek, and Walton Ford.

Robert M. Peck presents an overview of Edward Lear's wide range of artistic talents including detailed illustrations, thumbnail sketches, color studies, painting, lithography, multimedia in single compositions, and poetry.

Right: This cartoon was an example of Lear's "zoomorphism or anthromorphism—making many of his human characters look more like birds and animals." Perhaps Lear waltzing with a bluebottle fly. From *More Nonsense, Pictures, Rhymes, Botany, Etc.*, 1872.





Left: Eagle owl, lithograph, Academy of Natural Sciences of Philadelphia, Drexel University (QL69oA1G6).



Right: Red macaoco, lithograph, Academy of Natural Sciences of Philadelphia, Drexel University, (QL73D4D3).

many of the leading ornithological publishers in Britain in the 1830s and 1840s.

During his preparatory drawing and painting of this monograph, Lear painted color swatches around the birds—testing and developing accurate color recipes for the correct colors of the birds. He also produced smaller thumbnail sketches around the edges—further studies from the birds’ movements during his on-site drawing sessions. After successful artistic experiences in England, Edward moved to Italy, and traveled to Albania, India, Australia, and the Far East.

Throughout Peck’s inspiring, detailed, and entertaining presentation of Edward Lear’s multi-talented life’s journey, the reader will be introduced to a remarkable natural science illustrator and imaginative poet with a knack for limericks, rhymes, and nonsense verse for which he achieved great literary recognition. Many of Lear’s limericks and poems, written in the mid-to-late 1800s, were illustrated depicting some of the animals with human traits.

This book is recommended for study of science art history and techniques, along with a dose of inspiration and humor. Peck provides extensive and informative notes, an appendix, acknowledgements, list of illustrations, selective bibliography, and index.

In the conclusion, Peck writes, “Although they never met, the widely read British art historian and essayist John Ruskin (1819–1900) ranked Lear first among his favorite authors.”



Left: Heraldic Blazons of Foss, author’s collection.



Above: Detailed portrait of a cat. Watercolor over graphite.

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IMAGES TOP LEFT TO BOTTOM RIGHT: SALT LAKE VALLEY FROM ENSIGN PEAK BY BRICELYN STRAUCH, SALT LAKE CITY (PUBLIC DOMAIN), CEDAR BREAKS & LOCAL BIOME BY NATALIA WILKINS | LOGO: NATALIA WILKINS | DESIGN: MARIYA KHAN