imaging

Government of South Australia

South Australian Museum

Case Study: Equipment Options for Imaging by Volunteers

ATLAS OF LIVING AUSTRALIA
sharing biodiversity knowledge

Contents

1 Introduction

1.1 About this document

Large scale digitisation of biological specimens presents a particular challenge to museums contributing to the Atlas of Living Australia (ALA).

In December 2010 and January 2011, the South Australian Museum (SAMA) investigated imaging options as part of the scope of work under their ALA supported Volunteer Digitisation project. This case study describes in overview the observations and conclusions developed through that process. It encompasses lessons learned from the experience of Museum Victoria and the Queensland Museum, and reflects strategies adopted to tackle some of the SAMA's in-house challenges. During 2011 the systems discussed will be tested with the volunteer team, and SAM anticipates ongoing reports on the viability of the chosen equipment, and refinements to the proposed process.

This paper should be read in conjunction with the Digital Imaging Requirements Review, by Les Walkling (available at http://www.ala.org.au/wp-content/uploads/2011/02/ALA-Les-imaging-report1.pdf), and the Guidance: Image Manage Framework document prepared by ALA (available at http://www.ala.org.au/wp-content/uploads/2011/02/Imaging-Framework-v1.0.pdf). The latter document outlines issues such as image management, storage and institutional policies that must be considered as part of the planning for any digitisation project.

1.2 About the Volunteer Digitisation project

ALA is funding a project to explore how best to involve volunteers in a program of work to digitise specimens held in museums. The project is being conducted in association with the Council of Heads of Australian Fauna Collections (CHAFC) and is being run jointly by SAMA and the Australian Museum. It will develop suitable work practices and procedures and identify equipment that could be applied by a scalable volunteer workforce. Outcomes of the project will be shared with other museums and interested organisations and many of the images produced will be available through ALA.

The project is also intended to be of long term benefit to SAMA. The equipment to be purchased consists of components that can be re-purposed to photograph other collections in the museum. Similarly, the development of imaging standards, digital asset management procedures, and processes for the recruitment, induction and management of volunteers will be of considerable benefit to other activities of the museum. Documentation of this project will also aid future digitisation planning for SAMA.

1.3 The digitisation task

Essentially, the challenge confronting SAMA is to engage volunteers to photograph and record data on more than 8 500 terrestrial invertebrate holotype specimens held in their collection. The collection to be photographed includes pinned specimens, slide mounted specimens, slide mounted dissected material and specimens in spirit.

High resolution TIFF images will be created and stored as an archival record of the collection, distributed to users on request (appropriate uses include research, publication, exhibition or education activities) and used to document the condition of specimens. All images will have an accurate scale bar.

In the first instance, images will be delivered online via ALA. These will be in the form of 72 dpi JPG files, or higher resolution if delivered through a program such as Zoomify.

Up to 7 000 of the specimens will also need new database records, while some existing database records will need to be manipulated to become Darwin Core compatible.

Imaging is to be conducted rapidly, demonstrating ways of tackling the backlog in museum digitisation.

1.4 Workstation configuration

As a result of the analysis outlined in this case study, SAMA has decided to adopt three workstations to perform the digitisation:

- **Workstation #1: Databasing**—a regular desktop computer used to generate, check and edit database records
- **Workstation #2: Micro photography**—Leica Microsystem, including M205c microscope, DFC500 camera and a computer specified for the efficient processing of images
- **Workstation #3: Macro photography**—Canon EOS5D MkII camera with macro lens, mounted on a copy stand with a Stackshot automated focussing rail, and computer specified for the efficient processing of images.

The ability to operate three workstations simultaneously aids rapid digitisation. Each imaging workstation also consists of components that can be re-purposed for other digitisation projects.

Details of the chosen systems are discussed in Section 3.

2 Issues and Considerations

The particular characteristics of this project had an impact on the equipment to be purchased, and some issues raised in Dr Walkling's Digital Imaging Requirements Review also influenced the selected solution.

The bulk of the imaging is to be done by volunteers, with many people contributing to the final outputs. Therefore, the SAMA project team favoured measures that would prescribe the process, aid consistency in its application and improve efficiency.

Several of these measures are discussed below, along with other considerations that influenced the implementation of this project:

- users of the equipment
- automated focus stacking
- imaging whole drawers V individual specimens
- IT requirements.

2.1 Users of the equipment

The lack of sufficient skilled operators is one of the key hindrances to large scale digitisation in Australian museums. The Volunteer Digitisation project is designed to trial the use of volunteers to operate imaging equipment to speed the process of digitisation. Thus operators' skills, or lack thereof, must be considered in decisions made about the equipment. Similarly, the project will produce bulk images created by different operators. Measures that improve consistency of image creation will aid the quality of outputs.

The chosen solution and measures have been designed with the goal of simplicity and repeatability. Two workstations each tailored to capture images of different types of specimens mean that operators can simply mount specimens and take shots, rather than have to re-configure a workstation for different specimens.

Similarly, a decision to create four standard views of each specimen—dorsal, lateral, ventral (where the specimen is considered strong enough) and associated labels—is sufficient to aid discoverability of specimens through the ALA while providing a sufficient record of the specimen. This set of standard views can be recreated and repeated by non-specialist operators without any knowledge of invertebrates or their diagnostic characteristics. Further, the ongoing presence of high quality equipment at SAMA means that additional diagnostic images may be generated by specialists, or volunteers guided by specialists, when required.

Features of the selected equipment that contribute to ease of use for unskilled operators include:

- flash rather than fixed lighting on the macro photography workstation
- the Leica LED5000 HDI dome illuminator on the micro photography workstation
- the automated z-axis steppers to enhance depth of field.

2.2 Automated focus stacking

This project will use automated focus stacking—hardware and software–to create images with extended depth of field.

2.2.1 Hardware

In both micro and macro photography these programs benefit from automated z-stepping devices to efficiently create a series of images at different heights from the specimen, as nominate by the user. Focus stacking programs stitch together these photographs to create an image where the entire specimen is in focus. Algorithms in these programs find sharp edges and stitch 'in-focus' areas together.

This has previously been done in SAMA by hand, but automated z-stepping will speed up the process immeasurably, and will help control aspects of the process to aid greater consistency in the volunteers' outputs.

Most microscope manufacturers can supply motorised z-drives, which adds between $1 000 and $3 000 to the price of the system. Similarly, Visionary Digital's BK Lab Systems include an integrated hydraulic lift, which moves the camera body to take the required photographs.

For this project, SAMA is trialling the Stackshot focussing rail, which can be mounted on a copy stand and act as a motorised z-stepper. This product has not been used in Australian museums before, but is used in some USA museums and has been well received by the active amateur and professional community associated with the *Photomacrography* forums.

2.2.2 Software

There are several focus stacking programs on the market, including Helicon Focus, Zerene Stacker, Combine Z and Automontage. Most of these have been used in the museum environment. They vary in cost from freeware to quite expensive and many have short term trial versions. SAMA will use trial versions to compare the same image processed through different systems, and choose our preferred program based on a comparison of results.

2.3 Imaging whole drawers V individual specimens

The idea of imaging whole drawers of specimens has been adopted by some contributors to ALA as a way of speeding the digitisation of their collections. In contrast, SAMA will photograph individual specimens because such images will be more useful to the museum, as they can be provided to inquiring researchers, and may be used to monitor the condition of specimens. Also, some systems suitable for whole drawer imaging are particularly tailored to that purpose and are very expensive. On the other hand, a system consisting of 'prosumer' quality imaging components is expected to be more versatile for SAMA in the long run as well as being more affordable, so allowing the purchase of multiple imaging stations. Versatility, in this context, means that components can be re-purposed to capture other parts of the diverse SAMA collection. In fact, the proposed macro photography components can be re-modelled to capture whole drawers of insect specimens if required.

2.4 IT requirements

SAMA also considered the IT implications of this project.

2.4.1 Processing power

Image capture and manipulation programs like Helicon Focus, Zerene Stacker, Adobe Photoshop and Canon Photo Professional require extensive processing power that can over-tax standard desktop computers. While these programs may operate competently on computers with everyday specifications, they will operate slowly, which can lead to operator frustration, slower workflow and dissatisfied volunteers.

It should be noted that in the area of IT, specifications are superseded very quickly, and upgrades become standard within short periods. At the time of writing, the recommended computing hardware for imaging and image manipulation was:

- CPU: Core i7-870 (quad core)
- RAM: 16 GB
- HDD: 500 GB @ 7 200 RPM
- 22" 1680 x1050 monitor or better.

These specifications add approximately $900 to the cost of a basic desktop computer. Peripherals that can also be considered include a solid state drive and an uninterruptable power supply.

2.4.2 Data storage

Data storage is a challenge for SAMA as for many other institutions, especially in relation to this project, which will generate an estimated 2 TB of high resolution images. While SAMA is finalising a large scale data storage upgrade, the digitisation project will store images on external hard drives, with a strictly enforced routine to ensure the images are backed up.

Large scale data storage is a considerable investment. Desktop external drives are (at the time of writing) around $100 per terabyte. An institution that isn't planning for an upgrade of centralised storage might also consider 'network attached storage' systems that are available with RAID. These can be up to $1 000 per terabyte.

3 Workstation configuration

The SAMA Volunteer Digitisation project workstations are detailed in this section. The SAMA project team is happy to provide details of prices and additional observations on the systems' performance on request.

3.1 Workstation #1: Databasing

As mentioned, the project requires considerable improvement to existing database records, so a single workstation has been set aside to allow work on databasing. This is a regular desktop PC, without any particular specifications.

3.2 Workstation #2: Micro photography

This workstation consists of a Leica Microsystem comprising:

- Leica M205c optics carrier (7.8x to 160x zoom range)
- 620mm motorised focus drive
- incidental light base with anti-shock feet
- Planapo 1.0x objective and standard 10x adjustable eyepieces
- Leica LED5000HDI illuminator hood
- Leica DFC 500 camera kit (12 MP, colour co-sampling)
- Leica Application Suite software, including Interactive Measurement Unit (for automatic measuring), Montage Multifocus (for extended depth of field montaging)
- desktop computer with specifications detailed in Section 2.4.1.

A key benefit of this system is the motor drive, allowing automated z-axis stepping

The Leica LED5000HDI illuminator hood has been used by Museum Victoria for some time. It has demonstrated immeasurable benefits in support of speed imaging and allows for incredible consistency in lighting across a vast range of specimens.

The DFC 500 is a true colour camera, without Bayer filtering, and produces 12 MP, multi-shot, true RGB images. It is also compatible with any C-mount microscope, so can be mounted on an existing compound microscope to photograph slides. The images produced by this system have been subject to blind testing by Ken Walker, at Museum Victoria, and were rated very highly.

3.3 Workstation #3: Macro photography

This workstation, designed for larger invertebrate specimens and other SAMA collections, comprises:

- Kaiser 1.5m copy stand, with a 800mm x 600mm baseboard
- Canon EOS 5D Mk II camera body
- Canon 100mm f2.8 L series macro lens
- 2 x Canon 430EX Speedlites plus Canon ST E2 Speedlite transmitter
- Stackshot automated focussing rail.

The Canon EOS 5D MkII us a full frame 21 MP camera, one of the highest quality in the 'prosumer' range. The full frame camera makes the best use of available pixels and can improve contrast and reduce 'noise' on the digital image. Canon's electronic first shutter curtain has been recommended as being invaluable to minimise vibration during macro photography.

The height of the selected Kaiser copy stand and breadth of its baseboard will allow imaging of whole drawers of invertebrate specimens, and other parts of the SAMA collections. The copy stand is counter balanced with a height lock mechanism. Designed for the professional market, it is more stable than those available through many photographic retailers. Brackets can be purchased to mount the column on a wall, if the studio set up changes or if the column is needed to photograph very large specimens.

The L-Series macro lens is the highest quality Canon lens, which will be able to be re-used on new camera bodies if they are replaced or upgraded in the future. Flash lighting will improve contrast in photographs, and will be more efficient than fixed constant lighting, as it will require little manipulation between specimens. Also, short bursts of cool light will have minimal impact on specimens.

The Stackshot automated focussing rail will facilitate automated z-stacking, creating greater efficiency and consistency across different users.

4 Other imaging options

A range of information and quotes were sought by SAMA in December 2010, and form the basis of the observations in this section.

It should be noted that technology in this area is always advancing, and quotes are time sensitive, so this advice should be considered in conjunction with fresh supplier consultation. This discussion is intended as general advice and an aid to planning a digitisation project; all features should be checked before final decisions are made.

4.1 Micro photography workstations

All microscopy suppliers can provide systems that will photograph entomological specimens. Each supplier is able to supply a broad range of micro photography systems, and may be able to custom build systems to your requirements. Features such as automated z-axis stepping and higher resolution cameras are now available through different manufacturers, and in large part, the decision about which system to purchase will depend on the budget available.

Suppliers are able to advise on the best system, particularly if you clearly advise how will the equipment will be used, the intended use of the resulting images and the range of subjects to be photographed.

4.1.1 Nikon

Nikon's range of SMZ stereo microscopes is a popular and affordable option for many institutions. Nikon provides an automated z-axis stepping mechanism as part of a microscope, and their NIS Elements software can produce extended depth of focus images. Modules are available that can automatically insert measurements and scale bars. There is also an NIS Elements database module that supports the addition of metadata.

The NIS Elements user interface can be customised, so that greater or lesser access to configuration options can be tailored to different users. This means that a project manager can limit the elements that volunteers or other users are able to adjust.

Nikon also supply a range of Digital Sight microscope cameras, from 5 MP to 12 MP, and their top end includes a true colour camera.

These systems can use traditional bifurcated fibre optic light, or newer LED ring illuminators. Many ring illuminators can be controlled to angle or intensify light in halves and quarters.

A Nikon system including software, automated z-drive and 0.8x to 80x magnification range and computer can be built for less than $20 000.

Further information about Nikon products is available from http://www.nikon.com or Coherent Scientific (http://www.coherent.com.au).

4.1.2 Zeiss

The Zeiss Stemi series stereo microscopes can be combined with the Axio Cam and AxioVision software to conduct biological imaging.

A range of microscopes can be fitted with motorised focus drives and combined with cameras, from the AxioCam ICc3 (3.3 MP, CCD, 36 bit high resolution) to the AxioCam HRc (12 MP, colour co-site sampling, microscanning, 1:2200 dynamic range), depending on the available budget and imaging needs. These systems use traditional bifurcated fibre optic light source, a slit ring illuminator or telescopic diffuse light source, which is a dome-style illuminator.

Further information about Zeiss products, including local contacts, is available from http://www.zeiss.com.au/.

4.1.3 Leica

Leica Microsystems have been used by a number of institutions to produce high quality entomological photography. Museum Victoria, in particular, demonstrate excellent outcomes with the Leica Microsystem for their Pests and Diseases Image Library (PaDIL: http://www.padil.gov.au/).

Leica microscopes such as the M165c (7.3x to 120x) and the M205c (7.8x to 160x) can be combined with a range of cameras, from the DFC425 (5 MP, CCD) through DFC495 (8 MP, CCD) to the DFC500 (12 MP, colour co-sampling).

A particular selling point for this system that has demonstrated excellent results was the LED5000HDI retractable illumination hood, which creates excellent lighting conditions for a wide range of specimens in a single action, without the need for time-consuming manipulation of lighting between specimens. This dome has been demonstrated to have advantages over other ring lights, which can flatten the image, and traditional bifurcated fibre optic lights, which can slow the process. The efficiency and consistency benefits of this hood will help our project considerably.

The Leica Application Suite includes some image editing functions, including Montage Multifocus, for extended depth of field, and the Interactive Measurement Unit, which can apply scale bars and other measurements to images.

Further information about Leica products, including contacts for local representatives, is available from http://www.leica-microsystems.com/.

4.2 Macro photography workstations

In his Digital Imaging Requirements Review, Les Walkling describes 'adapted systems, that utilise professional/consumer technology and techniques'. As seen in our workstation configuration, the SAMA project team has put together such an adapted system. This was considered the most versatile and affordable system for this project.

The components that make up the SAMA system are discussed in his section, with some ideas and consideration of alternative options.

4.2.1 Camera bodies

Costs and specifications of cameras vary considerably and change constantly. Typically a 'prosumer' DSLR can cost between $800 and $6 500, depending on brand, sensor size, number of pixels and additional features.

The capability of the camera to be acquired depends in large part on the available budget. Good assessment of the scope of the task and the use of the images help guide the choice of camera. Different uses of the images may be to create low-resolution images for the web, images for publication, or archival or research images. When photographing invertebrates, it is important to remember that while images are not likely to be printed at extravagant sizes, users are very likely to need the capacity to zoom in on tiny structures or details that are necessary for diagnostic purposes.

DSLR cameras can be purchased with 'full frame' sensors. This refers to a sensor that is the size of a frame of 35mm film. A full frame sensor makes better use of the available pixels, and provides greater dynamic range than smaller sensors. It also has reduced 'noise' because flaws in the image will not be magnified as they can be with smaller sensor cameras trying to make the best use of the available light.

Nevertheless, many smaller sensor cameras produce more than adequate images that will satisfy the requirements of a museum user.

The SAMA project has chosen to use a Canon EOS 5D MkII. Canon's electronic first shutter curtain function, which lifts the viewfinder mirror and keeps it raised to minimise vibration while shooting, was recommended as invaluable when conducting macro photography. The Nikon full frame D700 was also be considered.

In some circumstances the choice of camera body will depend upon existing equipment held in a museum. Where a museum has already invested in one brand of camera gear, it is a good idea to make use of the existing interchangeable lenses and peripheral equipment.

4.2.2 Lenses

It is best to seek the advice of a photographic professional when choosing a lens. This project will use the Canon 100 mm f2.8 L series macro lens, which is one of the highest quality Canon lenses. It is anticipated that this lens can be used on upgraded or replaced Canon camera bodies in the future.

4.2.3 Lighting

Quality lighting is a photographic challenge, and will depend on the size and quality of the subject. It is valuable to seek advice from photography professionals. The most important information that will be required when seeking advice is the range of sizes of the subjects. Other important information includes a description of any peculiarities to do with appearance, such as reflective surfaces, dull surfaces, translucent subjects. Many photographic retailers will allow you to experiment with different lighting systems and may lend systems for trial periods.

SAMA considered different options for lighting, but chose to use flash lighting on the macro photography system as it is able to transmit brief bursts of light, shortening exposure times, minimising vibration and noise on the images, and minimising impact on specimens. We elected to use two Canon 430EX speedlites, which can be manoeuvred around the subject, and could also be used when photographing larger subjects. We anticipate experimenting with diffusion of the light from these devices with diffusion rings, light tents, filters on the flash units and other as yet unexplored means.

Other common options that might be considered include:

- small studio lights or soft boxes
- ring flash
- macro optimised flash units
- fixed constant lighting.

Both Canon and Nikon produce systems optimised for macro photography (Canon MT24EX and Nikon R1C1). These are useful smaller speedlights that can either be attached to a ring on the front of the lens, or are freestanding. These systems might be useful for unskilled operators as they are customised for macro photography use. They are also recommended for photography in the field or of live subjects.

4.2.4 Copy stand

Small vibrations can create blur when conducting macro photography of small subjects, particularly when using focus stacking for extended depth of field. It is thus worth investing in a sturdy copy stand.

Small, lightweight copy stands can be purchased from most retail photography outlets for approximately $150 to $250. These may lack the necessary stability for focus stacking, but will work if you have a particularly stable work space, or if you are able to modify the device with a heavier or fixed baseboard.

SAMA found it difficult to source a high quality copy stand from photographic retailers that supply Adelaide's consumer market: they are not commonly used. An appropriate stand was sourced from a supplier to the professional photography market. Many entomological photography enthusiasts use converted enlarger units or custom hand built systems.

The range of subject sizes will impact on the height of the copy stand required. Individual invertebrate specimens can be photographed using most copy stands without any difficulty. Museums that are interested in photographing whole drawers of specimens (approximately 500 mm x 500 mm) or other subjects of a similar size, will require a taller copy stand. A discussion of the required sensor to subject distance can be found on the ALA website (http://www.ala.org.au/tools-services/imaging/imaging-hardware/).

Key points to look for in a copy stand include stability and a counterbalanced adjustment mechanism, for ease of use. Some copy stands also advertise locking points for fixing height adjustment, which can be useful to prevent operators from accidentally lowering cameras onto specimens. Many good quality copy stands also advertise mechanisms to ensure stability and reduced vibration in the fixture between the column and base board. Depending on your work area, the copy stand column can be wall-mounted, which can counteract unstable benchtops or rooms prone to a lot of vibration.

4.2.5 Additional peripheral equipment

Battery life and the process of changing batteries can impact a project's workflow and budget.

Camera batteries and AC adaptors

SAMA has purchased a spare camera battery, and enforces a strict routine of putting the battery on to charge when it is not being used. AC Adapters are also available for most mainstream brands of camera, which is a good idea if a camera will be used in a fixed position for full days.

Flash and batteries

The choice to use portable flash lighting also means using batteries. The life of a battery in a portable flash unit is difficult to predict, as the intensity of power usage varies depending upon the space illuminated. Usually, battery life is between 200 and 1400 flashes. Using focus stacking software, these limits can be quickly reached as up to 10 flashes may be needed for a single image.

Some flash units can be attached to AC adapters, while small studio lights use mains power.

The cost of non-rechargeable batteries, particularly lithium batteries, can have a significant impact on the budget over the course of a project. SAMA has thus purchased chargers and rechargeable batteries, and will track how they are used as part of documenting the project.

4.2.6 Anti-vibration mats or supports

Vibrations can introduce unanticipated blurring into a photograph. These vibrations can be caused by buildings, passing traffic or a number of other sources. This issue and strategies to prevent vibration are frequently discussed by contributors to online macro photography forums.

Solutions to this problem discussed on online forums include copy stand base boards made from thick pieces of granite, photography equipment suspended from the ceiling, instead of being mounted on benchtops, or moving entire studios to concrete lined cellars!

A simpler solution could be the use of anti-vibration equipment, such as mats or hemispheres. Recommended products include Sorbothane hemispheres or Gelmec mats. Anti-vibration supports are commonly used in microscopy applications, including scanning electron microscopy, so may already be in use in the museum. The Kaiser copy stand can also be fixed to the wall instead of resting on the benchtop.

4.2.7 Diffusion tents, diffuser panels/ rings

The SAMA project team understands that the choice to use flash units for greater flexibility in lighting means that there is a risk of overexposure, glare or uncontrolled reflection on some surfaces in our macro photography. As discussed in Section 4.2.3, we anticipate experimenting with a range of methods of diffusion to determine the optimum set up for our project. This may vary according to the qualities of the order or family of invertebrates being photographed, and may be low-tech solutions such as rings of tracing paper, or white plastic or polystyrene foam. We may also consider purchasing a light tent, or diffusion filters for the flash units.

4.3 Custom/proprietary systems

The interest in establishing multiple affordable workstations has been behind SAMA's decision to work with the Leica Microsystem and the adapted macro photography station. The project team also explored the option of the Visionary Digital BK Lab System and viewed the Australian National Insect Collection's SmartDrive SatScan.

4.3.1 Visionary Digital

Some museums and other biological collections are upgrading their imaging systems to the impressive BK Lab System by Visionary Digital. This USA-based company produce is led by Roy Larimer, who works closely with the Arizona State University, and is a leader in new imaging technologies.

The Visionary Digital BK Lab is a complete imaging system, including macro and micro photography and a custom built computer system configured for efficient and reliable use of imaging programs. The patented hydraulic lift, FX lighting system and integrated PC graphics system mean that this system is versatile, reliable and well designed. It doesn't need any configuration and is well-supported by the Visionary Digital team, who will install it, and provide responsive follow up advice for users.

The system uses a DSLR camera on a hydraulic lift, with interchangeable regular and macro lenses, and a camera-mountable microscope objective. The system comes with montaging software installed, and is very user friendly.

Visionary Digital also produce a Passport system, which is a portable version of the BK Lab, and can sell many of their components separately.

The 'straight out the box' functionality of the Visionary Digital systems is ideal in an environment where imaging not the primary concern, and users does not want to concern themselves with construction or configuration. It is a versatile, complete and self-contained system that is ready for use on installation. It is an intuitive, well designed system that requires little user expertise. It is being used by the University of Adelaide Ecology and Evolutionary Biology Unit, and the Queensland Museum.

More information about Visionary Digital systems is available at http://www.visionarydigital.com/index.html.

5 Useful links and references

The following links were useful in deciding on the SAMA solution.

5.1 Focus stacking software

Helicon Focus
http://www.heliconsoft.com/heliconfocus.html

Cost approximately US$250 per licensed installation.

Zerene Stacker
http://www.zerenesystems.com/stacker/

Cost approximately US$250 per licensed installation

Combine Z
http://www.hadleyweb.pwp.blueyonder.co.uk/index.htm

Freeware

Automontage: Syncroscopy
http://www.syncroscopy.com/syncroscopy/automontageshort.asp

Cost unavailable without formal quote

5.2 Focus stacking hardware

Stackshot Focus Stacking Macro Rail
http://www.cognisys-inc.com/stackshot/stackshot.php

5.3 Imaging advice

European Network for Biodiversity Information Digital Imaging of Biological Type Specimens
http://www.enbi.info/forums/ig/repository.php

The E-Type Initiative @Harvard Entomology
http://insects.oeb.harvard.edu/etypes/index.htm

A Guide to Digitising Insect Collections, Sarah Ashworth and Jennifer Fogarty (Harvard MCZ Type Project)http://www.docstoc.com/docs/3416539/A-Guide-to-Digitizing-Insect-Collections

Charles Krebs, a marine biologist with considerable experience in micro and macro photography
http://www.krebsmicro.com/

Photomacrography discussion forum
http://www.photomacrography.net

Strobist lighting blog
http://strobist.blogspot.com/