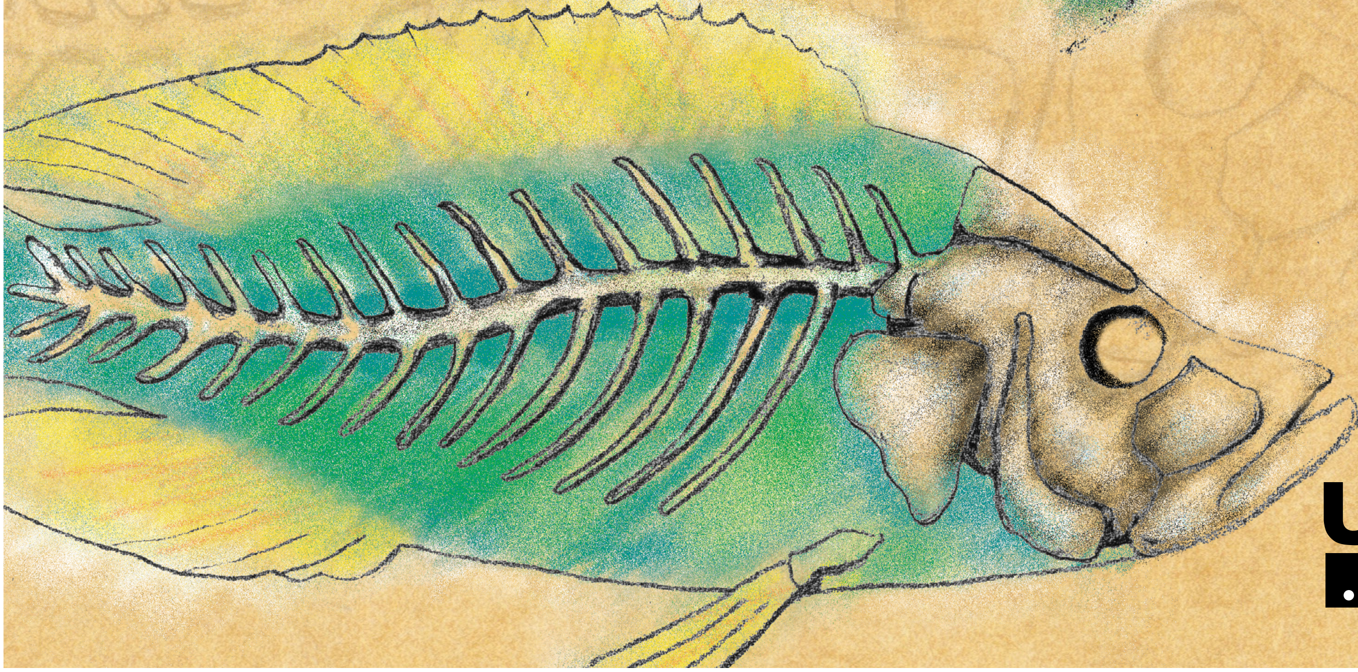
# Life Science Tactile Graphics

## Teacher's Guide



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Life Science Tactile Graphics

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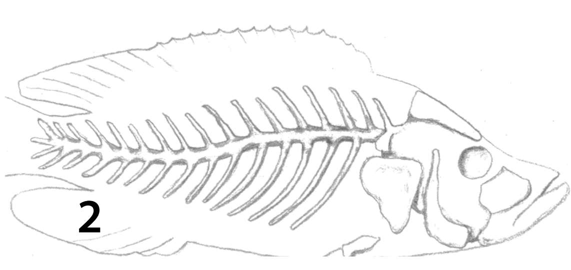
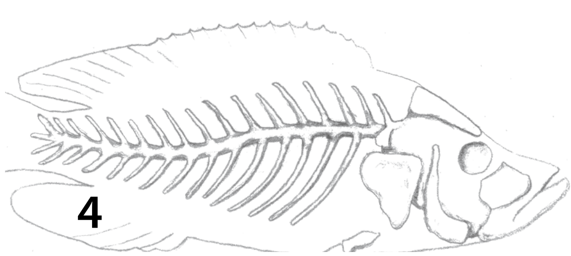


# List of Diagrams



**List of Diagrams cont.**





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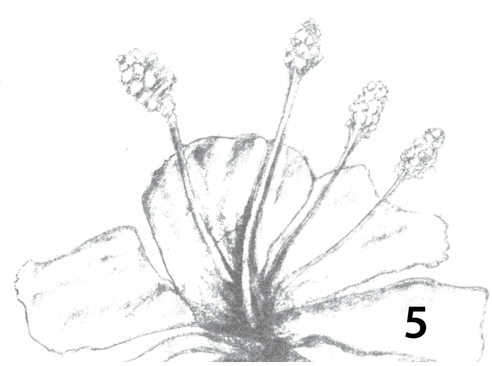
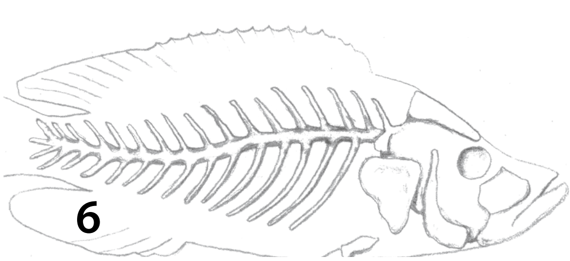




# Introduction

*Life Science Tactile Graphics* are vacuumformed raised line drawings depicting organisms, processes, concepts, and patterns which are typically covered in middle and high school life science courses. They are intended to supplement, not replace, the graphics in a student's classroom textbook.

These graphics may offer students a different presentation from their brailled textbook graphics. The emphasis in this adaptation is on tactual readability rather than adherence to a particular printed image, although scientific accuracy is always maintained. Because these graphics are not identical to any image found in a particular science text, they may not contain all of the same features as a given textbook graphic. Thus, these vacuumformed graphics and the student's braille textbook together make a good combination.

## Lines and Textures

The drawings in *Life Science Tactile Graphics* include many types of lines and textures, as well as surfaces of different heights. In general, higher or more tactually prominent ("loudest") textures signify the most important features of the diagram.

While it might seem preferable to give certain lines and textures the same meaning throughout the set, the limited selection of readable textures and the complexity of the graphics combine to make this goal

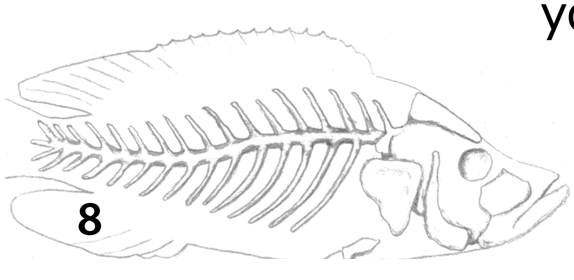
impractical. As a result, lines and textures should be interpreted within the context of each diagram. For example, similar textures may be used to indicate the soil in a plant diagram, a component of the skin in another diagram, and the surface of a sponge in another.

## Teaching Suggestions

All of the drawings in *Life Science Tactile Graphics* depict concepts, systems, or terms that are common to any basic course in life science.

Instructional hints are given for some of the tactile drawings in the set. They focus on how you might present the concepts to students who are blind and what these students might find most challenging about the drawing or the concept. The goal of the suggestions is to help you as you try to make science learning *real* for students who are not using the standard printed images.

**It is rare to find a tactile picture that stands on its own for the blind student to understand without explanation from the teacher.** Even the most well-crafted tactile graphic cannot overcome the fact that perceiving through touch is different from perceiving with sight, and things that are easily apparent with sight are usually less apparent through touch. These graphics may help demonstrate concepts in science just as print pictures do, but they always depend on the verbal description or physical demonstration that you provide to be effective. In other words, the graphics don't teach science concepts—*you* do!



Consider the range of pictures found in science books. They present front, side, overhead, and interior views, pictures of things real and imagined, and a scale from the microscopic to the cosmic. With sight, you can look at a picture and instantly recognize the *perspective*—the essence of how the information is presented—and, within this context, quickly focus on details of *what* is being conveyed. Using touch, this immediate grasp of the whole of the picture is not available. The *whole* must be pieced together with time and exploration.

As a teacher, you can help students read a tactile graphic by explaining *how* the graphic is presented and *what* it shows; for example: "This shows the plant at different times at different stages of the reproductive cycle," or "This is how the cell looks magnified thousands of times under a microscope." These different kinds of views require explanation and *demonstration*, because, as stated before, it takes time and practice to translate the many ways things can appear to the sense of sight into a worthwhile tactual experience.

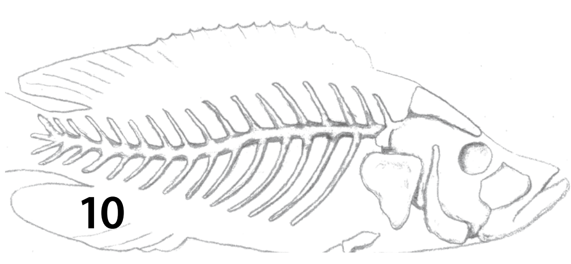
## Visual and Tactile Conventions

Print graphics, and those in this set, show things from many different perspectives. For instance, you can look down on an insect from above, as if it rested on the table; you can look at a plant from ground level, seeing its leaves and its roots at the same time; you can see the vast ocean floor as it stretches from one continental shelf to another; you can see an organism developing from one stage to the next; and so on—

all in pictures. With exposure and practice, we gain the ability to interpret and connect these images to a reality we are familiar with. Students who lack experience and practice will need some creative assistance from you to make these images “real.”

The issue of magnification also deserves special mention. In print textbooks, pictures often are not identified as magnifications because it’s assumed that students can recognize them as such. (These pictures are often shown with a round frame to suggest a view through a microscope.) This set of graphics assumes the same ability for blind readers, but you should be alert for opportunities to reinforce their understanding of the relative scale of the items pictured.

Many of the diagrams in this set contain arrows, which serve different purposes depending on the context. In general, thin, dashed-line arrows indicate the transition from one stage in a cycle to another. These diagrams show the first stage of the cycle at the top left or top center of the page, and subsequent stages (indicated by the arrows) moving clockwise or downward on the page. In contrast, a thicker arrow is generally used to show the actual motion of one substance into or away from another. *Students may need specific training in reading and following arrows*, depending on their previous experience with tactile diagrams.



# Notes on the Diagrams

The List of Diagrams breaks the tactile graphics into subject groups which may suggest ways they can be taught. Keep in mind that when you use these tactile graphics, you are not only teaching students life science, you are helping them to use and interpret tactile pictures in general. As you build up students' competence and comfort in reading graphics, you open up possibilities for them and prepare them for further academic success. Along the way you will introduce many concepts and, with luck, stimulate students to be active thinkers (that is, *scientists*).

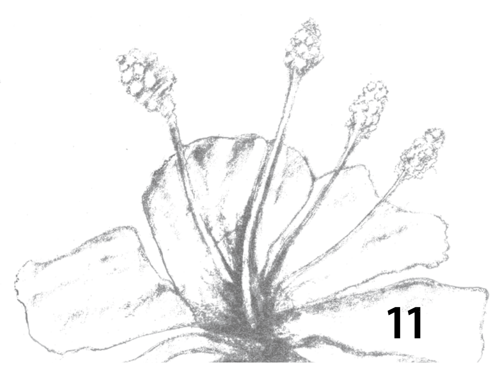
Following are some brief notes on the tactile graphics in this set, giving some considerations that may be helpful in your teaching.

## 1 Light or Compound Microscope

This simple diagram shows the components of a standard classroom microscope. While the actual tool may be of little use to blind students, microscope diagrams are often seen on standardized tests, and all students should become familiar with the basic parts and terminology.

## 2 Cell Sizes and Shapes

This diagram shows that cells are not uniform, either in size or in shape; these are related to their particular function.



## 3 Comparing Animal and Plant Cells

This is the first illustration in the set that relies on a key for the abbreviated labels. The two cells are placed on the same page for easy comparison of their components.

## 4 Mitochondrion

## 5 Chloroplast

Because these organelles are shown in cutaway view, students may need coaching to understand that they are really enclosed structures within a cell.

## 6 Prokaryotic Cell

The thickness of the cell's boundary is greatly exaggerated in this image because of the need to make the *cell membrane*, *cell wall* and *capsule* all tactually distinctive from each other.

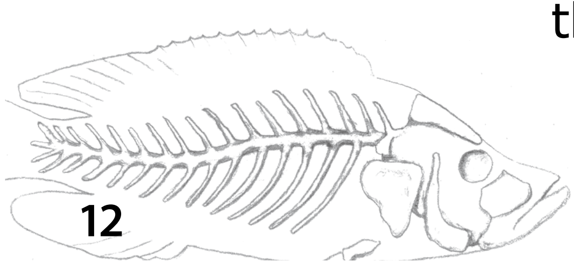
## 7 Bacterial Types

These highly magnified views give students the opportunity to see the bacteria in isolation and in colonies.

## 8 DNA

## 9 DNA Double Helix

The first diagram shows the DNA ladder and introduces the pairings of the bases. Students should note the way these pairings are typically shown, that is, base pairs are represented by pointed or rounded shapes



adjacent to their correspondingly shaped complementary bases. The second diagram may be used in conjunction with a 3D DNA model to show how a complex spiral structure can be represented in a textbook.

## 10 DNA Replication

## 11 Translation

These diagrams depict *processes*, that is, changes that take place within the structures shown. Students may need specific instruction to see an illustration as a series of steps rather than as a static image.

## 12 Chromosome Duplication

Although this is a simple picture, it is a chance for students to study and memorize the shapes of the single and duplicated chromosomes, which will be shown extensively (in smaller forms) in later diagrams.

## 13 Cell Cycle Chart

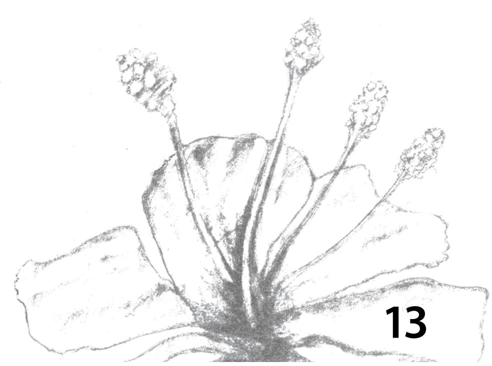
This chart is one of the few illustrations that depict an abstract sequence rather than an actual object or structure. The most immediate analogy is a clock face, with the sections representing relative time intervals.

## 14 Mitosis

## 15 Meiosis I

## 16 Meiosis II

## 17 Nondisjunction in Meiosis I



## 18 Nondisjunction in Meiosis II

The important task for students using these diagrams is to be able to move between stages by following the arrows, and to note the changes—which are sometimes very subtle—from one stage to the next.

## 19 Fertilization

This process, unlike others shown, begins with two "streams" on the left, one above the other, which combine into one as the reader moves across the page.

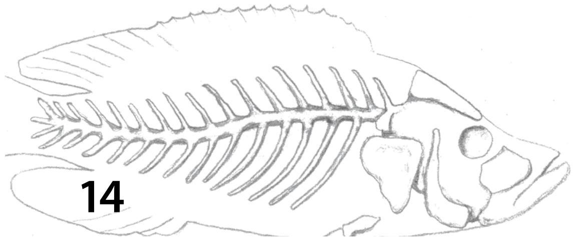
## 20 Viral Replication

Because viruses are so varied in their forms, they are represented here by an abstract, easily discerned shape (a triangle). The DNA strands are also greatly simplified to reduce tactual clutter.

## 21 Membrane Transport 1

## 22 Membrane Transport 2

Each of these complex graphics shows more than one process on the same page. It is important for students to see that the long columns represent only a *segment* of a cell membrane; that is, if the diagram continued, these columns would join to form a complete enclosure. The left side of the page stands for the inside of the cell. Since the whole cell is not shown, you may wish to illustrate this arrangement with a model or a hands-on enactment of the process.



In the first diagram, the sizes of the particles passing into and out of the cell membrane are relevant. The smallest particles are shown passing through directly, while the larger ones are shown going through the protein channels, which serve as “tunnels” to facilitate the process.

In the second image, the detailed view of the two lipid layers given in the first picture is replaced with a pair of thick lines. Students need to know that this simplified representation corresponds directly to the cell membrane shown in the previous diagram.

## 23 Pedigree

This chart does not illustrate any particular relationship; rather, it is a general example of the layout used to organize information about inherited traits.

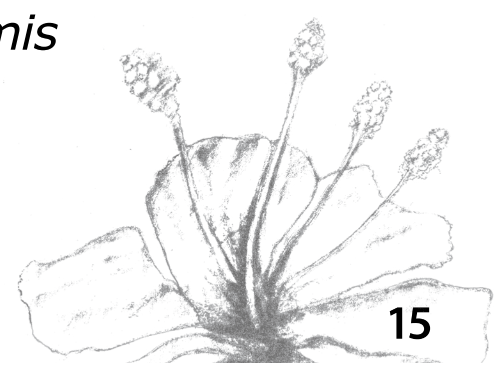
## 24 Forelimb Bones

## 25 Comparative Embryology

These diagrams illustrate both the important distinctions and the striking similarities in their subjects, and require fine discrimination and comparison skills from students.

## 26 Skin Cross-Section

At the right of this image are labels with lines indicating the range of the thin *epidermis* and much thicker *dermis*.



## 27 Neuron

Students should examine the left and right sides of the structure to see that, while they are similar, they have major differences.

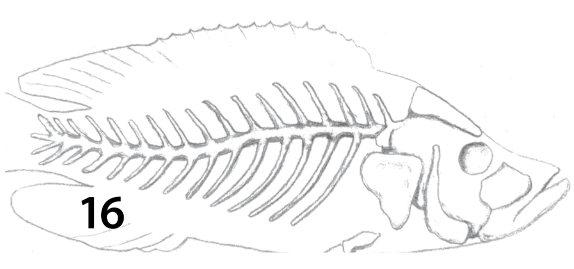
## 28 The Eye

## 29 The Ear

Because of the complexity and closeness of the structures in the eye and ear, these images are very simplified. The eye, in particular, is difficult to portray tactually, because the tactile graphic loses the depth and dimensionality of the actual eyeball, pupil and lens. Comparing the diagrams with larger 3D models will help students understand their features better.

## 30 Using Lenses for Vision Correction

This diagram shows two “before and after” scenarios, again with much simplification and size exaggeration for better tactual readability. Help students understand that the light rays coming from the “T” shaped object are actually intangible, but must be represented by solid lines in the diagram. The essential point to emphasize is the ability of the lenses to focus the light rays (and thus the perceived image) directly on the retina, as opposed to in front of or behind it.



## 31 Sense of Taste

The separate images in this graphic show the papillae of the tongue from two angles—from above, as a mass of bumps on the tongue, and from the side, greatly magnified and in cross-section.

## 32 Leaf Cross-Section

The cells in a section of a leaf are depicted in several ways here; some are shown with the nucleus as a small depression, and others with small bumps representing chloroplasts. Note that the *vascular bundle*, usually shown in print as a circular structure, is partly cut off to allow direct labeling of the *xylem* and *phloem*.

## 33 Tree Canopy & Roots

This image shows that the unseen part of a typical tree, the root system, can be as extensive as the branches rising above. Though the top of the ground is shown, this perspective magically allows us to see through it and view the entire tree as if we were a short distance away.

## 34 Vascular Structure of Wood

Because the tactile image lacks three-dimensionality, it cannot adequately show how the vessels are arranged within the wood. The lower parts of the diagram show both an end view and a side view of the vessels, but models that are held in hand will make the comparison clearer.

## 35 Plant Intake and Output

The graphic represents a typical leafy plant and the processes of gas and water exchange that occur.

## 36 Moss Life Cycle

## 37 Fern Life Cycle

Help students recognize that these illustrations are made from the "bug's eye view," that is, at or near ground level. From this perspective, the horizontal line thus divides what is above ground from what is below.

## 38 Pine Life Cycle

Hands-on comparison of the diagram to an actual pine cone with opened scales may make the life cycle more understandable.

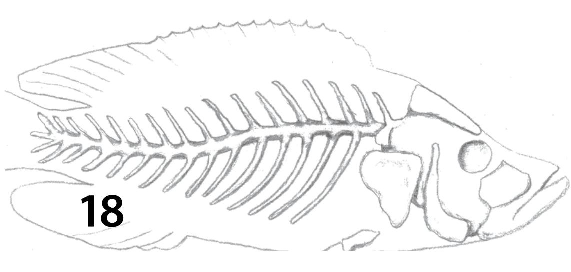
## 39 Parts of a Flower

Like the previous diagram, this shows the importance of a pollen tube for conducting sperm nuclei to the ovaries of the plant. The inset shows a magnified cross-section of the ovule and ovary.

## 40 Monocot and Eudicot Seeds

## 41 Seed Germination

These diagrams allow students to compare some of the similar and contrasting features of monocot and eudicot seeds and plants. The second diagram is another ground level perspective with the soil "cut away."



## 42 Sponge

## 43 Sponge Life Cycle

The sponge diagrams depict, in various ways, the outer wall, inner wall and inside the wall itself of a typical sponge. This change in views may present difficulty for blind students and require additional explanation.

## 44 Cnidarian Stinging Cell

## 45 Cnidarian Life Cycle

Because most blind students will not have seen or felt an example of a cnidarian, you may need to find models or create substitutes that convey the unusual nature of these creatures.

## 46 Flatworm and Roundworm

Note the paired lead lines connecting the labels to the images. The purpose of the diagram is to show the features these types of worms do and do not share.

## 47 Snail Body Plan

Drawings of snails and molluscs differ in the way the internal organs are arranged. This drawing is laid out to make the parts easily discernible and uncluttered.

## 48 Insect Metamorphosis

The perspective in this drawing is from water level, allowing us to see above and below the water's surface at the same time. Students may need to be introduced to the concept of *surface tension*, which allows the eggs to sit on top of the water and the larvae and pupae to hang below the water.

## 49 Insect Feeding Adaptations

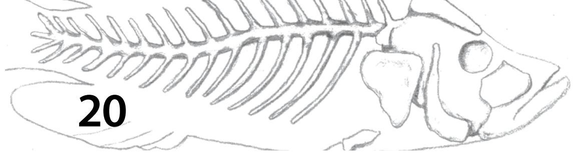
Three types of insects, each with a different apparatus for feeding, are shown. Although not all of the organs are labeled, students should note that all three have eyes and antennae of different sizes. The differences in feeding apparatus relate to the types of food the insects consume.

## 50 Fish Internal Organs

In this diagram, the organs are arranged to give an indication of what they are rather than for strict accuracy of placement. This retains the essential information while making the diagram readable.

## 51 Fish Skeleton

For both fish diagrams, be sure to orient students to the eye and mouth on the left side, which can serve as reference points for understanding the entire body plan.



## 52 Amniotic Egg

For students who are adventurous, examining the contents of a real chicken egg and comparing them with the drawing may give a better idea of the structures contained inside the shell.

## 53 Bird Flight Adaptations

Along with the skeletal structure of the bird, this diagram shows two additional features that contribute to a bird's flight adaptations: The air sacs that accompany the lungs, and the air spaces within the bones that make them light.

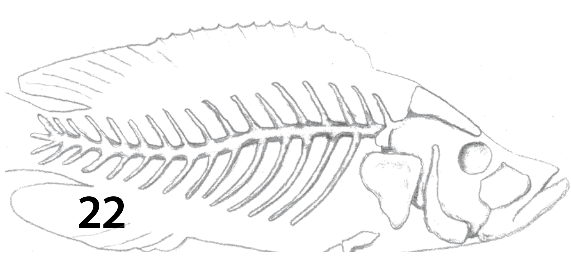
## 54 Water Cycle

## 55 Carbon Cycle

Two approaches are used for these diagrams, to give students exposure to different ways of representing similar information. The first graphic is in picture form and shows the movement of water through a landscape. The second graphic presents its information more abstractly as a system of labeled arrows with no objects pictured. Both present a "ground line" perspective to the reader.

## 56 Food Web

Students should be aware that the examples chosen are typical, but that other animals and/or plants could be added or substituted, making the web more complex. The arrows in this kind of diagram have a special meaning because, rather than indicating *motion*, they signify that one kind of organism is *consumed* by another.



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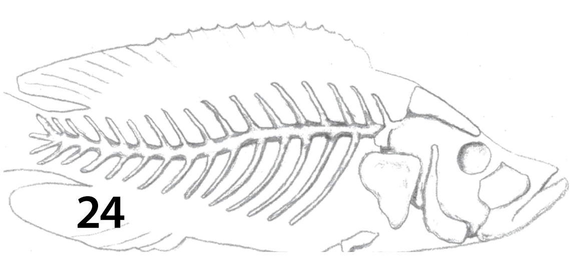

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