UNDERGRADUATE SUMMER VACATION SCHOLARSHIP AWARDS – FINAL SUMMARY REPORT FORM 2017/18
NB: This whole report will be posted on the Society's website therefore authors should NOT include sensitive material or data that they do not want disclosed at this time.

Name of student:

Adam Ismail

Name of supervisor(s):

Professor Susan Evans and Dr Sergio Bertazzo

Project Title: (no more than 220 characters)

Examining the regeneration of mineralised tissue in *Tarentola* genus geckos.

Project aims: (no more than 700 words)

To examine the structural differences between regenerated and non-regenerated *Tarentola mauritanica* and *Tarentola annularis* tails. Particularly to examine differences in mineralised regions of tails, osteoderms at the surface and vertebrae/cartilage centrally.

To compare shape, size, location and arrangement of key features of the tails before and after regeneration.

To use a range of modern imaging techniques, including micro Computed Tomography, Scanning Electron Microscopy and conventional Light Microscopy to observe structures at micron scale. These imaging techniques help develop understanding of function from observing features of the tissue.

To further understanding of the nature of regeneration though observation of structural differences. Using several imaging methods the project aimed to monitor the changes occurring in mineralised structures through the process of regeneration, by evaluating osteoderms in their macro scale environment and micro scale surroundings.

To contribute to an understanding of osteoderm microstructure by imaging them at high magnifications and observing them in their surroundings, using techniques such as polarised light imaging to determine whether contributing collagen fibres are continuous with their surroundings.

Project Outcomes and Experience Gained by the Student (no more than 700 words)

The project produced a wide spectrum of results. Images included 3D volume renders from the microCT scans, with density associated colours, which provided information about large scale arrangement of mineralisation in the tails.

Images also included scanning electron microscopy stills, which provided information about the microscopic scale structure of these mineralised sections of tissue. This helped develop understanding of the formation of the osteoderm parts visible in the CT scans above.

Finally histological images taken under both a regular light microscope and polarised light helped to contextualise mineralised regions imaged above within the soft tissue surrounding, helping to further understanding of how these mineralised areas interact with the soft tissue boundaries surrounding them.

Experience gained included learning to use a wide range of modern scientific equipment. I was trained to use an electron microscope, which involved learning how to vent the chamber, electron beam energy and focus as well as brightness and contrast settings.

I was also taught about how the micro CT machine works, and how the data is then reconstructed. I learned about the use of low density materials to stabilise the tails as they were being scanned, how the projections were then mapped based on angle and exposure time, and how subsequently this is reconstructed into a 3D density volume render.

In addition I learned to prepare samples for a wide range of imaging techniques. I took samples from each tail to prepare for histology and electron microscopy cutting each samples to expose the appropriate surface. I dehydrated the samples for electron microscopy, experimenting with using different organic liquids to find what worked best. As part of the sample preparation I was required to use a workshop to saw, sand and polish samples.

I learned to use different resin preparation to embed the samples for electron microscopy, as well as the benefits and disadvantages of each resin preparation. I was trained in use of the preparation lab as many of the chemicals used for these resins are hazardous and so safety was a big concern.

Finally I also gained experience in analysing all the data acquired over the course of the project, in constructing figures and quantitative analysis using statistical methods. These skills culminated in my writing a project report, and will lead to a poster (Anatomical Society meeting) based on the data produced and a contribution to a multi-authored publication.

Please state which Society Winter or Summer Meeting the student is intending to present his/her poster at:

London 9th to 11th of August (IFAA 2019)

Proposed Poster Submission Details (within 12 months of the completion of the project) for an AS Winter/ Summer Meeting – (no more than 300 words)

Mineralised Tissue regeneration in the gekkotan lizard *Tarentola*.

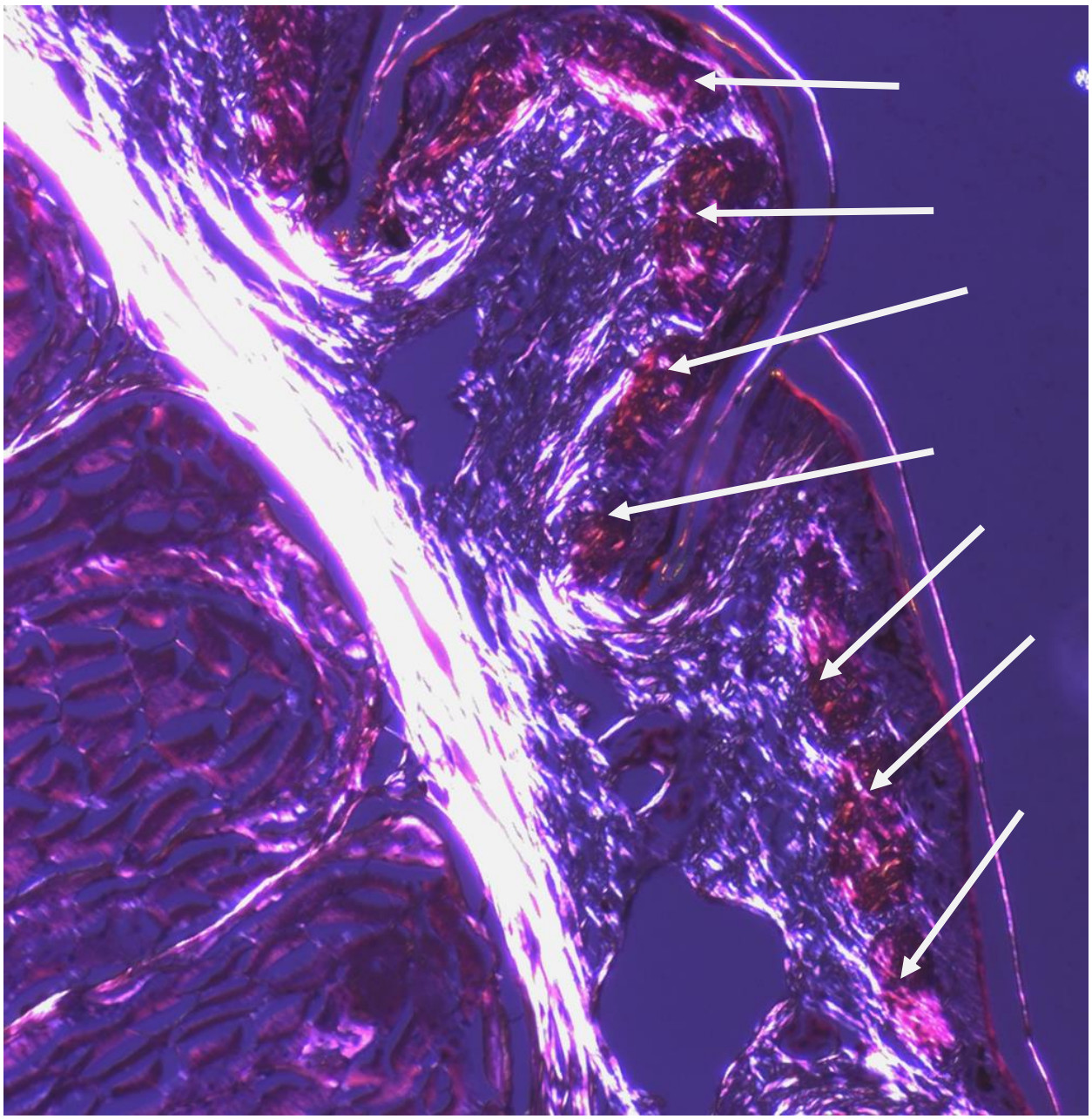
Adam Ismail, Alex Kirby, Eraqi Khannoon, Francesco Iacoviello, Alana Sharp, Mehran Moazen, Sergio Bertazzo, Susan E. Evans.

We examined four tails, *Tarentola mauritanica* non-regenerated and regenerated, and *Tarentola annularis* non-regenerated and regenerated. Through use of a range of imaging modalities (histology, polarised light imagery, computed tomography and electron microscopy), we have uncovered a series of morphological differences in a regenerated tail compared to the original, particularly focusing on mineralised regions of tissues in the dermis (osteoderms), but including axial mineralisation (the vertebrae and regenerated cartilage tube).

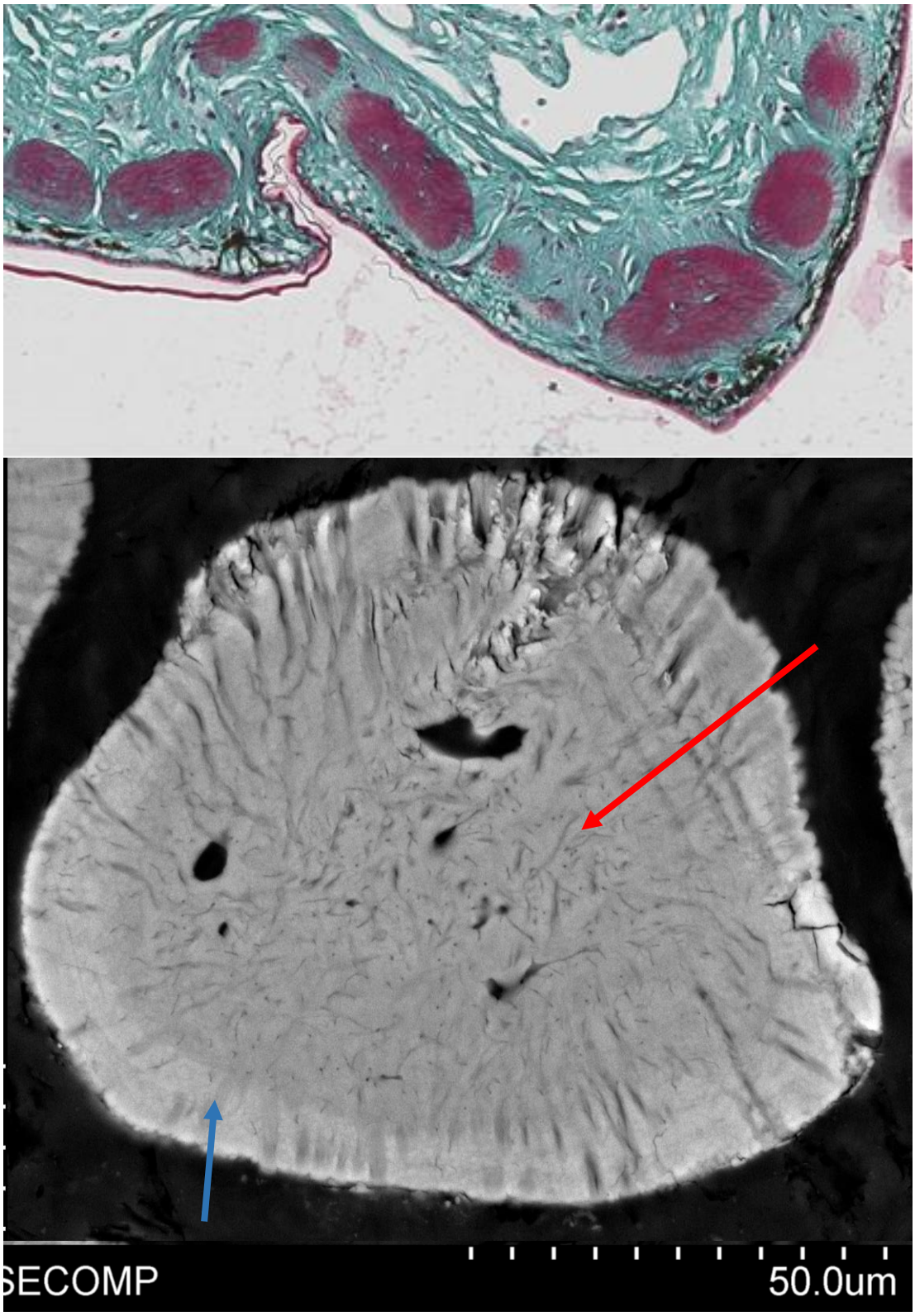
These morphological differences have suggested both different function and different development. Due to the lack of embryological structures such as somites, regenerated osteoderms arrange themselves in differently, with an apparent dermal contribution to their formation. Due to the wide range of imaging modalities these differences have been examined at a range of magnifications, focusing both on the osteoderms and their surroundings.

Brief Resume of your Project's outcomes: **(no more than 200-250 words)**.
The title of your project and a brief 200-250 word description of the proposed/completed project. The description should include sufficient detail to be of general interest to a broad readership including scientists and non-specialists. Please also try to include 1-2 graphical images (minimum 75dpi). NB: Authors should NOT include sensitive material or data that they do not want disclosed at this time.

Examining the regeneration of mineralised tissue in *Tarentola* genus geckos.



A polarised light image of regenerated T. mauritanica osteoderms (highlighted by white arrows) lying within the fibrous superficial dermis.



A histological section stained with Masson's Trichrome (top) showing osteoderms (red) and surrounding fibrous tissue (green) in the superficial dermis (scale bar 100 µm) in a Tarentola mauritanica *non-regenerated tail. Scanning electron microscope image of an individual osteoderm (bottom), lower surface is external, blue arrow showing the dense outer surface and red arrow shows the less well defined centre in a* Tarentola mauritanica *non-regenerated tail.*

The project aimed to develop our understanding of the regeneration process of the tails of *Tarentola* geckos, particularly looking at mineralised regions. The study focused on osteoderms, regions of mineralised tissue found in the dermal layer of the skin. These osteoderms normally provide a degree of armament for the skin, but show significant structural differences when regenerated after caudal autotomy (the process by which a gecko can drop its tail as a defence mechanism).

The regeneration of this new tail occurs without the embryological structures that contributed to the original tail (i.e. somites), resulting in some fundamental changes to the morphology and arrangement of the mineralised tissue components due to the loss of the original underlying segmental signal.

Through a variety of imaging techniques this project recorded the differences in the structure and arrangement of the mineralised tissues, but did so for the first time on both a macro 3D scale and on a micro scale. Although there were only minor differences in the micro-structure of the regenerated osteoderms, their pattern along the tail was clearly affected by the loss of the segmental signal.

Other comments: (no more than 300 words)

Signature of student Adam Ismail *Date:* 14/08/2018

Signature of supervisor Professor Susan Evans *…… Date 16-08-2018……*