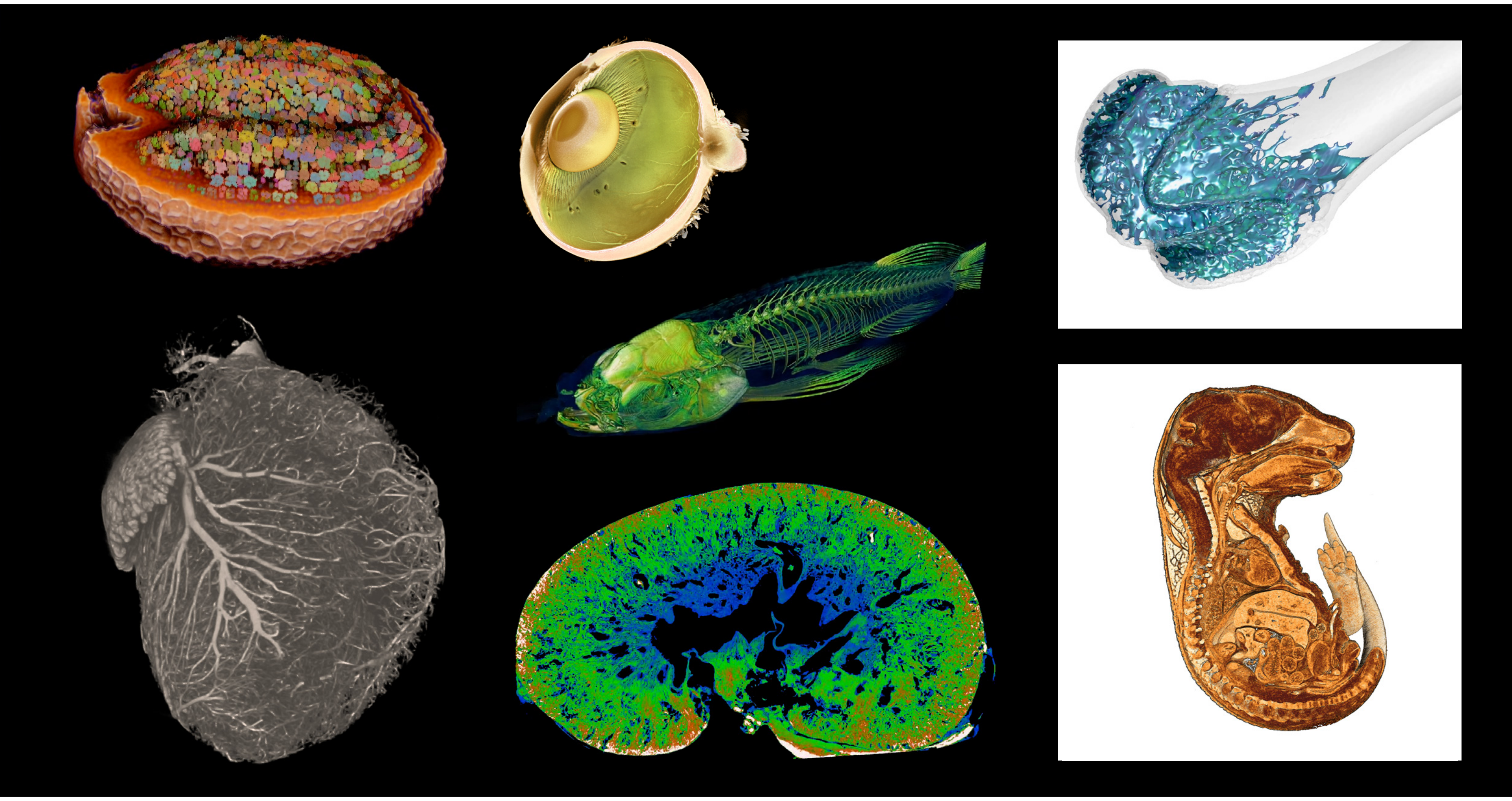
Reference List

ZEISS Xradia Versa X-ray Microscopy

A Reference List for Life Science



Seeing beyond

Author: Dr. Rosy Manser
Carl Zeiss Microscopy GmbH, Jena, Germany

Date: December 2022

X-ray computed tomography (X-ray CT) describes the acquisition and reconstruction of 2D X-ray transmission images to create a 3D representation of the specimen. Along with the increasing availability of suitable staining and mounting protocols, the use of X-ray CT in life science research is rapidly growing. The key benefit of imaging with X-rays is that it can be done without physically sectioning the specimen. For life scientists who study physiological structures, this can be extremely valuable.

While fluorescence microscopy is used to visualize specific, labelled structures and electron microscopy (EM) offers ultraresolution information of smaller regions of interest, X-ray CT offers larger volumes of structural information. Additionally, X-ray CT can streamline electron microscopy and synchrotron workflows by quickly acquiring a 3D overview dataset to check sample quality and guide subsequent, higher resolution acquisitions.

Laboratory X-ray Technology Options

Acquisition of 3D X-ray data in the lab can be done using different approaches. Classical instruments (known as CT or µCT systems) are limited in resolution by the size of the specimen as increasing resolution is only possible by bringing the source and sample closer together; a parameter known as geometric magnification. The X-ray microscope (XRM) overcomes this limitation by using optics, similar to a light microscope, in addition to geometric magnification. This two-stage magnification process provides a significant increase in resolution and image quality, which is of great benefit for the fragile yet complex structures of many biological specimens. The ZEISS Xradia Versa X-ray microscopes provide high performance, submicron resolution and can be used to image a wide range of biological specimens.

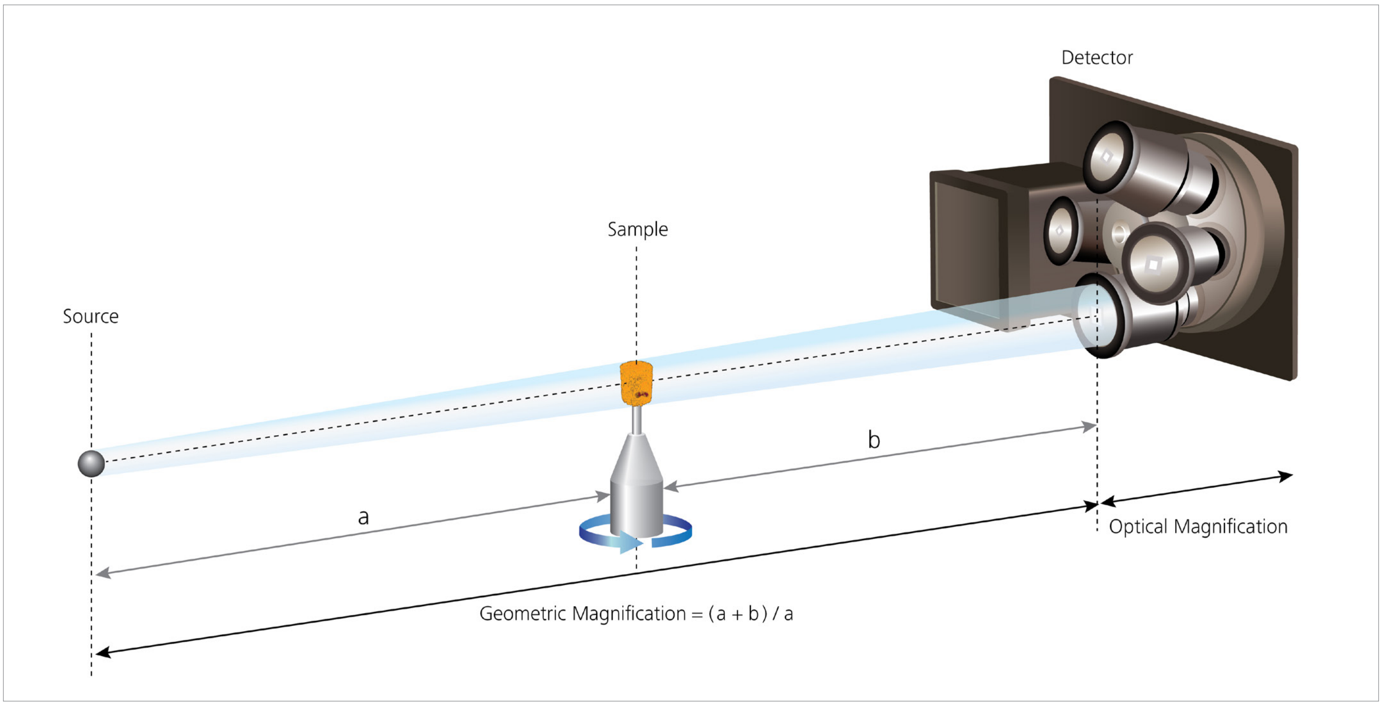


Figure 1 *The Xradia Versa architecture uses a two-stage magnification technique (geometric plus optical) for the unique capability to provide submicron resolution at large working distances. This is known as resolution at a distance (RaaD) and makes Xradia Versa a flexible solution for a large range of sample types and sizes.*

ZEISS Xradia Versa in Life Science Research

The ZEISS Xradia Versa family of X-ray microscopes provides high contrast, high resolution 3D imaging of delicate biological samples including mineralized and soft tissues, individual organs and organoids, embryos and whole animals, insects, fossils, plant tissues and more. The ability to study internal histology and structure, even down to a cellular level, without destroying the sample with dissection, is driving new discoveries and is gaining traction across many different life science research fields.
The following pages provide a sample of peer reviewed publications in biological research that have benefitted from using the ZEISS Xradia Versa XRM for high resolution and contrast 3D imaging. These publications illustrate not only how X-ray microscopy is enabling new scientific insights across diverse research fields but also how ZEISS Xradia Versa is compatible with a wide range of specimen types.

Neuroscience

From understanding our basic biology and body function to developing therapeutics for disease, aging or injuries that impact the brain or nervous system, neuroscience is a thriving field of research. Establishing the relationship between structure and function of neurons and brain tissue and how these relate to behaviour and wellbeing is a formidable challenge that demands a multidisciplinary approach. Multiscale analysis of structure is an important part of this understanding and X-ray microscopy delivers the high-resolution, non-destructive capability to provide vital insights. Some neuroscience discoveries found using high resolution X-ray imaging with ZEISS Xradia Versa are provided below.

C. Bosch *et al.* (2022) **Functional and multiscale 3D structural investigation of brain tissue through correlative in vivo physiology, synchrotron microtomography and volume electron microscopy.** *Nat. Commun.* 13: 2923,
https://doi.org/10.1038/s41467-022-30199-6

K. Song *et al.* (2022) **High-contrast en-bloc staining of mouse whole-brain samples for EM-based connectomics.** bioRxiv 2022.03.30.486341,
https://doi.org/10.1101/2022.03.30.486341

S. Ströh *et al.* (2022) **In situ X-ray assisted electron microscopy staining for large biological samples.** *eLife* 11: e72147,
https://doi.org/10.7554/eLife.72147

Y. Zhang *et al.* (2022) **Sample Preparation and Warping Accuracy for Correlative Multimodal Imaging in the Mouse Olfactory Bulb Using 2-Photon, Synchrotron X-Ray and Volume Electron Microscopy.** *Frontiers in Cell and Developmental Biology* 10: 2296-634,
https://doi.org/10.3389/fcell.2022.880696

Y. Lu *et al.* (2021) **Large-scale 3D imaging of mouse cochlea using serial block-face scanning electron microscopy.** *STAR Protocols*, Volume 2, Issue 2, 100515,
https://doi.org/10.1016/j.xpro.2021.100515

L. A. Scott *et al.* (2021**) Characterisation of microvessel blood velocity and segment length in the brain using multi-diffusion-time diffusion-weighted MRI.** *J Cereb Blood Flow Metab.* 41(8):1939-1953,
https://doi.org/10.1177/0271678X20978523

M. G. Haberl *et al.* (2018) **CDeep3M—Plug-and-Play cloud-based deep learning for image segmentation.** *Nat Methods* 15, 677–680,
https://doi.org/10.1038/s41592-018-0106-z

T. Katchalski *et al.* (2018) **Iron-specific Signal Separation from within Heavy Metal Stained Biological Samples Using X-Ray Microtomography with Polychromatic Source and Energy-Integrating Detectors.** *Sci Rep* 8, 7553,
https://doi.org/10.1038/s41598-018-25099-z

J. P. Choi *et al. (2016)* **Micro-CT Imaging Reveals Mekk3 Heterozygosity Prevents Cerebral Cavernous Malformations in Ccm2-Deficient Mice.** *PLoS ONE* 11(8): e0160833,
https://doi.org/10.1371/journal.pone.0160833

J. Ng *et al.* (2016) **Genetically targeted 3D visualisation of Drosophila neurons under Electron Microscopy and X-Ray Microscopy using miniSOG.** *Sci Rep* 6, 38863,
https://doi.org/10.1038/srep38863

E. Bushong *et al.* (2015) **X-Ray Microscopy as an Approach to Increasing Accuracy and Efficiency of Serial Block-Face Imaging for Correlated Light and Electron Microscopy of Biological Specimens.** *Microscopy and Microanalysis*, 21(1), 231-238,
https://doi.org/10.1017/s1431927614013579

Soft Tissue

From 3D cultures and tumors to entire organs or developing embryos, researchers have been interested in visualization the internal structures of these soft tissues to find new insights in cancer research, vascular research, developmental biology, tissue engineering, histology and more. Some examples of non-destructive, high-resolution imaging of soft tissues using ZEISS Xradia Versa in scientific literature are provided below.

S. Matthews *et al.* (2021) **Polystyrene micro- and nanoplastics affect locomotion and daily activity of Drosophila melanogaster.** *Environ. Sci.: Nano,* 8: 110-121, https://doi.org/10.1039/D0EN00942C

B. A. Metscher (2021) **A simple nuclear contrast staining method for microCT-based 3D histology using lead(II) acetate.** *J. Anat.* 238: 1036– 1041, https://doi.org/10.1111/joa.13351

Y. Sergey *et al.* (2021) **Visualization of different anatomical parts of the enucleated human eye using X-ray micro-CT imaging.** *Experimental Eye Research,* Volume 203: 108394, https://doi.org/10.1016/j.exer.2020.108394

Y. Yu *et al. (2021)* **Close to Real: Large-Volume 3D Cell Spheroids on a Superamphiphobic Surface.** *Adv. Mater. Interfaces 2021, 8, 2100039.* https://doi.org/10.1002/admi.202100039

Q. Chu *et al.* (2020) **CACCT: An Automated Tool of Detecting Complicated Cardiac Malformations in Mouse Models.** *Adv. Sci.* 7, 1903592, https://doi.org/10.1002/advs.201903592

N. Eder *et al.* (2020) **YAP1/TAZ drives ependymoma-like tumour formation in mice.** *Nat Commun* 11, 2380, https://doi.org/10.1038/s41467-020-16167-y

J. Marcé-Nogué *et al.* (2020) **Evaluating fidelity of CT based 3D models for Zebrafish conductive hearing system.** *Micron*, Volume 135, 102874, https://doi.org/10.1016/j.micron.2020.102874

N. Yoshida *et al.* (2020) **The zebrafish as a novel model for the in vivo study of Toxoplasma gondii replication and interaction with macrophages.** *Dis Model Mech* 13 (7), https://doi.org/10.1242/dmm.043091

P. Bidola *et al.* (2019) **A step towards valid detection and quantification of lung cancer volume in experimental mice with contrast agent-based X-ray microtomography.** *Sci Rep* 9, 1325, https://doi.org/10.1038/s41598-018-37394-w

C. Hsu *et al.* (2019) **High resolution imaging of mouse embryos and neonates with X-ray micro-computed tomography.** *Current Protocols in Mouse Biology,* 9: e63, https://doi.org/10.1002/cpmo.63

M. Busse *et al.* (2018) **Bismuth-Oxo-Clusters for Soft-Tissue Staining.** *Microscopy and Microanalysis,* 24(S2), 366-367. https://doi.org/10.1017/S1431927618014125

T. Hatani *et al.* (2018) **Nano-structural analysis of engrafted human induced pluripotent stem cell-derived cardiomyocytes in mouse hearts using a genetic-probe APEX2.** *Biochemical and Biophysical Research Communications*, Volume 505, Issue 4, Pages 1251-1256, https://doi.org/10.1016/j.bbrc.2018.10.020

M. Hoshi *et al.* (2018) **Reciprocal Spatiotemporally Controlled Apoptosis Regulates Wolffian Duct Cloaca Fusion.** *J Am Soc Nephrol.* 29(3):775-783, https://doi.org/10.1681/ASN.2017040380

Bone and Mineralized Tissue

Understanding the structure and mechanical properties of mineralized tissue, like bone and cartilage, as well as associated muscles and tendons is a thriving area of research with exciting developments in foundational understanding as well as therapeutic technologies. X-ray imaging is invaluable in skeletal research for capturing a wide range of bone morphometry measurements both *in vivo* and in dissected specimens. Additional insights into the micro- and nano-structure of bone at higher resolution are pivotal to determine bone quality and mechanical properties and this is where X-ray microscopy is extremely valuable. Some recent examples of the latest possibilities in skeletal biology using high resolution X-ray microscopy with ZEISS Xradia Versa are provided below.

A. Karali *et al.* (2022) **Full-field strain of regenerated bone tissue in a femoral fracture model.** *Journal of Microscopy*, 285: 156-166, https://doi.org/10.1111/jmi.12937

M. S. White *et al.* (2022) **Relationship between altered knee kinematics and subchondral bone remodeling in a clinically translational model of ACL injury.** *Journal of Orthopaedic Research*, Volume 40 (1): 74-86, https://doi.org/10.1002/jor.24943

N. K. Wittig *et al.* (2022) **Opportunities for biomineralization research using multiscale computed X-ray tomography as exemplified by bone imaging.** *Journal of Structural Biology,* Volume 214, Issue 1, 107822, https://doi.org/10.1016/j.jsb.2021.107822

R. Bonithon *et al.* (2021) **Multi-scale mechanical and morphological characterisation of sintered porous magnesium-based scaffolds for bone regeneration in critical-sized defects.** *Acta Biomaterialia* 127; 338-352, https://doi.org/10.1016/j.actbio.2021.03.068

R. S. Chisena *et al.* (2021) **Novel preclinical method for evaluating the efficacy of a percutaneous treatment in human ex vivo calcified plaque.** *Med. Biol. Eng. Comput.* 59: 799–811, https://doi.org/10.1007/s11517-021-02334-w

I. Dumbryte *et al.* (2021) **Three-dimensional non-destructive visualization of teeth enamel microcracks using X-ray micro-computed tomography.** *Sci. Rep.* 11: 14810, https://doi.org/10.1038/s41598-021-94303-4

A. Karali *et al.* (2021) **Micromechanical evaluation of cortical bone using in situ XCT indentation and digital volume correlation.** *Journal of the Mechanical Behavior of Biomedical Materials*, Volume 115; 104298, https://doi.org/10.1016/j.jmbbm.2020.104298

J. Sartori and H. Stark (2021) **Tracking tendon fibers to their insertion – a 3D analysis of the Achilles tendon enthesis in mice.** *Acta Biomaterialia,* Volume 120: 146-155, https://doi.org/10.1016/j.actbio.2020.05.001

D. Buss *et al.* (2020) **Crossfibrillar mineral tessellation in normal and Hyp mouse bone as revealed by 3D FIB-SEM microscopy.** *Journal of Structural Biology,* Volume 212 (2): 107603, https://doi.org/10.1016/j.jsb.2020.107603

R. K. Dirkes et al. (2020) **Global estrogen receptor-α knock-out has differential effects on cortical and cancellous bone in aged male mice.** *FACETS*, 5(1): 328-348, https://doi.org/10.1139/facets-2019-0043

H. Haimov *et al.* (2020) **Mineralization pathways in the active murine epiphyseal growth plate.** *Bone,* Volume 130: 115086, https://doi.org/10.1016/j.bone.2019.115086

F. Lacoviello *et al.* (2020) **The multiscale hierarchical structure of Heloderma suspectum osteoderms and their mechanical properties.** *Acta Biomaterialia*, Volume 107: 194-203, https://doi.org/10.1016/j.actbio.2020.02.029

N. Reznikov *et al.* (2020) **Deep learning for 3D imaging and image analysis in biomineralization research.** *Journal of Structural Biology,* Volume 212 (1): 107598, https://doi.org/10.1016/j.jsb.2020.107598

G. Tozzi *et al.* (2020) **Full-Field Strain Uncertainties and Residuals at the Cartilage-Bone Interface in Unstained Tissues Using Propagation-Based Phase-Contrast XCT and Digital Volume Correlation**. *Materials, 13, 2579*, https://doi.org/10.3390/ma13112579

A. Grüneboom *et al.* (2019) **A network of trans-cortical capillaries as mainstay for blood circulation in long bones.** *Nat. Metab.* 1: 236–250, https://doi.org/10.1038/s42255-018-0016-5

M. Peña Fernández *et al.* (2019) **Full-Field Strain Analysis of Bone–Biomaterial Systems Produced by the Implantation of Osteoregenerative Biomaterials in an Ovine Model.** *ACS Biomater. Sci. Eng.* 5 (5): 2543–2554, https://doi.org/10.1021/acsbiomaterials.8b01044

N. Reznikov *et al.* (2019) **Individual response variations in scaffold-guided bone regeneration are determined by independent strain- and injury-induced mechanisms.** *Biomaterials*, Volume 194, Pages 183-194, https://doi.org/10.1016/j.biomaterials.2018.11.026

I. A. Fiedler et al. (2018) **Severely Impaired Bone Material Quality in Chihuahua Zebrafish Resembles Classical Dominant Human Osteogenesis Imperfecta.** *J. Bone Miner. Res.* 33:1489-1499, https://doi.org/10.1002/jbmr.3445

Plant Science

As the world population grows, the need for sustainable and more nutritious sources of food becomes increasingly important. Some plant researchers have been working to understand how external influences can impact crop and the crop yield. Using X-ray imaging to reach cellular level understandings in the whole plant without having to trim the sample down into smaller pieces is revolutionary since these insights are unreachable through other means. All parts of the plant from structures such as seeds to inflorescence, leaves and shoots to visualizing undisturbed plant roots and their mycorrhizal relationships is all extremely valuable to researchers. The growing use of high resolution X-ray microscopy with ZEISS Xradia Versa in plant science is nicely represented in the below publications:

K. L. Cox Jr *et al.* (2022) **Organizing your space: The potential for integrating spatial transcriptomics and 3D imaging data in plants**. *Plant Physiology*, Volume 188 (2): 703–712,
https://doi.org/10.1093/plphys/kiab508

K. E. Duncan *et al.* (2022) **X-ray microscopy enables multi-scale high-resolution 3D imaging of plant cells, tissues, and organs.** *Plant Physiology*, Volume 188, Issue 2, Pages 831–845,
https://doi.org/10.1093/plphys/kiab405

K. Chen *et al.* (2021) **Microstructure investigation of plant architecture with X-ray microscopy.** *Plant Science*, Volume 311, 110986,
https://doi.org/10.1016/j.plantsci.2021.110986

B. Han *et al.* (2021) **Gaseous environment modulates volatile emission and viability loss during seed artificial ageing.** *Planta,* 253: 106,
https://doi.org/10.1007/s00425-021-03620-5

P. Mehra *et al.* (2021) **Changes in soil-pores and wheat root geometry due to strategic tillage in a no-tillage cropping system.** *Soil Research*, 59: 83-96,
https://doi.org/10.1071/SR20010

T. Guo *et al.* (2020) **A SAC Phosphoinositide Phosphatase Controls Rice Development via Hydrolyzing PI4P and PI(4,5)P2.** *Plant Physiol.* 182(3): 1346-1358,
https://doi.org/10.1104/pp.19.01131

A. Heiduk *et al.* (2020) **Pitfall Flower Development and Organ Identity of Ceropegia sandersonii (Apocynaceae-Asclepiadoideae).** *Plants,* 9: 1767,
https://doi.org/10.3390/plants9121767

K. Chen *et al.* (2019) **NAL8 encodes a prohibitin that contributes to leaf and spikelet development by regulating mitochondria and chloroplasts stability in rice.** *BMC Plant Biol.* 19: 395,
https://doi.org/10.1186/s12870-019-2007-4

A. Dirks-Mulder *et al.* (2019) **Morphological and Molecular Characterization of Orchid Fruit Development.** *Frontiers in Plant Science,* Volume 10: Article 137,
https://doi.org/10.3389/fpls.2019.00137

K. Duncan *et al.* (2019) **Using 3D X-ray Microscopy to Study Crown Root Development and Primary Root Tip Growth in Diverse Maize (Zea mays L.) Lines.** *Microscopy and Microanalysis,* 25(S2): 1032-1033,
https://doi.org/10.1017/S1431927619005890

Natural history

Scientists working in natural history are interested in both discovering new insights from ancient specimens as well as conserving them for future generations. However, in many cases the specimens of interest are extremely precious, often unique, and need to be treated with the utmost care. Non-destructive X-ray imaging is therefore hugely valuable for capturing the internal structure of these precious specimens without damage. The high-resolution 3D insights that can be reached using the Xradia Versa XRM provide levels of detail that continue to support exciting finds in the natural history realm. Some examples that leverage ZEISS Xradia Versa can be found in the publications that follow.

A. Casadei-Ferreira *et al.* (2021) **Head and mandible shapes are highly integrated yet represent two distinct modules within and among worker subcastes of the ant genus Pheidole.** *Ecology and Evolution,* Volume 11 (11): 6104-6118,
https://doi.org/10.1002/ece3.7422

M. J. R. Hall *et al.* (2021) **Micro-CT imaging of Onchocerca infection of Simulium damnosum s.l. blackflies and comparison of the peritrophic membrane thickness of forest and savannah flies.** *Med. Vet. Entomol.* 35: 231-238,
https://doi.org/10.1111/mve.12509

A. Jochuma *et al.* (2021) **Mother snail labors for posterity in bed of mid-Cretaceous amber.** *Gondwana Research,* Volume 97: 68-72,
https://doi.org/10.1016/j.gr.2021.05.006

S. Koch *et al.* (2021) **Nano-CT imaging of larvae in the ant Pheidole hyatti reveals coordinated growth of a rudimentary organ necessary for soldier development.** *J Exp Zool B (Mol Dev Evol),* 336: 540– 553, https://doi.org/10.1002/jez.b.23097

R. Kundrata *et al.* (2021) **A new enigmatic lineage of Dascillidae (Coleoptera: Elateriformia) from Eocene Baltic amber described using X-ray microtomography, with notes on Karumiinae morphology and classification.** *Foss. Rec,* 24: 141–149, https://doi.org/10.5194/fr-24-141-2021

J. Wang *et al.* (2021) **A monotreme-like auditory apparatus in a Middle Jurassic haramiyidan.** *Nature,* 590: 279–283, https://doi.org/10.1038/s41586-020-03137-z

R. Kundrata *et al.* (2020) **X-ray micro-computed tomography reveals a unique morphology in a new click-beetle (Coleoptera, Elateridae) from the Eocene Baltic amber.** *Sci. Rep.* 10: 20158, https://doi.org/10.1038/s41598-020-76908-3

C. Peeters *et al.* (2020) **The loss of flight in ant workers enabled an evolutionary redesign of the thorax for ground labour.** *Front. Zool.* 17: 33, https://doi.org/10.1186/s12983-020-00375-9

H. Wang *et al.* (2020) **Exceptional preservation of reproductive organs and giant sperm in Cretaceous ostracods.** *Proceedings of the Royal Society B: Biological Sciences,* Volume 287 (1935), https://doi.org/10.1098/rspb.2020.1661

M. Doeland *et al.* (2019) **Tooth replacement in early sarcopterygians.** *Royal Society Open Science.* Volume 6: Issue 11, https://doi.org/10.1098/rsos.191173

Z. Johanson *et al.* (2019) **The Synarcual of the Little Skate, Leucoraja erinacea: Novel Development Among the Vertebrates.** *Front. Ecol. Evol,* vol 7: article 12, https://doi.org/10.3389/fevo.2019.00012

D. Martín-Vega *et al.* (2018) **3D virtual histology at the host/parasite interface: visualisation of the master manipulator, Dicrocoelium dendriticum, in the brain of its ant host.** *Sci Rep* 8, 8587, https://doi.org/10.1038/s41598-018-26977-2

M. Raymond *et al.* (2017) **Habitat-specific divergence of air conditioning structures in bird bills**. *The Auk*, Volume 134, Issue 1, Pages 65–75, https://doi.org/10.1642/AUK-16-107.1

Directed Multimodal Workflows

Sample investigation often benefits from using more than one imaging approach since the combined information can provide greater value than the sum of the individual datasets. Such multimodal imaging approaches are increasingly used for many different specimen types and application areas. X-ray imaging can be a critical tool in such multimodal workflows by providing a bridge between functional data from light microscopy and ultrastructural insights from electron microscopy or synchrotron data. The high resolution and contrast imaging provided by the Xradia Versa XRM supports selection of the most optimal specimens and precise localization of the region of interest for high acquisition imaging. Some examples of the use of high resolution 3D X-ray microscopy with ZEISS Xradia Versa as part of a multimodal imaging workflow are provided below.

S. Agarwala *et al.* (2022) **Defining the ultrastructure of the hematopoietic stem cell niche by correlative light and electron microscopy.** *eLife* 11: e64835, https://doi.org/10.7554/eLife.64835

C. Bosch *et al.* (2022) **Functional and multiscale 3D structural investigation of brain tissue through correlative in vivo physiology, synchrotron microtomography and volume electron microscopy.** *Nat. Commun.* 13: 2923, https://doi.org/10.1038/s41467-022-30199-6

Y. Zhang *et al.* (2022) **Sample Preparation and Warping Accuracy for Correlative Multimodal Imaging in the Mouse Olfactory Bulb Using 2-Photon, Synchrotron X-Ray and Volume Electron Microscopy.** *Frontiers in Cell and Developmental Biology* 10: 2296-634 https://doi.org/10.3389/fcell.2022.880696

Y. Lu *et al.* (2021) **Large-scale 3D imaging of mouse cochlea using serial block-face scanning electron microscopy.** *STAR Protocols*, Volume 2, Issue 2, 100515, https://doi.org/10.1016/j.xpro.2021.100515

A. A. Polilov *et al.* (2021) **Protocol for preparation of heterogeneous biological samples for 3D electron microscopy: a case study for insects.** *Sci Rep* 11: 4717, https://doi.org/10.1038/s41598-021-83936-0

A. V. Weigel *et al.* (2021) **ER-to-Golgi protein delivery through an interwoven, tubular network extending from ER.** *Cell* 184 (9): 2412-2429.e16, https://doi.org/10.1016/j.cell.2021.03.035

P. O. Bayguinov *et al.* (2020) **Assaying three-dimensional cellular architecture using X-ray tomographic and correlated imaging approaches.** *J. Biol. Chem.* 295(46): 15782–15793,
https://doi.org/10.1074/jbc.REV120.009633

L. Meran *et al.* (2020) **Engineering transplantable jejunal mucosal grafts using patient-derived organoids from children with intestinal failure.** *Nat. Med.* 26, 1593–1601,
https://doi.org/10.1038/s41591-020-1024-z

C. Xiaotong *et al.* (2020) **Marked and rapid effects of pharmacological HIF-2α antagonism on hypoxic ventilatory control.** *J. Clin. Invest.* 130(5):2237-2251,
https://doi.org/10.1172/JCI133194.

N. Yoshida *et al.* (2020) **The zebrafish as a novel model for the in vivo study of Toxoplasma gondii replication and interaction with macrophages.** *Dis Model Mech* 13 (7),
https://doi.org/10.1242/dmm.043091

J. Ng. *et al.* (2016) **Genetically targeted 3D visualisation of Drosophila neurons under Electron Microscopy and X-Ray Microscopy using miniSOG.** *Sci. Rep.* 6, 38863,
https://doi.org/10.1038/srep38863

E. Bushong *et al.* (2015) **X-Ray Microscopy as an Approach to Increasing Accuracy and Efficiency of Serial Block-Face Imaging for Correlated Light and Electron Microscopy of Biological Specimens.** *Microscopy and Microanalysis*, 21(1), 231-238,
https://doi.org/10.1017/s1431927614013579

Cover images:

Rat Heart:	Courtesy of University of Radboud, Netherlands.
Pig eye:	Data courtesy of Prof. Rachel Williams, Dr. Brendan Geraghty, Dr. Victoria Kearns, Valentin Pied and Dr. Julia Behnsen, University of Liverpool, UK.
Mouse bone:	Sample from the collection of Daniel Wescott, University of Texas at San Marcos. Imagery and analysis performed using Dragonfly Pro Bone Analysis module.
Mouse embryo:	Sample courtesy of Massachusetts General Hospital.
Zebrafish:	Animation from Suniaga, S., Rolvien, T., vom Scheidt, A. *et al.* Increased mechanical loading through controlled swimming exercise induces bone formation and mineralization in adult zebrafish. Sci Rep 8, 3646 (2018).

Carl Zeiss Microscopy GmbH
07745 Jena, Germany
microscopy@zeiss.com
www.zeiss.com/xradia-versa