**Standard views for imaging mollusk shells**

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**Front cover:** *Three sets of syntypes of* Achatinella hawaiiensis *Baldwin, 1895, all from Hāmākua, Hawai'i Island. Exact posing reveals subtle variations in the height/width ratio, aperture profile and columellar callus as well as the difference between juvenile and adult whorl profiles.*
*Top two rows: ANSP 65696; middle two rows ANSP 65697; bottom two rows ANSP 65698* (KS).

## Introduction

Recent years have seen exponential growth in the number of digital mollusk images posted on line by museums and propagated through aggregators such as WoRMS and iDigBio. The free availability of high-resolution multi-view images of type and voucher specimens that were hitherto known only from inadequate figures or descriptions is improving taxonomic resolution, especially in groups that are poorly represented in primary literature.

Shell images are usually produced either in response to a specific request or as part of a project to image an entire class of specimens such as all material from a particular collection or all type specimens in an institution. An individual client may specify particular views, angles and magnifications, but when planning digitization for a program it is up to the project team to decide which views to take. It is not possible to predict which features each end user would want to see emphasized and time and resources are limited, so the goal should be to represent each specimen by a set of the most informative possible images.

Digital images can be used not only for identification but also for morphometric analysis. The latter is however possible only if every comparable specimen is positioned in the same way with respect to key points on the shell. Loose conventions such as “apertural view” or “apical view” have long existed, but to date these have rarely been standardized sufficiently to allow accurate cross-comparison of images from different projects.

Though guides to macrophotography exist that are useful in various aspects of photographing shells (*e. g.* Kurtz, 2016; Johannes, 2015; Savazzi, 2010; Moretzsohn, 2006; Freeman, 2004) none deals in detail with the positioning. Several papers have been published on morphometric analysis of shells (e. g. Rehder, 1945; Goodfriend, 1983), but without detailed instructions for standardizing poses. The purpose of this paper is to set out standard views for different morphological groups and add codes that make them easier to teach to technicians and students.

The need for this work was expressed during the iDigBio Mollusk Digitization Workshop held as part of the 83rd American Malacological Society meeting at the University of Delaware on July 16 and 17, 2017. At the end of the workshop the author undertook to publish the view sets and training aids that had been created for the molluscan type imaging project at the Academy of Natural Sciences of Drexel University (ANSP)[1].

It is hoped that this paper will be cited in support of digital imaging grant proposals and that versions can be produced for other frequently-imaged groups such as insects and crustaceans.

[1] http://clade.ansp.org/malacology/collections/search.php?search=advanced

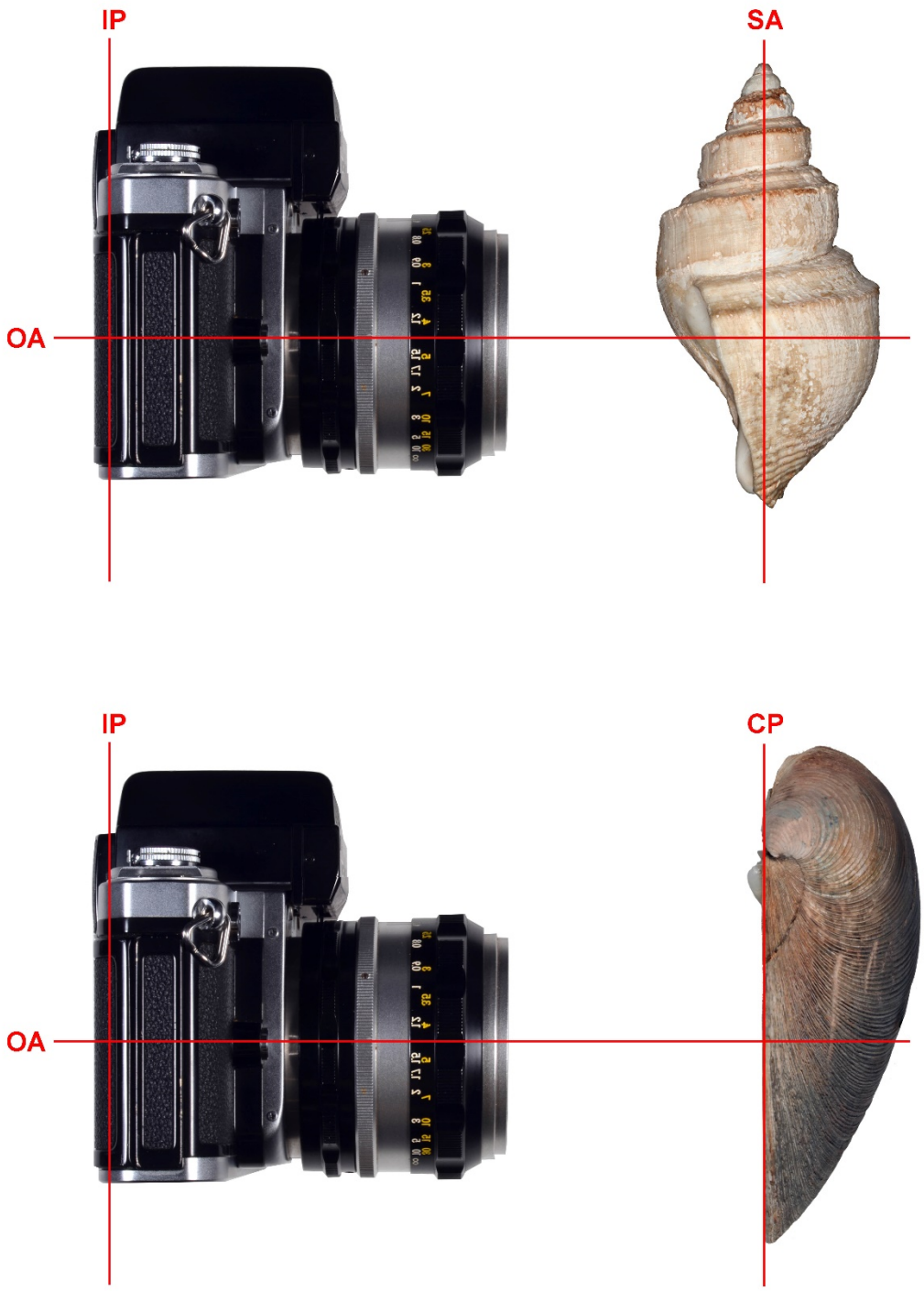



Fig. 1. The correct relationship of image plane (IP), optical axis (OA) and the shell axis (SA) and commissure plane (CP).

The image plane (also known as the film plane) is marked on many cameras with the symbol ⌖

**Terminology**

*Commissure plane*: the theoretical plane formed by the joining of the two shells in a bivalve. In some families (such as the Cardiidae and Lucinidae) it is a more or less a flat plane (Fig. 1); in others it can be curved or twisted (Fig. 27).

*Image plane*: the plane formed by the film in traditional cameras and the sensor in digital cameras. It is bisected at 90 degrees by the optical axis (Fig. 1).

*Optical axis*: a line that indicates the direction of light through the center of a camera's lens - that is, the direction in which the camera is "pointing". It is perpendicular to the film plane (Fig. 1).

*Shell axis*: the axis of coiling in a gastropod shell. It is usually straight, at least initially, but can twist or deflect in later growth stages (Fig. 1).

*View set*: a set of views that is standard for a particular general shell morphology, such as "taller than wide" or "broad and flattened".

**Photographing shells**

The goal of any high-volume photography setup should be to create pictures whose lighting, focus and resolution allow them to be used both as-is for identification purposes and as the basis for publication-quality work. Images are arranged in varying ways in different publications and the goal is thus to provide end users with fine raw materials rather than finished products.

Certain aspects of any unedited digital image can be adjusted to enhance comparability. These include vertical alignment, which can be fixed by rotating the image, and scaling and color, which can be corrected if standardized color cards or backgrounds are included in the image (Fig. 14). Incorrect lighting can to some extent also be remedied, though areas of zero data (100% black or white) are irretrievable.

However, two critical factors cannot be fixed later on: the turning and tilting of the shell. These are respectively the degree of rotation about the shell axis in gastropods and the setting of the axis (in gastropods) or the commissure plane (in bivalves) parallel to the film plane of the camera (Fig. 1).

Although this paper sets out some standardized views, they are not all applicable to any one shell. A subset (called the "view set") is therefore created for each major morphological group (see p. 10). In addition to these views, a particular species may require one or two optional ones. However, certain highly plastic taxa (such as oysters and worm snails) can defy standardization.

It is normal to image any original labels with the specimen; where these are marked on both sides, two images are needed.

In all cases the goal is to serve online an image that clearly depicts the shell in a standard view and correctible color that is consistent enough with other images of the same or similar species to allow morphological comparison.

The image from a conventional camera has an aspect ratio (width to height) of 3:2, which can be viewed in "portrait" (2:3) or "landscape" (3:2) rotations. For shell photography the portrait option is

usually more useful as the majority of shells are longer in one axis than the other and the conventional orientation for coiled gastropod shells is with the apex at the top of the image.

**Equipment**

Addressing the enormous diversity of camera models, stand designs and lighting equipment currently available is beyond the scope of this paper. To achieve consistency across sets of images, however, the camera should at least be mounted on a stand such as the one in Fig. 3. This fixes the film plane and optical axis (Fig. 1), requiring only that the shell then be aligned correctly. If possible, the camera should feed a live video preview image to a larger monitor that is positioned comfortably, enabling the operator to make fine adjustments to the position of the shell without incurring eyestrain.

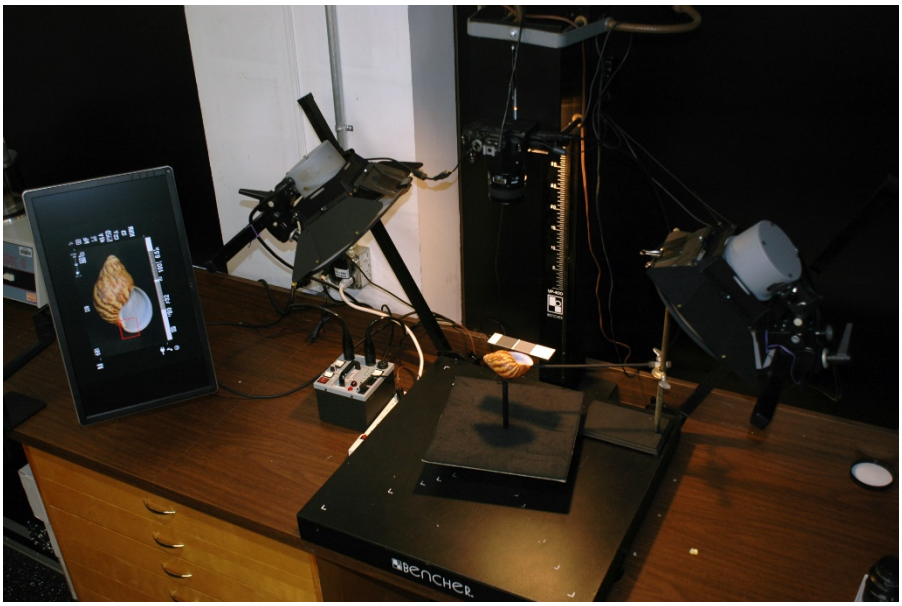



**Fig. 3**. *A typical camera setup for high-volume imaging of shells. A digital SLR camera with a macro lens is mounted on an adjustable stand with two flash units and a remote monitor for focusing and posing. The height-adjustable scale bar is mounted on a modified laboratory stand.*

**File naming**

Digital imaging projects follow various protocols for file naming, but standardizing file names and using suffixes for each view allow automated sorting of image files on web pages. The ANSP mollusk type imaging project uses a string consisting of the catalog number followed by the original combination and the view code, separated by underscores. For example:

6072_Murella_lauriensis_api
57810_Achatinella_grana_dor
10286_Unio_mortoni_v1i

If an automated system is used to generate thumbnails and link images within an on-line page structure, then they will sort alphabetically by view code. If a different sort order is required, the codes can be modified to produce it.
In the following sections, each view is accompanied by the code used at the ANSP.

## 1. Coiled Gastropods

These often make up the majority of specimens in museum collections. The ratio of shell length to diameter varies widely in gastropod shells, but most are coiled about a straight axis. Important factors to capture in images include the height/diameter ratio, the spiral growth algorithm(s), the profile of the apertural lip and the sculpture and details of the base.

### "Smiley", "Frowny" and "Sigmoid"

Most gastropod shells expand their length and diameter while coiling in a spiral that in all but its final stage conforms to a regular algorithm. To align the axis of the spiral parallel to the film plane of the camera, look at the distribution of curvature at the point where the suture of the lowest whorl crosses the axis (Fig. 5). If the shell is tilted too far forwards this will be a crescent with a depressed median, like a smile. If the shell is tilted too far backwards, the crescent will be the other way up, like a frown. With correct alignment, the curvature will be upwards at one end and downwards at the other, forming a sigmoid or "S" shape (Fig. 7). The same applies in the lateral and dorsal views.

In some shells, the later suture does not conform to the growth algorithm that pertained earlier on. In such cases it is often still possible to tilt the shell so that the last regular suture forms a sigmoid (Figs. 18, 22).

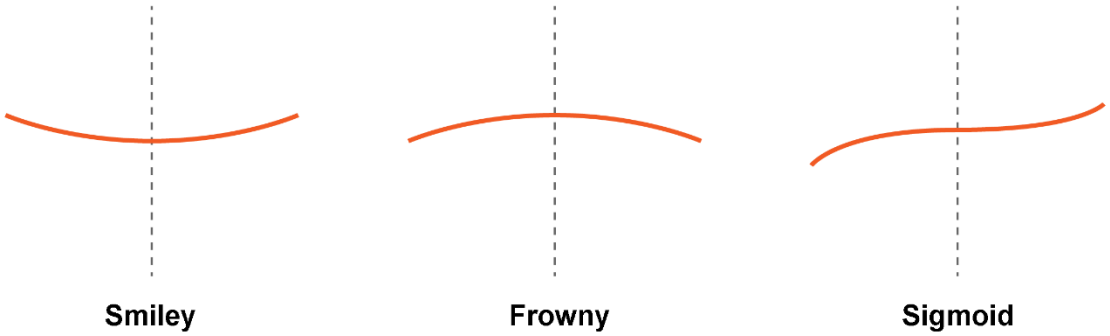



**Fig. 4**. Alignment of the suture, the line B-B in Fig. 5.

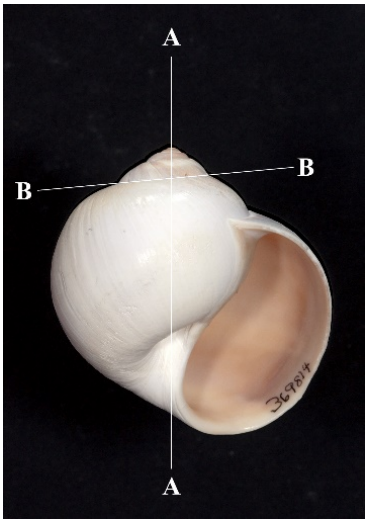



**Fig. 5**. *The intersection of the suture (B-B) and shell axis (A-A).*

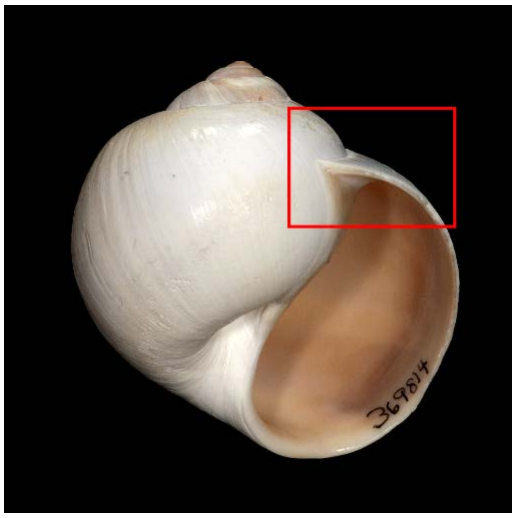
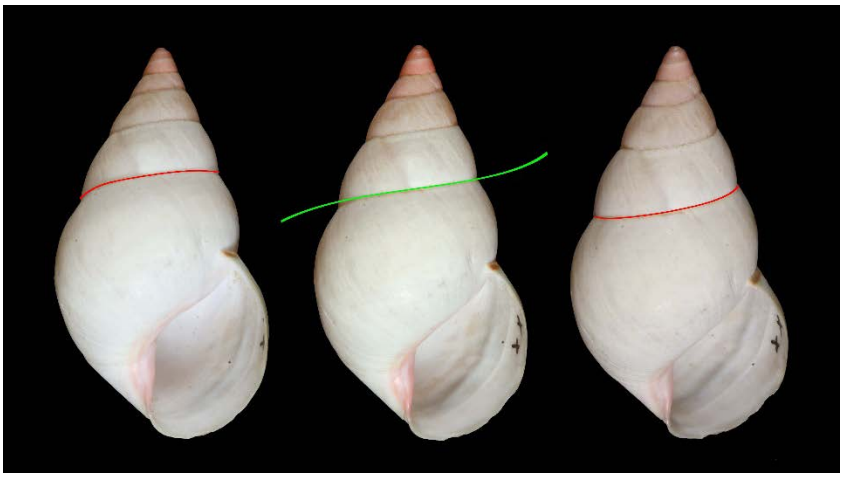


**Fig. 6** *The apertural view showing the area of overlap behind the terminus of the suture.*

**Fig. 7** Frowny (L), *smiley (R) and correct (middle) shots of a regularly coiled shell*



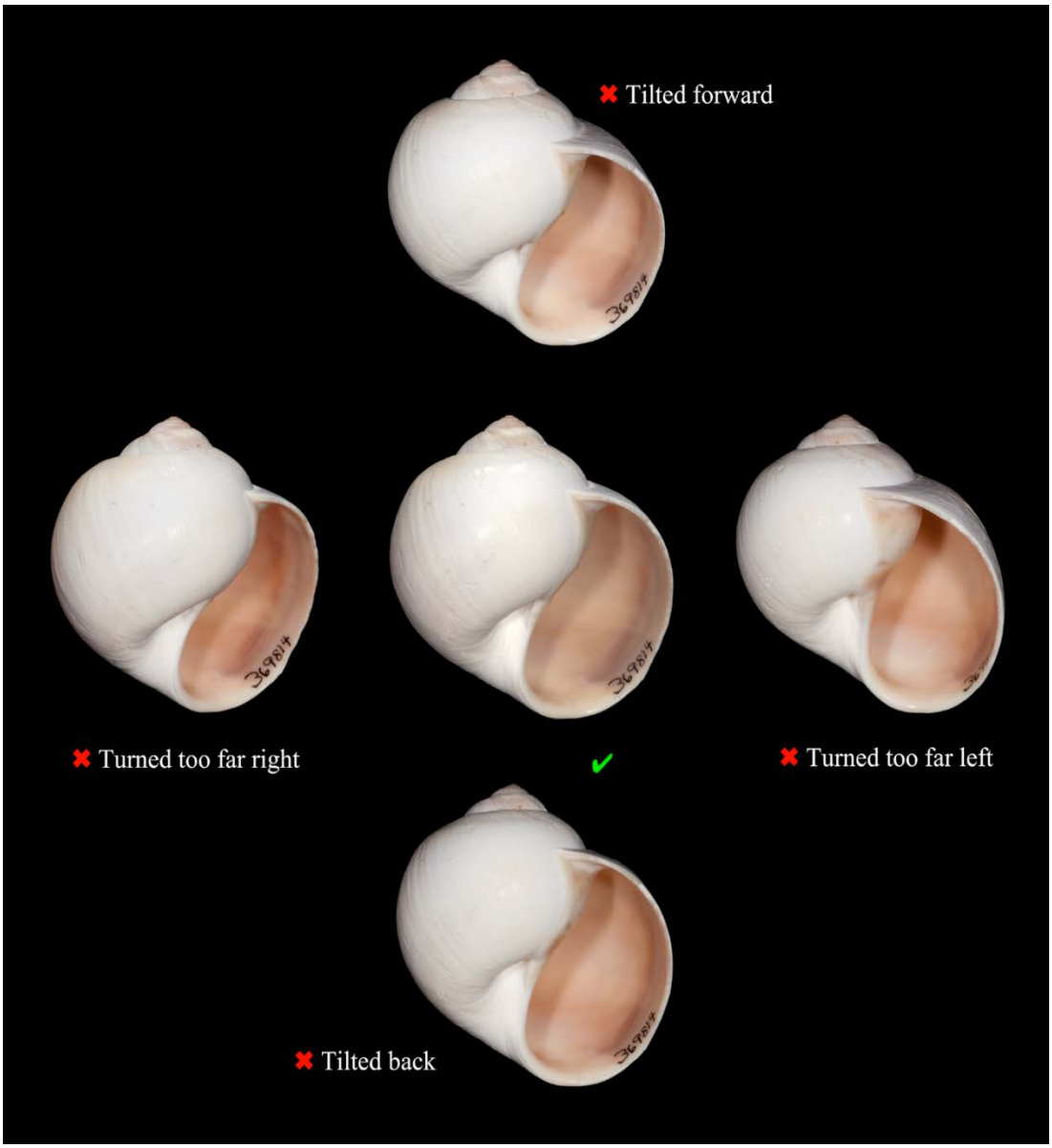



**Fig. 8.** *Correct and incorrect alignments of the apertural view of the shell in Figs 5 & 6.*

**Apertural view (APT)**

In most gastropod shells the plane of the apertural rim (or "lip") is not parallel to the axis. It can be prosocline (leaning forwards relative to the direction of growth), opisthocline (leaning backwards) or sigmoid in either direction (Fig. 9). In the apertural view, the triangular area below and immediately behind the terminus of the suture will thus vary in size depending on the angle of the aperture relative to the axis. The goal is to show the broadest view of the shell, and normally a triangular section of the outer surface of the shell in that area will be visible. This should not obscure too much of the interior of the aperture, however, and the degree of turn should be adjusted accordingly (Fig. 6).

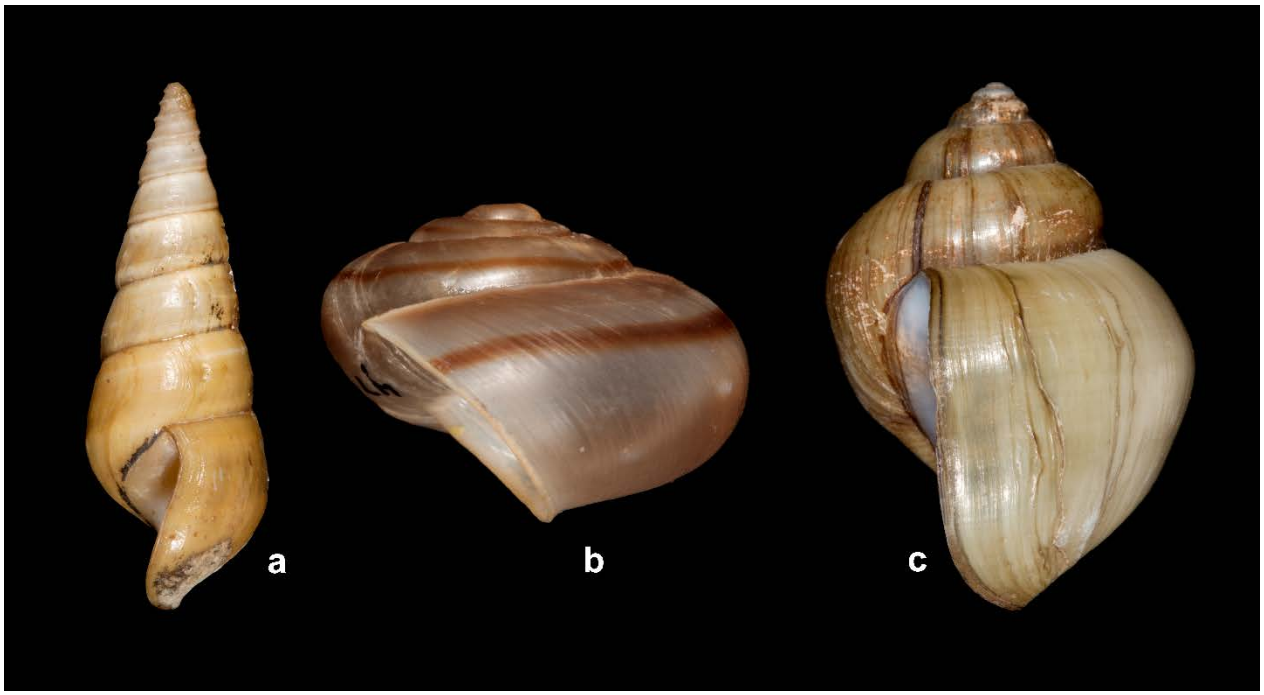



**Fig. 9.** *Three kinds of aperture profile: opisthocline (a), prosocline (b) and sigmoid (c).*

In some cases a carina or central spiral cord is a more reliable register for the correct sigmoid than the suture (Fig. 10).

**Fig. 10.** *Correct (middle) and incorrect apertural views of a flattened specimen, using the carina as a guide.*

**Lateral view (LAT)**

As with the apertural view, tilt the shell so that the final suture forms a sigmoid. In many land snails (*e. g.* Fig. 9b) the final part of the shell immediately behind the aperture turns downward and its plane thus assumes a different angle relative to the axis.

Some shells have slots or other processes that "stagger" the apertural lip. With these, setting the terminus of the suture near to or on the axis should produce a balanced figure (Fig. 11).

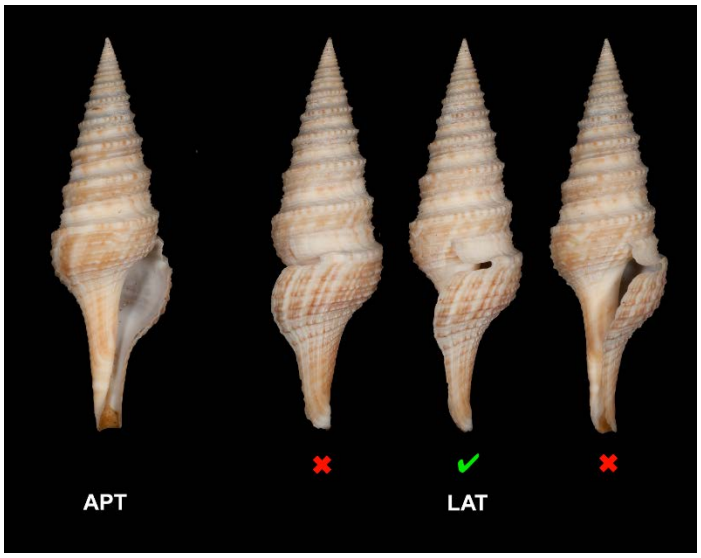



**Fig. 11.** *A turrid gastropod showing the correct apertural and lateral views.*

## Coiled gastropod view sets

These are the view sets used in the ANSP type imaging project:

- **Much taller than wide** (Figs. 15, 16): Apertural, lateral and dorsal.
- **Much wider than tall** (Fig. 19): Apertural, lateral apical and basal.
- **Conical with flattened base** (Fig. 21): Apertural, lateral and basal.
- **Biconical, spire roughly half of height** (Fig. 17): Apertural, lateral and dorsal.

**Apical view (API)**

The apical view is necessary for all planispiral shells and is also useful in cases where the spire angle is depressed enough that the protoconch and early whorls cannot be clearly seen in other views. It allows whorls to be counted and shows the number and arrangement of sculptural elements such as spines and varices.

The axis should be aligned perpendicular to the film plane of the camera; that is, the optical axis should be identical to the shell axis (Fig. 10).

**Basal view (BAS)**

The basal view is the counterpart to the apical view for shells that have a flattened base. It shows the breadth of the umbilicus and highlights differences in sculpture and color pattern between the base and the spire. Alignment is the same, with the shell viewed directly up the axis (Fig. 12).

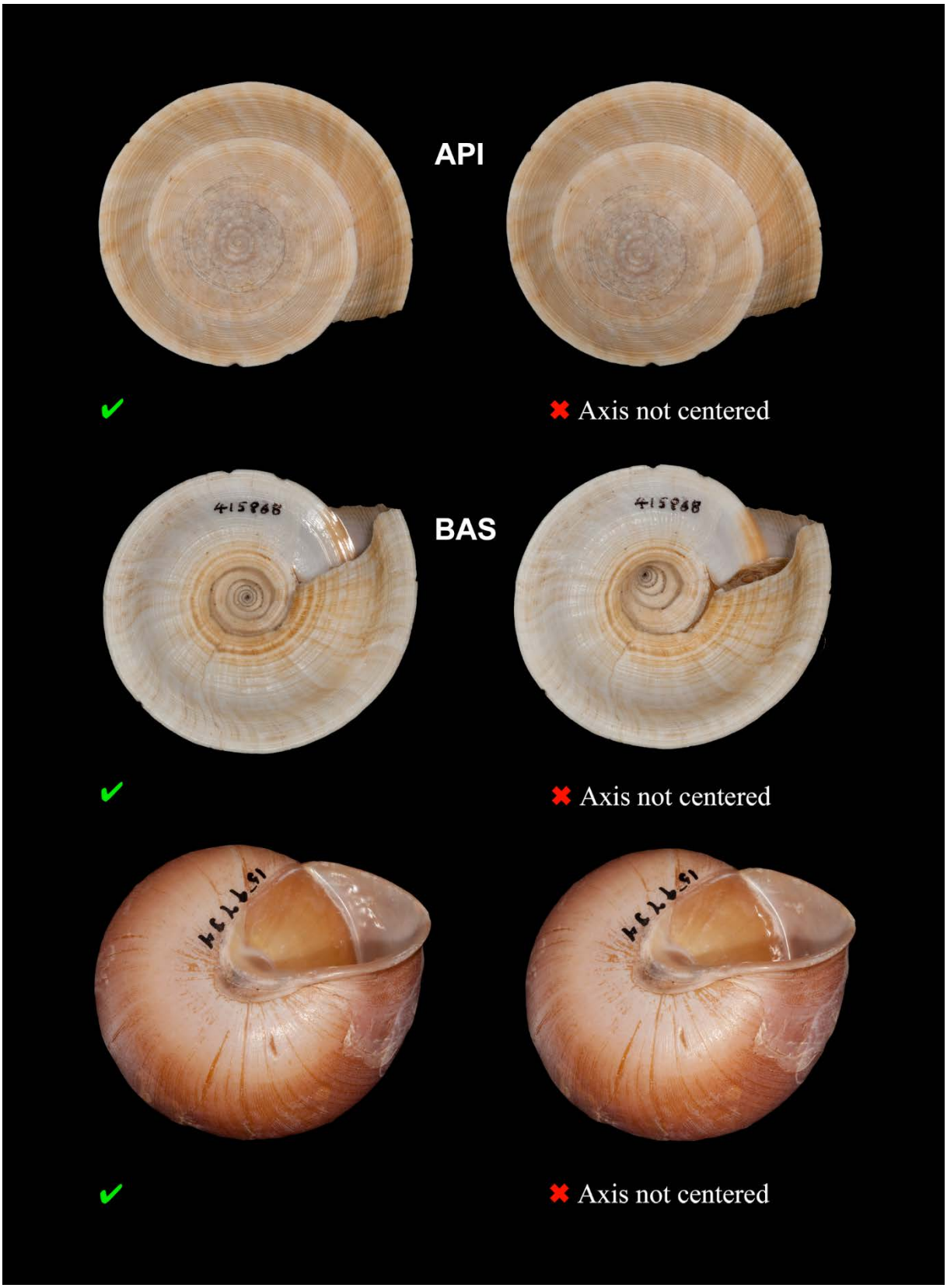



**Fig. 12.** *Apical (top) and basal (middle and bottom) views.*

**Oblique apertural view (APO)**

Many terrestrial gastropods terminate their growth by tilting the plane of the aperture downwards and some also develop teeth and flanges within the opening. For these, an additional apertural view can be taken with the plane of the aperture aligned with the film plane of the camera - looking straight into the mouth, in other words (Fig. 13).

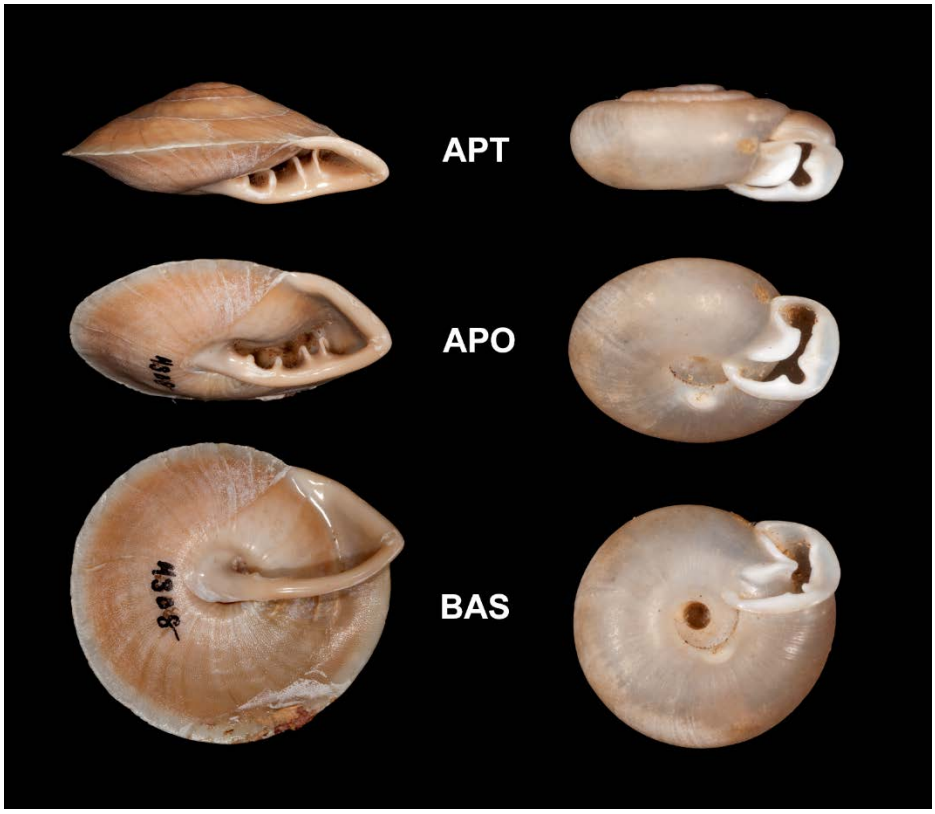



**Fig. 13.** The oblique apertural view (APO) compared with the apertural and basal views.

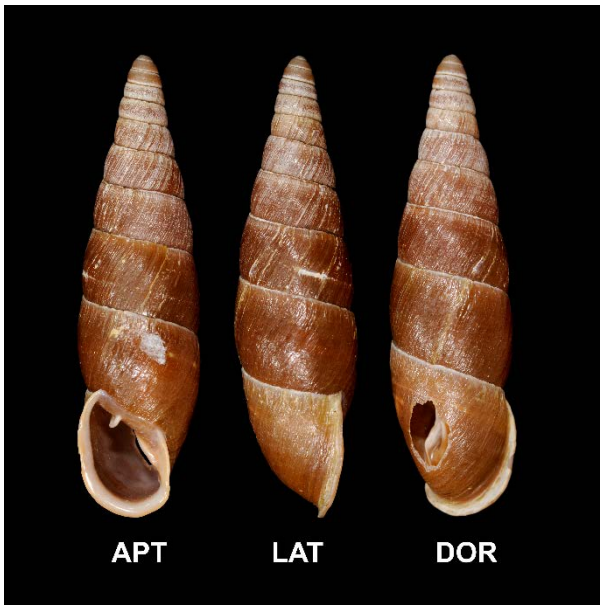
**Dorsal view (DOR)**

The dorsal view is the exact analog of the apertural view, but with the shell turned 180 degrees. Though traditionally included in plates, it often does not reveal anything more than the apertural and lateral views together do and can thus be omitted from image sets where time is a factor and a basal or apical view would be more informative. In other cases, however, it can be very informative regarding the morphology of the body whorl (*e. g.* Figs. 15, 16). It can be harder to align this view correctly as the terminus of the axis in the aperture is not visible but making sure that the suture of the final whorl is a correct sigmoid should achieve an acceptable shot.

**Fig. 14.** *An apertural view as shot, with the operculum placed on a microscope slide atop the scale bar. The scale bar is posed alongside the shell at the same height as the axis (Fig. 1).*
*It has bands of 50% grey (top), 18% grey (middle) and white (bottom) for color adjustment; the background is black.*

**Accessories**

Some specimens have other hard parts such as an operculum, clausilium or gypsobelum. These can be shot together with the apertural view (Fig. 14), or as separate accessory (ACC1, ACC2 *etc*.) images. Care should be taken that the accessory is positioned in the same plane as the scale bar. It is often useful to shoot both sides of the operculum by placing it in two shots.



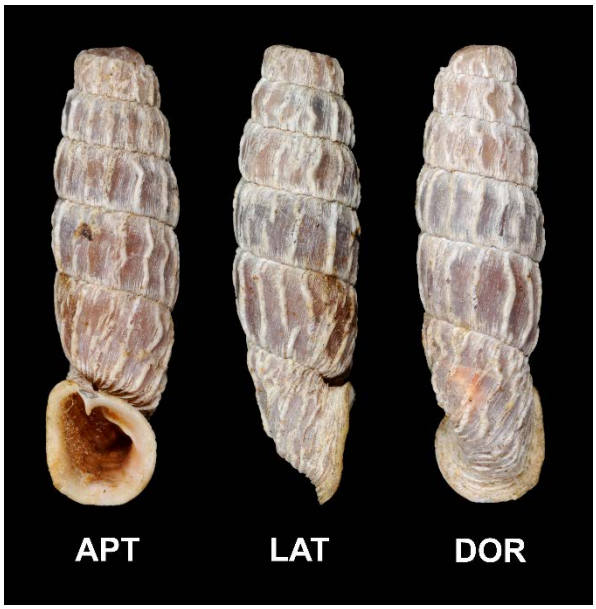




**Fig. 15** (L) and **16** (R). *Tall-spired gastropods in three standard views. In many land snail taxa the dorsal view shows diagnostic features such as plicae (KS).*


**Fig. 17.** *A regularly coiled gastropod in three standard views (KS).*

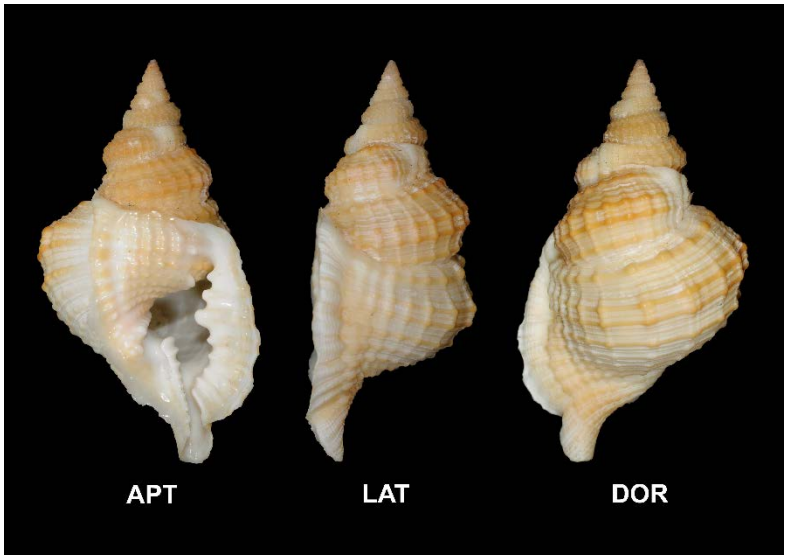



**Fig. 18.** *An irregularly coiled gastropod in three standard views. It is positioned so that the regularly-coiled early whorls conform to the standard and the peristome is parallel to the optical axis in the lateral view (KS).*

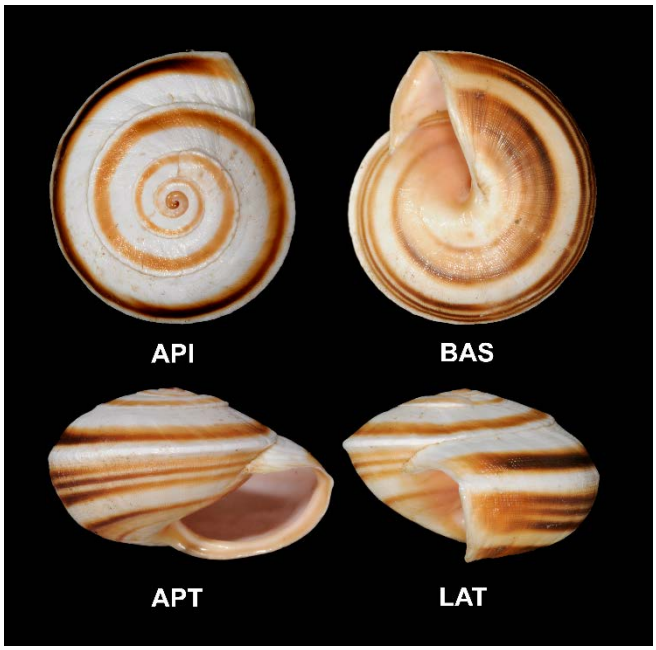



**Fig. 19.** *A gastropod with an irregular whorl cross-section in four standard views. The irregular whorl profile complicates correctly tilting for the apertural and lateral views (KS).*

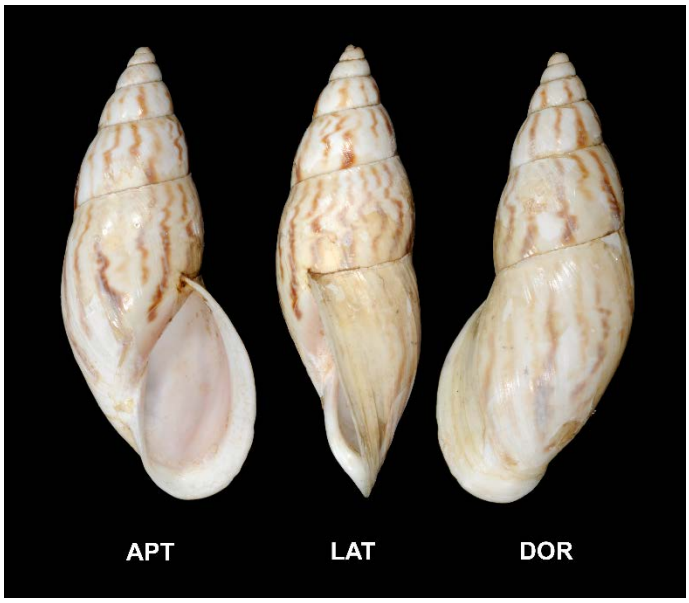



**Fig. 20.** *A gastropod with a constricted body whorl and highly produced aperture in three standard views (KS).*


**Fig. 21.** *A conical gastropod with a flattened base in three standard views (KS).*

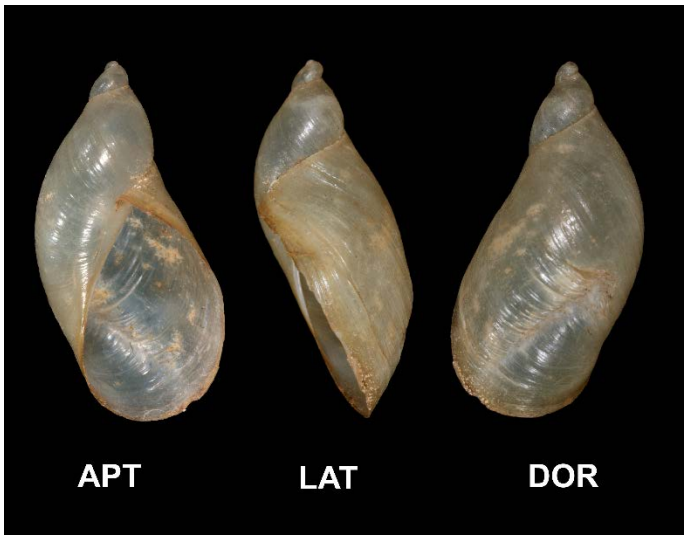



**Fig. 22.** *A gastropod with an accelerating growth algorithm that only allows a sigmoid suture position in the apertural view (KS).*

**2. Patelliform gastropods and chitons**

Limpet-shaped (patelliform) gastropods and complete, flat-preserved chitons are aligned parallel to the film plane of the camera and shot from outside (API) and inside (BAS). They are also shot from one or both sides (LAT1, LAT2) (Figs. 23, 24).

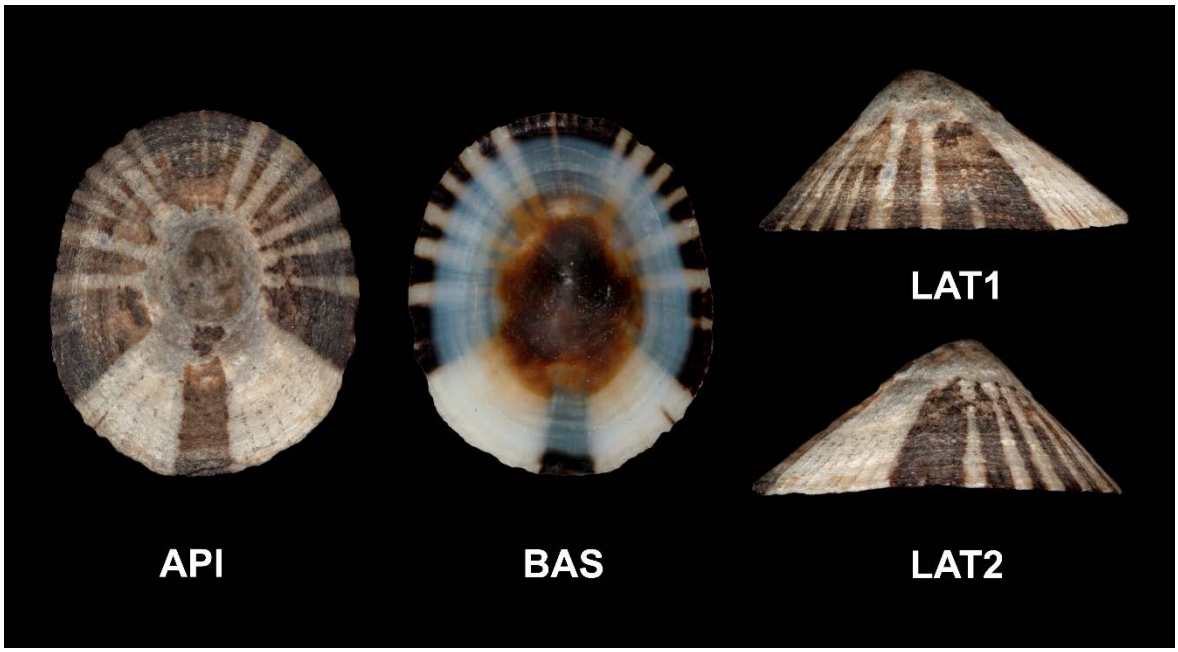



**Fig. 23.** *A patelloid gastropod with the three standard views and optional second lateral view (KS).*

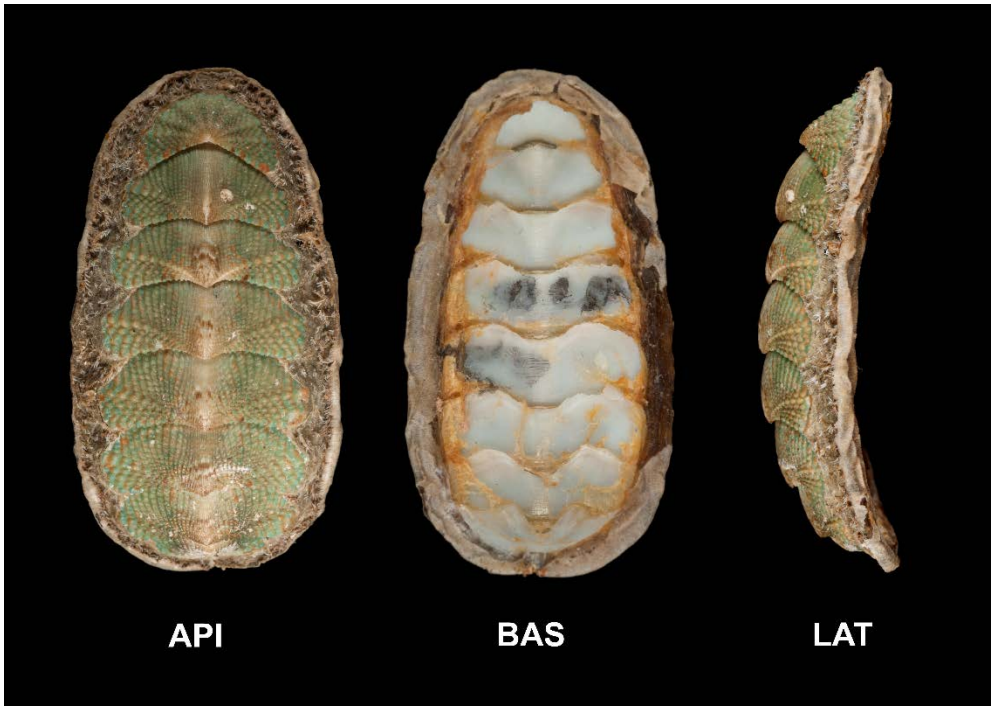



**Fig. 24.** *A chiton in three views. A second lateral can be added (KS).*

### 3. Scaphopods

Scaphopods should be shot entire from one or both sides (LAT1, LAT2) with each end then shot at higher magnification; the broader (ANT) and narrower (POS) ends should be rotated to show any distinguishing slots or notches (Fig. 25).

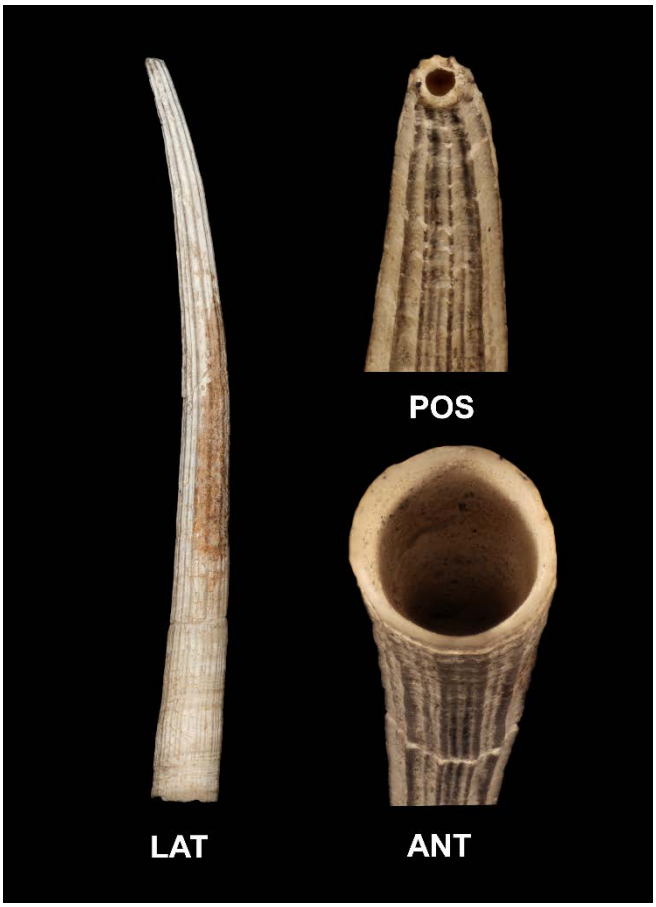



**Fig. 25.** *A scaphopod with a general shot and two detail views. A scale bar can be added to each or just to the general shot (KS).*

### 4. Bivalves

The majority of bivalves have a pair of roughly symmetrical shells. They can usually be separated and the individual valves shot inside (V1i, V2i) and outside (V1o, V2o) (Fig. 25). There are various conventions for rotation of images in final work (for example, umbo at the top versus at the bottom), but any can eventually be created as long as the original images use the same orientation for all shots. Some bivalves, such as pholadids, have accessory processes that can be treated as described under "coiled gastropods" above.

#### Joined pairs

It is often necessary to shoot a joined pair, either because it cannot be separated or in order to show the configuration of the umbos, lunule and escutcheon from the front (CJ1), side (CJ2) or both (Fig. 25).

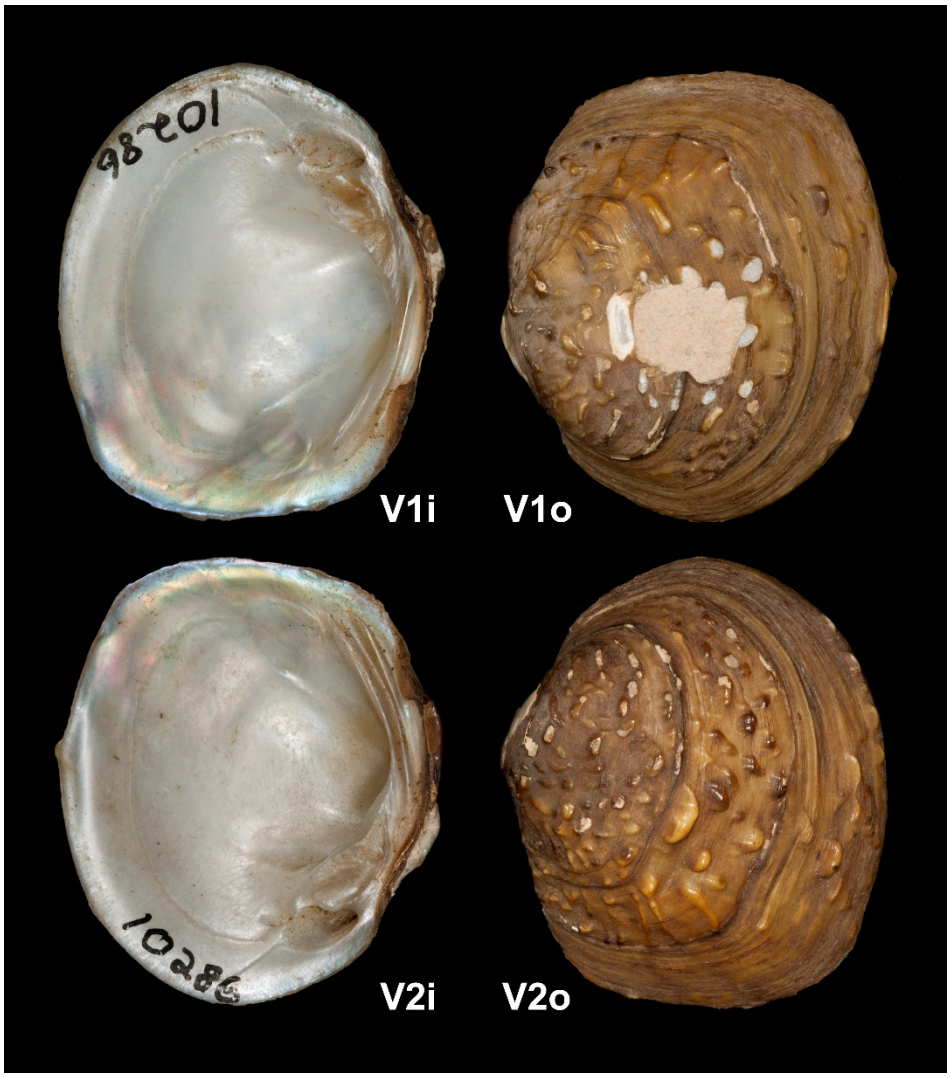



**Fig. 26.** *A bivalve in the four standard views.*

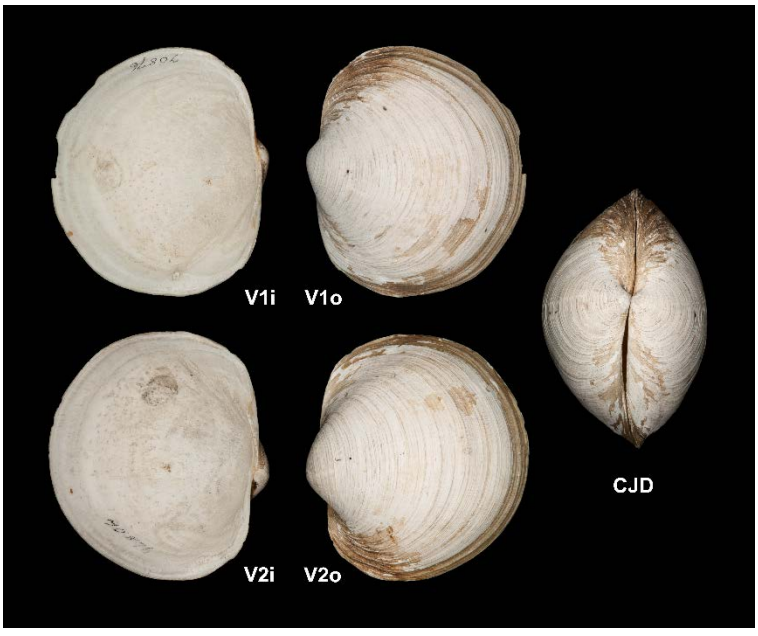



**Fig. 27.** *A bivalve with the optional conjoined view to show the twisted commissure plane.*

**Acknowledgments**

Images marked “KS” were taken by Ms. Krasimira “Kasey” Seizova, ANSP digital imaging technician. Figure 3 was created by Ms. Lauren Duguid, ANSP. All other images and figures are by the author. Dr. Gary Rosenberg (ANSP), Dr. Ellen Strong (NMNH) and two anonymous reviewers helped edit and enhance the manuscript.

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