Journal of Natural Science Illustration

GUILD OF NATURAL SCIENCE ILLUSTRATORS

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A Note From...

Britt Griswold, Senior Technical Editor

Spring is here and with it comes a new GNSI Journal! We cover an eclectic collection of topics in this issue, reflecting the many aspects of our professional life. Also this Spring, the GNSI is expanding an important aspect of any artist's professional life—the artist's portfolio. This new service is **GNSI Portfolio+**. GNSI members can show off their work as part of the process of promoting and educating the public and potential users about what a science artist does and the scope of the imagery.

We want to encourage everyone to take a preview look at the service at ArtworkArchive.com. You can view the current portfolio collection on our GNSI site (*gnsi.org/visual-scicomm-gallery*), and select an individual artist to view their work. Artists can receive a web link to embed a presentation of their own portfolio on their own website. You can participate by upgrading your membership level: learn more at *info@gnsi.org*.

While you plan the expansion of your visibility through your revamped portfolio, turn the pages of this issue and discover something new. View prehistoric reconstructions, learn how to chart data in creative ways, understand your copyright rights, explore a nature center; and learn how one person created gallery art grounded in science and another begins her career.

Finally, you can plan for your next learning experience by joining your colleagues at the 2023 GNSI Visual SciComm Conference. The Conference is once again virtual and available all over the world. Look for the details of the August 11–13th event—coming to you soon. It's time to blossom and grow with the GNSI!

Email us: *journal@gnsi.org*.

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Cover: Denisovan Girl, Artwork by Maayan Harel, © galaxie/France télévisions 2022.

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

MEMBERSHIP

USA Print: $95/year ($180 for two years)
Global: $115/year ($220 for two years)
Digital Delivery: $75/year ($145 for two years)

Other membership options are available; see website. Secure credit card transactions can be made through *www.gnsi.org*. Or send checks made out to "GNSI" at the address below. Please include your mailing address, phone, and email.

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Stay up-to-date with all GNSI happenings at *www.gnsi.org* and through our monthly newsletter. Here you can update your member information, find announcements about members' accomplishments, information about our annual Visual Science Communication Conference, Education Series workshops, and more. You can also find GNSI on Twitter (*@GNSIorg*) and Facebook (*@GNSIart*).

GNSI JOURNAL

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JNSI STAFF

Victoria Fuller: Inspiration Spurs Conservation

—by Kathleen Marie Garness

Ever since she was a child, Victoria Fuller loved the illustrations in biology and anatomy books. But did she know then that her passion would turn into a calling? She relates: "I grew up on a quarter horse farm in Pennsylvania surrounded by nature. Every day, we had the run of the place with forests, trees, wildlife, corn fields, a pond, a creek that ran through the property, and farm animals. I remember being fascinated by seeing tiny creatures swimming in a water puddle that formed in a hole in a rock; finding caterpillars, other insects; catching crawfish in the creek, seeing fox and deer; galls on the back of leaves, bark and lichen on trees and rocks; frog eggs and tadpoles; and watching robin eggs hatch in a nest on our window sill. My father was a serious hobby photographer, winning awards, and his photos of horses sometimes graced the covers of quarter horse magazines. My mother was an art minor in college. Both parents encouraged my artistic abilities and we often visited art museums. I loved the illustrations that I saw in biology books and encyclopedias, growing up, and also dioramas in natural history museums, so those things were also influences."

Victoria didn't realize that natural science illustration could be a career until she attended the School of the Art Institute of Chicago (SAIC), then met SAIC professor and Field Museum staff artist Zbigniew Jastrzebski, author of *Scientific Illustration—a Guide for the Beginning Artist* (1985: Prentice Hall). At SAIC she also met Olivia Petrides, who illustrated several North American tree guidebooks authored by her father George A. Petrides, botany and biology professor at Michigan State University.

Zbigniew introduced Victoria to the Guild of Natural Science Illustrators. Victoria then went to her first GNSI gathering, at Morton Arboretum, where she took a GNSI summer workshop. Her first conference was the one at Santa Cruz, in 1997. Since then her work—and her commitment to it—has grown in scope and scale, following two primary themes: direct depictions of nature, and sculptures that incorporate unusual manmade found objects such as wall outlets, electric cords, and doorknobs, contrasting made objects with natural ones. She purposefully has them resemble nature in some way and successfully combines whimsical delight in visual puns with a deeper social commentary on the pervasive human impact on the environment.

One of her monumental-scale sculptures, *Canoe Fan*, is installed in Ann Arbor. Reminiscent of the sun on the horizon, a peacock or turkey spreading its feathers, or even a lotus flower opening, it harkens back to our deep connections to nature. In her 2014 exhibition, *Nature Squared*, there were pieces with natural science illustrations and sculptures on cubes.

Above: *Bring Back The Extinct Northern White Rhino*, inflated and deflated. Printed Inflatable vinyl, blower machine, and timer, 156" x 66" x 48", 2020

Factory Farm, Epoxy Clay, Wooden Cube, Gas Pipe, Garden Hose, paper, wire, acrylic, mylar, flocking, 45 1/2" x 32" x 16", 2014

A recent piece, *Bring Back the Extinct Northern White Rhino*, is a powerful response to the news that another iconic animal had gone extinct. Victoria was awarded a City of Chicago grant from the Department of Cultural Affairs and Special Events to create this piece, which was featured in a solo show at Epiphany Center for the Arts in Chicago. It illustrates the extinctions our human cultural choices impose on this and so many other species in real time: every three minutes the sculpture inflates and deflates. "When it inflates, you can see its magnificence, life size; then it deflates like a really sad lawn decoration that people turn off during the day." This exhibition has its own room at the Buffalo Museum of Science, Buffalo, New York, until mid-April 2023.

Northern White Rhinos became extinct because of poachers who sold the horns for the Chinese medicine trade. Humans are causing extinctions within our lifetimes: the Mexican River Porpoise (fewer than 10 remain), Pangolins (the most widely-trafficked animal), Right Whales (only about 100 breeding females are left); plants and insect species are disappearing even before they have been documented by scientists. Victoria wants to make people aware that we are losing these amazing, irreplaceable beings through habitat encroachment, pollution, poaching, chemicals (especially insecticides), and plastics accumulating in the ocean. And on a more local note, Victoria is worried we will lose lightning bugs, which she feels are the most magical insects ever! "We are creating a wasteland."

Victoria has been honored with fellowships from the Colorado Council for the Arts and Humanities and the Illinois Arts Council, and with appearances in galleries, museums, and public spaces nationally and internationally. In January 2023, she flew out to the Artemizia Foundation Museum in Bisbee, Arizona to install six of her sculptures there. Back in the 1800s Bisbee was a copper mining town; now it is a popular and colorful refuge for artists, twenty minutes from Tombstone and other tourist attractions.

Victoria's new work, *Correlative Patterns*, more directly involves natural science illustration. The front polyhedron panel represents *Favolaschia calocera*, an orange, fan shaped fungus with teardrop–shaped holes; another panel has acorn in holes, put there by an Acorn Woodpecker, *Melanerpes formicivorus;* another has a white crab with red dots; another features a green cup lichen; others hold a lotus, a bone under a microscope, and plant cell structures—all things in nature that reveal similar if unrelated patterns.

Her recent exhibition *Project Nature*, was for the outreach arm of the Susquehana Art Museum, the Van Go, a mobile museum on wheels, to reach kids who don't have easy access to the museum.

Always inspired by nature and looking for new and creative connections, Victoria was inspired by a mathematical structure called a Conway Knot, a puzzle not solved for 50 years, until it was finally solved in 2018, by Lisa Piccirillo, who was a graduate student in math at the time. Now Victoria is creating intertwined mathematical knots out of garden and air hoses—how many crossovers can you make from one circle?

One of her most significant and complex works to date is the *Global Garden Shovel*, a commission for Seattle's Sound Transit, near one of its urban stations. The Columbia City neighborhood is Seattle's most ethnically diverse area in the Rainier valley. The concept arose while Victoria wandered the district. She was so impressed that, even when people just had small bungalows and very limited means, they had wondrous gardens, with food plants and flowers spilling over sidewalks — a veritable Eden on earth. The harmony between humans and nature, and each other, inspired her to create this 35-foot-high monumental cast bronze piece, symbolizing the global melting pot of the Rainier Valley, with each plant representing where different ethnicities came from. Strong, resilient vines creep up the handle of the shovel. Sunflowers live happily beside banana plants and cacao trees. Victoria recounts, "The sculpture was shipped whole on a flatbed truck and they had to lift it with a crane. There are steel girders inside; it was bolted to a huge cement slab underground, and then dirt was piled part of the way up the blade to make it look like the shovel head was in the ground. The sculpture is about conservation of the world's most precious commodity: plants, the trees, and flowers which all sustain us. We depend on plants to eat, we depend on them for our oxygen, we depend on them for a lot of things. So, it's an environmental sculpture, reflecting the ethnic diversity of our world but also the Rainier Valley in Seattle…a cornucopia of the world, right there on that shovel."

See more of Victoria's work online:

Global Garden ShovelVideo: www.youtube.com/watch?v=VhzsvXG2oNo

Portfolio: www.victoriafullerart.com

Left: *Global Garden Shovel*, Cast Bronze, 420" x 90" x 12", 2009

A Day at the Flint Hills Discovery Center

—by Gail Selfridge

Above: Outside view of the Flint Hills Discovery Center a regional facility located in Manhattan, Kansas.

All images © Flint Hills Discovery Center unless otherwise noted

Three years of living through the pandemic has left me concerned about the shift in attitudes toward science, and in watching it all I have speculated that the appreciation of nature and subsequently an interest and respect for science does not appear to be inherent in our species, but like many things, it is an acquired/learned ability.

As a child I discovered nature observation and drawing by running around the neighborhood picking up colorful leaves, beautiful (but dead) insects, pretty rocks, interesting pieces of bark, you know…treasures!…then turning those treasures into art. Now that was BC (Before Computers) when things were low–tech, so to make art we just used what was available. Looking back, there were many rich and creative experiences then that required nothing more than a few pencils, erasers, crayons, and plain paper. But today with a superabundance of materials and information, is there still a place for this kind of simple nature observation and learning?

Recently, I had an opportunity to explore this question by participating in a four-day event at the Flint Hills Discovery Center (FHDC). I was listed as a botanical illustrator, and because the event would take place during spring break, visitors would include many parents with children—a perfect opportunity for using *Colorful Leaves*, a program that combines nature observation with simple tools and techniques for learning about scientifically accurate drawing.

Located 8 miles north of the Konza Prairie and 70 miles north of the Tall Grass Prairie National Preserve, FHDC is a large regional facility in Manhattan, Kansas. Visitors include not only local residents but tourists traveling to the area to visit relatives or traveling across I-70 from Kansas City to Denver and points in between. The four-day event (March 15, 2022 through March 18, 2022) featured one artist on each day from 10:00 a.m. until 4:30 p.m. My day was Friday and the weather had been unseasonably warm without the high winds that are not uncommon on the prairie. However, on that day it began to rain and I while I thought that would mean a low turnout, I was assured by the staff that there was a possibility of increased visitation. After all, this was spring break and parents of school age children would be looking for indoor family outings.

Back in 2015 I received the Anne Ophelia Dowden Award from the American Society of Botanical Artists for *Colorful Leaves*, a publication and program of instruction for teaching adults and children how to make leaf rubbings then use them to create scientifically accurate leaf drawings. For an event like this one, which takes place within a short period of time and with an unknown number of participants, the

A: Leaf rubbing activity.

B: FHDC atrium/lobby showing display and work area with both children and adults participating.

C: Participant adding detail to a leaf rubbing.

best place to start is with the leaf rubbing. At this time of year (mid-March) there is no green foliage that is appropriate for the activity so I was out searching for specimens that, although brown and crispy, would still work well. Wanting to make this easy on myself as well as the participants I limited the selection to cottonwoods and pin oaks. Learning about nature begins with observation, and while I could have used specimens from houseplants, the intent of the activity was not just to make some leaf rubbings but rather to introduce and encourage nature observation by using items found outside.

Work station tables were set up with unwrapped pieces of broken crayons, half sheets (8.5" by 5.5") of plain copy paper, and of course the leaves. Each participant had to decide whether to use pin oak or cottonwood, although it was pointed out that cottonwood is the Kansas State Tree (learning number one). The next step was to show the difference between the front side and the back side of the specimen (learning number two). And always there was this question, "Which side should we do?" Answer: "Try both sides to see the difference."

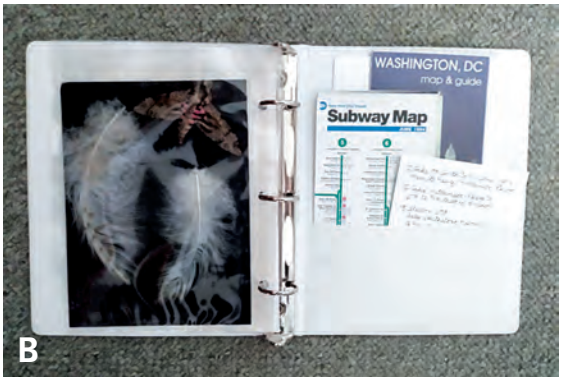
Although making the actual rubbing sounds easy, instruction with demonstration is needed: how to position the specimen under the paper, how to hold the specimen in place once it is under the paper, how to hold and use the side (not the point) of the crayon, how to use firm but gentle pressure on the crayon, and how to bring out the pattern along the edges as well as the pattern of the veins. Once they saw how the process worked many of the children went on to create their own art by overlapping leaves, trying various colors, and drawing over the rubbing. *All this with just some crayons, paper, and a leaf.*

Throughout the day, many adults participated in the leaf rubbing, but some were interested in going to the next level using tracing paper to create a preliminary drawing from the rubbing. For those, tracing paper was available along with a hands-on demonstration of the process and how to then transfer the image to suitable art paper. There was a table with leaf pages that had been printed from *Colorful Leaves* (cottonwood of course) along with colored pencils and crayons. There was a three-panel display that featured images of both adults and children using the online *Colorful Leaves* materials plus a printout of the entire publication that was made available for viewing in a three-ring binder. There were little take-home handouts listing websites for my free online art and science materials. For many, particularly parents with small children, free is always good.

If the program had ended here it would have been considered a success. However, there was one more demonstration/item to which the parents enthusiastically responded. It was the traveling notebook/sketchbook. I'm not referring to those bound sketch books that only include paper, but rather the one I developed for my own use but have also used with children.

Many of the visitors to the FHDC are travelers and preparing for a summer with no school, vacations and trips with children. I have traveled around the

A



B

Above (A): Binder with art supplies. **(B)** Binder with maps, and a pocket for collecting found items like feathers or colorful leaves. Photos © 2022 Gail Selfridge

country by plane, by train, and by car; some of those trips were even with children, *and I have lived to tell about it*. One item that accompanied us on all of the trips was a small three-ring binder with pockets on the front and back covers that held 5.5" x 8.5" sheets of paper, special drawing papers, maps, notes with detailed instructions for maneuvering the way from New Haven, CT to West 11th Street in Brooklyn, or the street map of Washington, DC; you get the idea. Then there is the three-ring punched paper, both lined and blank, and lastly there are the transparent holders: one for sketching tools (pencils, kneaded eraser, pencil sharpener, etc.) and ones for those treasures collected along the way (feathers, pretty leaves, a mummified white line sphinx moth).

Unfortunately, you cannot just go out and buy a traveling notebook/sketchbook complete with all these accessories. You must actually make it yourself; however, one can easily be put together for a very reasonable cost, so I had a DIY demonstration that included sources for obtaining the necessary supplies.

A small three-ring binder can be found at Staples (Avery Economy version, $8.79), and when in stock, punched lined and blank paper is also available there. But my own transparent zippered pouch for holding supplies is no longer readily available and this is one of the most valuable accessories. Similar ones can be found online (plus shipping), but fortunately, ones can easily be made using heavy zipper seal quart size freezer bags, clear 1.88" packing tape, and a single hole punch. Reinforce the edge of the freezer bag with tape (opening at the top) then punch three holes to fit the notebook rings.

Regarding the art supplies: even though I use Berol Prismacolor® colored pencils and Derwent® graphite pencils, these are not what parents on a budget need as beginning art supplies. For them I recommended Crayola® colored pencils, ordinary number 2 pencils, a ball point pen, erasers, and a small pencil sharpener—all available at Walmart, Target, Staples, Hobby Lobby, etc. Special papers of your choice can also be sized and three-hole punched to fit into the binder.

My day at the Discovery Center was well received by visitors, both children who participated in the activities and adults who were interested in sharing the information and free downloads with others. Several of the parents told me how clever the little notebook was and that they intended to use the idea to make some of their own for use on trips over the summer.

For me it provided a way to again test the usefulness of the *Colorful Leaves* material and it was found to still be fulfilling the original purpose of providing simple tools and techniques for exploring and learning about nature observation and about scientifically accurate drawing. The images and text have remained online along with the workshops that show how each workshop leader chose to present and use the same materials but each in a different way. The materials are free to everyone and located on the official ASBA website: *asba-art.org/merchandise*.

It's hard to know where the discrediting of science is going, how it will end, or the long-term ramifications, but I continue to work through outreach programs to encourage learning about nature and science through observation and about scientifically accurate drawing using simple tools and techniques. The intention is not to prepare participants for becoming professional illustrators but rather to reach a broad audience, many of whom suffer from "drawing phobia" and to introduce them to the enjoyment of nature, the appreciation of science, and the pleasures of drawing— activities that can all be pursued for a lifetime.

Member Spotlight

Sara Lynn Cramb

Sara can often be found drawing in her studio with some tea, lazy cats dozing nearby, with a view of the Alaska Range out her window.

I like to say that I draw things for a living. It's what I've wanted to do for as long as I can remember. I grew up in rural Ohio and had abundant time to explore outside when the weather was agreeable, and a wonderful library of beautifully illustrated children's books to pore over when it was not. I illustrated stories on loose sheets of paper that my mom helped me staple together into makeshift books. I wanted to be like my idols: children's illustrators Jan Brett, Eric Carle, and Charley Harper.

My family spent the summers traveling for work and I enjoyed many days of exploring campground trails all over the Midwest. I loved exploring outdoors almost as much as I loved learning about animals. I pored over animal fact books (Zoobooks were my favorite) and watched nature programs in awe (I particularly liked the combination of humor and education on Going Wild with Jeff Corwin). I preferred learning in a more visual way and disliked being in a classroom with dry, image-poor textbooks.

Knowing I wanted to do something related to art for a living, I went to college for graphic design and illustration at the University of Akron. My parents wanted me to pursue something that I was interested in that would also allow me to make a stable living. Graphic design seemed like a way to do art while having a steady income. While in college I took classes and independent studies in children's book illustration, trying to learn as much about the subject as possible. During my last year at college I interned at both the Akron Zoo and the Summit County Metro Parks as a graphic artist, and my passion for working on projects that educate and inform the general public was ignited. I illustrated and designed many signs featuring the amazing animals on exhibit while at the zoo and spent my lunch breaks observing

Above: 50 States map art from *Smithsonian Young Explorers Fact Book & Floor Puzzle: 50 States*, published by Silver Dolphin Books. Illustration © Silver Dolphin Books.

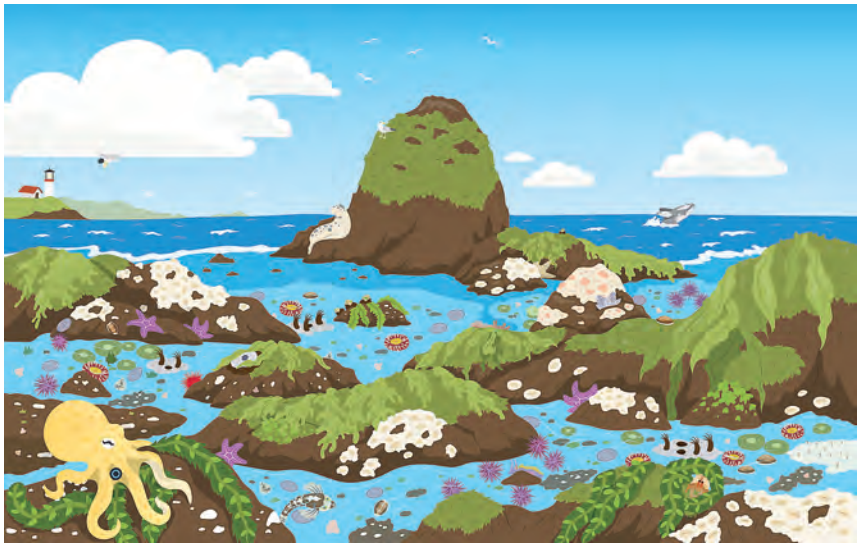
Above: Black-capped Chickadee illustration from *If You Are a Kaka, You Eat Doo Doo*, published by Tilbury House Nature Books.

and drawing the animals. The metro parks internship allowed me to reconnect with spending time outdoors. Both were extremely valuable in helping to shape the direction of my future career.

The next few years after college were a bit of a blur as I secured an in-house design job in Michigan. There, I further honed my design skills and created map illustrations for use on the company's websites. It was during my time there that I realized that while I didn't hate what I was doing, I wanted to draw more. I wanted to refocus and see if illustrating books for a living was really possible. So, I started to work on my illustration portfolio. I spent many nights and weekends building up my portfolio with the type of work I wanted to be creating, and I started to pick up small freelance jobs. Near the end of my time living in the Mitten State, I got married to my longtime partner before moving to Georgia so he could attend grad school.

In late 2013 I started freelancing full time. I worked on a mix of design projects and the occasional small illustration commission. I had a lot of map and animal artwork in my portfolio at the time. To my surprise, in November of that year, Silver Dolphin Books contacted me to illustrate an educational book and puzzle kit about the 50 states which lent itself very well to my skill set. To say that I was elated would be an understatement. I was getting to illustrate a children's book for the first time! This was a dream come true for me. I've illustrated a number of other titles for Silver Dolphin over the years, but this one holds a special meaning for me.

Over the next few years I slowly built up a robust client list of publishers, small businesses, museums, schools, and individuals. I added new work to fill in the gaps in my portfolio in between client projects. I kept my portfolio up to date and reached out to publishers with postcards, emails, and at conferences. Through trial and error I found my publishing agent and started to get a wider range of publishing projects through them. I learned that my first agent didn't seem to value my skill set shortly after signing on with them. They tried to push my portfolio in a direction I wasn't interested in and also pressured me to take on high volume, low paying jobs. I parted ways with them a few months after signing on. About six months later I found my current agency and sent in my work though their submission process. I was accepted for representation and we've developed a good working and portfolio building relationship over the last 5 years. It seems like the changes happened quickly looking back on it, but at the time I remember it feeling like slowly climbing a mountain. There were times of boom, when there were seemingly not enough hours in the day to get through all of my work, and bust, when all of my leads seemed to turn to dust and my inbox was distressingly empty. I learned to pick up more design work when the illustration work slowed and how to create personal projects that would generate passive income through licensing. I also learned how to gain a bit more work/life balance over time by turning down projects that were not a good match for me. I'm still working on all of these skills today—portfolio building, marketing, personal projects, and trying to find balance.

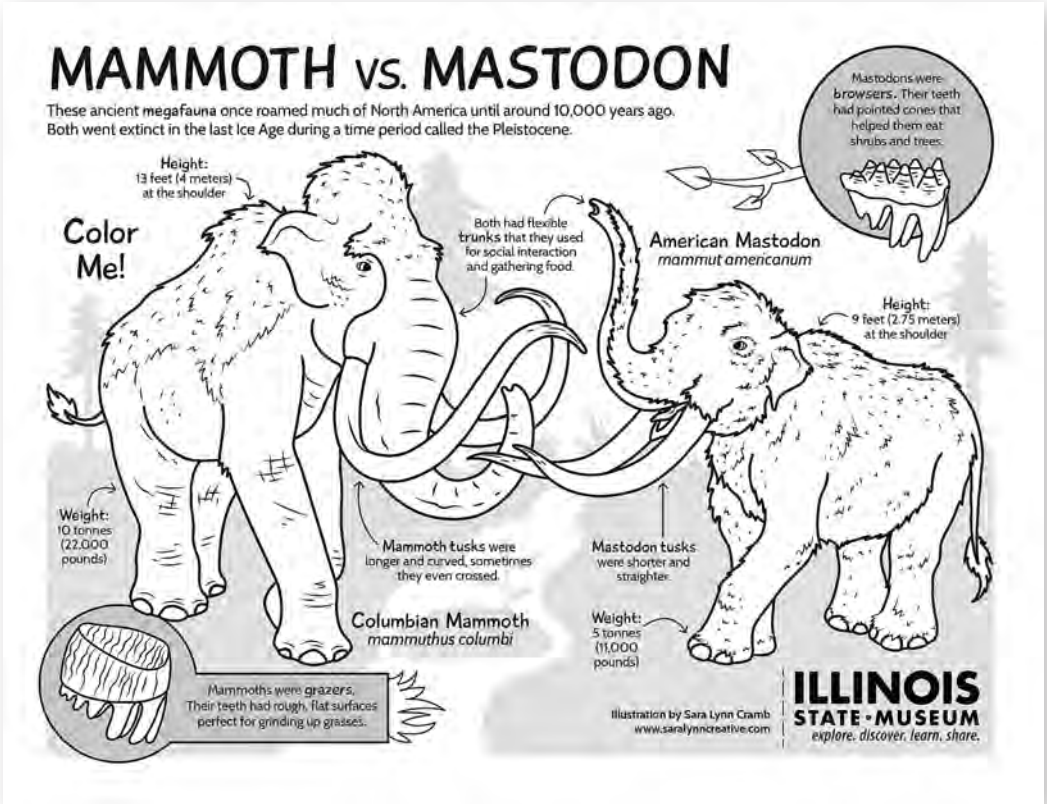


Left: Tidal pool illustration from *Search the Ocean: Find the Animals*, published by Rockridge Press.

Above: Photo of Sara on the atoll of Rakahanga holding a mischievous coconut crab nicknamed 'Citizen Snips', who was found stealing water bottles at the dig site.

2017 presented some unique opportunities and challenges. I joined my partner on a trip to do archaeological research for his doctoral dissertation in the South Pacific. We lived and worked in the Cook Islands for seven months, starting on the main island, Rarotonga, and then traveling by cargo ship to the coral atolls of Manihiki and Rakahanga, and then back to Rarotonga again before returning home. In addition to helping with the excavations, I also did all of the photography and the drawing of unit walls and special surface features, including several coral-lined courts (square or rectangular meeting places, lined with coral blocks and filled with small rounded pieces of coral to act as ground cover). It was an absolutely amazing experience which still informs my work to this day.

Shortly after returning home I started to prepare my presentation on "Creating Educational Illustrations for a Young Audience" for the 2018 GNSI Conference in Washington D.C. I was excited to share what I had learned these past several years about adding

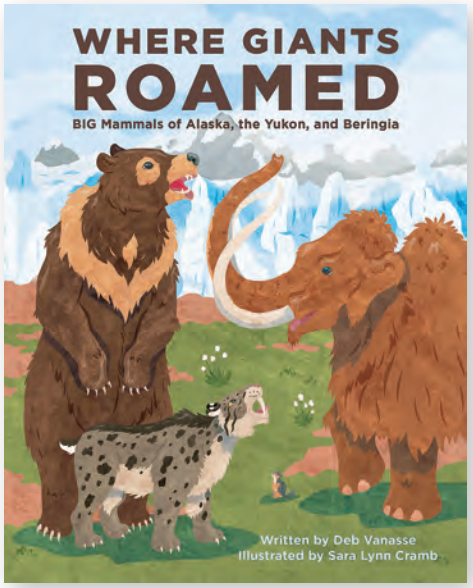


Left: Mammoth vs. Mastodon coloring page, licensed by the Illinois State Museum.

Above: "Thin Ice" textured style study.

Right: Cover art created for *Where Giants Roamed*.

diversity, personality, and clarity to one's educational illustrations. The presentation went well (even though I have terrible stage fright) and I received many wonderful questions from a room packed full of attendees. These conferences are a truly great way to connect and share information and experiences. I met so many amazing like-minded people at the conference, including many artists from Georgia that I had never met before. A small group of us, led by Olivia Carlisle, started to work on setting up a GNSI Georgia Chapter in the months after the conference.



In 2018 I began taking on more publishing work than I ever had before. I slowly added to my publishing list, reaching a total of over 30 educational children's books featuring my illustrations with a wide range of subject matter - dinosaurs, human anatomy, nocturnal animals, scat, ocean life, geography, history, and many more. I was lucky enough to work in many interesting book formats such as picture books, activity books, and interactive kits and puzzles. In addition to children's publishing, I was able to work on a number of other exciting projects over the years. I created illustrations for mobile apps focusing on teaching scientific concepts, museum signage, websites, coloring pages, and character licensing, to name a few. Throughout all of this I continued to draw inspiration from being in nature, and from learning about the amazing plants and animals that inhabit our world.

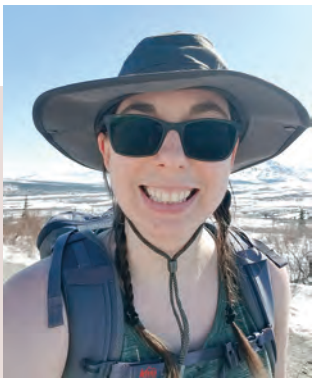
I have been creating self-initiated work for my portfolio for many years to show that I am capable of doing the type of work I want to do. I came up with the idea in late 2019 for my most recent personal project, a series of educational coloring pages that I release to my newsletter subscribers on a bi-monthly basis. This project has allowed me to have a creative outlet in which I research and explore topics that I haven't had the chance to delve into in my client work. These nature coloring pages have led to working on several books with Rockridge Press, and a licensing deal and

Left: "Use Less Everything" illustration created during the 2021 Our Planet Week illustration challenge.

mascot commission with the Illinois State Museum. I am hopeful that even more opportunities will arise as I continue to create them.

In July of 2020 I moved to Fairbanks, Alaska leaving my home for the last 7 years behind in the heart of the early pandemic. My publishing work had started to slow as well, as everyone tightened their belts in the uncertain climate that existed throughout much of 2020. The isolation of the pandemic made adjusting to my new home challenging, but the abundance of natural beauty made it a little easier. The first natural phenomena I witnessed after my initial quarantine was the southern migration of sandhill cranes to Creamer's Field. It was like nothing I had ever seen before, hundreds of giant graceful birds dancing, eating, and making calls so loud you could hear them for miles. Inspired by my new environment, I started experimenting with my work, developing a more textured style that I felt more in tune with. I've recently started to work on client projects in this new style.

Right now I'm working on the finishing touches for a book about the megafauna of Beringia. I'm also continuing to make nature coloring pages and have started developing licensing artwork featuring animals and other natural elements. I look forward to hopefully many more years of creating illustrations that educate, inform, and excite the general public about our natural world. I'm very pleased with how my recent GNSI conference presentation, Illustrating for the Educational Children's Market, went this past August and I am working on ideas for my next talk. I hope to see you there!



Sara Lynn Cramb creates colorful illustrations full of personality for educational children's books, websites, apps and other media with a focus on engaging and educating young audiences about the natural world. She also creates patterns, puzzles, and greeting card designs for art licensing. Sara currently lives in Fairbanks, AK. Sara's portfolio can be viewed at *www.saralynncramb.com*. She can be followed at *@ saralynncreative* on Instagram to see current work.

Off the Charts: How a Personal Project Fueled My Knowledge for Data Visualization

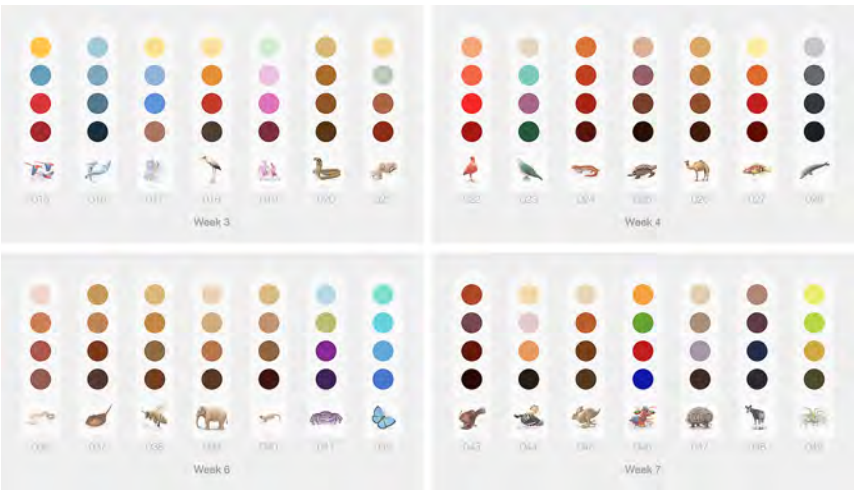
—Diogo Guerra, DVM, dr. med. vet.

Figure 1 (above): Color extraction process. Animal illustrations created by Mesa Schumacher. ©Mesa Schumacher 2021

Figure 2 (below): Examples of weekly color palettes. Animal illustrations created by Mesa Schumacher. ©Mesa Schumacher 2021

In an era of information explosion[1] and misinformation risk[2], Data Visualization (dataviz) is an increasingly important tool for science communication. Scientific artists, as a melting pot of knowledge in Science, Design and Visual Perception, are in a unique position to optimize graphs, and bridge the gap between what scientists want to say and what the audience can understand.

This article explores how I, as a medical illustrator, used a personal project to deepen my knowledge in dataviz (sections 1–3). At the same time, I want to raise awareness for this field within the Sciart community, and provide useful resources for anyone interested in learning more (section 4).

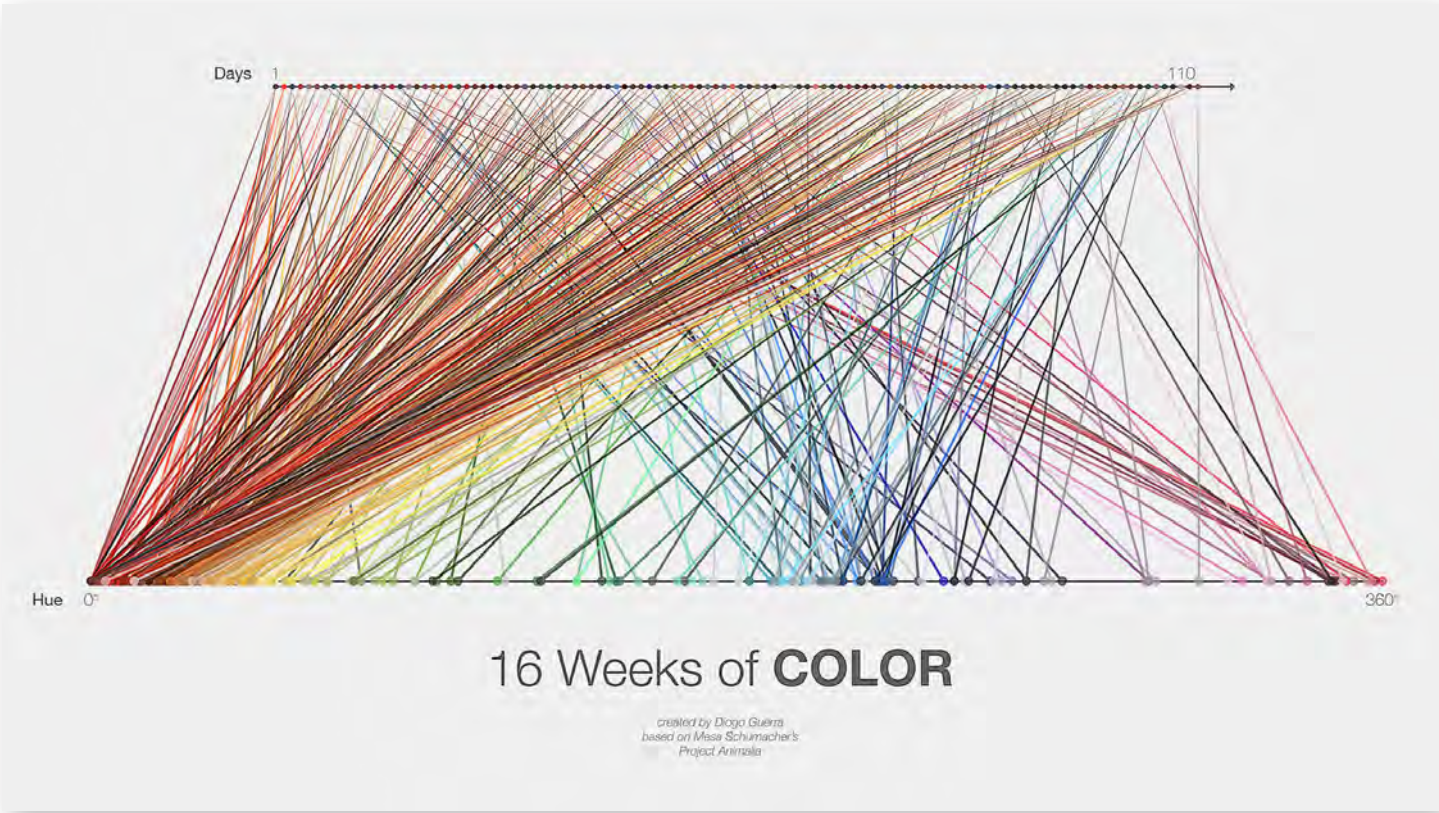


1. GETTING STARTED

By early 2021 I had been working more and more with data visualization for pharmaceutical companies, mostly creating and optimizing scientific graphs on the development of new drugs. I was fascinated by this field and wanted to learn more about different tools and graph types. The way to achieve this came to me as I saw an interaction on Twitter between Mesa Schumacher, a medical and biological artist, and Alli Torban, an information design consultant. Mesa had set herself the task of creating one illustration of a different animal species per day throughout 2021; and for a while, Ali was designing patterns based on these illustrations. This "creativity train" inspired me to start my own regular personal project. As a lover of color theory and color palettes, I began extracting colors from Mesa's drawings and using them as data to create visualizations.

2. METHODS

Each animal illustration was uploaded into Adobe Color® and a four-part color palette generated. The obtained hex codes were compiled in a Microsoft Excel® data-sheet. For each code, I listed the source illustration's day, animal taxonomic group (mammal, bird, reptile, fish, amphibian or others), the HSL and RGB codes (Fig. 1).



Every seven days, I visualized the generated color palettes (Fig. 2); and every four weeks I created a main visualization piece highlighting a particular finding. These monthly dataviz summaries were developed in Flourish® or Rawgraphs® and the final layout designed in Adobe Illustrator® (Figs. 3–5).

3. RESULTS

In the end, thirteen dataviz summaries were created for a total of 365 four-part color palettes (1460 hex codes). Here are some interesting outcomes:

3.1. 16 Weeks of Color

I used a Slopechart to figure out the most frequent hues in the palettes. Slopecharts depict positions of a point at two different times[3]. They are also very useful to display trends, especially when plotting a lot of data. In this loom–like chart, I linked each daily color (top line) with its respective hue value (bottom line). In Figure 3, it is clear how most lines converge to low hue values (reds, oranges and yellows).

3.2. 44 Weeks of Color

I used Radar Charts to create a calendar, showing the color profiles of each week. Radar charts plot series of values over several quantitative categories[4]. In this case, each weekly chart visualizes 28 RGB codes, resulting in colored triangular shapes, where each vertex corresponds to a value ranging from 0 to 255 for the amount of Red (R), Green (G) or Blue (B) (Fig 4.). Although visually interesting to reveal patterns, radar charts may not be the most didactic plot. If your goal is to compare between different numerical categories, use bar charts.

3.3. 365 Days of Color

For the final visual summary, I used a Pictogram chart (top) and a Sunburst plot (bottom) (Fig. 5).

Pictogram charts are similar to bar charts, but they use icons to represent one or more units of data. They are quite useful in communicating with lay audiences, as the icons are more engaging and help frame the context of the visualization[5,6]. Here I wanted to visualize every single color and categorize them by the taxonomic group of their origin illustration.

Sunburst plots can be used to depict hierarchical organizations[7]. Here, color palettes are organized by day, and displayed in a circular fashion to emphasize the cyclic nature of a year. Finally, I was very interested in showing the four parts of the color palettes, organized from darkest (inner ring) to lightest values (outer ring).

Figure 3: Slopechart visualizing 16 weeks of colors.

Figure 4: (A) Radar charts visualizing 44 weeks of colors. (B) Zoomed view showing the colored triangular shapes.

4. MAIN TAKE-AWAY MESSAGES AND USEFUL RESOURCES

Combining a personal project with the need to learn a new skill can be an extremely rewarding and sustainable venture. Here are some of important learnings and resources I collected along the way:

4.1. Learning More About Basic Charts

Set a clear, initial question for your dataviz. Use websites such as The Data Visualisation Catalogue *(datavizcatalogue.com)* or From Data–to–Viz *(www.data-to-viz.com)* to figure out the best graph to visualize the answer to your question.

4.2. Finding Inspiration

Studying other people's work is a great way to learn and get inspired. Platforms like DataViz Inspiration *(www.dataviz-inspiration.com)* or Information is Beautiful *(informationisbeautiful.net/visualizations)* are useful to analyze how others have visually answered similar questions, and understand what does and does not work.

4.3. Collecting Data

Make sure you use accurate data from reliable sources (e.g. peer–reviewed journals or governmental websites). Be mindful of how the collection method may skew the data, as biased sampling and collection will distort the final results.

4.4. Creating and Managing your Dataset

Regardless of the software you are using, get familiar with time-saving spreadsheet formulas. Here's a nice introduction to formulas in Microsoft Excel *(bit.ly/3EJcpTU)*. Furthermore, make sure your dataset is clean before exporting it (e.g. double check there are no typos, and that columns are properly recognized as number/date/word). Finally, pay attention to the language settings and the different roles of commas/periods as decimals/thousands separators.

4.5. Using DataViz Tools

One of the main factors impacting the selection of a DataViz tool is the initial question you want answered, and therefore the graph type you need. Different tools allow you to build different graph types. If you are a beginner, start by using free tools, that do not require coding. Examples include DataWrapper *(www.datawrapper.de)*, Flourish *(flourish.studio)*, Rawgraphs *(www.rawgraphs.io)*, or Tableau *(www.tableau.com)*.

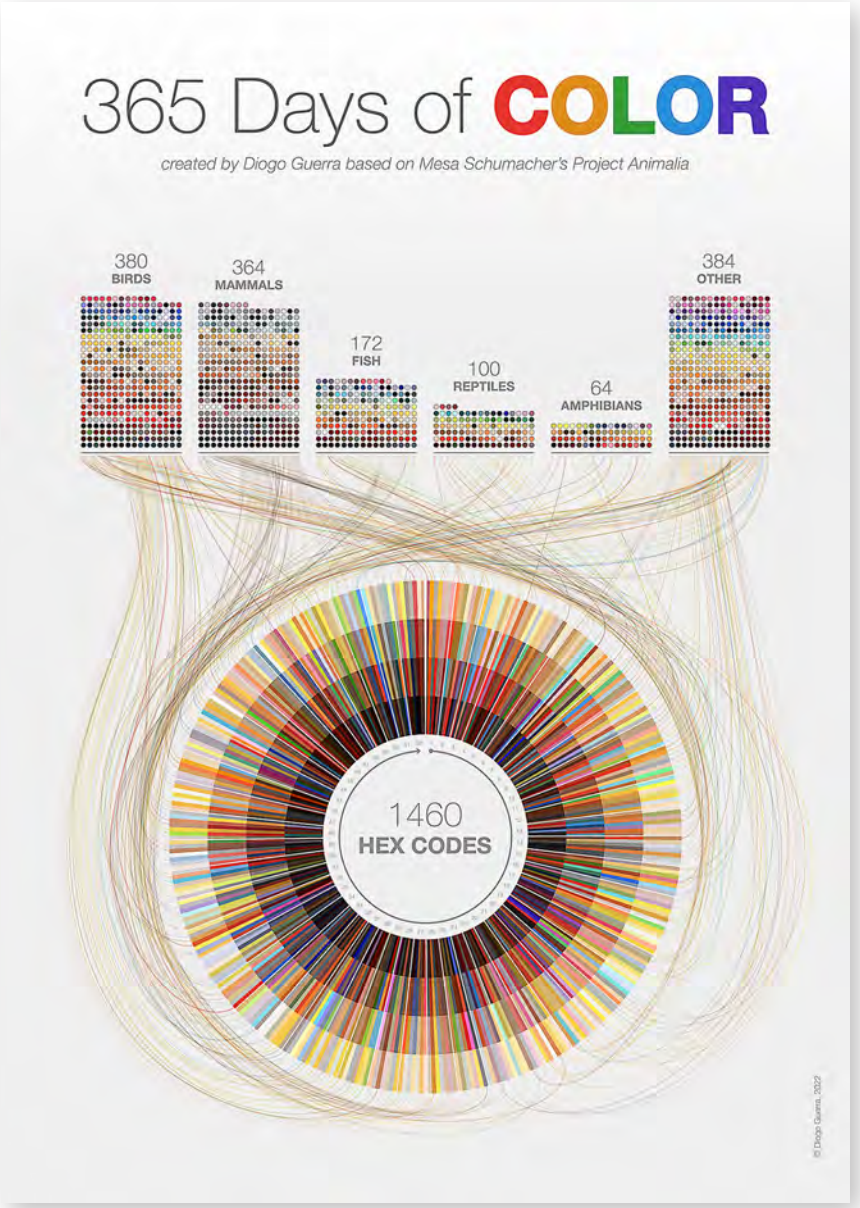


Figure 5: Final visualization summarizing 365 days of color.

4.6. Using Color in DataViz

When designing color palettes for DataViz, do not use too many color categories (max. 5), and make sure you test them for accessibility (e.g. color–blindness, contrast, name).

Adobe Color *(color.adobe.com/create/color-wheel)* is an excellent tool to create and test color palettes. If you want to learn more about colorblindness, check the colorblindness simulator Coblis *(www.color-blindness.com/coblis-color-blindness-simulator/)*, and this three-part post from Datawrapper *(blog.datawrapper.de/colorblindness-part1/)*.

ACKNOWLEDGEMENT

A big thank you to Mesa Schumacher for allowing me to use her artwork in this article. Another shout–out to Mesa and Alli for inspiring me to start this journey. You can view the full project at: *diogoguerra.com/color-dataviz*.

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portfolio: *www.diogoguerra.com*

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The Value of United States Copyright for Natural Science Illustrators

—by *Wm. B. Westwood, MS, CMI*

As visual artists, our livelihoods depend on our skills to create specialized artwork advancing natural science and medicine. Equally important are our abilities to claim authorship and ownership of that artwork, allowing us to build our careers, enhance our professional reputations, secure new clients and achieve financial success.

Authorship and ownership of our artwork is protected by ***copyright law***. Copyright ownership grants illustrators, artists and other visual creators like ourselves almost total control over the use of the images we create.

Copyright is "the right to copy". It's a type of Intellectual Property which grants "authors" of creative works (art, writing, music, videos, etc.) legally protected monopolies over their works for a limited period of time, allowing them to fully benefit from the value of those works.

The concept of protection for creative works hasn't always existed. For centuries in Europe, the Catholic Church and monarchies controlled the development and dissemination of ideas and printed works to the masses. The A.D. 1440 invention of the moveable type printing press in Germany changed this status quo by allowing for the rapid dissemination of new ideas through the inexpensive and rapid production of books, pamphlets and newspapers. Unauthorized copying of these materials, especially books, became rampant. Publishers (and later authors) began to ask for governmental protection against such piracy.

However, protections didn't appear quickly. It wasn't until 150 years later, in 1710, that the British Parliament enacted the world's first formal copyright law promoting the notion of literary property rights. This law was the Statute of Anne. Initially, it applied only to publishers and protected their interests in keeping others from copying their books. There was nothing in the Statute granting creative rights to authors.

Later, in the wake of the Statute of Anne, English courts decided that *authors* should have a perpetual right in the works they created and should be able to profit from their "ingenuity and labor"; protect the association of their name in relation to their work; and have control over how and when their works were published (or not) and by whom.

Around the same time the Statute of Ann appeared, copyright laws in France, Germany, Spain and other countries began to appear as well, following paths similar to those in England.

U.S. Copyright Law evolved directly from the Statute of Anne and is enshrined in Article 1, Section 8 of the Constitution. Our nation's founders recognized the value of intellectual property, and from the beginning of the nation established copyright and other intellectual property rights to protect the works of creative people.

The primary purpose of U.S. copyright law isn't to protect creator's artistic rights. Rather, it is: "*To promote the progress of science and useful arts, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries.*" Through this protection, the goal of the law is to encourage the creation of more work.

You obtain a copyright the moment you create something and fix it in a "tangible form"! "Fixed it in a tangible form" means putting it on paper, canvas, film or computer screen, etc.

Copyright law protects all works of original authorship, including pictorial, literary, dramatic, musical, dramatic and artistic works. However, there are some things copyright does not protect, including ideas. Copyright protects the ***expression*** of an idea, *not the idea itself*.

The duration of a copyright in the U.S. is the life of the creator, plus 70 years after his/her death. In Canada, the term is the lifetime of the copyright owner, plus 50 years. The term varies in other countries. When copyright terms of protection expire on a given work, (or it is forfeited or was never copyrighted) it falls into the "Public Domain". Works in the public domain can be used by anyone, without obtaining permission, but no one can ever own the copyright to that work again.

Rights Granted to Copyright Owners
Under U.S. Copyright law, creators are granted exclusive rights to control the following:

The right of reproduction; you can control how, when, where and if your work is reproduced.

The right of derivatives; a derivative is a revision or modification of an existing work.

The right of distribution; you control where your artwork can be used.

The right of display; a copyright owner can control how and where his/her work is shown.

The right of performance; this right doesn't apply to illustration or artwork, but instead literary, musical, theater, and dance.

Exceptions to Copyright Protection
As stated, copyright protection exists from the moment a work is created in fixed form. However, there are several narrow exceptions to this right of exclusivity.

The first is "work–made–for–hire" (also work–for–hire or WFH). Work–made–for–hire can come about in two ways. The first way is through an employee/employer relationship. If you're employed by a company, you are in a work–for–hire situation. Your employer owns your work and is legally considered to be the creator of any artwork you produce "within the scope of your employment". Employee/employer work-for-hire arrangements are acceptable, because the illustrator receives significant benefits beyond salary.

The second way work–for–hire can potentially come about is if—as a freelance illustrator—a client hires or commissions you to create artwork.

Obviously, this second category can theoretically include almost every project that a self-employed illustrator might be hired to do. Clients' frequently demand that illustrators sign work–for–hire (or all rights) contracts, as a condition of getting a project. Many businesses, magazines, publishers and advertising agencies try to force illustrators to accept these terms as a condition for taking the project. Such clients are well aware of the added value of your copyrights to their bottom lines and will frequently try to bully, badger or intimidate illustrators into signing away their rights. Work–for–hire in these situations can be legal, but is generally not acceptable to the creative community.

However, in this second category, not just any project can be a "work–for–hire". To qualify as such, a project must fall into one of nine specific categories:

1. ***a contribution to a "collective" work***
2. ***an instructional text***
3. ***an atlas***
4. ***a movie or audiovisual work***
5. ***a supplementary work***
6. ***a compilation***
7. ***as a test***
8. ***as answer material for a test***
9. ***as a translation***

Any project commission that falls outside of these categories cannot legally be work–made–for–hire.

It's important to remember that in any freelance situation, just because a client demands you sign a work–for–hire contract, there is no rule or law requiring you to do so. If you do agree to sell or transfer your copyright to a client, it must be done in writing and signed by both you and the client to be legally valid. If you do sell an image's copyright, you forever lose all your ownership rights and control over that image.

Technically, that means you can't put that artwork in your portfolio or post it on social media (display it). It may sound absurd, but you can never even create another similar image (a derivative) from your original sketches without infringing your own work, and risking being sued by the copyright owner!

My advice to illustrators is to resist work–for–hire contract terms and always try to negotiate around such demands. I have done it successfully innumerable times.

Creative Commons

You will also get requests from some authors and clients to grant usage of your work through a Creative Commons license. Creative Commons is a U.S. organization that was founded in 2001 under the concept of allowing "free" distribution of otherwise copyrighted work.

It's important to remember that in any freelance situation, just because a client demands you sign a work–for–hire contract, there is no rule or law requiring you to do so.

A "CC" license is asked for when a publisher or author wants to give other people the right to share, use, and build upon work that an author has created. Creative Commons licenses are only applied to already copyrighted materials. There are six different levels of Creative Commons License usage permissions. The least restrictive allows anyone to distribute, modify, and create derivatives from copyrighted material, including commercial use. The only other requirement is that attribution must be given to the creator.

The most restrictive license still allows anyone to copy and redistribute copyrighted material, but doesn't allow any modification or derivatives of the original work or commercial use and attribution must still be given to the creator.

My recommendation regarding these types of licenses, is to avoid them if you can. But if you do agree to let an author use your work under a CC license, it's best to only agree to the most restrictive version.

Fair Use

Yet another exception to a copyright owner's complete control over the use of their protected creations is "Fare Use" OR "Fair Dealing". Fair use allows use of another's work without the copyright owner's permission. The Fair Use doctrine "promotes freedom of expression" by permitting unlicensed use of copyrighted work for certain purposes—such as news reporting, criticism, commentary, or parody. If use of a copyrighted work qualifies, then it wouldn't be considered an infringement.

The fair use doctrine sets out four factors the courts consider in determining whether or not a particular use is fair:

1. ***The purpose and character of the use***, including whether such use is of commercial nature, is for nonprofit/educational purposes or is in some way "transformative" (i.e. creating something new adding new meaning to the original)

2. ***The nature of the copyrighted work*** (what was it created for)

3. ***The amount of the portion used*** in relation to the copyrighted work as a whole

4. ***The effect of the use upon the potential market*** for, or value of, the copyrighted work

The courts try to make balanced applications of the four factors in every case. However, the distinction between fair use and infringement can be unclear and is not easily defined. The factors are vague and different judges in different cases often make different rulings. Still, knowing about and understanding fair use is important for scientific illustrators so they can protect their own work and know how to avoid infringement when using the work of others.

Copyright Notices

Before 1989, a copyright notice—either a "C" with a circle around it or the word "copyright" was required on copyrighted art to signify protection. Today, in the US and most other countries, copyright notices are not required on your artwork. However, use of a copyright notice is still important and should always

accompany your work, because it informs the public that your work is protected and identifies you as the copyright owner.

Copyright Registration

In the U.S., registration of your copyright with the Copyright Office in Washington, D.C. serves to provide verifiable evidence of the ownership and date of creation of an illustration or piece of artwork. Copyright protection does not require government registration to be legally valid, but for works created in the U.S., it is highly recommended because it allows a copyright owner to more fully enforce their protection through legal action if the work is infringed.

Copyright registration is a simple, fast, and relatively inexpensive process. (The electronic filing fee for one illustration for a single author is currently $65.00 online). At *www.copyright.gov*, you fill out an online application, file a "deposit" (digital copy of the artwork) and pay a fee. In several months the Copyright Office sends you a "Certificate of Registration", formally establishing legal evidence of your ownership of the copyright to the registered image.

Illustrators may register up to 10 unpublished works as a collection on one application, with one title for the entire collection, if certain conditions are met. (Cost $85 for all 10.) If illustrations have been published prior to registration, they must be registered individually, at a cost of $65 each.

There's a popular myth online that you can avoid copyright registration fees by mailing yourself a copy of your artwork and not opening the envelope until you need it for proof of copyright ownership. This myth is called the "poor man's copyright". It is untrue. There is no provision in the copyright law regarding any such type of protection, and it is not a substitute for registration.

Copyright Infringement

Copyright infringement is the unauthorized use of a copyrighted work, violating one or more of the exclusive rights granted to a copyright owner. In today's world, in large part due to the internet, "copyright infringement" or "theft of creative works"—especially visual works, is rampant—but it's not new!

Artists, writers and musicians have been plagued with the piracy of their creative work for hundreds of years. During the medieval period, artists and writers resorted to curses and threats of bodily harm to discourage thievery and piracy of their works.

FIgure 1: Albrecht Dürer's self-portrait at 26, 1498, oil on panel.
Source: Wikipedia, PD-Art

In the 16th century, the famous German artist and printmaker Albrecht Dürer (Fig 1) often complained about other artists copying his work and selling these copies as their own. In an attempt to ward off the art thieves and protect his works, he placed this threat at the end of his book the *Life of the Virgin*:

> *"Hold! You crafty ones, strangers to work, and pilferers of other men's brains. Think not rashly to lay your thievish hands upon my works. Beware!*
>
> *Know you not that I have a grant from the most glorious Emperor Maximillian, that not one throughout the imperial dominion shall be allowed to print or sell fictitious imitations of these engravings?*
>
> *Listen! And bear in mind that if you do so, through spite or through covetousness, not only will your goods be confiscated, but your bodies also placed in mortal danger."*

Fortunately, today we don't have to rely on physical threats or curses to try to ward off thieves, pirates and infringers, we have Copyright law. In the U.S., someone who infringes your artwork, can be sued for actual damages (monies lost) or statutory damages. Statutory damages can range from $250.00 to $30,000.00 for a "non-willful" (accidental) infringement or $750.00 to $150,000.00 for a "willful" (knowing) infringement, if the artwork has been registered with the Copyright Office BEFORE infringement occurred (timely registration).

If your work is properly registered, you can find copyright attorneys who will work with you on a contingency basis, costing you little money to pursue an infringer. If your work is not registered prior to an infringement, the most money you can ask for is an amount equal to what you would normally license your work for, plus must pay your own legal fees.

Just this year, the U.S. Copyright Office has launched a new Copyright Claims Board to help creators resolve certain smaller copyright claims disputes. This is an "alternative" to having to sue an infringer in Federal Court, with its attendant expenses and difficulties. CCB cases will be heard by a tribunal of three copyright experts and cases can be brought by creators without having to hire an attorney for a cost of about $100. Penalties awarded in a successful case can range up to $15,000 for a work registered prior to infringement and up to $7,500 for a work not registered prior to infringement.

The main potential shortcoming of this new legal proceeding is that the person or company you might want to sue has the right to "opt out" of the proceeding. The CCB has just begun to hear cases, so we'll just have to wait and see how successful it will be in resolving copyright disputes.

Reference Illustrations & Copyright Infringement
As illustrators, we have to be extremely careful using the artwork of others as "reference". It's easy to over-rely on someone else's work and become an infringer. There is nothing to stop you being inspired by the work of others, but when it comes to your own work, start with a blank sheet and do not try to copy what others have done.

In conclusion, copyright grants you control over your artwork, enabling you to leverage the value of your work in the marketplace. This control allows you to earn a better living and profit from your work beyond its original use. The illustrative work of scientific illustrators educates and inspires others and its value and usefulness can be greatly enhanced through understanding and managing the copyright protections granted to us all. These protections are worth guarding.

Additional copyright references:
Circulars at the U.S. Copyright Office at *www.copyright.gov*

The Copyright Zone, A Legal Guide For Photographers And Artists In The Digital Age, by Jack Reznicki and Edward C. Greenberg, Esq.

Graphic Artist's Guild Handbook Of Pricing & Ethical Guidelines

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William B. Westwood, MS, CMI, FAMI

Bill is a Georgia Medical Illustration Program graduate with over 40 years of experience in Medical Illustration. He worked at the Mayo Clinic in Rochester, MN for ten years before leaving to establish his own successful business in Albany, NY.

Bill is a Past-President of the AMI, a Fellow and is Board Certified. His medical artwork has won 37 awards, including a Billings Gold Medal from the American Medical Association. He is a recipient of the AMI Lifetime Achievement Award and the Brödel Award for Excellence in Education.

Bill is a frequent speaker on business issues affecting medical illustrators (negotiation, copyright, contracts, pricing, etc.) and a long-time panelist for a popular regional call-in radio program, "The Copyright Forum" on WAMC Northeast Public Radio.

Bill has taught "Business Practices for Visual Artists" as an Adjunct Instructor at the Sage Colleges, in Albany, NY and is currently on the Adjunct Faculty of the Medical Illustration Graduate Program at Augusta University.

Portrait of a Denisovan Girl: Reconstructing Anatomy Without a Skeleton

—Maayan Harel

Paleoanthropology has been undergoing a revolution in recent years due to the development of faster and more advanced methods of working with ancient DNA. One hub of this activity is Denisova cave in Siberia. The cave is located in the Altai mountains, a region thought to have been inhabited by Neanderthals as well as modern humans.

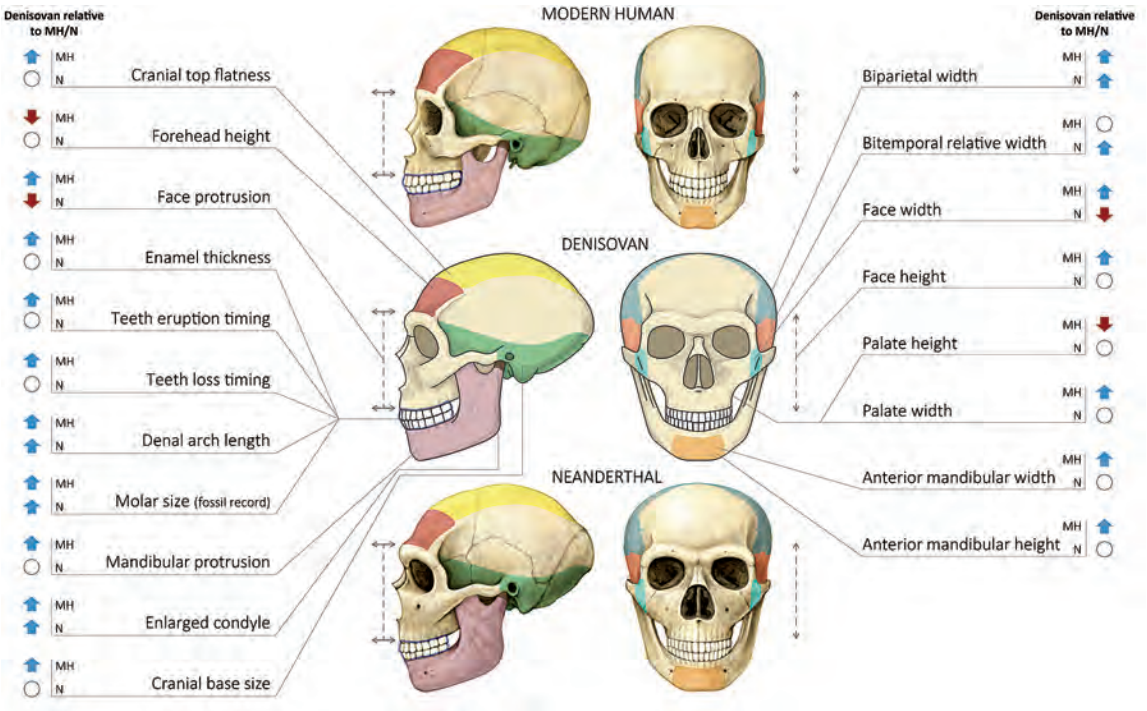
In 2008, diggers in Denisova found a tiny pinkie bone fragment belonging to a young girl who lived approximately 70 thousand years ago. This fossil is known as Denisova 3. Mitochondrial DNA was successfully extracted and analyzed in the lab of Svante Paabo, who recently won the Nobel prize for his work on ancient DNA. The Paabo lab's analysis revealed that the fossil could not have come from a modern human nor was it a Neanderthal. The implication was that it must have come from a separate group of humans that were not yet known. This new group has since been dubbed the Denisovan hominin. The nuclear genome was later sequenced by David Reich. Not long after the initial finding, another clue emerged from the cave: an unusually large molar was found and confirmed to be Denisovan in origin, though not from the same individual.

These discoveries presented a dilemma. Usually, when a new species is discovered, it involves a holotype—a first finding. But the discovery of Denisovans was made in a lab, initially with no specimens besides a tiny bone fragment, and shortly thereafter a molar. But how can we describe something when its defining feature is its DNA?

The Carmel Lab at Hebrew University had been trying to derive anatomical information from DNA. In 2017 Dr. David Gokhman, then a Ph.D. student at the lab, contacted me about a comparative analysis they were working on to try and learn what features could be attributed to Denisovans.

Gokhman was looking at DNA methylation patterns and comparing them between species whose anatomy is known (Neanderthals, chimpanzees, and modern humans) and the Denisovan. Combining these patterns with information about genes associated with particular traits and the direction of the change allowed them to infer specific phenotypes (see *www.sciencedirect.com/science/article/pii/S0092867419309547*).

Above: Denisovan Girl, Artwork by Maayan Harel, © galaxie/France télévisions 2022.



Right: Comparison of Modern Human, Denisovan, and Neanderthal skulls.

Observable traits result from genetics (the DNA code) as well as epigenetics. Epigenetics is the study of how different behaviors and environments can cause changes that affect the way genes work. Unlike genetic changes, epigenetic changes do not change your DNA sequence, but they can change how your body reads a DNA sequence. Epigenetic changes can be reversible, but they can also pass from parent to child through generations. One example of an epigenetic change is methylation. Methyl groups are often added on to the DNA molecule, and when this occurs it can, in effect, "turn off" specific genes.

The lab tested their method on chimpanzees and Neanderthals and found that it was approximately 85% accurate in predicting general anatomical features. They then applied the method to the Denisovan genome. The result was an identikit for the Denisovan, a spreadsheet of traits. Only some characteristics were listed, while others remained unknown. Due to the nature of the analysis, all of the information in the identikit was comparative. For example, the analysis predicted the Denisovan would have a larger pelvis than a modern human, but they found no difference in the size of the pelvis of the Denisovan compared to the Neanderthal.

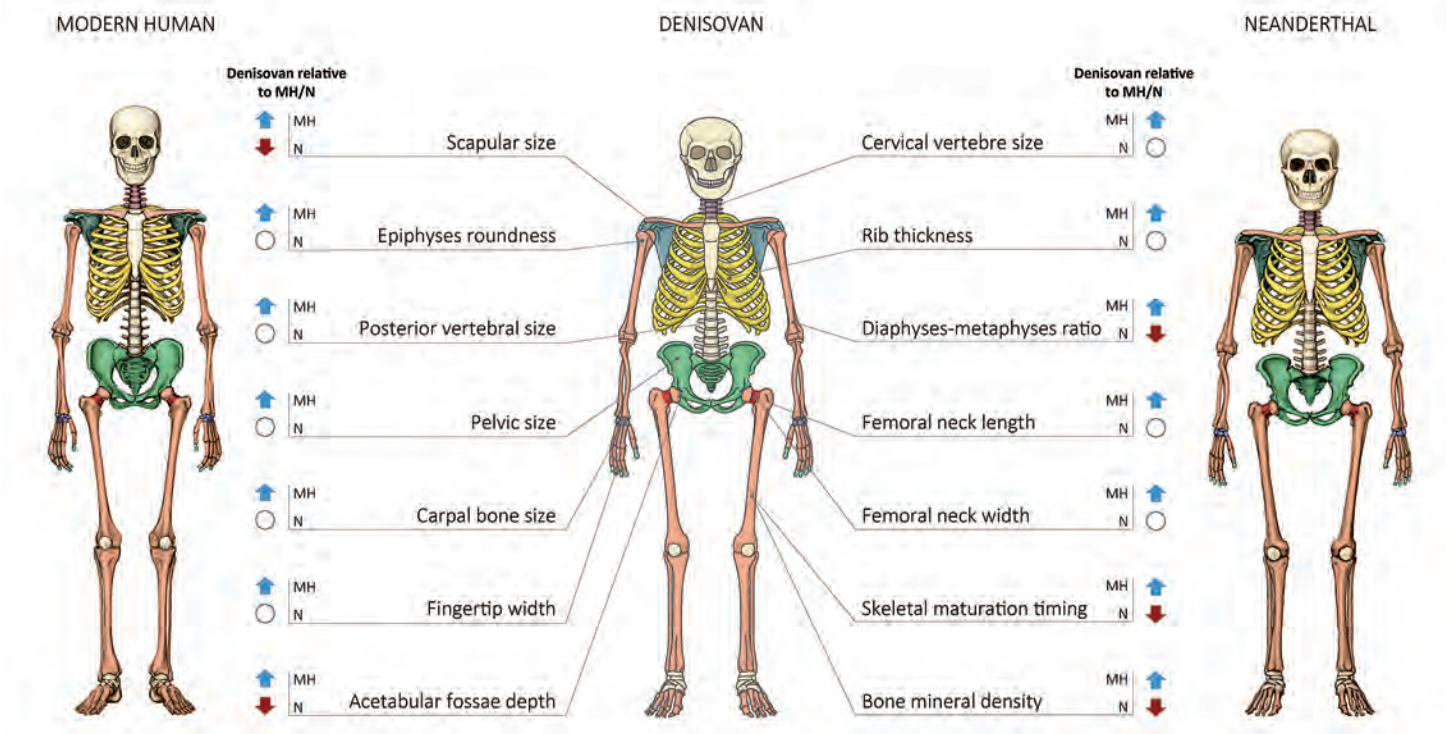
Based on these lists, I was asked to produce illustrations of the skull, the skeleton, and a face. The first step was to decide on a process: what would the visual references be? When illustrating the unknown, it often makes sense to turn to the closest relative as a reference point. Denisovans are most closely related to Neanderthals, followed by modern humans.

The study was comparative, so we felt the illustrations should also be comparative. My first step was illustrating representative skulls of modern humans and Neanderthals to give me a better understanding of the anatomical traits and how to alter them for the Denisovan model. To match with other descriptive literature, it made sense to describe adult males.

For a representative modern human skull, I turned to medical textbooks. For the Neanderthals, I referenced two of the most complete fossil skulls (Shanidar and the Old Man of La Chapelle Aux Saints). Throughout the process, I worked with our collaborator, Dr. Yoel Rak, an anatomist and an expert on Neanderthal skull anatomy.

With these drawings complete, it was finally time to begin working on the Denisovan model. At the time, I had the following information at my disposal:

- First, there was the fossil record of confirmed Denisovan findings. Contrary to the analysis' prediction of large finger bones similar to Neanderthals, the original pinkie implied delicate finger bones similar to modern humans.
- The fossil record also indicated oversized molars. It is generally acknowledged that with time and evolution, molars have consistently gotten smaller, so the large molars are an intriguing feature, more commonly seen in archaic species like *Homo habilis*.



Above: Comparison of Modern Human, Denisovan, and Neanderthal sketal features.

- Meanwhile, the study's results suggested several traits similar to Neanderthals, such as face length and forehead height, cranial base size, cranial top flatness, mandibular protrusion, and the palate.
- The study also found several unique features of the Denisovan: a wide skull, wider even than Neanderthal skulls in terms of the biparietal and bitemporal relative width, a large dental arch with large molars, an enlarged condyle on the jawbone, and interestingly, the analysis suggested a facial projection that would fall somewhere between that of Modern Humans and Neanderthals.

Neanderthals are famous for their heavy browbone, but they have another unique feature: their facial projection. On a modern human or a chimpanzee skull, there is a flat frontal plane where the eyes sit, and a near 90–degree angle on the zygomatic arch, where the cheekbones fold back from the plane. On Neanderthals, there is no such corner. Instead, the cheekbones project forwards at an angle, and the nose's protrusion from the face is very pronounced. This projection suggests Neanderthals had huge noses. By comparison, we modern humans have a small nasal bone protruding from a plane. The Denisovan needed to fall somewhere between these two extremes.

Because, genetically speaking, Neanderthals and Denisovans are sister groups, we decided that any unknown trait would be assumed to be like the Neanderthal trait. This gave us a baseline and allowed our representative Neanderthal to serve as a jumping–off point for the Denisovan model.

To emphasize that this would be an artificial model, we decided the Denisovan would be less highly rendered than the other skulls. To achieve a naturalistic treatment of the Neanderthal and modern human, I used Photoshop® to blur my graphite drawing slightly and give it a sepia tone. I also applied a concrete texture to provide a mineral-bone feeling. The last step was painting detailed shadows and highlights. We followed the same process for the skeletons. In the final art, we highlighted all of the features derived from the study.

In 2019, while I was polishing the final artwork, a new finding got us excited. The Xiahe mandible from the Tibetan plateau, a long and robust jaw with large molars, was confirmed to be of Denisovan origin. We found this very encouraging as it matched our model well in 7 out of 8 traits.

Currently, the Harbin man (published in 2021, *www.sciencedirect.com/science/article/pii/S2666675821000552*) seems to be the likeliest Denisovan skull to date. It matches our model well in many features, including the wide skull, low forehead, and subtle midface projection.

With the skeletal model complete, I began work on a facial reconstruction. The idea was to make a

A: Work in progress.

B: Process of building a model.

C: Tool and workstation set-up.

D: Finished model.

portrait representing Denisova 3, whose DNA sparked these discoveries. A rough estimate of her age is 13.5 years old.

The first step would be to adapt my adult male skull into that of a young female. Juveniles of different primate species tend to look more similar to each other than adults, especially in the face. My best references were skulls and reconstructions of Neanderthal children.

For the juvenile skull, the eyes needed to be bigger, and the jaw, forehead, and nose more delicate. The adapted skull served as the basis for the reconstruction.

The plan for the final art was inspired by Fernando Baptista of National Geographic and his technique of working with Super Sculpey® clay models. After consulting with Fernando, my process began with sculpting the skull, making sure I was working consistently with cutouts of the head–on and profile illustrations. Rather than bake the skull to harden it and sculpt overtop, I chose to 3D scan and print it so as not to lose the original. I inserted hard eyeballs and then began soft tissue sculpting, adding muscles, fat pads, and a face. The finished sculpture was lit and photographed; I then used Photoshop to paint over the image digitally.

Regarding her external appearance, there were two sources of information. First, her genetics suggest that she likely had dark hair and skin with no freckles. Because climate substantially impacts melanin, we decided on a medium–dark complexion.

The second source is informed by the admixture of DNA. Genetic sequencing studies have revealed that there was limited but significant interbreeding between different populations of humans, including Denisovans, Neanderthals, and modern humans. For example, all non–African populations derive approximately 2% of their ancestry from Neanderthals (see *www.nature.com/articles/nature12886*). A first-generation hybrid with a Denisovan father and Neanderthal mother has also been found: (*www.nature.com/articles/s41586-018-0455-x?smid=nytcore-ios-share*). Among people living today, the group with the highest proportion of Denisovan DNA is Melanesians, with up to 4% of their DNA attributed to the Denisovan genome (*www.science.org/doi/10.1126/science.aad9416*). Therefore, images of children from these populations were also sources of inspiration.

In September 2019, the final art appeared on the cover of the journal *Cell*, and the image attracted more press attention than we ever expected.

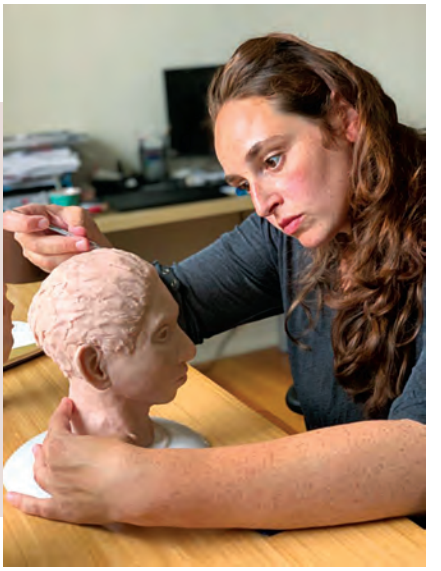
When I was a student at California State Monterey Bay, my teachers (Ann Caudle and Jenny Keller) made a critical point that has stuck with me: when it comes to text, authors can choose what to say and when to remain silent. But to create a complete image, silence is usually not an option. It is a luxury we as illustrators are not afforded; and, while exceptionally exciting, paleoart can be quite unforgiving. Working on this project felt like exploring somewhat uncharted territory, which allowed for a fantastic learning experience through the unique creative process as well as the scrutiny the image received.

Above: Portrait of Denisova 3 which appeared on the cover of *Cell* in 2019; the most recent illustration is presented at the beginning of this article (page 23).

I was also very fortunate to get another opportunity to illustrate Denisova 3 and incorporate some of the lessons from this project. This newer illustration appears at the begining of this article.

I am incredibly grateful that I get to create art that helps connect us to our history and our evolutionary story. I hope to be able to continue telling these stories and improve upon my approach.

Maayan Harel is a scientific artist and designer. She has an M.S. in atmospheric science from Tel Aviv University, and after attending the science illustration program at CSUMB, she interned at National Geographic Magazine and the Smithsonian. Maayan spent two years working at the Los Angeles Zoo as a graphic artist, and currently gives workshops and talks to scientists looking to improve their visual communication skills. Her studio, known as Maayan Visuals, specializes in visual storytelling for institutions and publications across a broad range of fields, including geosciences, ornithology, entomology, artificial intelligence, neuroscience, psychology, and human evolution.



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