

## Imaging New Paths for Malarial Parasites

Stephen W. Carmichael and Jon E. Rosenblatt,<sup>1</sup>

Mayo Clinic

[carmichael.stephen@mayo.edu](mailto:carmichael.stephen@mayo.edu)

In general terms, parasites that cause malaria are injected into the skin by mosquitoes. They then travel into the bloodstream and then to the liver where they invade liver cells and mature into forms called schizonts. Within each schizont, cell division produces thousands of tiny new forms called merozoites, each of which, when released into the bloodstream, is capable of infecting a red blood cell. This “traditional” pathway for malarial parasites may not be the only way these parasites travel through the body. Using some increasingly more powerful immuno-imaging tools, Rogerio Amino, Sabine Thiberge, Béatrice Martin, Susanna Celli, Spencer Shorte, Friedrich Frischknecht, and Robert Ménard have demonstrated an additional route that could have profound implications for developing effective vaccines for this major worldwide disease.<sup>2</sup>

*Plasmodium* is the parasite that causes malaria. The infectious form (sporozoite) of *Plasmodium* was engineered with Green Fluorescent Protein (GFP) and mosquitoes injected it into the dermis of rodents (hairless mice, Brown Norway rats, etc.). The path of the parasite could be followed to a certain extent using epifluorescence time-lapse microscopy. The parasites were observed to move in a robust forward-gliding locomotion that was quite distinct from movements *in vitro* or within the salivary ducts of mosquitoes. Whereas some parasites invaded blood vessels and were swept away at speeds expected in blood circulation, others invaded lymphatic vessels. These parasites appeared to be mostly filtered out of the lymph

by the first lymph node that they encountered. They were first seen at the location where the lymph vessel enters the node, and in time they relocated toward the vessel leaving the node. During this period, many of the parasites were degraded. Other experiments suggested that dendritic cells of the lymph node were degrading the parasites. Interestingly, if parasites were introduced into the rodent with a syringe, rather than by a mosquito, the number of parasites in the lymph nodes was decreased about 20-fold!

To rule out the possibility that some parasites were getting through the lymph nodes and entering the general vasculature, Amino *et al.* examined lymph nodes further along the drainage route. Less than 1% of the parasites were found further downstream. They also cannulated the thoracic duct, the lymph vessel that carries most of the lymph back to the bloodstream, and no parasites were detected. This convincingly demonstrated that malaria parasites not only enter the bloodstream, as has been known for years, but about 25% of the parasites enter lymph vessels and most are filtered out at the first lymph node they encounter.

This is the first evidence of the *Plasmodium* parasite being processed by the lymphatic system. What may be the most important part of this study is that some parasites are degraded by the dendritic cells of lymph nodes, and thereby present antigens to immunologically active cells. This will be an important factor to consider when developing vaccines for this global scourge.

1. The authors gratefully acknowledge Dr. Rogerio Amino for reviewing this article.
2. Amino, R., S. Thiberge, B. Martin, S. Celli, S. Shorte, R. Frischknecht, and R. Ménard, Quantitative imaging of *Plasmodium* transmission from mosquito to mammal, *Nature Medicine* 12:220-224, 2006.

## INDEX OF ARTICLES

### Imaging New Paths for Malarial Parasites ..... 3

Stephen W. Carmichael and Jon E. Rosenblatt, Mayo Clinic

### Examination of the Gospel of Judas Using An Integrated Approach to Ink Characterization ..... 6

J.G. Barabe, K.A. Martin, E.F. Schumacher, J.R. Swider, and A.S. Teetsov, McCrone Associates, Inc., Westmont, IL

### Active Optics Improve Microscope’s Field of View ..... 16

B. Potsaid and J.T. Wen, Rensselaer Polytechnic Institute, Troy, NY

### An Introduction to the Helium Ion Microscope ..... 24

J. Morgan, J. Notte, R. Hill, B. Ward, ALIS Corporation, Peabody, MA

### Solutions to the Problem of Substitution of ERL 4221 for Vinyl Cyclohexene Dioxide in Spurr Low Viscosity Embedding Formulations .. 32

E. Ann Ellis, Texas A&M University, College Station, TX

### Atom Probe Tomography Defines Mainstream Microscopy at the Atomic Scale ..... 34

T.F. Kelly<sup>1</sup>, K. Thompson<sup>1</sup>, E.A. Marquis<sup>2</sup>, and D.J. Larson<sup>1</sup>, <sup>1</sup>Imago Scientific Instruments Corp., Madison, WI, <sup>2</sup>Sandia National Laboratory, Livermore, CA

### Keeping Life in Focus New Systems Prevent Z-axis Drift in Time Lapse Studies ..... 42

Edward Lachica, Olympus America Inc., Center Valley, PA

### Infrared Chemical Imaging: Semi-Quantitative Analysis of Components ..... 48

J. Tarr, K. Nishikida, F. Izzia, Thermo Electron Corporation

### Creating Pseudocolor Images using ImageJ ..... 52

Joel B. Sheffield, Temple University, Philadelphia PA

### Nanoparticle Visualization with an AFM ..... 54

Paul West, Natasha Starostina, Pacific Nanotechnology, Tustin, CA

### The Identification of Particles in a Polymer Film Using Nano-Thermal Analysis ..... 58

David Grandy & Kevin Kjoller, Anasys Instruments Corp., Santa Barbara, CA

### Environmental Contamination Sources and Control in High Resolution Scanning Electron Microscopy ..... 62

Ronald Vane and Vince Carlino, XEI Scientific, Redwood City, CA

### Water — A Clean “Glue” to Attach Hydrophilic Plates to an AFM Sample Stage ..... 62

Yang Gan, University of Newcastle, Callaghan, NSW, Australia

### Protect Your Detectors ..... 62

C. Michael Stanley, Chroma Technology, VT

### Dissolving Osmium Tetroxide the Easy Way ..... 63

Debby Sherman, Purdue University, West Lafayette, IN

### Industry News ..... 66

### NetNotes ..... 68

### Index of Advertisers ..... 90

## ABOUT THE COVER

Showing the damage wrought by time and mishandling, the image is a page from the papyrus manuscript known as the Gospel of Judas. This page is one of several found in a leather-bound codex said to date from the third or fourth century C.E., that came to light in the late 1970’s. Wrapped in newspaper and stored in shoe boxes, the pages disintegrated into hundreds of fragments as the codex passed through the hands of antiquities dealers and collectors. A five-year effort by a team of preservationists and scholars has led to the recreation and translation of 90 to 95 percent of the manuscript. The results of this undertaking were recently revealed by the Washington, D.C.-based National Geographic Society, which joined forces with the Maecenas Foundation for Ancient Art in Basel, Switzerland, and the Waitt Institute for Historical Discovery in La Jolla, California, to rescue the document. While biblical scholars have focused on translation and interpretation of the Coptic text, an array of microscopes and other analytical instruments have been focused on the papyrus and the ink, to assess the authenticity of this historically significant manuscript. Photograph courtesy of Joseph G. Barabe.

## COMING EVENTS

### 2006

- ✓ **Microscopy and Microanalysis 2006**  
July 30-August 3, 2006, Chicago, IL  
[mm2006.microscopy.org](http://mm2006.microscopy.org)
- ✓ **Electron Crystallography Workshop**  
August 7-11, 2006, UC Davis, California  
<http://2dx.org/workshop>
- ✓ **ICEM XVI International Microscopy Congress**  
September 3-8, 2006, Sapporo, Japan  
[www.imc16.jp](http://www.imc16.jp)
- ✓ **Society for Neuroscience**  
September 9-14, 2006, Washington, DC  
[info@sfn.org](mailto:info@sfn.org)
- ✓ **12th International Metallography Conference**  
September 27-29, 2006, Leoben, Austria  
[reinilde.stopar@unileoben.ac.at](mailto:reinilde.stopar@unileoben.ac.at)
- ✓ **The Fourth Int'l Congress on Electron Tomography, (4ICET)**  
November 5-8, 2006, San Diego, CA  
<http://www.4icet.org>
- ✓ **GATAN GIF & the FELMI EELS and EFTEM School - Europe**  
November 8-10, 2006, Graz, Austria  
[www.gatan.com/training/index.html](http://www.gatan.com/training/index.html)
- ✓ **Society for Neuroscience**  
November 21-25, 2006, New Orleans, LA  
[info@sfn.org](mailto:info@sfn.org)
- ✓ **American Society for Cell Biology**  
December 9-13, 2006, San Diego, CA  
[www.ascb.org](http://www.ascb.org)

### 2007

- ✓ **PITTCON 2007**  
March 11-16, 2007, New Orleans, LA  
[www.pittcon.org](http://www.pittcon.org)
- ✓ **The American Chemical Society**  
March 25-29, 2007, Chicago, IL  
[natlmtg@acs.org](mailto:natlmtg@acs.org)
- ✓ **American Soc. for Biochemistry and Molecular Engineering**  
April 2007, Washington, DC  
[www.asbmb.org](http://www.asbmb.org)
- ✓ **34th Annual Mtg. of the Microscopical Society of Canada**  
June 18-20, 2007, Alberta, Canada  
[www.phys.ualberta.ca/MSOC-2007/](http://www.phys.ualberta.ca/MSOC-2007/)
- ✓ **Microscopy and Microanalysis 2007**  
August 5-9, 2007, Fort Lauderdale, FL  
[mm2007.microscopy.org](http://mm2007.microscopy.org)
- ✓ **The American Society for Cell Biology**  
December 1-5, 2007, Washington, DC  
[www.ascb.org](http://www.ascb.org)

### 2008

- ✓ **Microscopy and Microanalysis 2008**  
August 3-7, 2008, Albuquerque, NM  
[www.msa.microscopy.com](http://www.msa.microscopy.com)

### 2009

- ✓ **Microscopy and Microanalysis 2008**  
August 3-6, 2009, Baltimore, MD  
[www.msa.microscopy.com](http://www.msa.microscopy.com)

Please check the "Calendar of Meetings and Courses" in the MSA journal "Microscopy and Microanalysis" for more details and a much larger listing of meetings and courses.

## MICROSCOPY TODAY

**The objective of this publication is to provide material of interest and value to working microscopists!**

The publication is owned by the Microscopy Society of America (MSA) and is produced six times each year in odd months, alternating with MSA's peer-reviewed, scientific journal *Microscopy and Microanalysis*. We greatly appreciate article and material contributions from our readers—"users" as well as manufacturers/suppliers. The only criterion is that the subject matter be of interest to a reasonable number of working microscopists. *Microscopy Today* has authors from many disparate fields in both biological and materials sciences, each field with its own standards. Therefore *MT* does not have a rigid set of style instructions and encourages authors to use their own style, asking only that the writing be clear, informative, and accurate. Length: typical article length is 1,500 to 2,000 words plus images, longer articles will be considered. Short notes are encouraged for our Microscopy 101 section.

## MICROSCOPY TODAY

ISSN 1551-9295

**Ron Anderson, Editor**

[randerson20@tampabay.rr.com](mailto:randerson20@tampabay.rr.com)

**Phil Oshel, Technical Editor**

[oshel1pe@cmich.edu](mailto:oshel1pe@cmich.edu)

**Thomas E. Phillips, Contributing Editor**

[PhillipsT@missouri.edu](mailto:PhillipsT@missouri.edu)

**Dale Anderson, Art Director**

[microscopytoday@tampabay.rr.com](mailto:microscopytoday@tampabay.rr.com)

**Renée Stratmoen, Advertising Director**

[oshel1pe@cmich.edu](mailto:oshel1pe@cmich.edu)

**Regular Mail to:**

Microscopy Today, P.O. Box 247, Largo, FL 33779

**Courier Mail to:**

1001 Starkey Road, Lot #374, Largo, FL 33771

**Telephones:**

1-(727)507-7101 • Fax: (727)507-7102 • Cell: (727) 631-1022

**e-Mail:**

[microscopytoday@tampabay.rr.com](mailto:microscopytoday@tampabay.rr.com)

**www Page:**

<http://www.microscopy-today.com>

Colophon: *Microscopy Today* is created using components of Adobe Creative Suite CS2\*

Total Circulation: 14,319

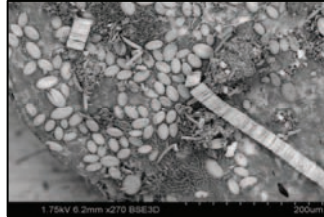
**Disclaimer:** By submitting a manuscript to *Microscopy Today*, the author warrants that the article is original (or that the author has the right to use any material copyrighted by others). The use of trade names, trademarks, etc., does not imply that these names lack protection by relevant laws and regulations. *Microscopy Today*, the Microscopy Society of America, and any other societies stated, cannot be held responsible for opinions, errors, or for any consequences arising from the use of information contained in *Microscopy Today*. The appearance of advertising in *Microscopy Today* does not constitute an endorsement or approval by the Microscopy Society of America of the quality or value of the products advertised or any of the claims, data, conclusions, recommendations, procedures, results or any information found in the advertisements. While the contents of this magazine are believed to be accurate at press time, neither the Microscopy Society of America, the editors, nor the authors can accept legal responsibility for errors or omissions.

© Copyright, 2006, The Microscopy Society of America. All rights reserved.

# The Ultra-Large Chamber Variable Pressure Analytical SEM.



12-inch diameter wall clock



270X, 1.75kV, *diatoms, foraminifera and epiphytes from pond water in BSE.*

## Hitachi S-3700



190X, 1.0kV, 6Pa, *corrosion.*

The Hitachi S-3700 is an ultra-large chamber variable pressure (VP) analytical SEM to handle large samples with high resolution and analytical capability in VP mode.

The ultra-large specimen chamber accommodates 300 mm diameter samples at a large sample traverse of 150mm X 110mm and 65mm Z-motion on the 5-Axis computer eucentric stage.

The S-3700 has versatile chamber design with 11 accessory ports for EDS, WDS, XRF, EBSD, chamber scope, cooling stage, etc.

Enjoy more of your SEM work without having to cut your sample into pieces.



**Hitachi High Technologies America, Inc.**  
5100 Franklin Drive  
Pleasanton, CA 94588  
800.227.8877 / 925.218.3230 (F)  
[www.hitachi-hta.com](http://www.hitachi-hta.com)

**HITACHI**  
Inspire the Next