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SOUTH AUSTRALIAN MUSEUM

TEACHER BACKGROUND INFORMATION

Wonders, Documenting Life: The intersection of Art and Science

Educator Resource with Illustrator Jennifer Thurmer

South Australian Museum

NINNA MARNI
(hello in Kaurna language)

We acknowledge this document was created on Kaurna Miyurna land.

The Dreaming is still living for all Aboriginal and Torres Strait Islander peoples. From the past, in the present into the future, forever.

Image: Stick insect, SAMA970/1, South Australian Museum, Rosa C. Fiveash.

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Scientific Illustration

Wonders, Documenting Life: The Intersection of Art and Science

The intersection of art and science is a fascinating place where concepts relating to the smallest units of matter up to the largest galaxies can be shared and explained. Scientific illustration is 'art in collaboration with science' and its practice requires patient observation and usually, active communication between artist and scientist.

In the *Wonders* from the *South Australian Museum* virtual exhibition, you can explore some early illustrations from our collections showing different ways of documenting and communicating scientific concepts.

The greater part of this document is a compilation by Jennifer Thurmer from her research, presentations', and personal experience as a scientific illustrator over 46 years.

It includes key aspects of the history, development and purpose of scientific illustration as well as a range of tips and hands-on techniques to use in the classroom with students and your own art practice.

Image: Jennifer Thurmer, scientific illustrator.

Jennifer's association with the South Australian Museum began with technical roles in the biological collections before transitioning to the position of Scientific Illustrator and Publication Manager until changing roles in 2001.

During her time at the Museum and beyond, she has contributed illustrations to hundreds of publications including books and posters and importantly many scientific papers including new species descriptions.

Now in retirement, Jennifer is a Museum Honorary working to document and archive the Museum's illustration collections.

Curriculum Alignment

VISUAL ARTS

Years 7–10

- Build on their awareness of how and why artists, crafts people and designers realise their ideas through different visual representations, practices, processes and viewpoints.
- Use historical and conceptual explanations to critically reflect on the contribution of visual arts practitioners as they make and respond to visual artworks.

Years 7–8

- Develop ways to enhance their intentions as artists through exploration of how artists use materials, techniques, technologies and processes.

Years 9–10

- Develop and refine techniques and processes to represent ideas and subject matter.

Stage 1 and 2 (SACE) Visual Arts

- Use a variety of systems of visual representation such as graphical illustrations, graphs, charts, maps, and diagrams to communicate research findings.

SCIENCE

Year 7

- Classification helps organise the diverse group of organisms.

Science Inquiry Skills F–6

- Share observations and ideas, represent and communicate observations and ideas in a variety of ways, communicate ideas using scientific representations in a variety of ways.

Science Inquiry Skills 7–10

- Communicate ideas, findings and evidence-based solutions to problems using scientific language, and representations, using digital technologies as appropriate.

Learning intentions for students

The distinction between scientific illustrator and artist may be challenging for some students to understand.

A scientific illustrator is an artist but an artist is not necessarily a scientific illustrator. A key point is the importance of close observation and accurate documentation rather than creating an artistic response to a subject from the natural world.

Scientific illustration is about communication and clarification of scientific concepts and an understanding of scientific illustration will help students learn about the features of organisms as well as the value of taxonomic keys.

At the South Australian Museum, it is a vital element in describing new species and broadening our knowledge and understanding of the biodiversity of life in South Australia and beyond.

Scientific illustration teaches students how to observe at a deeper level as well as to plan and wonder. It also involves mathematical and critical and creative thinking as well as encouraging students to explore pursuits that help develop their personal and social capabilities such as an interest in biodiversity and sustainability.

Scientific illustrators may go on to become scientists, lab technicians, national park rangers, lecturers, zoo workers, or officers in other research institutions. They open businesses allied to the sciences, arts, marketing and there are many international opportunities. Scientific illustration also provides a window in to other leisure-time pursuits which are so important for mental health and confidence building.

Scientific illustration

- Is an art-form that is highly disciplined, and requires patience and perseverance.
- Aligns closely with the presentation of scientific descriptions and facts: new species; revised methods; discoveries; or revisions of earlier material.
- Enhances the presentation of exhibitions, websites, lectures, teacher and public-oriented material (medical and botanical illustration is used in a similar way).
- Is basically copying from nature.
- Is unlike most other artforms in that the illustrations produced are often labelled, have a scale bar, and require a caption. There may be several illustrations on the same page, grouped as a 'plate'.
- Requires the keeping of notes and records, about, both the item being illustrated, and the illustration.

Pathway to becoming a scientific illustrator

For the first four years of Jennifer's life she lived together with her parents and sister with her grandmother, whom she remembers as a wonderful, inspiring person who took time with each of her grandchildren to help them develop their interests and passions.

Jennifer's passion was nature which led to much time spent strolling around her garden watching birds, finding cocooned butterflies, gathering mushrooms and enjoying the magical colours of autumn leaves as well as visits to the zoo and Museum.

Later she spent time in the garden with her father, a quiet man with an appreciation of the seasons who enjoyed astronomy and the observing the patterns of the weather.

Early drawings from the age of three or four were not exceptional, much like the work of any typical child of that age.

However, as her drawing skills developed, most of her drawings of people from this period were rather different – they included wings and antennae as a matter of course.

Image: Duck drawn at age 3, J. Thurmer.

Image: Frog drawn at age 3, J. Thurmer.

Hybrid people drawn at age 4, J. Thurmer.

Her observation skills were sharpened by two acts of kindness when she was given access to binoculars and a Brownie box camera.

With her father's encouragement, her drawing and painting skills improved and portraits of guinea pigs and other pets became part of her regular output.

Image: Pet guinea pig – one of the first animals that she studied carefully, at about aged 10 or 11. It records the veins in 'Guinea's' ear-flaps, and her food sources, arranged carefully, J. Thurmer.

Image: Oil paints for Christmas when I was 12 or 13, helped develop my painting skills, J. Thurmer.

Aged 17 Jennifer began studies in commercial art as there were no courses in scientific illustration offered anywhere in Australia.

She began work in an advertising agency, and called in to the Museum regularly with her portfolio which led to a three month grant illustrating insects in the Entomology Department. The grant was extended several times, and when the Museum's scientific illustrator resigned, Jennifer was offered that position. She continued tertiary studies to gain formal qualifications majoring in illustration.

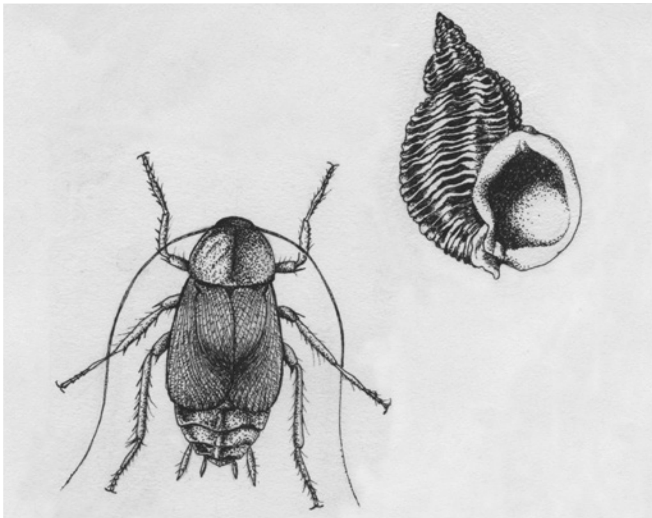


Image: Cockroach and shell, by J. Thurmer.

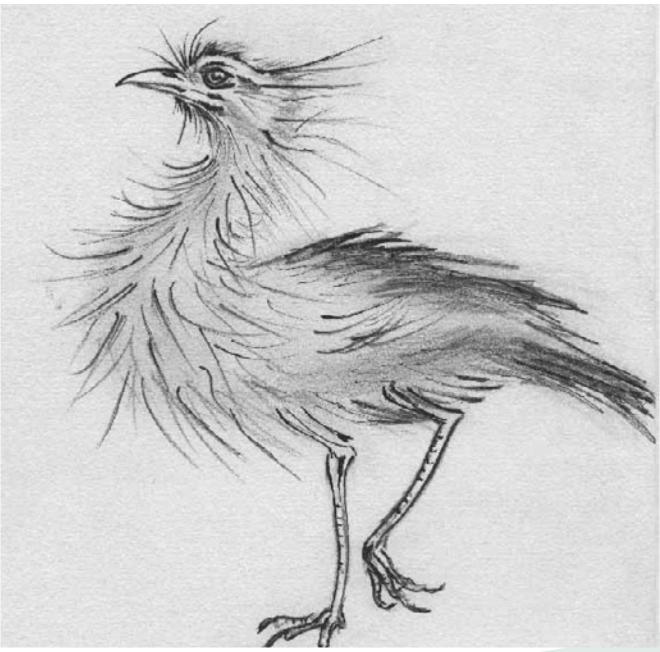


Image: Bird, Seriema. Illustrated using pencil and ink, J. Thurmer.

Image: A young ape, by J. Thurmer.

Is scientific illustration art?

It's a commonly discussed question and the answer is that scientific illustration is not a 'creative' art in the traditional sense — in fact it needs to be the opposite. The scientific illustrator does not use creativity or imagination to invent or add to what they are rendering. They illustrate only what is there... what is visible. Their finished work must not be design-like in approach, especially when the illustration is to be published in a scientific journal. Scientific illustrations are an important part of the publication of results.

It is not about the artist, it is about the specimen, and science.

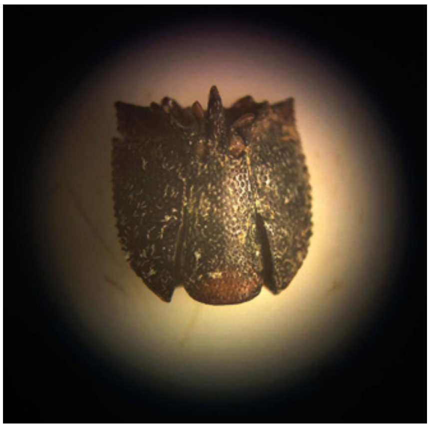
A scientific illustration, fit for purpose, is as close a representation of the animal, plant, fossil or artefact as possible — usually achieved via open collaboration with the scientist or author of a text, and within a given time frame and budget. The scientific illustrator discusses with the scientist the important features that are critical to the description of the specimen, and must understand what to leave out, and in some case what to emphasize.

Some would argue that scientific illustration is observation and rendering, only.

Why not use a photograph?

Image: Showing an insect in poor condition, and a challenge for the illustrator.

Photographs are often used in scientific publishing to show important structures of a specimen (known as taxonomic features), or as a quick or general reference to the entire specimen or object. However, photographs are not always the best answer. For example, flippers, wings, or legs may be obscured from view in a photograph. A bird's feathers may be damaged or missing on the actual specimen or insects may have missing legs or antennae. The animal may have died in an awkward position or be slightly damaged. It may have been stored in a jar of preservative such as formalin or alcohol for decades and be faded white, bleached unevenly, contorted, or shrivelled. There may be slight bulges or tears on the surface or skin of the specimen.



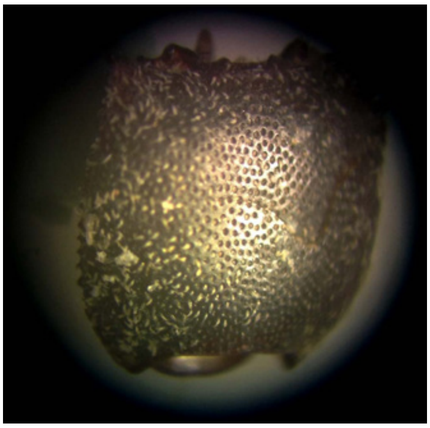


Image: Showing why in many instances a drawing is better than a photograph.

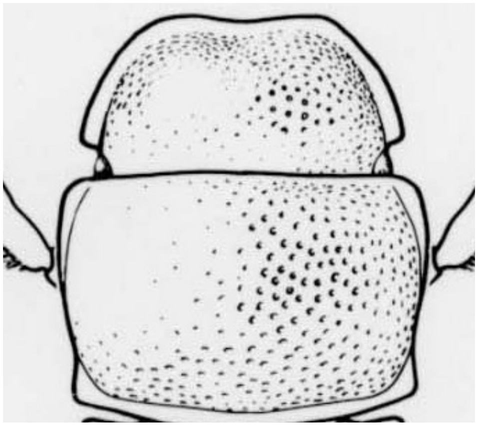


Image: *Saposites mendax*, AA298/42/15/16/4, South Australian Museum, J. Thurmer.

Image: Examples of preserved specimens, J. Thurmer.

Image: Examples of preserved specimens, J. Thurmer.

Sometimes extremely close-up detail is required and a camera cannot get in close enough to capture the detail required. A scientific illustrator can use a microscope and prepare many sketches of the various parts of the specimen and later combine them to form a drawing or painting of the whole specimen in the most appropriate pose.

A scanning electron microscope (SEM) with a camera attachment takes very close-up images but the specimen often needs to be coated in a thin layer of carbon or gold before it can be scanned. The scientist may have only one specimen, or one specimen in perfect condition, and does not wish to destroy it by coating it in gold, or the specimen may be too fragile to withstand such a process.

Image: Scanning electron microscope produces close-up detail, but the process is expensive, time consuming, may damage the specimen, and is generally not suitable for soft tissued specimens.

The differences between scientific illustration and wildlife art

Scientific illustration and wildlife art (also termed natural history art) are two separate art forms.

Wildlife art may still be quite scientific in approach in that the result is an obvious rendition of something from nature. It can also be more creative and less-disciplined where artists add to what is there and manipulate aspects of their work to achieve a preferred look such as adjusting colour; adding design features and experimenting with techniques and media.

A knowledge of scientific illustration techniques is very useful in a student's artistic pursuits, and it might be noted that you cannot draw well, what you have not 'seen'. Younger students may, at least initially, prefer to embrace this more relaxed way of engaging.

Scientific illustration as a career

Scientific, medical, and botanical illustrations are still key in the world of science, and especially popular science to help communicate complex ideas to a broad range of people.

While it could be challenging to find a full time role as a scientific illustrator especially in Australia, there are opportunities for flexible careers working as a freelance or on contract with employers such as universities, museums and private researchers.

Other potential employers include advertising agencies, media outlets and publishers.

For highly skilled artists the international art market for original works and limited-edition print runs can be lucrative and animators sometimes use scientific illustrations as a starting point, prior to digitising and tweaking a character.

Perhaps the best way to forge a career in scientific illustration is to train as a scientist, or laboratory technician in order to gain a grounding in the sciences, and work at a university, museum, research institute, or teaching hospital etc.

Preparing professional scientific illustrations

After much observation and comparison, often taking weeks, months or years, a scientist describes something new by writing about it and formally publishing it to the scientific community. The illustrations required to help describe these discoveries are prepared in a disciplined manner and follow rigid standards.

Successful illustrators use excellent planning, interpretive and drawing skills, as well as patience and determination to achieve the best outcomes.

Any person who decides to try this type of illustration will study a specimen or object to understand why the specimen is new or different to what has been found previously. The artist must be aware of the correct shape, features and textures before they start.

Whether a scientific illustration or a work of wildlife art, it's important to have good preparation for a successful finished piece.

Consider whether the work will be framed and if so, leave plenty of space around your drawing or painting for the mount board and frame.

Scientific illustrations often form part of the permanent record to which future scientist will refer as part of the 'original' description of the first-discovered or 'holotype' specimen so it's essential they be accurate. The artist's responsibility is to portray 'visually' what the scientist describes in words, in scholarly texts.

Strictly speaking the term 'scientific illustration' includes the preparation of distribution maps, graphs, sectional drawings, interpretations of different types of habitat, and other diagrammatic works. This type of illustration is usually labelled or annotated in some way. Sometimes, if used online, these may be a little more design-like in appearance but nevertheless accurate and carefully prepared.

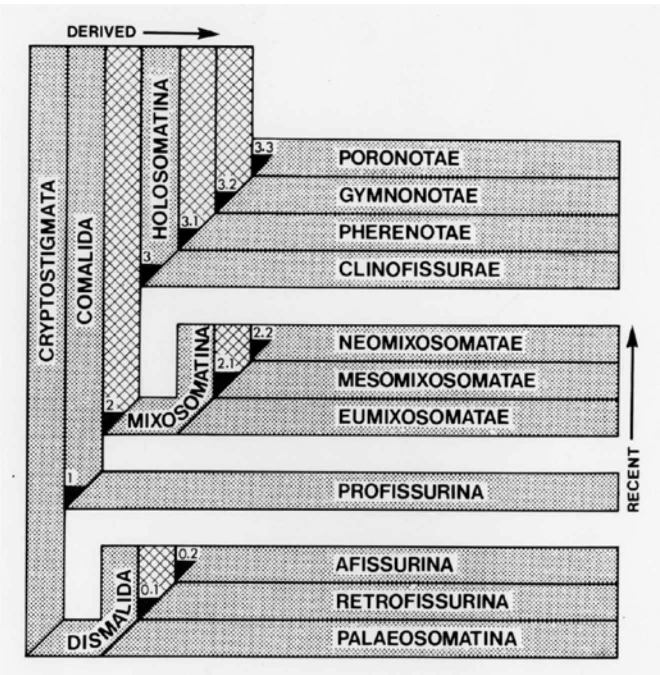


Image: Example of presenting data as a diagram.
South Australian Museum, J. Thurmer.

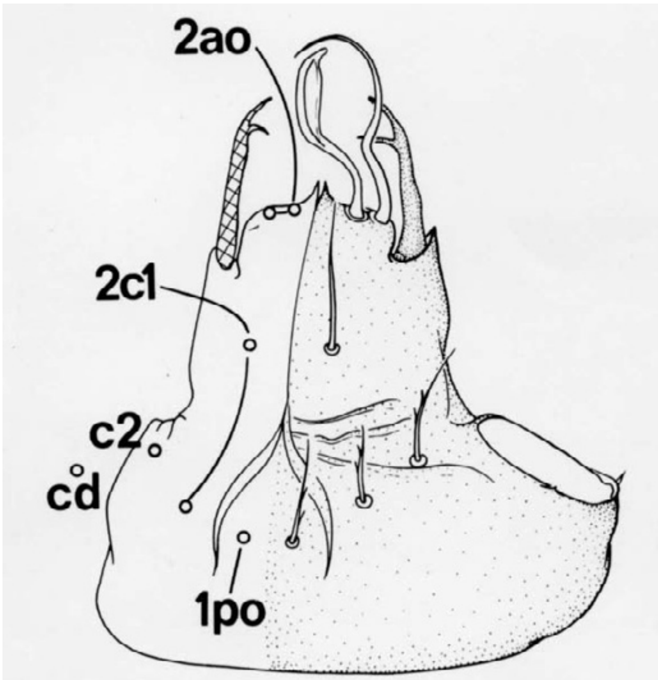


Image: Example of presenting data as a diagram.
South Australian Museum, J. Thurmer.

Until confidence and experience develop, it is better to keep things simple, for example insect wings can be extremely difficult to illustrate, as can iridescence and complicated textures or backgrounds. Shells and insects may be plain or highly textured so there are plenty of challenges as the artist gains more confidence. Regardless of the subject of the illustration, the equipment available will affect what can be achieved.

Ordinary A4 bond paper and a sharp lead pencil are all that's needed to start. Without a microscope very small insects or shells will be difficult, but this could be overcome by supplying students with enlarged images.

A hand lens (magnifying glass) is a useful tool for close-up observations. As students gain confidence, they may decide to incorporate associated materials (as supporting images) such as leaves, flowers, stems, seaweed or other beach artefacts, in their illustration, so further careful research may likely be required.

Knowledge of the animal's life-cycle may be important. For instance, does it live in a burrow, or has it built a cocoon, did it hatch from an egg, and will it emerge at a certain time of year? Knowing these details may impact on the vegetation included in the work. Learn which plants the specimen is likely to inhabit – perhaps the insect only goes to a particular plant when the plant is in bud or flower. The insect may consume only certain leaves, or parts of the trunk.

Does the animal eat only plant material, or does it consume other insects or animals that live on the plant? Where does the insect breed? Does the insect build a cocoon, nest or hive (as with wasps and bees), and what do they look like for each particular insect that is to be illustrated?

Does the insect use the plant for shelter only, or simply rest on the tree trunk and scurry back under bark as danger or bad weather approach? If it is a borer consider illustrating the opening to its hole, or its nest. Perhaps the plant has nothing to do with the insect, and it was simply sunning itself prior to flying or crawling away?

If supplementary drawings are included do not overdo this. It is better to keep the illustration fairly simple.

Don't forget to collect (or photograph) examples of the plant on which the insect was found, or if a shell, research the animal that once lived in it. Research is most important, and will help prevent any mistakes as students learn.

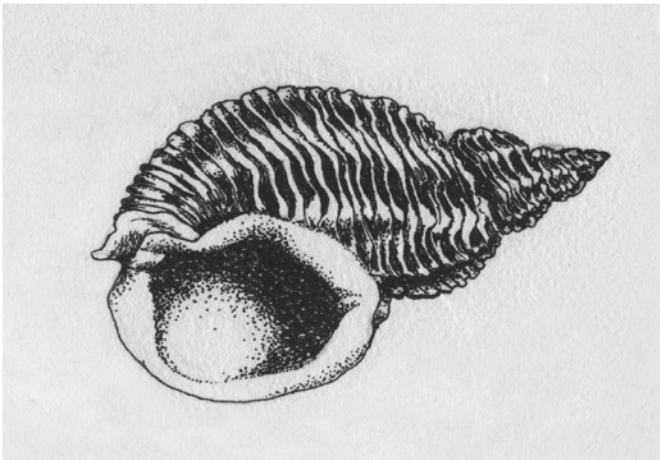


Image: Simple black ink line and stipple drawing of a shell, by J. Thurmer.

Image: Multiple specimens, all examples of supporting images. Artist: Joris Hoefnagel (1542-1601). Courtesy, University of Strasbourg, France.

Shells or insects are great objects for beginners to illustrate

SHELLS

- Shells are easily found and small enough to transport home in a pocket or small bag. But check with your local council before taking shells or other specimens from the beach.
- Shells are robust and do not damage easily.
- These treasures retain their colours for a long period.
- Coloured pencils are an excellent medium for illustrating shells.
- The artist does not require a microscope, and mostly a hand lens will do.
- There is great variety in size, shape, texture etc.

INSECTS

- Insects also make great subjects for illustration.
- A variety may be found in your garden, or near your home.
- They may be collected and placed in a small container for safe keeping.
- The diversity of insects is wide.
- A great project might be to illustrate several different species.

Basic materials for scientific illustration

The materials available will initially dictate the style and techniques explored. For younger students and beginning artists, it's best to start with basic materials including several grades of lead pencil (HB, 2H and 4H), with 2H the best for preparatory sketching, and for the final sketch, prior to inking or painting. An HB is useful at times for sketching, when using different papers, or when stronger line-work is required, especially if tracing over the drawing, as 2H can sometimes be too faint to see once tracing paper is laid over it. Many artists prefer to use sketch books but ordinary bond paper is also good.

Tracing paper is useful for transferring the final sketch on to the selected board, card or paper. A 2B (or soft) lead pencil, and a hard 4H pencil work well for this process. A clean, soft, white eraser and a rough surfaced eraser sharpened to a point are handy, as are a selection of brushes, a standard ruler, steel ruler and scissors.

If coloured pencils are to be used, these should be of good quality. Fabre-Castell is an excellent brand, as are Prismacolor and Derwent. A pencil sharpener is a must.

Materials for black-inked line drawings

Bristol board or card is a great surface to work on for preparing a black-inked scientific illustration. It is useful for pen and ink illustrations of all types. Bristol Board 250 gsm (uncoated, hard machine finished) is available in hot press or cold press.

Rotring technical pens and inks, work very well on Bristol board. Professional grade polyester drafting film also works very well for all black ink illustrations and in particular the surface on the film is best for stipple-drawings as the dots tend be consistently round and with clean edges, making for a crisper finish.

Nib-pens or mapping pens that are dipped into the ink can be used to control the thickness of line work without the need for several Rotring pens with tips of different sizes. However, the older style nibs don't work very well for stipple drawing as the dots tend to come out as random shapes, and because the ink dries much more slowly, work can be easily smudged.

Coloured pencils are also great to experiment with particularly for younger students.

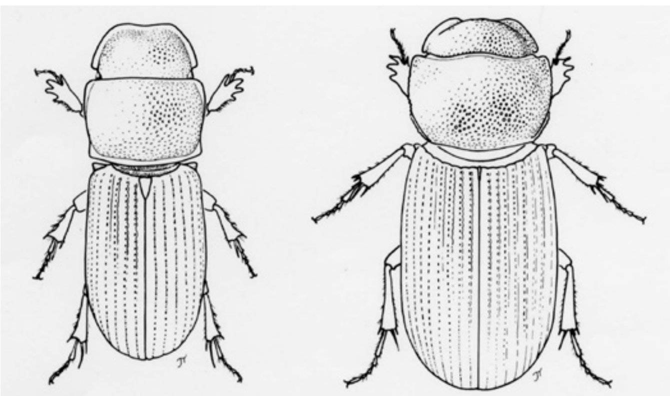


Image: Two carefully prepared black-ink line drawings of beetles. South Australian Museum, J. Thurmer

Painted scientific illustrations

For painting use several good quality brushes such as Winsor & Newton sizes 000, 00 for finely detailed work, a '1' and '2' for filling-in small areas, and perhaps a '3', '4' and '6' for backgrounds. These are very expensive brushes, but are best in order to achieve very fine illustrations. Take care to check the hairs when purchasing new brushes to ensure they come to a sharp point and that hairs aren't sticking out at odd angles from the base.

Always store brushes laying flat with the bristles well away from the top, sides or bottom of the container to ensure they dry straight and not in a curved or bent position which will render them almost useless.

Never leave a paint brush standing upright in water with the bristles facing downward, again this will bend and damage the bristles, as the wooden handle will absorb water, swell and cause the hairs to fall out after a short time. Always gently wash your brushes when you have finished a session.

There are products available for this, but velvet laundry soap or shampoo work very well. Do not force the bristles back and forth, or roughly separate them at the base, just a gentle massage and rolling between your fingers should do it. A lot of rinsing is important.

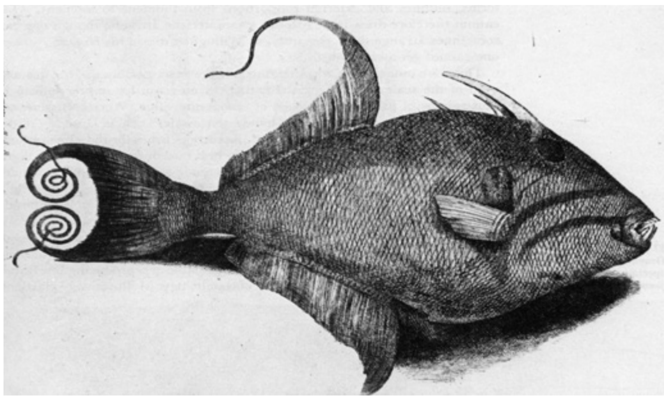


Image: Black-ink illustration, drawn using a fine nib pen from Willughby's Historia Piscium (1687).

Materials for painting in colour

For painting with colour, Winsor & Newton coloured inks or watercolour paints in either tablet form or from the tube are a good choice. For highlights a tablet of solid white watercolour paint, and a jar of 'Process White', are useful.

With experience, every watercolourist will discover a preferred paper or board, and it's really a personal choice learned through experimenting and experience. Depending on the project and outcome, 'Artist' grade papers and boards rather than 'Student' quality may be best, as the latter may be disappointing due to being too absorbent, more likely to buckle or warp, and sometimes have a feathery or fluffy surface.

For beginners, watercolour board with acid free cotton surface rather than watercolour paper is a good starting material as it tends not to warp, is easier to turn while working, and transports relative safely. Large boards should be cut to a suitable size for working with plenty of space around the subject and also a 30mm margin so that the artwork does not appear hemmed in and if there are any splashes or finger marks around the edges there is room for further trimming.

Boards: Any watercolour board with an acid free cotton surface should be satisfactory, those marked 'cold-pressed' are definitely worth trying – they have a very slight tooth or texture to the surface ('Hot press' has a harder, smoother surface, and may not be what works best for all artists). As watercolour boards are thicker than watercolour paper, this eliminates the need for stretching, and prevents warping, buckling, and puckering.

Illustration Board: Cold Press, Surface No. 300, Medium Weight (51 x 76 cm), is a good choice for inks and watercolour paints.

Watercolour papers: 'Arches', have a range of watercolour papers and have an excellent reputation for quality. Their 'Watercolour Block' of sheets, comes in many different prices and sizes and is great for beginners – they can cut each sheet into four or six and practice brush work and test their colour-mixing skills.

Different watercolour papers have different surfaces, and some have a definite front and back, so make sure the correct side is used.

If you continue with watercolour painting, it is worth experimenting with a wide range of papers and boards, and read widely to learn of other, or different techniques, hints, and pitfalls etc.

Refer to the section on black-ink wash illustrations on p. 26 for guidance on brushes.

Checklist of equipment for scientific illustrating (also useful for wildlife art)

- Microscope, magnifying glass and/or hand lens.
- Drawing board, that can be placed on the top of a desk or table and the slope adjusted to suit the comfort of the artist.
- Note paper or a small note book, or journal and a pen.
- Sketch pad, and/or sheets of A4 paper.
- Adhesive tape (Scotch brand – non-adhesive, and peelable).
- Tracing paper, and polyester drafting film.
- Ruler.
- Lead pencils. Start with (HB, 2H, 4H).
- Rotring technical pen and several different sized tips. If too expensive, ask at an art shop or check online.
- Rotring inks for the above pens.
- Coloured pencils of a good quality.
- Pastels, Conté and charcoal sticks, if you are likely to take up wildlife art.
- High quality paint brushes, 000 to about size 6 (Winsor & Newton series 7) are best, but expensive. Hairs should come to a point, with no bristles protruding at angles from the base or sides.
- Watercolour papers and boards (a selection to try is a good starting point)
- Acrylic paints (may be used for diluted washes).
- Watercolour paints, either tube or tablet form.
- White paint (for highlights) - tablet form is good, as is Winsor & Newton 'Process White'.
- Oil paints are almost never used for scientific illustrations, as it is difficult to achieve fine detail, due to the nature of the paint but can be used for wild life art
- Unbreakable container for water.
- Block of wood with suitable holes in it, in which you can stand bottles of ink (to prevent accidentally knocking-over a bottle ink onto your work).
- Small saucers, or an ice-block tray, etc. (for mixing inks and paints).
- A test piece of the actual watercolour paper, or illustration board to be used for the project to test the colour and depth of colourwash mixed prior to applying it and to practice different techniques if there are many different types of surface to record: shiny, textured, marbled etc.
- Blotting paper, tissues, and an absorbent cloth to remove any excess of wash and lighten areas when building up colour.
- French curves can be useful at the sketching stage for smooth curves.
- Steel ruler and Stanley knife, scalpel, cutting mat for trimming art board, paper, etc.

- Soft eraser, and abrasive pencil-shaped eraser, (like a pencil, but with an abrasive eraser core) are handy to remove paint or ink to lighten a particular area once it has dried, and just prior to adding highlights.
- Folder and bag for carrying items and to store artwork.
- Compass and dividers may be useful for measuring off the length of an insect's leg to match it accurately on the other side of the insect. A compass is also useful for drawing circular structures, and frames for cross-sections or support drawings, or inset drawings, which show a close-up view.

Types of scientific illustrations

- Simple single-line drawing with a lead pencil (which is the result of sketching and refinement).
- Grey scale lead pencil illustration, rendered to a high degree, where a 3D effect is achieved.
- Simple single-line drawing finished in black ink. A technical pen, dip pen, or mapping pen are used.
- Highly detailed black-ink illustration utilizing lines, cross hatching to indicate any shaded areas.
- Stippled ink-drawing (comprised of tiny ink dots) using technical pens of different sizes. Bristol board or drafting film are often used.
- Highly detailed coloured-pencil drawing (not usually used as finished art in a scientific paper, but more likely to be used in a text book, a web site, for a poster a display, or in an exhibition).
- Black ink-wash painting with white gouache highlights.
- Carbon dust on paper.
- Scraper board. The board is supplied from an art supplier with a coat of white, absorbent, China clay. A silhouette of the specimen or object is drawn on sketching paper and transferred to the surface of the board, then completely filled-in with black ink. Sharp tools e.g. nibs, needles, pins, scalpel blades etc. are used to scrape away the black ink to reveal the white surface below. A useful technique used in illustrating black or dark specimens and artefacts.
- Highly detailed watercolour painting of a single object or specimen from several angles: top view, side view, etc.
- Watercolour painting, showing additional support structures, such as food plant, life-cycle or habitat, but focusing on mainly the animal or specimen.

Creative wildlife artworks are those where you may combine art mediums, products, styles and techniques:

- Coloured pencils and coloured inks.
- Lead pencil and black ink.
- Scraper board and several different coloured inks.
- Turpentine and oil-paint wash. (The artist mixes a thin wash of oil paint and turpentine and quite roughly paints the general shape of the specimen or object, and then, using a 6B lead pencil, adds the detail, and finishes off with black ink.
- Acrylic paint washes, with lead pencil and/or coloured pencil details.
- Pastels and lead pencil
- Conté and lead pencil, or water colour wash
- Watercolour or coloured-ink wash with contrasting coloured ink pen-work.
- Watercolour painting with detail added with coloured pencils.

Art shops can provide a range of materials and equipment that are suitable for scientific illustration, and wildlife art. You may also purchase items online once you know your preferences, and have had the opportunity to try them.

Image: Grasshoppers

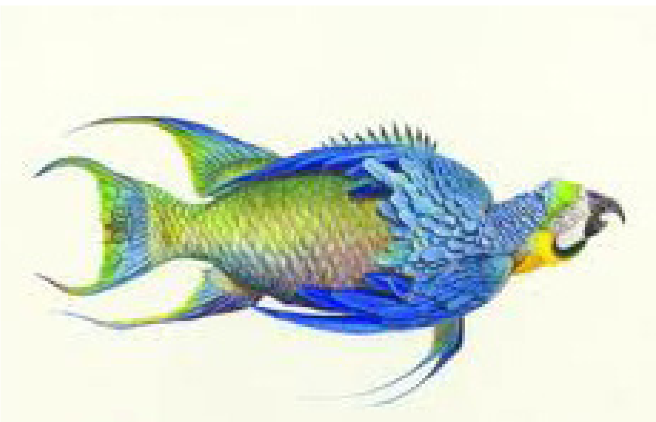


Image: Parrot fish

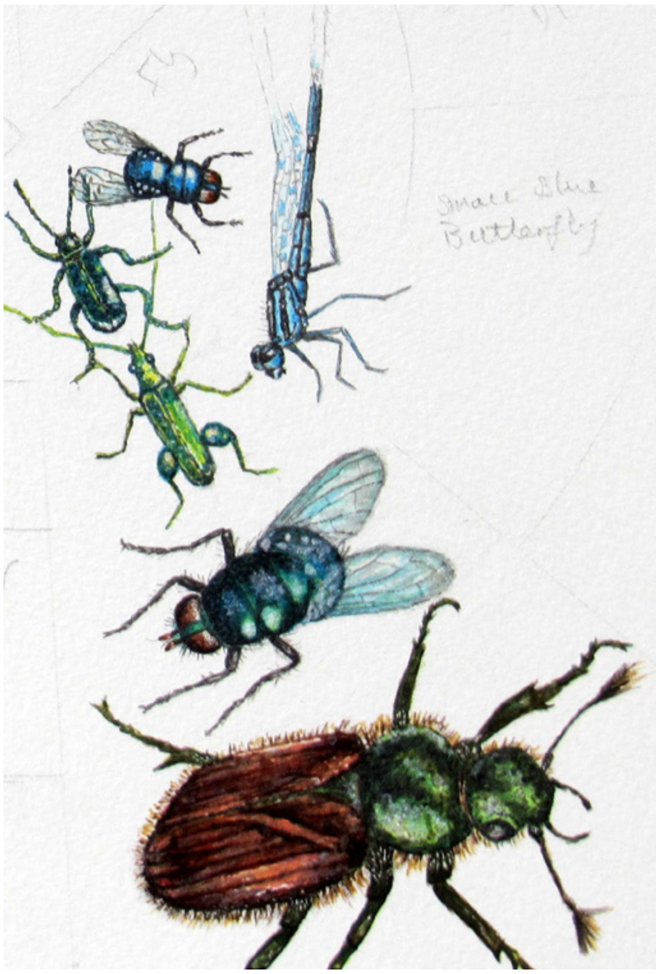


Image: Flies

Scientific Illustration: How to get started

Photographs are a great way to see different angles and details of specimens and they can be on a macro or micro scale.

A time-saving method is to project an image onto a large sheet of drawing paper attached to a wall, then trace around the shape. This technique is particularly useful if a really large illustration is required and no, it is not cheating – it is time saving, and gets you started.

Seek out reference materials if you are wanting inspiration. Look to see what other scientific illustrators have done in the past and what is being done currently.

Know your specimen

Understanding the anatomy of any animal or specimen is extremely important. For example, there is an amazing range of differences in the structure of insects' antennae, legs, claws, eyes, etc.

These differences in structure, including: length of hairs (or setae), bristles, spurs, types of textures, length of legs, width of head, colour, pattern, etc. are known as taxonomic features. Scientists use these features when describing a species, and sometimes the differences are used in the naming of new species.

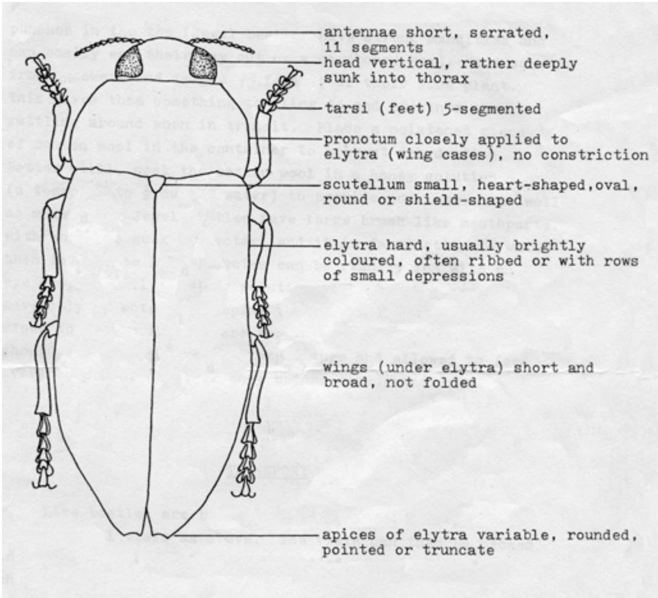


Image: Illustration with body parts labeled.

Developing observation skills

Although a lot of useful information is available online, a handy text book is a good idea. The Guild Handbook of Scientific Illustration, Elaine R.S. Hodges (Editor), currently out of print is available second-hand online — it is a great resource.

Browsing online is an excellent way to learn about your subject, and the object that you have chosen to illustrate.

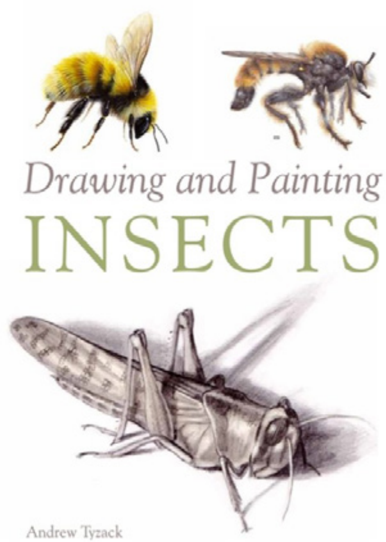


Image: A textbook on the subject is extremely handy and encouraging. Author: Andrew Tyzack.

Good observation skills often need to be explicitly taught and practiced. Students should be given time and supported to 'notice' and ask questions in order to develop their skills.

Pose challenges and ask what they can discover about particular specimens or objects that they did not previously know or see. Making lists and discussing ideas in groups or as a class can be a great way to start.

It is necessary to observe very carefully the item that you are going to illustrate and if you have access to a microscope, this is much easier, but a magnifying glass or hand lens may do.

You need to know the structure of your specimen well, and how the various parts actually fit together, to be able to illustrate it accurately.

Observe the specimen from several angles, and if it has legs, or wings, a stinger, claws or fins etc., notice how they attach to the body.

When drawing an insect, look closely at the head and the mouth-parts, the eyes, underside of body, is it segmented? Does it have jaws, or a sap-sucking proboscis?

Check to see if the antennae are rigid, or flexible, does the specimen have wings, if so how are they attached to the body? Notice if there are hairs (setae) or spurs on the insect's legs, and how many there are — and do they extend along the entire leg or stop short at some point?

Perhaps the setae are found only around the base of the leg? Are there hairs on the back and underside of the insect.

If your specimen is a shell, watch for the number of ridges on it, the shape of the edges, and how the shell closes if it is comprised of two matching halves. Is there any sculpturing, or special feature on the outside of the shell? Are there lumps or dents on the surface of the specimen?

Are there any particular textures or patterns to be seen?

It is important to prepare enlarged, supporting, sketches of any unusual features you notice and may wish to check, later, for reference, and for practice. If working from a photograph and cannot quite see a particular detail, try looking online, or in a reference book for additional information.

Accuracy is vitally important.

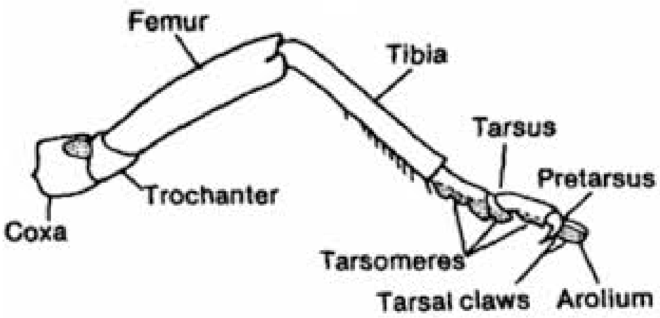


Image: Beetle leg, thinkinsects.com

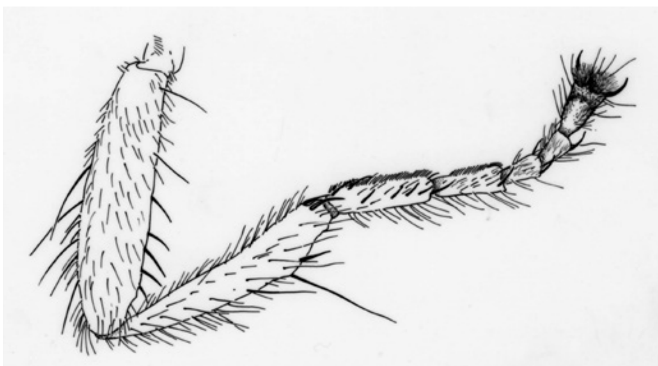


Image: Blowfly leg, J. Thurmer.

Tricks, conventions, and tips for professional scientific illustration

The scientific world has certain ways of doing things – here are a few examples:

- If the specimen or object is symmetrical, then only one half or side needs to be drawn from the centre line of the object. The paper is then folded down the centre and the second half simply traced, creating a drawing of the complete animal or object, thus saving time and effort in the early stages.
- Illustrations for a scientific paper require a scale bar indicating size.
- Missing legs or other body parts should be indicated. There are several ways of doing this, e.g. with dashed lines, a silhouette of the part in black ink or paint, a blank area; or an inset drawing. There should always be a note in the figure caption explaining what and why this has been done.

Image: Scientific illustration showing how light emanating from the left reflects off the various areas of the beetle. J. Thurmer

- The source of light from a lamp or window should always beam left to right. This convention is accepted world-wide it helps scientists present, and interpret descriptions in a standard, consistent manner.
- Remember to make supporting sketches of plant material, e.g. leaves twigs, gumnuts, buds, blossom, marks, defects etc. and add them to your illustration if needed or wanted, but do not over do this.
- Record details on each of your sketches or in a diary, e.g. the date, the scientific or common name of the specimen, exact locality where it was found, GPS details if known, the weather, scale, magnification details, e.g. lens size of eye piece if using a microscope, what equipment you used, and your name, the date you started the illustration and the date you finished.
- Make notes regarding any important observation of something that you may later wish to check, emphasize, or include in your illustration. The colour and shade of an insect or plant may change quite dramatically as it dries, oxidises, or becomes stale, so colour references are important. If possible use colour cardsor swatches to record colours when the insect, plant etc. is fresh, or mix a sample of the relevant colour yourself using your own paints and apply the colour to a sample of the board, or paper, on which you will be working. If you are unsure of the colours of your subject, perhaps a bird, or an insect, research online or in person such as a zoo or wild life park for a better idea.

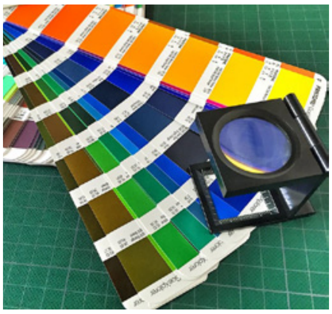
 

Image left: Colour swatches are a reliable way of matching a colour to your specimen. Image courtesy: PX here

Image right: A spare piece of illustration board is useful for testing the colours you have mixed before you apply them to your work. J. Thurmer

- Legs and antennae may be moved into slightly different positions on your illustration to give a more natural look. However, do not change the place from where the legs or antennae are attached to the body. Never overlap them or other important structures, unless asked to do so, and even then, consider carefully the consequences.

  Re-arranging the animal's pose:
  For instance, insects tend not to die in a neat, symmetrical position, and they are often tightly curled up. When this is the case you will not be able to draw the specimen until you can see all of the body parts properly. Most specimens that are dead are very fragile and prone to damage. Firstly, you will need to 'relax' or soften the specimen by placing it in a damp situation for a suitable period of time. Insects may be placed between layers of wet (but not dripping) paper towel in a sealed container for 2-4 days depending on size and structure (large, hard-shelled beetles take the longest, for butterflies and moths, a much shorter time is required).

  Once softened and relaxed you will need to 'pose' the specimen in a suitable position. Push a long pin through its thorax and mount it on a sheet of polystyrene foam. Gently tease out the legs and antennae until the pose is reached.
  For moths and butterflies, and other, delicate insects/specimens place the pin in the centre of the thorax) until there is about 1 cm of the pin showing below the insect. Then push the pin with insect attached, into the foam block. You can now tease out the legs and antennae, into a new 'pose' etc.

  Leave the insect to dry and 'set' – it should be ready in a few days. If you then make take two small squares of polystyrene foam, about 3 cm x 3cm and use pins to create an 'L-shape' by joining along two edges so that one piece is horizontal and one piece is vertical you have a very useful tool. Use this to support your pinned insect by pushing it into the foam at any angle that you require.

  This system allows you to turn the specimen so that you can draw each segment of a leg or antennae etc, in a flat position to see and draw the full length of each section. This technique can be used for manipulating many different, small, specimens or objects, but you will have to discover new techniques, or methods for most of what you illustrate.

- Being able to observe the specimen easily and completely is one of the greatest challenges in science and scientific illustration. You will need great patience and excellent lighting. You may spend more time setting-up and reaching a point where you can see all of the parts to be illustrated, than actually completing a finished sketch, ready for inking or painting.

Types of scientific illustrations in more detail

Pencil sketching

It is important to experiment with the different grades of lead pencil to ensure that a particular pencil suits the paper selected and style required.

Warm-up sketching is an important part of the process e.g. a row of over-lapping circles of the same size, without taking the pencil off the paper or a line of figure eights which run one after the other as in cursive writing. The aim is to control the line work to ensure consistency.

Next draw something a little more taxing, perhaps a five-minute sketch of an object in the kitchen – a piece of fruit, a cup, or your dog or cat. Anything really, but it's essential to work quickly – it helps with learning close observation.

Lead pencil is generally used for the many working sketches that are required to produce an accurate illustration, although some artists prefer to work with a technical pen and black ink.

Initially while learning it's best to limit the size of artwork to A4 and choose a fairly simple subject, or illustrate just one part of an insect, shell or animal.

Image: Initial sketch of a beetle's head showing mouth-parts and the point at which an antenna inserts into the head. J. Thurmer.

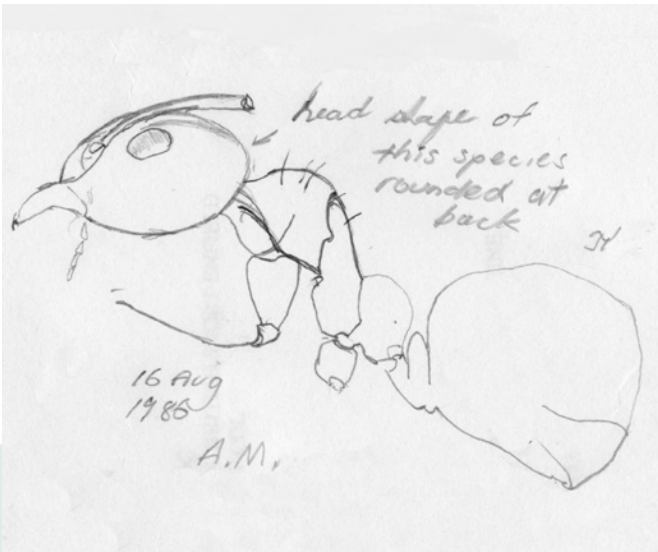


Image: Sketch of the body of an ant with relevant notes. J. Thurmer.

Working sketches

It may be helpful to produce additional sketches and notes of any difficult areas, especially if the insect or animal is damaged or curled up. The parts may be drawn separately and assembled in the final illustration.

Sketch plant or food source elements separately – extra leaves, seedpods, blossom, other insects, reptiles, small mammals etc., so that they can be added later if necessary, ensuring they are accurate. Sketch more of the plant than might be used – longer stems help, as this allows more choices for positioning, for instance, an insect.

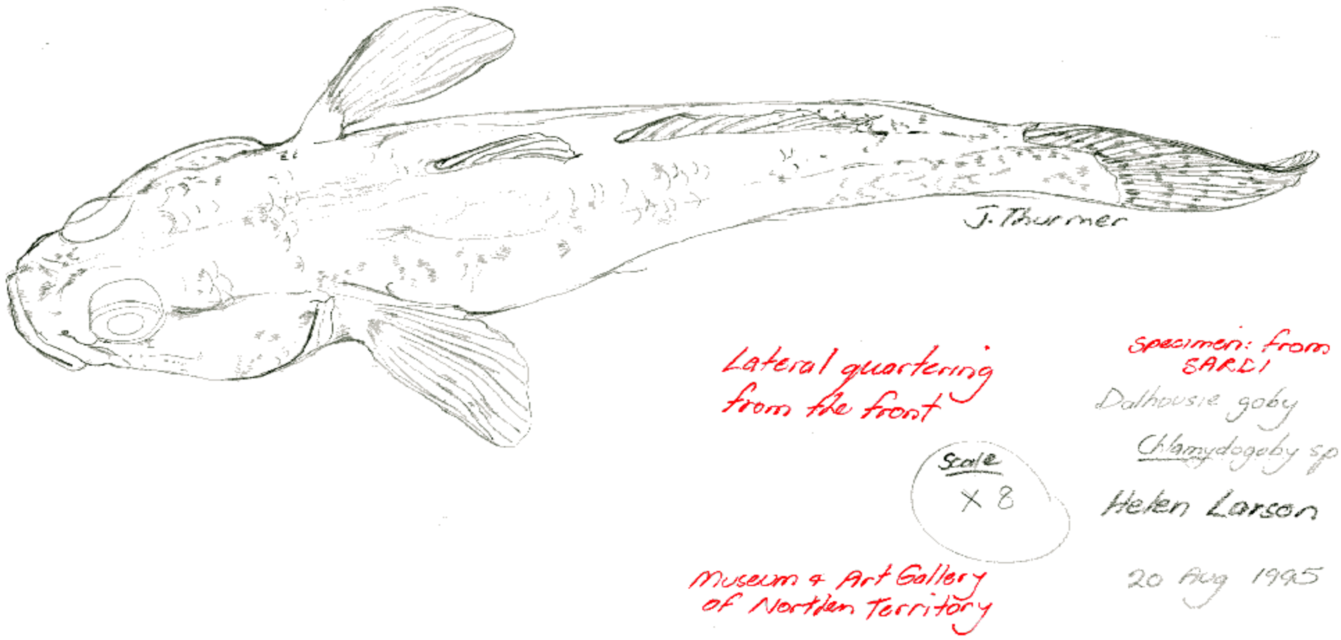


Image: An example of the types of notes recorded on one of Jennifer's sketches, a desert goby.

Image: A preparatory sketch of the skull of a Red-necked Avocet (Recurvirostra novaehollandiae) J. Thurmer.

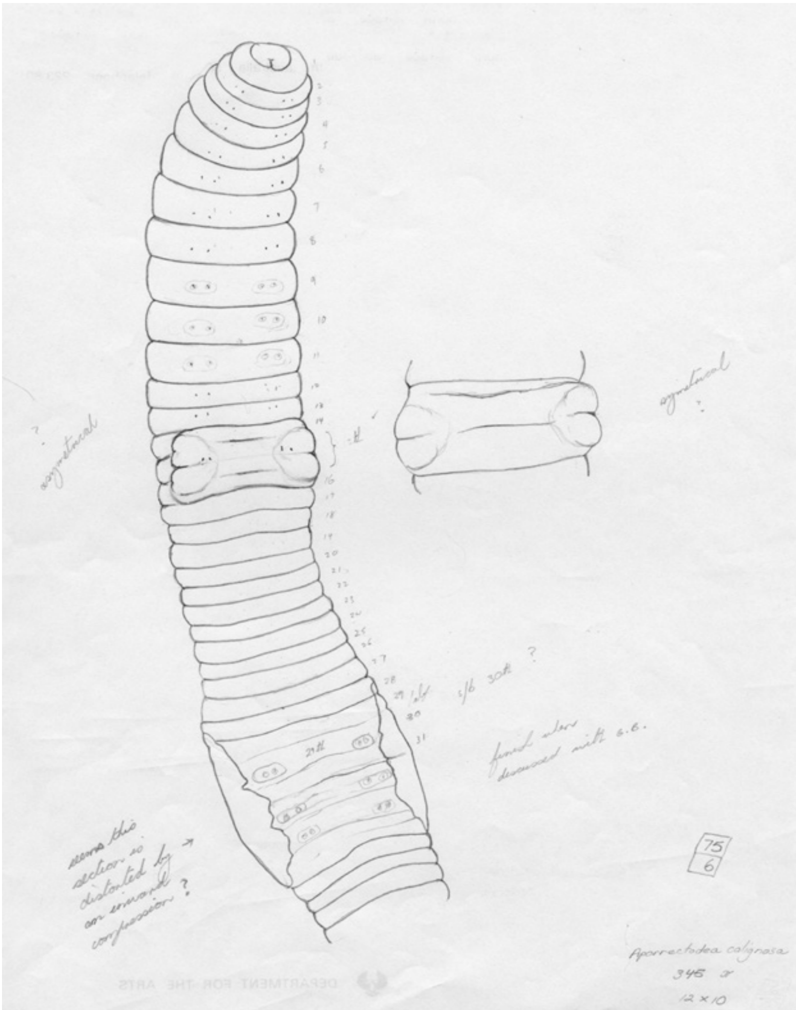
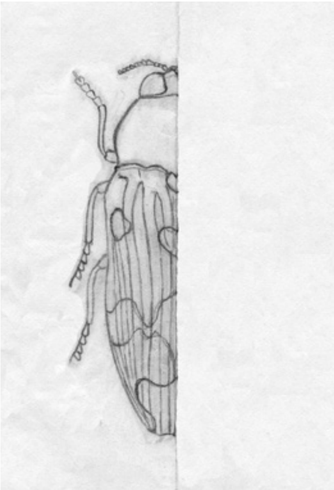


Image: Sketch of earthworm, with accompanying notes. J. Thurmer.

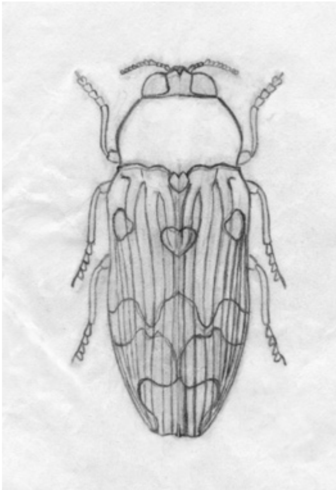
A lesson in illustrating a beetle:

Closely observe the beetle and prepare sketches of it from several angles to determine the correct 3D shape of all structure. This may result in many sketches.

Produce a final, neat, clean, 'single-line' drawing on tracing paper from your sketches of only half of the specimen then fold the paper and trace through the other side using a lightbox. Artist J. Thurmer.

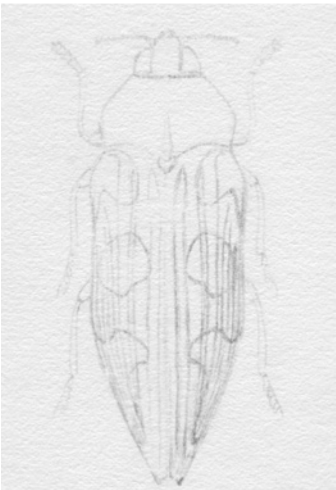


To achieve a pencil sketch of a symmetrical item, in this case an insect, you need draw only one side.

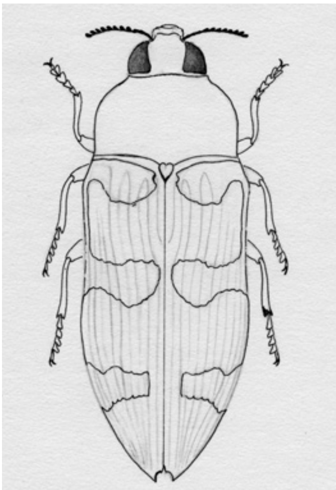


Complete the drawing as described above. Ensure that it is correct.

Scribble over the back of your line drawing using a 2B lead pencil and rub it down on to your chosen paper, card or board (in this case a small sheet of illustration board, suitable for watercolour, or coloured ink work).



The rubbed-down outline of the beetle, should now be tidied-up if necessary, and the line work refined with a sharp 2H pencil (see next illustration).



The line work is now clean and sharp, and the areas of the beetle's two wing cases and legs etc. that will appear black have been outline in black ink with a technical pen size 0.25 mm. Painting would be the next stage.

An example of the finished jewel beetle (go to the section on illustrating with coloured inks or watercolours on pp. 27-29 for details of this method.)

Lead pencil drawings as finished art

Scientific illustrators who specialise in lead pencil drawing as 'finished' art, devote many hours to shading and highlighting. The work of Peter Schouten, an Australian artist and illustrator of publications in the field of zoology and palaeontology, is an example of this style. David Attenborough termed his skills as 'rare and precious', and among the world's best.

If not working to a deadline drawing with a pencil is a relaxing style of illustration to keep working on, over time. There is little equipment to put away; you do not have to wait for paint to dry; and errors can be erased without too much trouble. The results can be outstanding.

Image: Magnificent illustration of an ancient horned turtle by Peter Schouten.

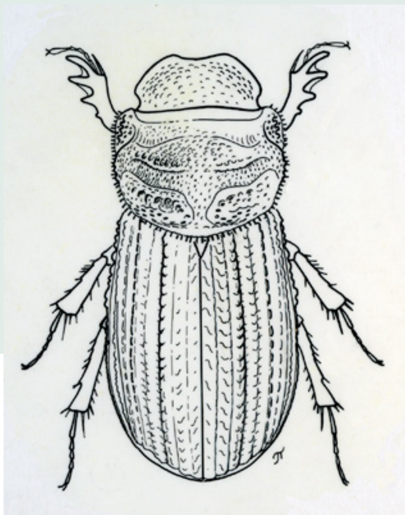


Image: A line illustration, where the thickness and careful positioning of lines, and the shape of pits and dents increase the 3D look, without using any actual shading. AA298/42/15/15/#4 South Australian Museum, J. Thurmer.

Black-inked line drawing

Once the initial pencil drawing has been completed, line work may be transferred to a suitable card, board or paper, and the inking process begins.

You may use any of several types of pens: the older style of dip pen, a mapping pen, or a technical pen such as a Rotring.

The important thing is to work painstakingly. Try to achieve crisp line-work, with little bleeding of the ink, and no blotches. This will initially be challenging, but with practice there will be improvement, as all becomes second nature.

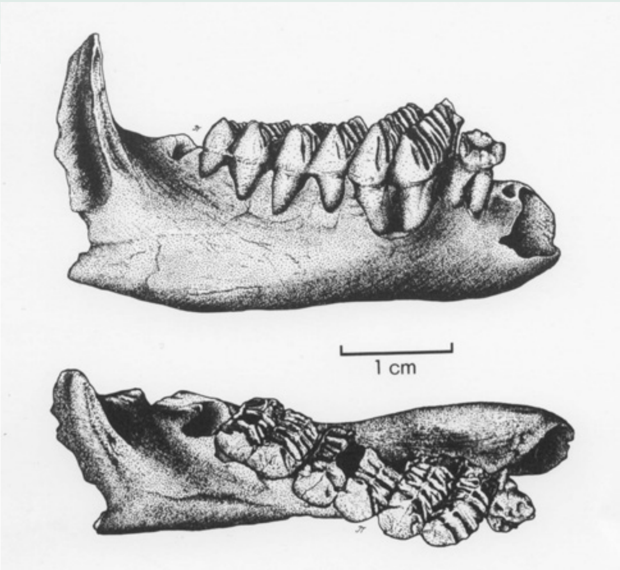
Some artists use a high-quality card, with a hard surface. I prefer polyester drafting film – this product was traditionally used by architects and technical illustrators. The surface is frosty in appearance, and smooth, with just enough 'tooth' to absorb the ink. Your work dries almost immediately. A dampened eraser will remove mistakes. I use tape to mask off the error when doing this, to prevent smudging areas that are not to be removed. If a really crisp intersection is require a scalpel is used to 'shave-back' any minuscule overlaps.

A slight emphasis or thickening of a line can imply shadows or depth. Fine lines, or missing lines, can create the impression of height. Lines drawn closer together give the illusion of depth and curve, and add to the 3D shape.

Stipple drawing

Although this type of drawing (in black ink) is classified as 'line drawing' it is actually composed of many thousands of dots. Some artists use a solid line as their outline, but other artists use no lines at all. The dots are unevenly, or evenly space, depending on the amount of light hitting the surface. Each individual dot should be clean and sharp. Dots are always carefully placed (although in dark areas random dots are fine). From a distance this technique creates the impression of shades of grey— the more shaded, or dark, the area the more dots per square centimetre.

Stipple drawing is time-consuming, but has two advantages: it is 'line art' (only one solid colour), and therefore inexpensive to print (if needs be); secondly, it creates a 3D appearance that gives extra depth to the drawing, and a certain reality – in a similar way that a photograph does. This type of illustration works well on websites and in conventional publications.



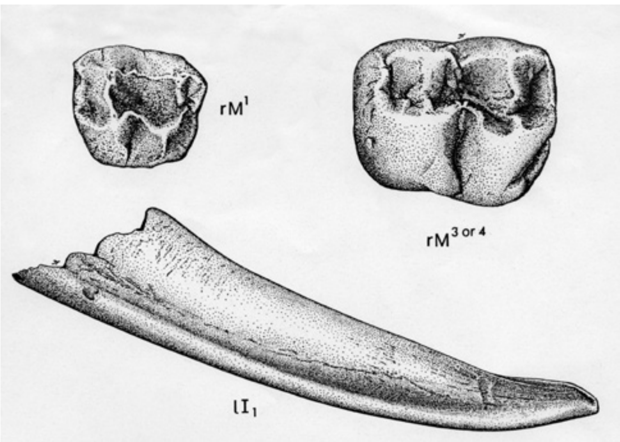
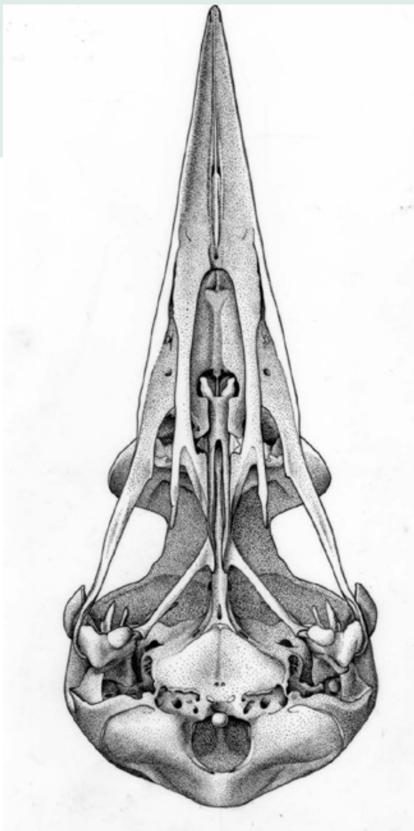


Image: Stipple drawings, this time a side view and top view of a fossil of the lower jaw of Ektopodon, a possum-like marsupial that once lived near Lake Eyre in South Australia, AA298/42/15/35. Individual teeth were also drawn to accompany the two illustrations, AA298/42/15/39 (in part), South Australian Museum, J. Thurmer.



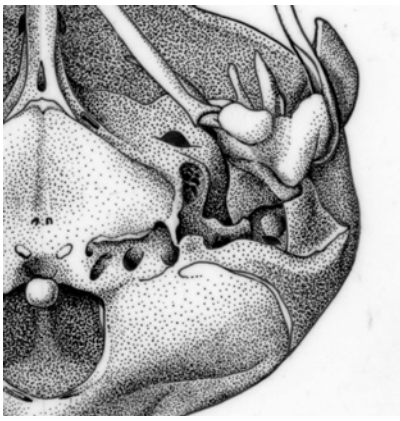


Image: A finely executed stipple drawing of a bird skull, Gymnorhina tibicen, and a close-up view to show the method of applying the dots. J. Thurmer.

Black ink wash paintings

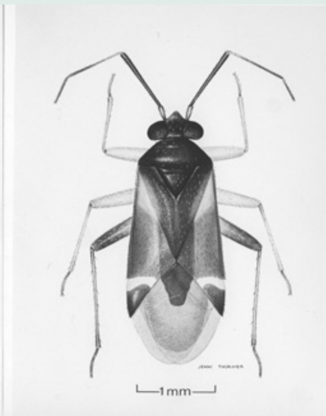
This is an excellent method for painting a wide range of specimens and artefacts. These paintings are built up using many layers of diluted ink, or in some cases black tube paint – we also know of them as greyscale images, although no grey paint is actually used.

A first application of very dilute ink wash is applied to the entire outlined insect, it is very pale, and allows the watercolour or illustration board to absorb a little moisture in readiness for an application of a slightly darker wash to areas that are darker on the specimen. By approaching this cautiously one builds confidence and there is little chance of making a mistake that cannot be corrected.

Wash is slowly added to each area until the full 3D effect is achieved, and no more shading or shaping can be done to improve the painting. The final coats of wash will be the darkest, but are applied only to those areas that are in deepest shade, or for depth.

Usually, as the final stage, highlights of white paint are added to any high points and to edges, ridges, texture, hairs, where the light source falls.

Illustration 125 Carualho and Gross *Blesingia tamborinea*, Aust Journal Zoology Sup. 86



Sejanus albisignatus (unregistered)

Image: Here are two examples of black-ink-wash paintings of true bugs – sap-sucking insects of the family Miridae. They were painted on to illustration board. South Australian Museum, J. Thurmer.

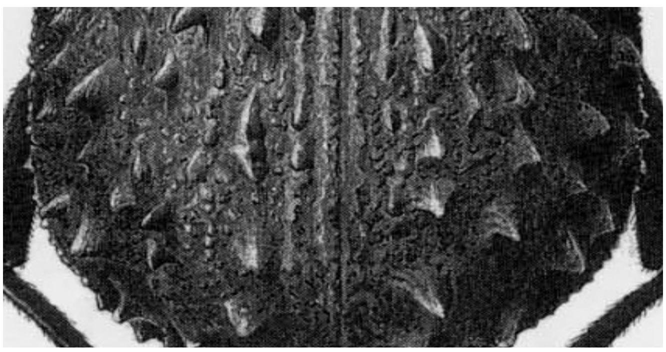


Image Left and above: A finished beetle painting showing a remarkably textured beetle. *Dysarchus tuberculatu*, AA298/242/15/6, South Australian Museum, J Thurmer.

Watercolour paintings

In regard scientific illustration, the most expensive and desirable type of illustrations, are of course, those that are coloured.

These are usually executed in watercolours or coloured inks (although acrylics may be used). These artworks are time-consuming to prepare, and they add considerably to publishing costs. Coloured illustrations often appear on a cover, or frontispiece in a book. However, the fact that most scientific publishing is now done online allows the almost limitless use of colour.

Watercolour painting is a method where a simple coloured 'wash' may be used to provide a hint of colour, or a 'layer upon layer' effect results in the full-depth of colour as close in appearance to the specimen being illustrated as possible. White paint is used, as previously described, to add highlights.

To produce fine watercolour illustrations a great deal of patience and skill is required. The exact matching of colours to the original specimen is imperative, and an ability to mix that colour is essential in scientific illustration.

Four (or more) separate printing 'plates' are utilised when reproducing coloured illustrations – one for each of the process colours (magenta, cyan, yellow and black). Therefore, there are four separate 'runs' of the printing press, at least. If a top-coat of varnish is required, or an additional 'spot' colour, this can lead to five or six 'plates', and therefore five or six 'runs'—making the final publication or limited-edition print rather expensive. This is where, and why digital publishing has been so successful.

Coloured ink paintings

The use of coloured inks in scientific illustration and natural history art is rarely seen — watercolour tube paints, tablets of solid watercolour, or acrylic paints are more usual.

Coloured inks are particularly useful when you wish to achieve brighter, or deeper colours than watercolour paints allow. Inks can dry with a somewhat shiny surface and this can enhance a painting if the insect has a shiny exoskeleton. Windsor & Newton and preferably Reeves inks are recommended.

Image: A Pie-dish beetle (the background of red desert - sand is to scale), AA298/42/15/12 South Australian Museum, J. Thurmer.

Image: The halide mineral Atacamite, AA298/42/15/71, South Australian Museum, J. Thurmer.

With inks, watercolour board is used because it has a more robust surface than watercolour paper, which allows you to use an eraser on the surface of the board, and it is unlikely to warp when applying the many wet coatings of ink wash.

The method with coloured inks and watercolour paints

This technique is for working with both coloured inks and watercolour paints. The whole process can take many days depending on the size and complexity of the work.

As with all styles of illustrating, the specimen to be rendered should be closely studied and the usual preparatory sketches made before transferring the final pencil drawing to a sheet of watercolour board.

- Use a number three or four brush to apply very dilute washes of ink and water to the illustration using the colours that are relevant to the particular areas of the insect and/or plant.
- Now, following careful observations of the specimen, begin by carefully applying a further wash of colour to the area selected for attention being careful to dampen and not flood the area.

  Then begin to build up the layers of diluted ink wash until the painting, including any appendages have a little more strength of colour; be it black ink or colour. The painting may need to dry properly between 'coats'.

  Do the same for any plant material that is to be included in the illustration; and to the background if there is to be one. The illustration at this stage has just begun and It may take many sessions to reach the full colour needed, drying the work overnight, several times.
- As you proceed be aware of the areas to be shaded or light to give depth and shape. Smaller brushes will help. When you have finished this stage, your painting should be a paler version of what you want the finished artwork to be like.
- For the next, or future session/s, using even smaller brushes, begin to add and build up, any texture, sculpturing, ridges, recessed areas, lumps, etc.
- Next, will be the finishing process of the illustration, you will apply greater attention to achieving full depth of colour, and shading, to reach the correct 3D shape, depth and texture. Legs are a good place to begin this process/ stage because nothing much can go wrong. Legs, compared with other parts of, for instance an insect or many other animals, are fairly simple structures, and a good place to practice before tackling the body head, eyes, feathers, or wings etc.
- Having completed the legs, move on to the body of the animal, and this is where close observation is critical.
- Keep your colour work smooth and well blended – it is important – so practice on a separate piece of the same board until you get the feel of how the board is working. Your layers of paint can be worked-over to a degree, enabling a blending effect, but one needs to be aware though, that too many layers of ink or paint that become too thick may cause a certain blotchiness, which is not desirable, and will leave you disappointed. Caution and practice are needed.
- Plant material and the background should not be overworked, keep those items, slightly subdued, so that the focus is on the specimen that is the subject of the paper, exhibition, article etc. If the artwork is not to be used for such purposes, this may not be important, and just a preference to do so.

- Once the colour work is complete, hairs, spurs, spines, dimples may be added with very fine brushes, or a technical pen. Close observation as to the placement of these details is paramount.
- Highlights, using white paint and extremely fine brushes, may now be added.
- Carefully observe where the light (always beamed from the left to right) hits the specimen. If an animal or insect, look at the eyes, the head, any ridges, tips of the sections of the legs, or sides of hairs, the wing casing (elytra) etc. and apply very small dots, lines etc. as indicated. A fairly dry brush loaded with white paint can be dragged across the surface to enhance the look of a fold, texture, or other surface.

Additional notes:

For illustrating areas of iridescence on a specimen or object that is basically black, coloured inks can be applied full-strength to those areas, of the final artwork e.g. there may be bands or patches of magenta, green, blue or purple. Where there is a blending of colours build up layers by the coloured-wash method until the colours are rich and of full-strength and then leave the artwork to dry thoroughly. The next stage is the application of a complete layer of black ink to the areas that are to be iridescent – sometimes the whole beetle. If the beetle is basically blue or green all over, yet has iridescence of another colour, omit using black ink, just stick with the colours you observe, and only use a dilute wash of black ink to create depth and shape - and only where it is needed.

When the ink is absolutely dry, take a slightly abrasive pencil-shaped eraser that has been sharpened to a point. Gently erase the top layer of black ink to reveal the colour underneath. This process will at the same time create/reveal the 3D shape of the area/specimen, as the colour is removed. Go gently, and softly. Additional light washes of paint may be added if too much ink is removed, but only if the surface has not been very abraded by the eraser, you really only get one go at this, so practice is important.

Illustration board is firmer and tougher that watercolour paper, so it a better product for this type of illustration. If the insect has pits, or dimples, hairs, spines or there is a texture to the surface of the iridescent area, these can be added at this stage where the ink/colour has been erased. They are applied as simple black, grey or brown dots or lines, using a Rotring pen, perhaps a 0.5 nib, or if your painting is larger, a number 8, or even a number 1.2 nib (a brush may be used if preferred). Remember that hairs and setae are not random, there is usually an order to their positioning and number. Highlights can now be added. These are small carefully placed dots, lines (use brushes size 00 or 000), or frostings of white paint applied with brushes: size 1 or 2.

Remember, too, that every spine, ridge, etc. catches the light, so be aware of this and do not overdo the addition of white paint, just because you know that there are hairs present – let what you actually see be your guide. The same with pits, and other tiny structures; make some of them obvious by placing a small semi-circular of white paint around the rim of each pit. Sometimes an application of white paint is used 'wet' and applied carefully with a very fine brush, sometimes the paint used is much thicker and the brush drier, and only lightly frosted over the surface using the texture of the board to pick up a tiny amount of paint.

As with all techniques, practice on a separate piece of the same board, but always use the technique that works best for you, so practice and experiment.

Coloured pencils

Although, Jennifer has rarely prepared coloured pencil scientific illustrations, they still have their place as useful enhancements to almost any publication—as cover illustrations; coloured plates, paintings used in exhibitions and on websites; the covers of books; as posters, and to promote various science-related projects.

Illustrating with coloured pencils is great for students, especially as they are already familiar with this medium. It is not messy, there is less likelihood of spilling ink or paint, it takes less time to set-up; far less space is required; and artwork does not have to sit-around drying. However, in regard to scientific illustration, it's important to give students the opportunity use paint and inks from a young age to build their skills and confidence.

Image: Here we see an outstanding scraperboard illustration by Linda Blesing, who was Scientific Illustrator at the South Australian Museum in the early 1970s.
Aulocopris maximus AA298/42/8/1

There is also the bonus of scientific illustration or wildlife art becoming a useful adjunct to a student's career.

Illustration is also an excellent leisure-time activity that may serve them well, and perhaps provide another income stream at a later stage. Some people find illustrating relaxing, which can never be a bad thing, and coloured pencils make this an easy-to-do interest.

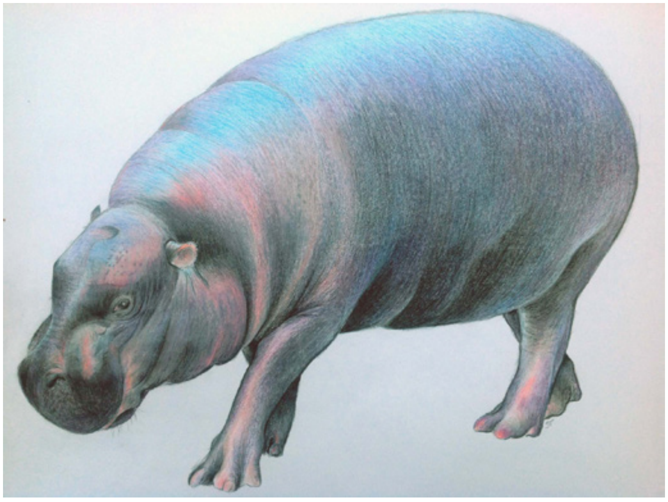


Image: Janice, 1982. Above is a coloured-pencil illustration of the much-loved pygmy hippopotamus, which once resided at the Adelaide Zoo. Drawn at a much larger scale than Jennifer's usual illustration, it appears here, more refined, at the reduced size. A great tip when producing your own work.

Scraper-board illustrations

Although scraper-board is rarely used these days it is a wonderful medium in certain circumstances as the results are can be stunning, with crisp detail.

It is a fun technique to use, and with a little invention may be successfully used in other creative ways.

Scraper board has a thick coating of white china clay on its surface which absorbs ink, or watercolour, readily.

Method for using scraper-board

Firstly, an accurate line-drawing of the specimen is prepared. A single outline of it is then transferred to the scraper-board surface by rubbing it down and refining the line work if necessary (no details are added at this stage). The shape is then filled-in with undiluted black ink to form a silhouette of the original specimen. Then, using suitable scraping tools (perhaps a sharp nib, a dental tool, or even a pin for producing fine textures or hairs) the black ink surface is scraped away to reveal the white clay underneath.

A scraper board illustration is particularly useful if the specimen to be drawn is black, or a very solid single colour. For example, a black beetle, or an ant. The resulting work is usually quite striking. Up to 70 hours may be spent in producing extremely fine illustrations of this type.

Carbon dust illustrations

This technique is not used a great deal today as there are so many other options, and yet it can produce quite spectacular life-like results.

Pioneered in the early 1900s by Max Brödel, of John's Hopkins University, the technique produces very fine grey-scale, tonal illustrations.

Image: A carbon dust illustration of a sheep skull prepared by Natalya Zahn, an artist whose work, predominantly wildlife art, can be found online.

Method used in preparing a carbon dust illustration

Using a soft lead pencil, perhaps a 2B or 4B, a sketch is made of the specimen and transferred on to board or paper that is very fine and yet microscopically textured. The texture traps and holds small quantities of the carbon dust. The transferred outline sketch may then be strengthened if necessary.

Next, brush in a controlled manner, over the drawing with a soft flat paintbrush to smooth and blend the penciled line work (the line work is very slightly greasy to work, and smudges well — and unlike other forms of lead pencil sketching, this is important).

Carbon dust is produced by sharpening a very soft lead pencil (although carbon dust can be still purchased in bulk). If needed, additional fine dust is transferred on to the illustration via a dry soft watercolour brush, and worked and blended gently with a cotton bud or a tiny pad of soft fabric to slowly build up the tones, and the strength of the carbon dust can be reduced by the careful use of a chamois cloth. Light areas are created by removing tone or even erasing all the way back to the board.

More carbon dust may be added at any time to create depth and shape.

Work gently to ensure that the surface of the is not damaged. To a degree, a soft eraser may be used to remove mistakes, or create lighter areas.

A final application of dots (or lines) of white paint adds any important highlights. This type of illustration should be sealed with a spray fixative to prevent smudging, but do this very cautiously.

Airbrushing

The airbrush is a hand-controlled instrument, first patented in 1876, which emits a controllable mist of paint, ink or dye, under pressure. Compressed-air passes through the airbrush forcing the diluted paint to spray, very finely, from a nozzle. Areas where paint is not to be applied may be masked-off with adhesive films or solutions, and then the unprotected area sprayed with colour.

This technique is especially useful for backgrounds or large areas that need to appear very smooth.

For small illustrations the preparation time takes almost longer than the actual painting, so as a technique it has dropped out of favour for the scientific illustrator, although it is still used by some.

Today, mural painters rely on the airbrush technique, although mostly they are likely to be using aerosol packs of paint. A very similar effect can now be achieved on a computer.

Image: The device used for airbrushing the illustration of the fungi below. The artwork was finished by hand, as is often the case in this type of illustration. Refinements, and fine details may be added or areas highlighted as required.

Digital Illustration

Most, if not all, of the illustrative styles can now be performed digitally. Some are more successful than others. Some are prepared relatively quickly, and others take almost as much time as conventional methods. Artists report varying degrees of success. Many find that the time it takes to execute a drawing or painting on a computer, sometimes results in it not being a cost-effective method. Others are not satisfied with the result, as computer generated illustrations often have a more designed, or stylised appearance, which is not always appropriate for scientific purposes, but may be what an artist is looking for within another genre.

Some artists use a computer to render part of the job and finish their illustration by hand, or vice versa. If a scientific illustrator is involved in a project where many species are similar in appearance, it may be useful to use an appropriate illustration 'app' and simply tweak-in the differences of colour or relevant taxonomic features.

There is also a range of apps available for devices such as tablets, that may work well for students to experiment with. One such app is 'Procreate'.

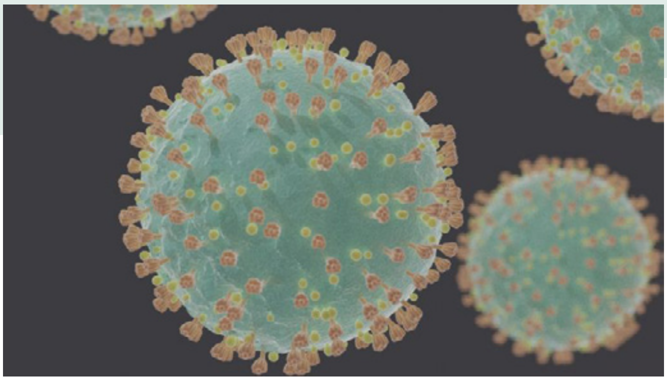


Image: A computer-generated representation of COVID-19 virions (SARS-CoV-2) under electron microscope. (Credit Felipe Esquivel Reed on wikimedia commons)

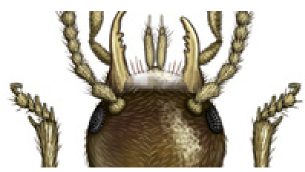


Image Above: Beetle prepared digitally, with enlargement to show mouth-parts, below. Courtesy, University of Kansas, Dr Steve Ashe.

Image far left: (Before): Here we see a dull grey background, and the specimen is crooked with legs at all angles. Wings are untidily visible, as is a part of the tag of white paper supporting the specimen.

Image Right : (After): A greatly improved image that will present the correct information, without the distraction and ugliness seen on the illustration on the left specimen.

Sketching and producing fine lines, easily, on an iPad

It is now possible to achieve a high level of accuracy and refinement on an iPad using the illustration app 'Procreate'.

The lack of a suitable program has been a major reason why scientific illustrators were often critical of earlier digital results.

Generally speaking, for scientific illustration it is a fine line between an accurate illustration and a stylised one.

There is a place for creative art, and it offers a great pleasure to all artists, but scientific illustrators must remain selective, diligent, and copy nature's detail closely—this is the most important role of the scientific illustrator in science.

Image: Coloured illustration of the anteater, Tamandua, was prepared by Pat Latis, DVM (Doctor of Veterinary Medicine) on her iPad.

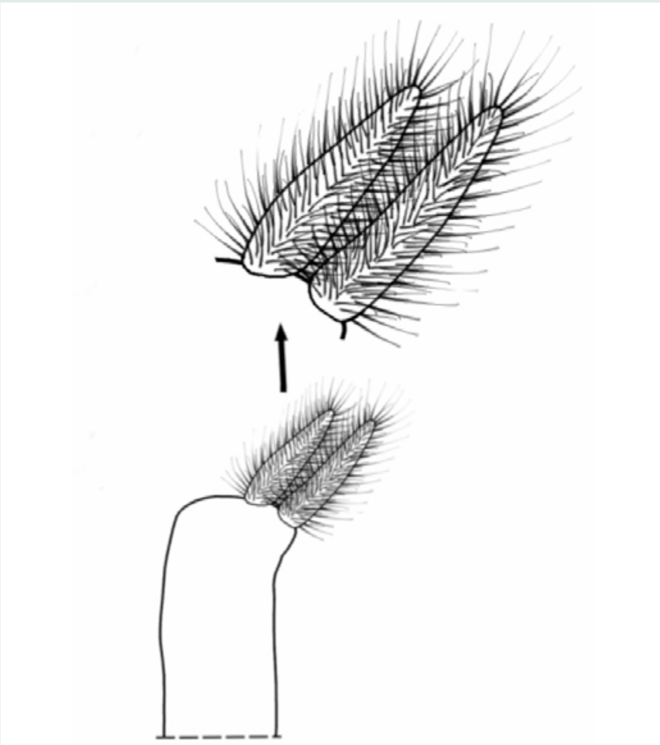


Image: Fine line-work is now possible on a computer by using a digital pen and various 'brushes' and other 'tools' that come as part of the app.

Image: This digitally generated line-drawing of Javalina (a peccary), was prepared by Pat Latis, on her iPad.

Creating a digital scientific illustration of a bird with Procreate

The following method and tips were provided by Dr Pat Latis a veterinarian based in Tucson, Arizona, who specialises in the conservation and rehabilitation of parrots.

The aim in this project was to produce a digital scientific Illustration of a complete bird by combining several images. The result is termed a 'hybrid illustration'.

STEP 1
Planning and preparation:

An existing pencil sketch of the bird's head was selected, along with a photograph of the bird (which did not show the lower part of the legs). [The legs were later 'sketched' with Procreate tools, using sources on the internet to discover their appearance and structure. The photograph was the main reference, and one that could be used to harvest fine details of the bird (once the image had been scanned). All scanned parts were kept as separate 'layers'.]

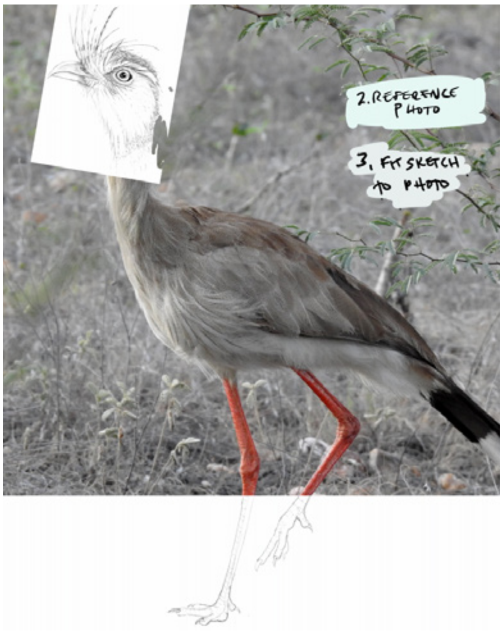
STEP 2
Observation and checking:

Subtle details of the bird's features were noted, e.g. the different types of feathers, and their colour; the texture of the skin around the eye, the shape and colour of the eye, colour of beak and legs, and the posture of the bird. References for the lower legs, feet and claws were found, studied, and sketched using the 'sketching' tool. There were now many layers.

STEP 3

Assembling all of the parts:

Digital versions of the head, and 'sketches' of the legs were carefully aligned with the scanned photograph of the body using the appropriate 'tools'.



STEP 4a

Preparing the digital sketch:

It was now possible to complete the sketch by tracing over all of the aligned body parts with the digital 'pencil'. This was saved as a new combined layer, and became the illustration that would be coloured.

STEP 4b

Adding fine details:

The digital illustration was improved by adding details of feather arrangement on the body; shape to the tail; and markings as required—again using the digital pencil.

STEP 5
Main blocks of colour added:

After careful observation of the original photograph to ensure the sketch was accurate, the main blocks of the different shades of grey and other colours were added using digital 'brushes'. These were saved as separate layers (in case any colour or shade of colour needed to be adjusted).

STEP 6
Refining:

The feathers and the crest were softened to provide a more natural blended look. Special attention was paid to the wrinkles in the skin around the eyes. Stronger shades of orange were used to picked-out the scales on the legs.

STEP 7
Final session:

Shadows were added to develop the overall shape of the bird, and the markings on the head and the body were worked-over. Final touches of pinkish brown were also 'brushed' on. Highlights of white were added digitally to add life to the illustration. All layers were combined in the final artwork. The Red-legged serima (Cariama cristata) was prepared for the book 'Birds of the Caatinga', 2021.

APPENDIX 1.
A brief history of scientific illustration

Early attempts to record the images of animals: Palaeolithic cave-paintings

The first illustrations that were scientific in approach may be the images of animals painted on the walls of caves. The world's oldest known animal cave painting is in Indonesia, a wild pig believed to have been drawn 45,500 years ago. Scientists believe an Aboriginal rock art depiction of an extinct giant bird, part of the megafauna group, Genyornis on Jawoyn Country in the Northern Territory could be Australia's oldest painting of around 40,000 years old. Illustrations of bison and horses drawn in caves in Spain and France are so accurate that scientists have been able to determine the season, due to the carefully recorded density of fur. Scientists have stated that these paintings 'demonstrate early humans' capacity to give meaning to their surroundings and communicate with others'.

Image: Archaeologist Ben Gunn said the giant birds became extinct more than 40,000 years ago. "The details on this painting indicate that it was done by someone who knew that animal very well and the detail could not have been passed down through oral storytelling." (credit Ben Gunn ABC news)

Image: A painting from Niaux Cave, France depicting a recognisable horse dates back more than 12,000 years. Many such paintings record the colour of the horse, and coat markings, for instance: spots or stripes. These coat variations are not fanciful, and are believed to be accurate records.

The first known illustration of an insect

This tiny work of art, produced about 20,000 years ago, illustrates a camel cricket. The insect was etched on the bone of a bison by a Cro-Magnon person (the earliest known modern man). It was discovered in the Caverne des Troise Frères in Ariège, France.

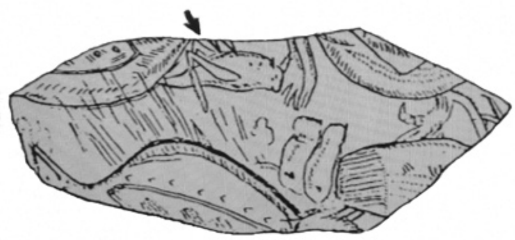


Image: The first known illustration of an insect (a camel cricket), etched on a bison bone, about 20,000 years ago. See arrow. Found in the cave of the Troise Frères.

Egyptian wall paintings – 3,000 to 1,000 BC:

Many of the artworks of the Ancient Egyptians may also be classified as scientific illustrations, as they are not purely decorative. The artist is conveying information about an animal, a farming technique, or a ritual.

These early efforts were two dimensional – flat and usually drawn from just one angle... a side view.

Image: Anubis (a jackal-headed diety, who presided over the embalming process and accompanied dead kings in the after-world), finishing a mummification. Tomb of Amennaht at Deir el-Medina Egypt. This is an early example of a visual record of a technique. (Credit Ancient World History)

Image: A modern-day interpretation of the original wall painting. South Australian Museum. Artist Kath Bowshall.

Papyrus: a form of early 'paper'

Papyrus was made from the flattened stems of a reed which grows in the marshy delta of the River Nile. As a writing-material, papyrus was utilized by Ancient Egyptians from around 3,000 BC. Many texts recorded on papyrus survive today. Some of these early records are illustrated, and show day-to-day activities, major events, and images of the early kings and queens of Ancient Egypt.

Image: When more than one sheet of papyrus was required for a lengthy text the sheets would be bound together with a cord that was also made from papyrus fibre.

Image: The Heracles Papyrus, showing text with accompanying illustrations, this is an example of the realization that an illustration is a useful method of recording, visually, an event (in this case), details of the event were not described. (Credit Public Domain)

Image: An illustrated scroll of papyrus, showing attendants wearing decorative head-ware. At bottom left, we see Anubis, Ancient Egyptian god of the dead, represented by a jackal or the figure of a man with the head of a jackal. Bottom right we see a representation of Horus, the 'victorious' god of the sun, who overcame darkness. He is represented with the head of a Eurasian sparrow hawk. (Credit Tour Egypt)

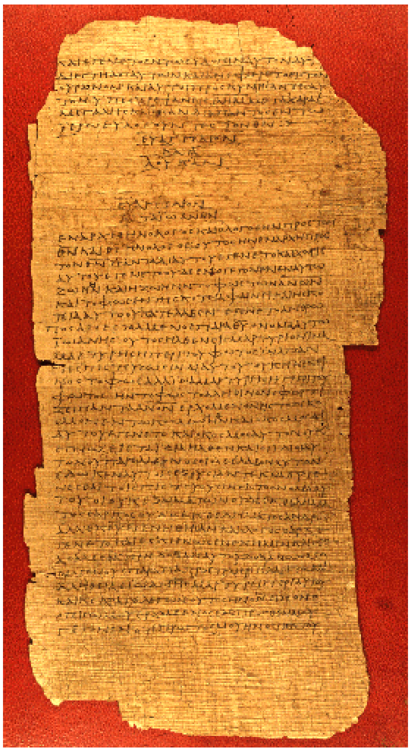


Image: Papyrus, an early writing material of the Ancient Egyptians, which had a rough surface; decomposed under damp conditions; and was not an ideal surface for the painting of elaborate illustrations.

The technique for making papyrus spread throughout the Mediterranean and was used commonly by the Greeks. It remained a popular writing material until the early 2nd Century AD. Examples of its use by the Byzantine Empire are recorded as late as the 12th Century AD.

Papyrus was eventually replaced by parchment made from the split-skin of sheep, and is thought to have been in use from as early as 1,500 BC. Vellum (possibly just another name for parchment) is thought to have never been split, and may have been made from cow's hide, only. These materials were more resilient, long-lasting, and provided a smoother surface, for writing and illustration.

Pliny the Elder

Gaius Plinius Secundus, also referred to as 'Pliny the Elder', was a Roman naturalist, writer, philosopher, and army and naval commander, born in 23 AD. He was also a friend and servant of the Roman Emperor, Vespasian. For most of his adult life he wrote, attempting to describe all known plants and animals of the Roman world.

His massive illuminated 'Natural History' encyclopedia 'Naturalis Historiae, of more than 30 volumes, was completed in 77 AD, shortly before his death. The hand-written book, also purports to record 'all Roman Knowledge' and covers most of the other sciences of the day. It is not illustrated in the traditional sense.

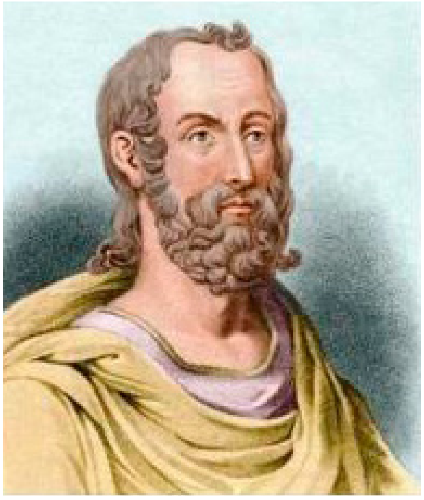


Image: Gaius Plinius Secundus, (Pliny the Elder) 23 AD –79 AD, a Roman scholar whose illuminated text 'Historia naturalis', served as 'the' encyclopedia of natural history for hundreds of years.

Image: A Roman mosaic showing a rather 2D-looking peacock. Likely the result of the limitations of the materials used.

Image: Bishop Apollinare (Sanctus Apolenaris), surrounded by stylized trees, rocks and sheep. An attempt at painting in the third dimension is present in a subtle way: the rocks are shaped, and the sheep show form, however the trees are flat, and most elements seem pasted into position. The painting shows little understanding of perspective.

5th Century AD, artworks of the Romans

Roman mosaics were created from around the 5th century — they were a common decorative feature of homes and community buildings from Africa to Antioch, an ancient Greek city. Mosaics that have survived are considered invaluable visual records of life at the time, including animals and plants. Activities such as hunting, gladiator sports, farming, cooking are well recorded. Every-day items are also 'illustrated' – clothes, tools, food, and weapons.

Mosaics seemed mostly to show only 2D renderings of animals and people at this time for a very good reason, as to do otherwise with the limitations of small pieces of tile, glass, pottery, marble, and smalto (a form of glass paste) would have been a costly and a labour-intensive job. Also, there was only a vague understanding of perspective by most people, at this time.

7th Century BC, Greek ceramics illustrated with animals

For hundreds of years the Greeks and Romans fought in wars, travelled, and returned home with new ideas. The way they decorated their homes was to slowly change, influenced by their journeys and what they had seen.

The ceramics were occasionally illustrated with images of exotic animals they had encountered and spoken about, and became popular. They decorated vases, cups, urns, platters, pots, and the walls of their homes. Many are beautifully rendered, and the artwork considered with great care.

Over the centuries, these rather flat-looking images were used as a main point of reference as to the appearance of an animal, and no one thought to question the accuracy. They were seen as designs or patterns, and people had no reason to improve on them, or check them against the actual animal. In most cases they could not have checked – as citizens were unlikely to have seen these animals, or perhaps only from a distance, as a bloodied specimen fighting for its life at the local amphitheatre. These illustrations were copied over and over, and copies of copies were made – mistakes being perpetuated – the animals stylised over time, as their detailed characteristics mostly forgotten.

Romans, however, did begin to resolve the problem of the third dimension e.g. the shape and depth of an object or animals was recorded, partly addressing the flat shape of a only a side view. Many illustrations from this period show an emerging understanding of perspective.

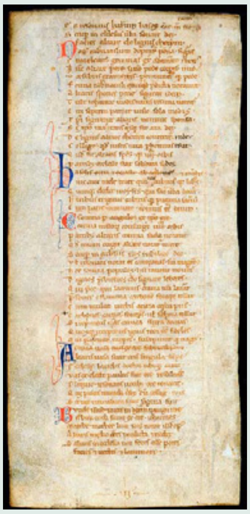
Image: This ancient cup from the Greek kingdom of Macedonia (Thessaloniki) shows an early attempt to illustrate a roaring lion. The image is flat with little 3D shape, and viewed from the side. This is typical of the period.

Image: A Corinthian vase from the 7th Century BC, showing the image of a water-bird, and fowl. An acknowledgment that illustrating a vase added value to it, at the same time the artist was creating a record of two of the animals that existed at the time. Nature was being noticed, and used.

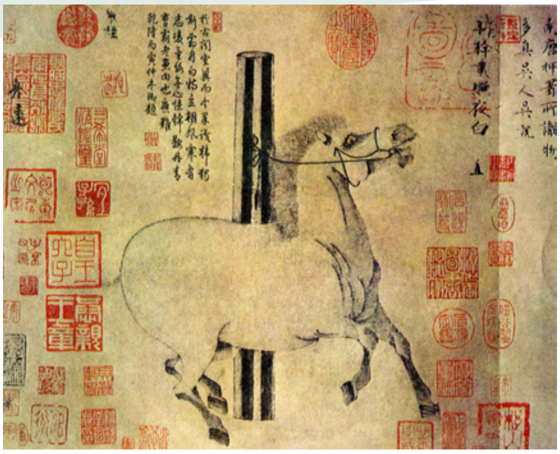
First Books: Codices (singular: Codex) (they were the early ancestors of the bound books of today)

These comprised of sheets of parchment or vellum made from the skins of sheep, cow, or deer; papyrus, fig tree or other types of bark, depending on the country of origin and the period in time.

Codices were for record keeping; for lists of medicine, chemicals, food, etc. Poems, verse, and extracts from scholarly works and religious texts and manuscripts. Several or many loose pages were often bound together. Some codices were illustrated with decorative features; images of animals; or important or renowned religious leaders. One much later Codex is a bound collection of pages written by Leonardo Da Vinci.



Left image: The single page of a hand-written codex (early book) dating from circa 5th century. Right image: An early codice. Note the black stitching down the centre – an early form of binding. Earlier, bundles of loose pages were simple kept together, or sometimes tied with cord.



The Chinese development and refinement of paper

From around 105 AD the Chinese improved and 'invented' paper (a highly portable product). They utilized it initially for the recording of official documents, and later we see learned texts beautifully illustrated with animals and plants.

Paper-making moved slowly to Korea around the 6th Century, but it took almost 600 years to reach all of Europe. From this time, we see a great demand for paper, and a huge rise in the number of hand-written books.

Top image: Chinese artist Han Kan (active 740–760) painted the image of rotund little pony named 'Light of the Night' for his imperial majesty as a type of stock record. It shows realistic features and 3D shaping. Bottom image: A superbly illustrated Chinese painting entitled 'Loquats and Mountain Bird' by an anonymous artist of the Southern Song (Sung) Dynasty (1127–1279). It is a highly detailed, accurate study. Such paintings were popular and valued for the knowledge and respect of nature, they displayed.

Pliny's the Elder's book finally printed and published in 1469

Pliny's book 'Naturalis Historiae', hand-written in many volumes during the middle of the 1st Century AD was not issued as a printed book until 1469 – some 1,400 years after it was completed. Only 100 copies were printed — just 30 years after the invention of the printing press.

The text is noted for its importance to the history of the Middle Ages.

Pliny's original hand-written texts were not illustrated, but were used by others who employed illustrators to render suitable images to match Pliny's rather dated descriptions. The artists created images of exotic animals and often strange unrecognisable beast that scientifically bear little resemblance to any known animal. The prevailing world cared little about the accuracy of the natural world. They were simply amazed by its variety, and often the novelty.

Most of Pliny's descriptions were solid and correct, but some align with Biblical accounts of devils and demons. The grip of the Church, and these biblical stories, coupled with the lack of general education that prevailed at the time, added to the problem. So, the fact that people could not observe these hybrid creatures 'first-hand' was no obstacle to a belief that they existed. For most of this period, people believed only that the world was divinely created, and ordered by their god (or gods).

Generally speaking, texts, from this period, along with their inaccurate illustrations, were rarely based on in-depth scientific study or research. Education was denied to the poor, as this was a powerful way of controlling what people did, thought, and what they might question.

Manuscripts and books (and therefore knowledge), were written and mostly owned by the church. There were no libraries as public institutions, where people could borrow books to educate themselves — and there would have been few texts that told a different story than that of the church.

Scientific-like illustrations were included in hand-written manuscripts (texts) to visually explain specific details, or to highlight the different features of one plant against another. In the case of plants, one species might look the same as another, but one may be deadly if eaten.

Another point to consider is that ordinary citizens were pre-occupied with their own survival — poverty and hunger were common. Invasions from neighbouring states or countries, and outbreaks of deadly diseases, were events that caused great fear and anxiety. People, in their panic became suspicious of anything new, or any opinion that was different to the traditional view.

Image: Lions with cubs. (Credit The British Library)

Image: A gruesome portrayal of the death of a person by a crocodile. The painting may have been a warning as to the danger of these animals. (Credit Crocodile in Museum Meermanno, MMW)

Image: An ostrich, illustrated in medieval times—the painting being based on Pliny's written texts. (Credit Kongelige Bibliotek, GKS)

Illustrating during the 11th Century of the Medieval Period

Fine instruments for close-up viewing were not yet available, and would not be for almost four centuries. Consequently illustrations that required a microscopic study of small structures were, still, almost impossible and mostly inaccurate and awkward-looking.

Image: An 11th Century, hand-painted, botanical illustration of Common teazle and yellow bugle, from the 'Winchester Herbal'. The illustrator is unknown.

Image: The earliest printed book, the Diamond Sutra, block-printed by hand in the year 868, during the Tang Dynasty, China. Held in England by the British Library.

The earliest printed book

The earliest printed, dated, book is the Diamond Sutra from the Tang Dynasty, China. It was hand printed, using carved wooden blocks.

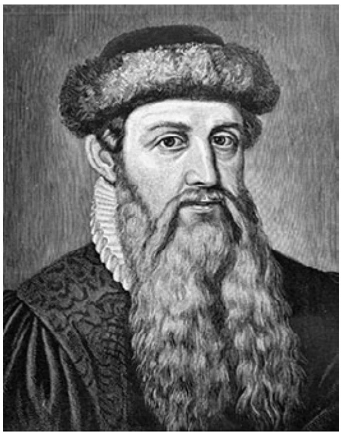
Johannes Gutenberg produces the first commercially viable printing press, 1450

Towards the end of the 15th Century, Johannes Gutenberg, a German political exile, who was a goldsmith and inventor, experimented from 1440 with his idea of producing a printing press. He was not the first, but the first in Europe to do so. By 1450 he had developed a commercially useful press with movable type, and the printing of multiple copies of books slowly became possible—and profitable. Ironically the only book to emerge from Gutenberg's printing shop was a bible, in 1452. It is thought that he produced 180 copies of the 1,300-page book, which became known as the 'Gutenberg Bible'.

Others improved on the press, and although expensive, books could now be illustrated with the use of carved wooden printing blocks. Illustrations and text could, now, be easily printed on the same page.

Initially woodcuts were used in the printing process. Drawings were often fairly crude.

Here we see pink dianthus, and wormwood.



Left image: Johannes Gutenberg, who developed and made the first commercially useful printing press in 1452. (Public Domain)

Right image: Illustrations of plants printed on a similar press to the Gutenberg press, in 1491 from the 'Hortus Sanitatis'. (Credit Wikimedia Commons)

Great adventurers and explorers

Marco Polo, an Italian from Venice, made a sea voyage to Asia in 1271. He travelled with his family and they remained in China for 17 years. His book 'The travels of Marco Polo' did not bring him fame in his lifetime. It did, however, inspire great adventurers, explorers and scholars to set off in search of far-away lands to investigate the 'New World' (a term that covered especially European and American parts of the Western Hemisphere).

Christopher Columbus, also from Italy, went to sea on trading vessels as a teenager. He visited the Island of Khios. In 1492 he sailed from Spain to Santa Maria, hoping to find a new route to India. Between 1492 and 1504 made four additional voyages to the Caribbean and South America. He was responsible for opening up the Americas to European colonization.

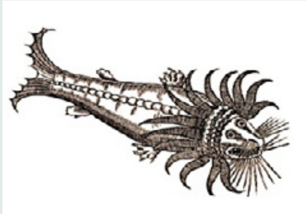
At this time, most of the population of the world was still very much uneducated by today's standards. However, this was going to change as scholars became increasingly interested in pursuing the excitement of discovery, and challenges of world travel.

Monsters of the Sea

Explorers, and mariners brought back stories of sea monsters and exotic creatures they had encountered on their journeys.

These supposedly new animals were 'faithfully' illustrated by artists and engravers – often from the spoken words of rum-affected sailors (16 nips of brandy per day for each sailor, being the usual allocation, due to the poor quality of water carried on board ship). Some stories were no doubt based on a fleeting glimpse of a whale, salt-water crocodile, or giant octopus.

(Credited Albertus Seba, 1734)



(Credited Conrad Gesner, 1558)

(Credited Conrad Gesner, 1560)

(Credited Conrad Gesner, 1558)

Image: Sea monsters illustrated by artists who had likely never seen an octopus or hydra, whale, crocodile, and walrus.

The birth of 'scientific' illustration

Slowly, with further exploration, there was an increasing interest in the nature of the physical world. Thinking people began to question the meaning of the diversity in the plant and animal kingdoms.

Scientists and artists, also began to take more notice, and followed the example of the great artists, Leonardo Da Vinci (1452–1519), and Albrecht Dürer (1471–1528), whose approach had always been more scientific — dissecting, and observing what was actually there — they had no need to 'delight' or 'entertain'. Albrecht Durer's legacy to the natural sciences, in which he is honoured, has caused him to be regarded as the father of naturalistic illustration.

'Not the least of the virtues of portraying things with the intensity demanded by Dürer is that it disciplines our looking. We "learn to see" through the act of drawing, as art critics such as John Ruskin maintained. This is one of the reasons why scientific drawing is not obsolete, even in this technological age.'

[Source of quotation: Martin Kemp, Department of the History of Art, University of Oxford.]

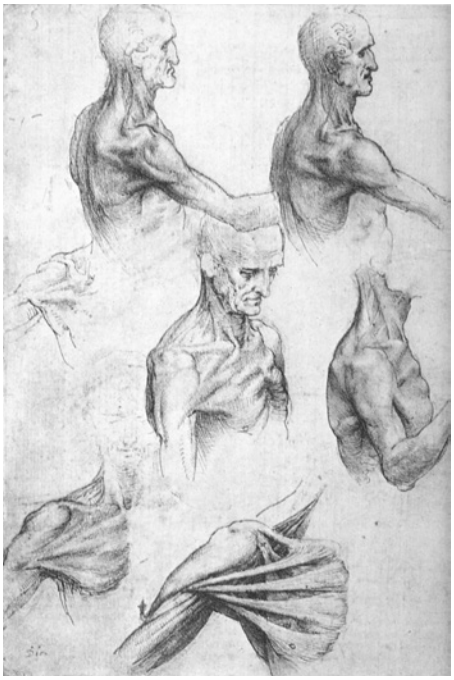


Image: A series of early medical illustrations, by Leonard da Vinci, showing how the muscles of the arm and chest function to allow movement. The artist has drawn what is there, and has not 'created' any aspect of it. These are accurate studies, which describe musculature, visually. (Credit The Florentine)

The arrival of glass and the potential of magnifying lenses

From ancient times, small polished gems and crystals were known to magnify whatever was placed under them.

The Romans made glass in the 1st Century AD and soon noticed its magnifying properties. Although somewhat crude, ‘magnifiers’, served a limited purpose until the arrival of the first compound microscope in 1595.

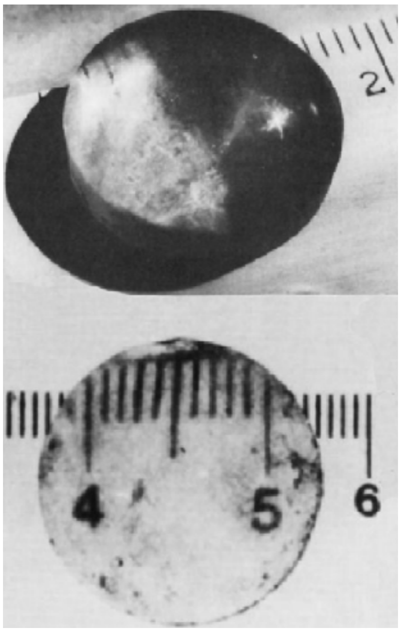


Image: Two crystal lenses from the Idaean Cave, Crete, Archaic Greece. (Credit jstor.org)

Image: A Medieval reading stone. (Credit Eyezon Mag)

Image: The first compound microscope, the leather grip having been made from fish skin. (Credit cambridge.org)

1595: the arrival of the first compound microscope

Two Dutch spectacle makers, father and son, Hans and Zacharias Janssen, and Hans Lippershey, from Middleburg, Holland, have been given the credit of inventing the first Compound microscope. They began experimenting with magnifying lenses, and eventually positioned several lenses in a tube, and made an important discovery – the compound microscope. The development of the many branches of the natural, botanical and medical sciences really begin from this time.

Image: Zacharias Janssen, one of the three spectacle makers who are credited as the inventors of the first compound microscope, around 1595. (Credited FaceBook.com)

Development of the microscope

During the 1600s, there was a weakening of the grip of the Church on people's lives. Learned individuals began to challenge the traditional ideas of the Church, and scholars began increasingly to turn their interests to the natural world in search of answers – and the natural world was about to be studied in a way that had not previously been possible – with the aid of the microscope!

Englishman, Robert Hooke was best known as an astronomer and instrument maker. He was also a skilled physician, surveyor, architect, anatomist and artist. He was keen to create a better way of seeing detail, and worked toward designing and engineering a superior microscope. This he achieved, in 1665.

During this period Hooke's skills in microscopy were honed, and in 1665 he discovered the first-known microorganisms: fungi. He published his famous work on microscopy, entitled 'Micrographia' in that year.

Image: Englishman, Robert Hooke, inventor of a superior microscope in the mid-1660s. (Public Domain)

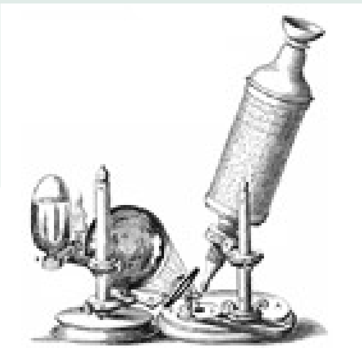


Image: Robert Hooke's microscope. (Public Domain)

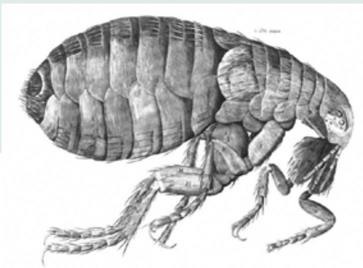


Image: Robert Hook's famous early drawing of a flea, magnificent in its detail it stunned his colleagues. He had built it up from a series of meticulous drawings of all the separate parts of the insect (a technique that is often used today). (Public Domain)

Image: Hooke's famous illustration of an ant, from 'Micrographia" 1665 – the first work of microscopic studies. (Courtesy Slideplayer)

Image: The beautifully decorated microscope that Robert Hooke engineered in the mid-1660s. (Public Domain)

With improvements in the printing process, illustrations become more refined

Etching on copper and brass also came into its own during the 1600s, permitting greater refinement and detail in printed illustrations.

Right image: With the arrival of brass and copper printing surfaces, etching of finer detail became possible. Here we see a peregrine falcon and gyrfalcon from Francis Willughby's 'Ornithology', 1678.

Scientific societies established

The 1600s, saw the rise of a new 'affluent' well-educated, middle-class', in Europe. They wanted accurate portraits, realistic landscapes, well-written texts with reliable-depictions of exotic animals, and plants.

In response, several formal scientific societies were established. The Royal Society of London, and the Academy of Sciences in Paris, are two of them.

Many of these societies, as well as individuals, took it upon themselves to undertake research and exploration to foreign lands. They also began studying the flora and fauna of their own local areas, and soon they were publishing the results of their efforts as major works, or in journals, which they established for this purpose.

With this amazing period of discovery, the development of the microscope, and the arrival of the printing press a trickle of scientific papers and books began to appear, then in the 1600s a flood of scholarly works began – and the greater need for scientific illustrators.

'Scientific illustration' really springs from this time, and was recognised immediately as a vital part of scientific publication – text and illustrations complementing each other – scientist and artist each trying to achieve accurate descriptions of the specimens they studied.

The late 1600s – 1700s

By the mid-1700s, scientists and scientific artists became prominent figures and received increased funding from wealthy benefactors. This led to an even greater urgency for discovery, in parts unknown.

Image: The Magnificent hand-coloured copper engraving from Maria Merian's 'Metamorphosis Insectorum Surinamensium', 1714.

Superb illustrations from the 1700s:

Dozens of museums were established around the world by the end of the 17th century, and universities were teaching the sciences — research was in full swing, and illustrators were a vital acknowledged part of it.

Thousands of superb illustrations were produced during this period, and many survive today in the collections of major libraries and museums.

Image: Individual paintings of shells, prepared as a plate. Believed to have been painted by Dutch, naturalist, artist, and collector, Albertus Seba (1665–1736), for F.M. Regenfuss's 'Choix de Conguillages et de crustacies.

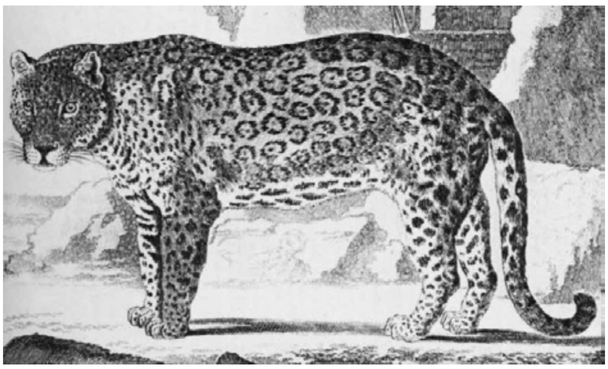


Image: Female panther, after drawing from Buffon's 'Historie Naturelle'.

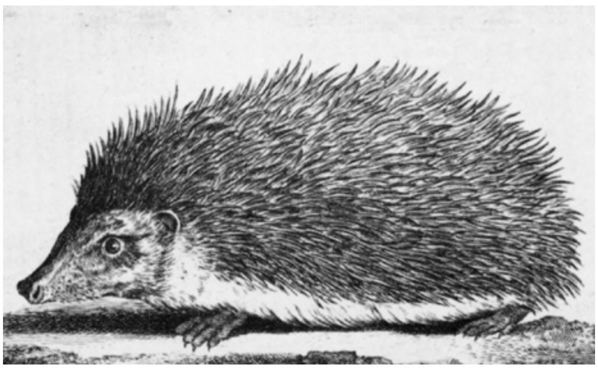


Image: Hedgehog in pen and ink, with subtle washes of black, after drawing from Buffon's 'Historie Naturelle'.

Why do some early illustrations seem odd, or inaccurate?

- Early artists may not have seen the animal 'alive', and worked from hastily recorded, or very brief notes.
- Specimens often arrived in damaged condition after many months at sea.
- As there was no refrigeration most specimens were stored in a pickling solution or were salted. These processes tended to distort the shape and size of specimens

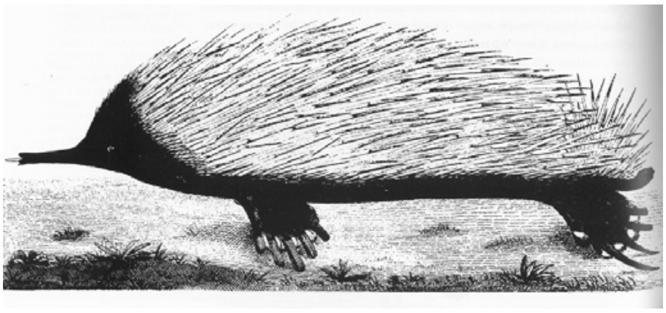


Image: Echidna, rigid body with no natural shaping, posture incorrect, insufficient density of spines, clearance of the ground too extreme. (Attributed to Shaw, 1792)

Image: Black swan, vegetation imagined, swan's neck attaches to the body in an unnatural way, curve and length of neck incorrect. Painting by T.R. Browne (Public Domain).

Image: Kangaroo, ears too erect, posture unrealistic, tail not positioned correctly, legs not in a natural position, forelimbs too small and natural position not recorded. State Library of N.S.W. Courtesy, Artist T.R. Browne, 1813.

The 1800s: Darwin, & Wallace

The 1800s saw further exploration, discovery, and scientific zeal. Museums, botanical gardens, and zoological parks had opened in many capital cities – and for the first time we see Governments beginning to sponsor the natural sciences. Charles Darwin's controversial book 'The Origin of Species' published in 1859, would probably never have been printed, if the State had not assisted with funding. Darwin theorized 'that all species of organisms arise and develop through the natural selection of small, inherited variations that increase the individual's ability to compete, survive, and reproduce'.

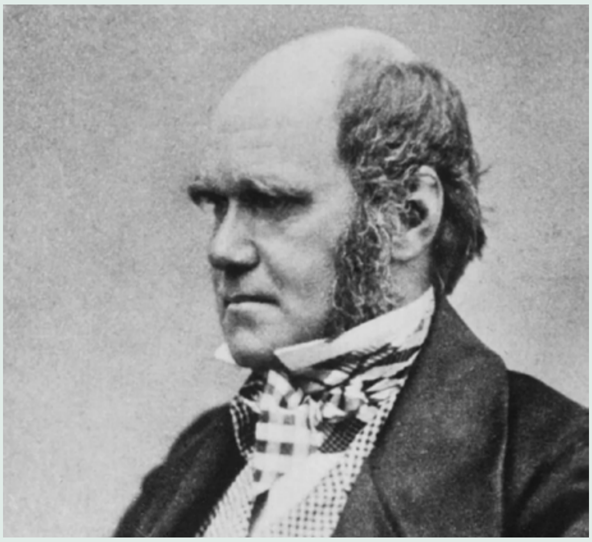


Image: Charles Darwin (1809–1882): scientist, explorer, and author of the controversial book 'The Origin of the Species'. Wellicom Library of Congress.

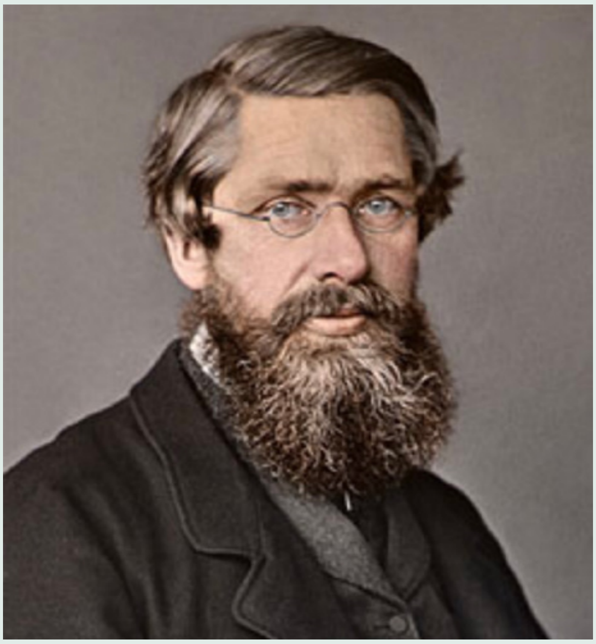


Image: Alfred Russell Wallace (1823–1913), scientist, collector, naturalist, geographer, anthropologist, political commentator and author, came separately to the idea of evolution by natural selection. Biodiversity Heritage Library, George Beccaloni.

Darwin was one of the most important and influential scientists during the 1800s. His independent colleague, Alfred Russell Wallace introduced the theory of Evolution to the world of science. They basically determined that over time and many generations, evolution changes the characteristics of a species depending on the environment in which it lives. These changes cause a species to do well if the change is a beneficial one, or eventually die out if it is not. This process is also known as Natural Selection.

Image: 'Scientific Conversazione at Apothecaries' Hall'. From the Illustrated London News, 1855.

1970s – 1980s

For many decades, there was little change regarding techniques used in scientific illustration. Airbrushing became popular in the late 1970s, but the process was so time consuming and tedious that it did not survive for more than five or 10 years in the workplace.

There were several other techniques that ceased being used for the above-mentioned reasons. Scraper board and carbon-dusting are two of those methods. You may like to give them a try (see pages 30+31). You may also investigate them online.

The next major change did not happen until the arrival of the desktop computer in the late 1970s – mid-1980s, and the development of illustration software.

The 1900s and beyond ...

By the early 1900s, many of the techniques of scientific illustration we use today, were well-developed and in common use: pencil sketching, using a microscope or hand lens to discover the detail; pen and ink drawing; and B&W and watercolour painting.

1980s: Digital illustration

When scientists including A. Michael Noll, and several engineers began their research into algorithms, mathematics, and computing, in the 1960s, digital illustration became a possibility. Initially, the results were simple patterns based on square shapes and line work. The first exhibition was held in 1965.

With further development, it became possible in the 1980s to illustrate in a completely new way when illustration software became available to the general public. Adobe Illustrator, Corel Draw, and Paint, were the first software packages ('apps') that enabled artists to manipulate images and create new artworks on a computer.

At first most scientific illustrators were hesitant to use this new technology, but soon there was the temptation and interest in producing graphs, pie charts, and histograms on the computer. Overhead projectors and white boards were still being used to present data and new ideas to individuals in packed lecture rooms. The publication of scientific results in respected hard-copy journals was the norm.

At first, in the work-place, the illustrations generated on a computer could not compete with fine detailed scientific illustrations prepared by hand. Financially, because they took so much more time to produce, and coupled with the fact that digital tools were less advanced than they are today, meant that the required detail and refinement could not be achieved.

However, it was not long before determined individuals began to produce much better results, and software companies realized the great future in this new method of illustrating. Each new version of their software brought new possibilities and refinements.

Today, we see wonderful new apps that are of great benefit and pleasure for the scientific illustrator to use, although the learning curve is often considerable, the results can be excellent. (See p.35 for a lesson using Procreate, on an iPad in 7 steps).

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