A new cowrie from NW Australia

Haliotis papulata in the Indo-West Pacific

A new *Scaphella* from Yucatan, Mexico

Fossil cowries, *Amphidromus*, and more

Quick, massive (~1,000 items), manual digital photography of small (~ 1/10cm) specimens collection by a professional digital video camera and a photo camera zoom lens

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ABSTRACT A practical, manual workflow to obtain a quick, exhaustive digital photographic coverage of all the items in a collection is described, together with the technical details of the equipment used. Even though no radical technological improvement over similar techniques is adopted, the unique combination of a professional video camera, dimmable indirect lighting, a self-built background stage with a peculiar sliding ruler allowed a particularly quick, easily repeated process to obtain pictures of the required quality.

KEYWORDS Digital Photography, Video Camera, Collection, Seashells

In the community of seashells collector, it's relatively common to observe collections with an adequate digital documented in terms of accompanying data, but completely or partially lacking a digital image coverage, thus hampering information interchange within the conchological community and limiting the scientific importance of the information unaccompanied by visual media.

Here, a quick and relatively economical solution is provided by putting into play a combination of technology and manual procedures that will be proved able to fulfill all the stringent time-dominated requirements detailed further down.

The workflow described in this paper was field-tested to obtain – as quickly and economically as possible – digital pictures of around 1,000 seashells, whose size ranges approximately from 1 cm to 10 cm, covering two sides (in informal jargon, apertural and dorsal) of each specimen, and including a 1mm precision measurement of shell length in at least one of the two pictures of each shell.

Workflow speed
The first and foremost requirement, for obvious economical and practical reasons, is that the image capture process must be capable to provide as quickly as possible a full coverage at the required quality. Any acceptable compromise between quality and processing speed must be carefully evaluated, and may make the difference between a feasible and unfeasible solution. The author was able to engage in the activity only after having designed a workflow that could be completed in a predefined time box: hence this short paper, meant as a proposal to collectors facing the same problem.

Desktop-friendly equipment
A search for simplicity is implied in the above requirement for speed: operationally, the whole process should be managed on a physical desktop where specimen handling takes place (as described further down) in the immediate vicinity of a personal computer. A desktop photographic stand with a table approximating an A4 / Letter size, and with an extensible column of 27÷37 cm range (originally bought with a 15÷25 cm column, then extended by threaded bar and junction nuts) was used in this case. Camera attachment allowed for a further 8 cm vertical adjustment in each direction, bringing the operational range from about 20 to about 45 cm (height of camera tripod receptacle) above the table.

"One Shot per Specimen" approach
To speed up process, just one shot per specimen (in the case of *Oliva* shells: one shot per side, total 2 per specimen) will be taken. This requires that all the conditions (framing, lighting, exposure, focus) could be accurately previewed and fully controlled before each shot.

Required picture resolution
The aim of the photographic documentation is twofold:
- providing adequate coverage of all the diagnostic features of each shells, to allow – wherever possible – an unambiguous determination of the pertinent species: this implies also a good reproduction of colors, and makes fundamental an automatic white balancing feature;
- allow collectors, while holding a specimen in their hands or visualizing a digital image of their own specimen, to perform comparisons with the documented specimens.

Furthermore, the pictures obtained are to be published on a dedicated website.

Those requirements rule out high resolution pictures, whose size is unsuitable for quick downloads and whose exceedingly high level of detail would not be appreciated.

By previous experience of the author, pictures of linear size around 1,000px along the longitudinal axis are sufficient to fulfill the requirements. Thus, any picture resolution providing a vertical size around 1000 px may be generally regarded as suitable. Yet, conditions at the moment of image capture, including the requirement to include a length measurement, may prevent the subject to cover the whole vertical span of the picture. It's therefore reasonable to adopt a vertical resolution at least double than the minimum requirement, in other words 2,000px or more. An 8Megapixel resolution (capable to deliver snapshots of 3,264 x 2,472 pixel) is well suited for the purpose, and will eliminate the need of time-consuming zoom level adjustments for each specimen, that may be successfully covered as long as its maximum vertical length engages at least half of the framed area.

Exceptions apart, considering that the usual length/width ratio of gastropod seashells is very different from monitor and picture horizontal/vertical size ratio, and considering that a zoom lens will be used (see below), it can be expected that the pictures will need individual cropping, to preserve only the informative part of each image and to limit picture size.

In the light of workflow streamlining, and considering that image-capture software may not include a cropping tool, it's wiser to consider postproduction/cropping as a separate successive phase, to be performed massively after the completion of the image capture phase.

A very desirable requirement: tethering with a Personal Computer
As stated above, the digital images obtained will be uploaded on a website, and will normally need a basic postproduction (picture cropping): it's reasonable to desire to manage the whole process smoothly by using a Personal Computer. A device capable to send previews to the PC monitor is therefore preferred, and this may be obtained by USB cable connection / tethering between the imaging device and the computer.

Image format
The jpeg high quality format, even if lossy, ensures the best image quality/image size ratio, provided that high quality/low compression settings are used. If the image capture software, as is the case of DeltaPix InSight,

allows to predefine image saving resolution, the full resolution 8MP 3,264 x 2,472 (or the native maximum resolution of the available equipment) should be used.

Imaging device
Digital photo cameras have several drawbacks, including the following:
- resolution exceeding the requirements outlined above;
- tethering with the PC not always possible – when possible, it's a feature of high resolution models, and thus is incompatible with the desirable picture size;
- if tethering is impossible, the preview is performed only on the photo camera, in a necessarily lower screen size;
- if tethering is impossible, manual transfer of images between the camera and the PC is needed, adding further steps to the workflow;
- as long as the preview is thru the lens as in DSLR cameras or via a small display, the quality of the preview may not allow sound decision in a "one shot per specimen" scenario.

Professional video cameras, instead, are expressly conceived to deliver an on-screen preview and provide one-click capture and real-time image adjustment features, including flexible, real time white balancing. In that respect, video camera pictures may be more color true.

By previous experience of the author, an high quality, USB, professional microscope camera, DeltaPix Invenio 8DII, natively delivering the required 8 Megapixel resolution, was chosen as the best candidate, with its accompanying software DeltaPix InSight. Any comparable USB camera operating in the 8MP range may prove equally valid, provided that it delivers flexible exposition time and appropriate white balancing.

Lens
The objective lens should respond to several mandatory requirements:
- provide a wide zooming range (in line of principle a one to ten range, to cover 1cm and 10cm subjects with the same picture size);
- be parfocal throughout the whole zooming range (in other words, not needing focus adjustments when the focal length is changed)
- provide a very short minimum focusing distance, compatible with a small table stands (in the order of 20cm).

Considering that professional cameras have a C-thread mount, and that C-mount objectives of the required performance are unavailable or exceedingly costly, the only viable alternative are photo camera objectives that, in turn, require a C-thread to camera mount adapter.

Adapters that allow iris diaphragm adjustments are preferable: they allow to set a narrower aperture (that in first approximation translates into an higher depth of field) than the fully opened diaphragm setting, the only available without adjustment.

For previous experience of the author in macro photography, the best price/value ratio is granted by a Sony brand objective, the SAL 1855 3.5-5.6/18-55 SAM lens. Any comparable objective may be used as long as the requirement of a 20 cm minimum focusing distance and very wide zoom range are respected.

153

Volume: 51	THE FESTIVUS	ISSUE 2

Figure 1. From left to right: DeltaPix Invenio 8DII Camera, C-thread adapter, Sony SAL-1855 lens

Lighting

The availability of an indirect light source greatly enhances the quality of pictures. In the case herein described, a self-built dimmable led-strip illuminator, described online here: http://www.cesarebrizio.it/Photomicrography/LED_strip_illuminator.html, was available and was used even if out of scope: even though it was conceived to enclose fully the specimen, that in theory must lay on the same plane where the illuminator is laying, it was used from above, at some distance (a few centimeters) from the specimen surface. As a consequence of this suboptimal setting, parasite reflections are not suppressed but anyway are greatly limited. Whichever the lighting equipment, care should be taken to avoid too evident reflections that may obliterate significant details of the specimen.

The most desirable lighting source should not only be indirect (capable to generate diffused light), but it should also be continuously dimmable: although the automatic exposure provided by the camera control software is sufficient to ensure a reliable real-time adjustment, it may be unwise to rely only on software to determine the ideal exposure. In the case herein described, a fixed exposure was adopted, and modified whenever the zoom level changed – as long as a wider or narrower field of view changes radically the amount of light available. Once each zoom level was set for a different group of similarly sized specimens, all the pictures were taken with the same fixed exposure setting, usually in the range of 100÷200 msec. In the case of an *Oliva* shells collection, the dimmer was adjusted twice per subject: while the dorsal side is usually less reflective and requires a stronger lighting, the apertural side has invariably brighter and more reflective surfaces, and is overexposed if photographed in the same conditions as the dorsal side. For this reason, the dimmer was lowered until the parietal plications and the details of the fasciole / anterior band could be clearly made out.

It's clear that the dimmer knob must be kept handy during all the image capture session.

Figure 2. Self-built, diffused light illuminator

Background / measurement stage
The specimen must lay on a special surface providing an even background and some plasticity in particular in the case of rounded objects as seashells that should be firmly positioned at the moment of taking the picture. In the case described here, a small square bag ("cushion") of thick cotton fabric, filled with coarse sand, and enclosed in a wooden frame, was used. This assembly will be referred to as the "background stage". The quantity of sand filling is determined as the amount of sand needed to have the cushion flush with the external frame.

Its size, 11.5 cm, was determined on the basis of the size of the biggest specimen in the collection (around 10 cm). Its color was chosen based on the mostly light-colored specimens in the collection, knowing that to enhance the contours of the darker specimens the superposition of a white fabric square to the cushion would have been required. Even though theoretically a neutral gray cushion would have provided a suitable background for any specimen regardless its darkness, by trial and error this solution was discarded because, depending on the exposure levels and the dimmer regulation, it generated overall less satisfactory pictures. Obviously, any collection may require a different background, and it's wise to adapt the cushion to specific needs.
As stated above, one of the secondary aims of the imaging process, was to provide a reading of each shell antero-posterior length in at least one of its pictures. To that purpose, a precision millimeter ruler, printed on cardboard , was glued to one side of the background stage, with the scale contacting the cushion.

Even before taking a picture, it was clear that, as long as the longitudinal anterior-posterior axis of the shell lies in a plane well above the cushion/ruler, and nearer to the camera, the apparent size of the shell exceeds its real size, as illustrated in figure 3.
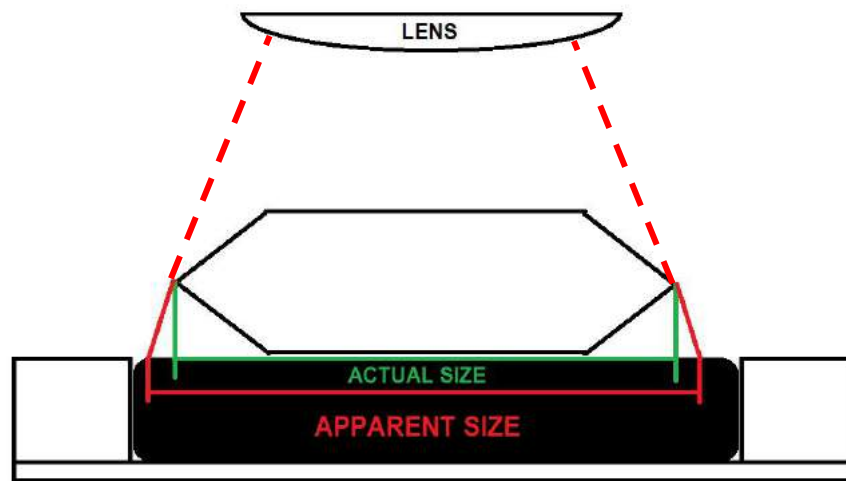
Figure 3. Apparent size of the shell may exceed its actual size if projected on a distant ruler

The only way to provide a reliable, even if approximate, visual measurement, is to prepare a sliding appliance whose surface contacts the millimeter ruler, while an orthogonal surface contacts the apexes of the shell, allowing a reliable reading of the actual distance between apexes at the exact level of the millimeter ruler. This was done by cutting two whole edges form a suitably sized, clear plastic box, as illustrated in Figure 2, and by gluing each of the pieces thus obtained to two short L-profile aluminum sections kept flush with the external frame of the background stage and thus capable to slide above and along the millimeter ruler.
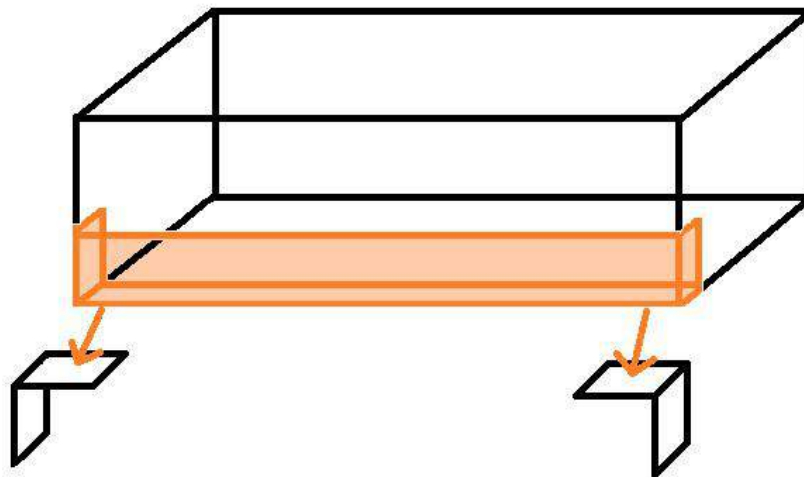
Figure 4. Construction of the sliders: selection of whole edges, including corners, of a clear plastic box

One of the sliders ("lower" or "fixed" slider) was fixed at the 0mm position. To avoid interference with the lighting equipment, part of the plastic was removed, leaving vertical surfaces only in the possible contact areas of the actual seashells, with some generous allowance.

A second millimeter ruler was added on the right side of the frame, to allow a perfect alignment of the top slider, parallel / orthogonal to the frame sides. The final aspect of the stage can be observed in figure 3.
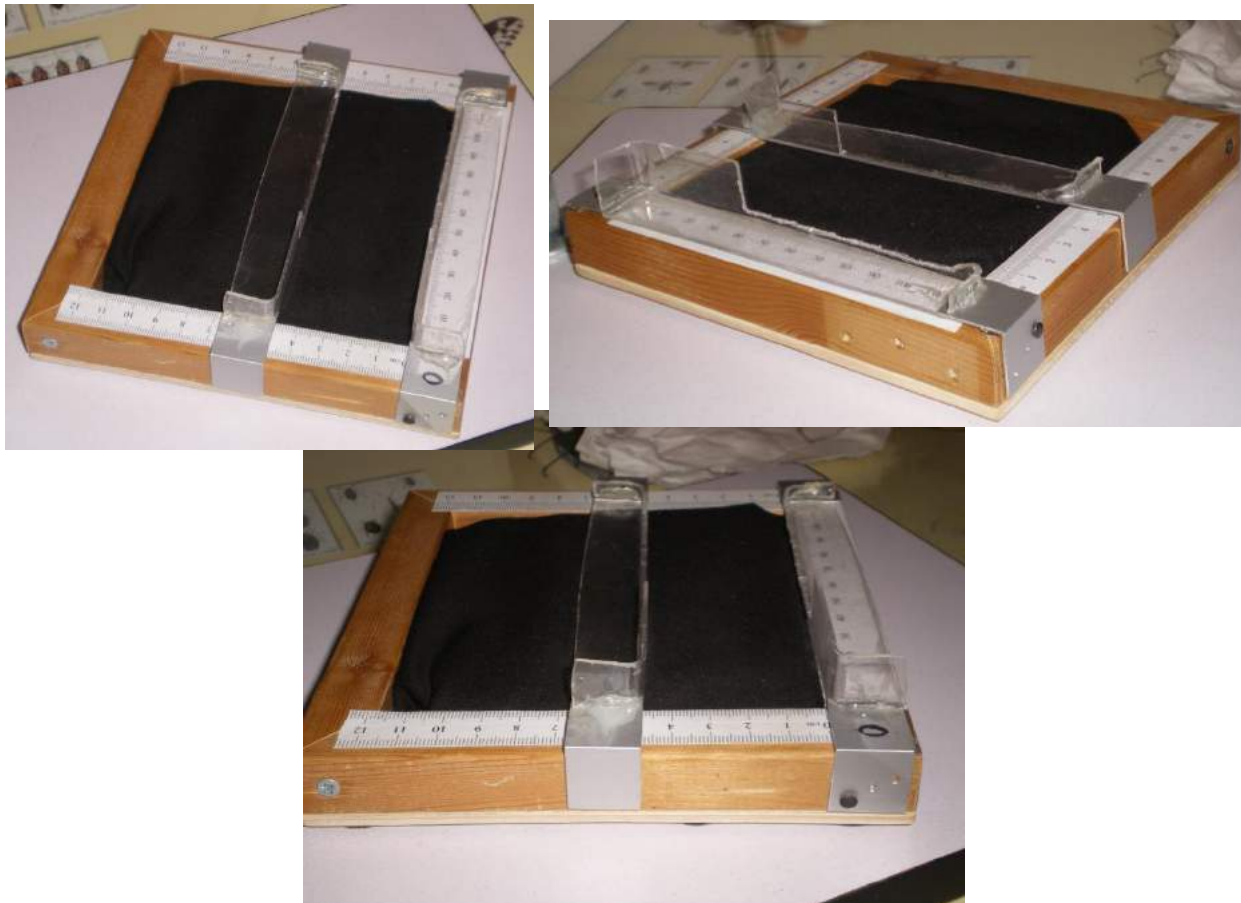

Figure 4. Details of the sliders and of the background stage

Minimum requirements for the collection
In the case here described, all the specimens of the collection are individually numbered and labeled. Plus – although this is definitely not a requirement – they are arranged in special drawers (the most frequent alternative are small clear re-closable bags).

To ensure a correct coupling among pictures and specimens, it's mandatory that each specimen is uniquely identified, the easiest way being the assignment of a number or of another unique code to each specimen. This must be made beforehand, and is usually done by putting a cardboard label alongside each specimen (same bag or same drawer compartment).

Image naming: individual labeling of each item during image capture
By trial and error on a small sample of specimens, it has been determined that the quickest and most effective name assignment to each picture, is obtained by giving to the pictures a name identical to the unique code of the specimen (in this case, two pictures of each specimen are taken, and the picture of the apertural side has a final capital "B" added, as in the following example: dorsal side, 100.jpg; apertural side, 100B.jpg).

The image capture software assigns conventional names, usually based on a progressive number, to the snapshots taken. It's very time consuming, error prone and unpractical to try and change the name of each picture on the fly, during the image capture phase.

As long as we won't assign the final names to pictures during the image capture session, it becomes mandatory to include in the picture an "hook" that allows its successive renaming.

That "hook" is a small (Arial Narrow 8pt bold, around 10x5mm) label carrying only the unique number or code of the specimen.

Although apparently time consuming, the physical pre-labeling of the specimens in fact saves huge amounts of time. The time lost in small label printing, distribution in the collection and – at the moment of taking the picture – positioning of the label aside the specimen is recovered at the moment of renaming the pictures, a process that can be done quickly by visualizing the folder with the pictures in "very large icons" mode and reading directly from the preview icon which name is to be assigned to each picture.

Furthermore, a picture including specimen number is much more useful than a mere file name.

The final installation
Here the technical components of the installation are listed: the software cited operates under Windows 7 Home Premium 64 bit operating system:

Software
- Capture
  - DeltaPix InSight 6.0.5.0
- Postproduction/Cropping
  - Adobe Photoshop Elements 4.0

Hardware
- Personal Computer
  - Gigabyte Brix i3-5010
  - Table camera stand, as described above
- Monitor
  - Dell P2416D (operating at a resolution of 2560x1440 pixel)
- Professional microscope camera
  - DeltaPix Invenio 8DII
  - USB cable
- C-mount adapter
  - Photodiox ProSN (a) – C adapter
- Lens
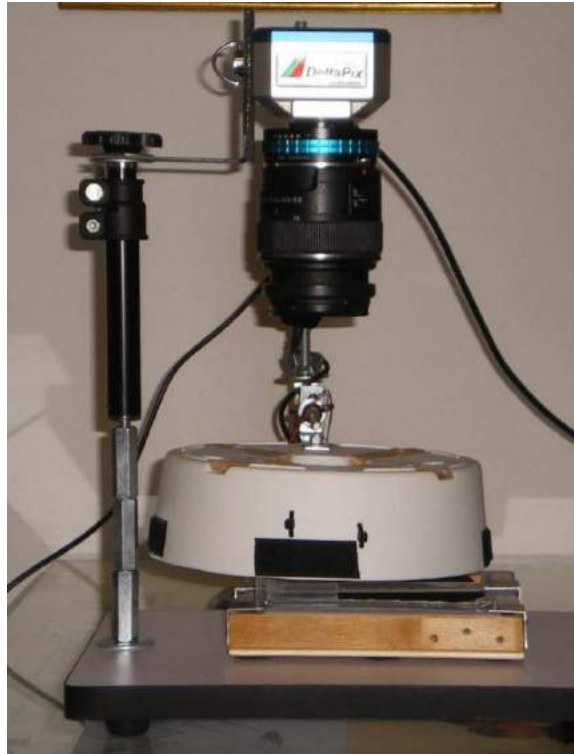 - Sony SAL-1855 3.5-5.6/18-55 SAM, Sony A / Minolta Autofocus mount

Figure 5. The full imaging setup

The workflow

This is not a detailed step by step guide, considering that the same sequence of activities can be performed under different software and operating systems. Subjects as creation and naming of a folder for the captured pictures, of subfolders for the post-produced or renamed pictures, as well as software setup, will not be covered here and should be part of the basic IT knowledge of anybody engaging in a digital imaging project. Rather, this is a detailed description of the exact steps taken in the case study on which this paper is based.

Preliminary steps

Label each specimen with 10x5 mm label carrying its unique code. Labels may be created as a table with growing number sequence in Excel or Word, or similar software: the table should be formatted until each cell is 1 cm wide and 5mm high, then printed on 200gr/m2 cardboard and separated by paper cutter or scissors.

Each box or drawer cell or bag should be marked with its label **before** the process begins.

Batch size

The process may be carried forward in two ways:
- perform the complete process for lots/batches of specimens
- perform a complete phase for all the specimens, before passing to the subsequent phase. This obviously may imply working on different lots/batches on a daily basis

The second option was chosen and, in successive days, totaling between 4 and 5 hours per day, the images were captured. In the days that followed, in two 6 hours sessions, cropping and postproduction took place.

Batch composition

To speed up work, adjustments should be reduced to a minimum: then, it's better to treat specimens of similar size as a single lot. Specimen size affects zoom level, that in turn may require raising or lowering the extensible column and/or repositioning the camera vertically on its attachment: even though at any given zoom level the lens is parfocal (in other words, maintains the pre-set focus distance), when the lens-specimen distance changes, focus adjustment is needed. For those reasons, treating similarly sized specimens in each session is advisable.

The same may apply to specimen color: considering that – depending on the color of the cushion - very dark or very light specimens may require a different background (*e.g.* a square of white fabric above a black cushion, or vice versa), it would be better to treat similarly colored specimens in sequence.

Suggestions

- Particularly when working on specimens arranged in drawers, some sort of physical signal or "marking peg" must be used to mark the position of the last specimen treated or the next specimen to treat, thus avoiding the omission of whole rows or columns by oversight. When using small bags, it's advisable to put the worked specimens' bags in a separate container to avoid undesired reprocessing.
- For specimen that, as in this case, need to have both sides pictured, it's useless to take length measurements on both sides of the specimen. It was decided beforehand that the dorsal view would be used for measurement, and the apertural view would not include the vertical ruler.
- The ID label should appear in both the pictures of each specimen, thus allowing both the correct naming and the reliable coupling of the two images.
- Considering that the ruler will appear to the left of the dorsal side in just one of the two images, it wouldn't be wise to put the label at the base of the ruler during image capture. By juxtaposing the label to the right of the specimen it suffices to flip the specimen after the first capture, leaving it in the same position respective to the label. On the other side, we should strive to reduce image size: before cropping the dorsal side picture, to minimize its horizontal size, the portion of the picture with the small label was selected and moved at the base of the ruler. This passage is entirely optional, yet compactness is surely a desirable property off the picture, and the select and drag of the label requires just a few seconds per picture.
- The diffused light illuminator illustrated above and used for this case study has a structural limitation: a peeking hole for the lens that, depending on the zoom level, may cause vignetting or obliteration of part of the field of view. The same applies if one uses an annular illuminator not fixed to the objective. The following considerations may not apply to different sources of indirect, diffused light. While taking pictures of the bigger specimens, engaging a larger field of view and requiring a bigger focusing distance, the top of the illuminator occupies increasing areas of the field of view, and the true picture is restrained to a circular area in the field center (see Figures 6 and 7). It's obvious that the nearer to the lens is the hole, the less obliteration will occur: so, why can't we just put the illuminator higher above the subject? The reason why it was unadvisable to raise the illuminator much above the subject is that in fact it ceases to deliver diffused light, and a rapid increase in parasite reflections is observed. A compromise was found but all the bigger specimens where literally photographed "through the hole", and even after cropping some traces of the hole edge may be observed in the corners of some pictures.
- Handling small labels may require the use of tweezers.

Notes about image capture

Image capture and image saving are two distinct operations. Depending on the software used, the procedure to save the captured images may vary. In a general sense, while it's time consuming to save each image immediately after capture, it's much quicker to suspend image capture operation every 10 to 20 captures, and save all the pictures obtained. This is a very quick operation, usually requiring exiting momentarily the image preview feature used for capturing, viewing all the captured pictures as tiles, and press Ctrl-S or another combination to save each picture. As long as pictures will be renamed in a subsequent phase, the name automatically assigned to each picture can be confidently accepted: the presence of the numbering small label in each photo will guide us at the moment of renaming. Since the acceptance of the default name for each picture requires just to press enter (the OK button is usually pre-selected), saving each picture would require: one click to select the tile with the picture; just two keystrokes: Ctrl/s and Enter; one click on the "X" (close) button of the tile of the image just saved. After saving all the captured images, one returns to the preview/capture screen and continues the activities.

Image capture

The procedure adopted for *Oliva* shells is described here: it may vary depending on the nature of the specimens photographed.

For each batch
- (optional) if the cushion color is unsuitable for the specimen, change cushion or cover the cushion with a square of fabric of suitable color;
- adjust zoom level for the maximum expected size in the batch;
- if at minimal focal length (widest field) the shell is not entirely visible, raise the camera (by increasing column length or moving the camera above on its attachment;
- if the camera was raised, check and adjust the focus

For each element in the current batch:
A. pick the shell and the small label (if applicable: at current peg/physical marker position);
B. put the shell on the background stage, gently pressing it on the cushion, dorsal side up, near the left (vertical ruler) side, upright, with longitudinal axis vertical and its anterior apex laying on the 0mm lower (fixed) slider;
C. put the label at the right side of the shell: the left side of the shell should be as near as reasonable to the vertical ruler, leaving some space on the left to maintain visible the outline of the shell above the cushion (the shell should not touch the frame). By arranging the label at the right side of the shell, it will suffice to flip the shell and slide the whole background stage a little to the left to exclude the ruler from the apertural side picture; the nearer to the shell is the label, the tighter the cropping can be made, resulting in a smaller image file.
D. Slide the upper (movable) slider towards the shell until it touches the protoconch. If sand has moved inside the cushion, bumps may have formed and the slider may not touch both the sides of the frame. Bumps should be flattened by gently moving the slider up and down, until it touches, on both sides, the rulers and, on its front vertical face, the protoconch. Verify that the same reading occurs on both left and right rulers;
E. position the background stage under the camera;
F. adjust luminosity with the dimmer, to the highest setting where no parts of the picture are overexposed (unnaturally white). Usually, when taking the second picture (apertural side), intensity should be decreased as the fasciole and "shoe" of the shells are very reflective;

G. verify that the upper and lower readings of the vertical ruler, including the sliders' bases, are visible, that the small label is readable in full, and that the shell is upright;

H. capture the image. See above "Notes about image capture";

I. put away the shell and the small label;

J. (if applicable: move the peg/physical marker to the next position);

K. see if it's time to save the images captured: in case, save the images as explained in "Notes about image capture";

L. repeat the sequence from point A.

When fluency in this phase is obtained, if the shells are arranged in easily accessible drawer cells with no box or bag to open, the A-L iteration should take no more than 25 seconds.

Renaming

At predefined intervals (typically, at the end of a day's work), or in any case when the image capture phase is completed, pictures, now assigned default meaningless names, should be manually renamed according to their actual content.

To proceed, it suffices to select the folder containing the captured images, maximize it and select the "details" visualization, from which an alphabetical ascending order by filename will be chosen. Then, once the alphabetical order is in place, visualization is changed to the "very large icon" mode. In 8Mpixel images, the 1 cm label should be clearly visible up to a specimen size of 8÷9 cm, only for specimens above 9 cm the label may have become so relatively small as to become unreadable. Only in those cases it may be needed to open the image to read its specimen number. In the actual case here described, the label could be read from "very large icons" in all the 1,832 pictures made. In this case study, the name assigned to each picture, as stated above, is its unique ID, with an added final B for the apertural side picture.

Postproduction

Once the pictures are taken and renamed, they should be cropped to preserve only the meaningful part of the picture (see the two examples in Fig. 6 and 7). To this purpose, Adobe Photoshop Elements (as well as many other graphics software, including open source and freeware solutions) provides an effective tool for image cropping, that can be invoked by a single keystroke.

It's suggested to open groups of 6 to 10 pictures by dragging them on the graphics software window, then for each picture:

A. select picture,

B. select the cropping tool,

C. select by dragging the tool the area to preserve,

D. adjust area size and position

E. press enter to actuate the cropping,

F. press Ctrl-W to save the cropped picture, and then enter as required, always checking that best quality JPG option is selected at the moment of saving

G. repeat sequence from point A

(keyboard shortcuts may vary with the software).

In the case study here discussed, another activity took place: to reduce image size further, before cropping the dorsal side pictures, the portion of the picture with the label was selected and dragged at the base of the ruler,

thus allowing to preserve a narrower area. This was made by different combinations of keyboard shortcuts and mouse (or trackball) action, that may vary depending from the graphics software.

The excellent color and white balance response of the combination of Invenio 8DII and DeltaPix InSight did not require the use of "auto levels" function. With different devices, it may be useful to use the automated batch procedures of the graphics software to apply "auto levels" (contrast, brightness, color cast removal) to the cropped images. In that case, it will suffice to specify a source and a destination directory, and the software will generate new pictures with auto levels applied.
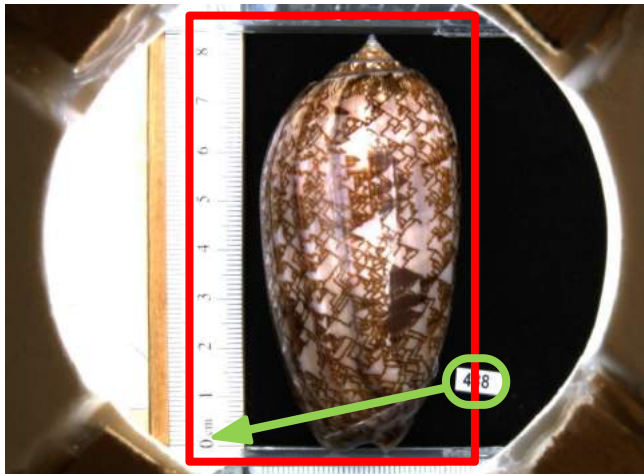

Figure 6. Dorsal side picture, specimen near the ruler. Label Repositioning (green arrow) and Image Cropping (red line)
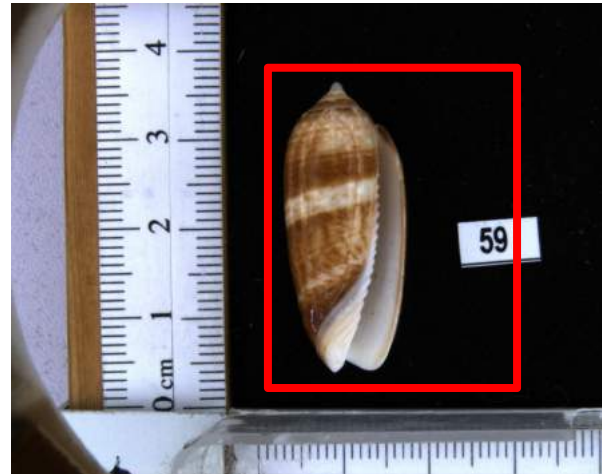
Figure 7. Apertural side picture, specimen away from the ruler. Simple Cropping (red line)

Thumbnail generation

Once the pictures are taken and renamed, if their destination is a website it may be desirable to generate much smaller thumbnails/previews to be put on a web page for giving access to full size pictures.

This operation can be automated by most graphics software. In the website structure, it is wise to keep in separate subfolders the full size pictures and the thumbnails, respectively. The web page will be placed in the main folder and access both. The automated batch resizing procedure allows to specify different origin and destination folders.

Results

The times provided here are influenced by 30+years of author's experience in IT tools and in graphics software, but the ease of the iterative operations described above points at the possibility that any average PC user, after some times of use of his own favorite image capture and graphics software, can match or improve those results.

Production

The combination of technological stack and workflow described above allow the author to take 1,832 pictures (including specimen handling, picture saving and renaming) in under 28h (divided in 6 days, averaging 4h40' per day), equal to around 1,680 minutes averaging 55 seconds all-inclusive time per picture capture, saving and renaming, with custom lighting for each picture.

Post-production
Post-production operation including cropping and label repositioning (an optional activity whose omission would have significantly reduced working time) were performed in two successive days in a total of 12 hours, equal to 720 minutes averaging less than 24 seconds all-inclusive time per picture post-production. Around 30 cases of unreadable labels where solved by adding a digitally generated label or moving labels from a picture to another: those operation did not alter significantly the overall performance.

Conclusions
All the pictures obtained may be accessed here: http://www.cesarebrizio.it/oliva/index_olive.html, by a click on the corresponding thumbnail (warning: the download of the thumbnail page, currently having 1,832 entries, may require one or more minutes).

All the pictures were individually checked and fulfill the requirement to cover adequately the diagnostic features and allow comparisons with other images or physical specimens.

For the scenario of one-shot, medium resolution, massive capture of images of catalogued collections, even though time constraints did not allow to process the same specimens with different imaging devices and workflows, it seems that the combination of technologies and techniques here described has a decisive advantage over other kinds of manual workflow involving the use of photo cameras.

Suboptimality of the pictures
The pictures obtained do not represent the maximum possible quality obtainable with the proposed combination of camera and lens, but rather the best compromise between speed and desired quality. Among the steps not taken that would have ensured an even better image quality:
- zoom was not customized for each specimen, but for each batch;
- focus was not adjusted on each specimen, but on the first specimen of each batch, with occasional readjustments;
- fixed exposure time was not adjusted for each specimen, but for each batch (as long as illumination was individually dimmed for each capture, this should not be a problem);
- diaphragm aperture was identical in all the 1,832 pictures (to avoid introducing a further variable in exposure), while in fact it could have influenced picture sharpness at different zoom levels and focusing distances.

The excellent technical characteristics of the imaging equipment, and the generally good quality of the lighting equipment, allow to obtain a more than reasonable result considering that one and only one shot was taken for each subject and side combination.

A side benefit of image naming: from excel to HTML table in a few simple steps
An HTML web page can be seen and downloaded here: http://www.cesarebrizio.it/oliva/index_olive.html

It contains all the pictures obtained via the process described above, and as of August 2018 is still unrefined. Thanks to image names exactly matching the unique code of each shell, the table filling the body of the HTML page (containing all the thumbnails and the data of each specimen) was automatically generated from the same Excel sheet where the data of the collection are stored. This was made possible by a basic knowledge of HTML and by the usage of simple Excel functions. Details will be provided upon request.