Microscopy TODAY

Coming Events

2011

Neuroscience 2011
November 12–16, 2011
Washington, DC
www.sfn.org

MRS Fall Meeting 2011
November 28–December 2, 2011
Boston, MA
www.mrs.org

American Society for Cell Biology
December 3–7, 2011
Denver Convention Center, CO
www.ascb.org/meetings

2012

ASU Winter School—HREM
January 4–7, 2012
Tempe, AZ
http://le-csss.asu.edu/winterschool

SPIE—Photonics West
January 21–26, 2012
San Francisco, CA
http://spie.org

High-Throughput Structural Biology
January 22–27, 2012
Keystone Resort, CO
www.keystonesypmposia.org

10th Asia-Pacific Microscopy Conference
February 5–9, 2012
Perth, Australia
www.apmc-10.org

PITTCON
March 11–15, 2012
Orlando, FL
www.pittcon.org

Microscopy & Microanalysis 2012
July 29–August 2, 2012
Phoenix, AZ

2013

Microscopy & Microanalysis 2013
August 4–8, 2013
Indianapolis, IN

2014

Microscopy & Microanalysis 2014
August 3–7, 2014
Hartford, CT

2015

Microscopy & Microanalysis 2015
August 2–6, 2015
Portland, OR

More Meetings and Courses
Check the complete calendar near the back of this magazine and in the MSA journal *Microscopy and Microanalysis*.

Carmichael's Concise Review

Elaborate Helmets are Actually Appendages!

Stephen W. Carmichael
Mayo Clinic, Rochester, MN 55905

carmichael.stephen@mayo.edu

Of the winged insects, adults have one or two pairs of wings. During the past 250 million years of insect evolution, there have been no exceptions to this. In a fascinating study, Benjamin Prud'homme, Caroline Minervino, Mélanie Hocine, Jessica Cande, Aïcha Aouane, Héloïse Dufour, Victoria Kassner, and Nicolas Gompel may have found something resembling an exception [1].

Treehoppers (specifically the family *Membracidae*) are characterized by a "helmet," which has been thought to be part of the animal's camouflage (Figure 1). The helmet expands dorsally over most of the body length and has diversified to extremes within the family resembling natural forms ranging from thorns or seeds to animal droppings or aggressive ants. Without their helmets, treehoppers are very similar to cicadas. The helmet has been considered to be an expansion of the pronotum, an outgrowth of the cuticle of the first thoracic segment.

The anatomy and evolutionary origin of the helmet remain controversial. Using different microscopy methods, specifically scanning electron microscopy and light microscopy (including confocal), Prud'homme et al. showed that the helmet is attached to the first thoracic segment by a complex articulation. A jointed articulation distinguishes an appendage from a simple outgrowth. They found that the attachment points consisted of thin, non-sclerotized (that is, flexible) cuticle flanked by thicker, sclerotized cuticle. This configuration of flexible and hard cuticle defines cuticular joints that connect appendages to the body. In insects with two pairs of wings, this is the type of joint that connects the wings to the second and third thoracic segments. Because the helmet is attached to the first thoracic segment by jointed articulations, it follows that it is a dorsal appendage of that segment. This was completely unexpected in extant insects!

Unlike most appendages, which are obviously paired, the helmet appears to be a single structure in treehoppers, both in adult and nymphal stages. However, Prud'homme et al. found that the helmet originates from two bilateral primordia that later fuse along the dorsal midline. The helmet is therefore a dorsal appendage of the first thoracic segment with a bilateral origin. Additional anatomical observations made with microscopes suggest that the helmet is a fused pair of wing serial homologues.

Figure 1: Three examples of the wide variety of treehopper helmets.

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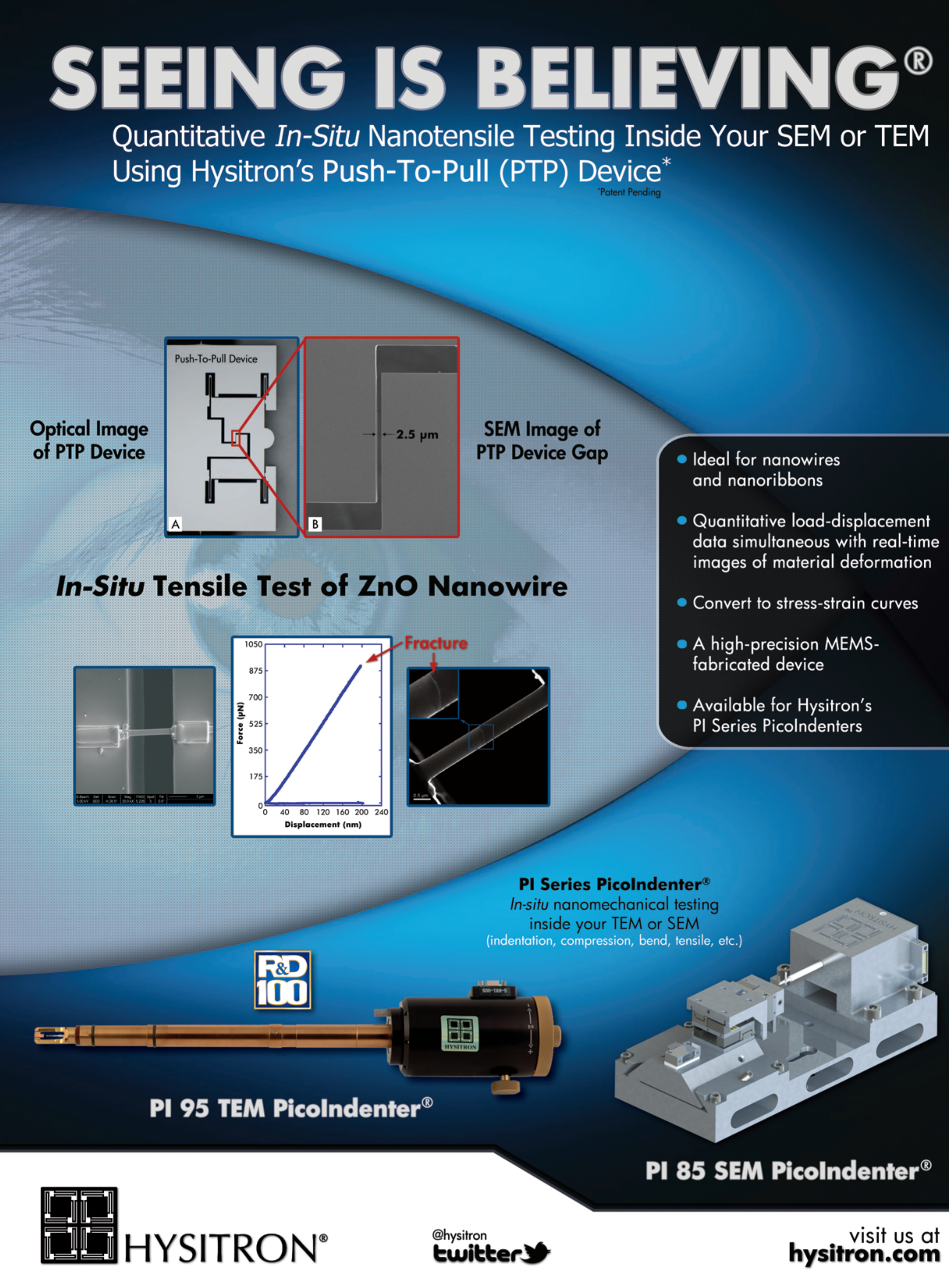

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If the wings and the helmet are serial homologues, then their development must rely on a shared genetic program. A search for shared molecular signatures revealed that a transcription factor (Nubbin) had a spatial deployment during development that corresponded to that seen in wings. There was also evidence suggesting that the helmet escaped the ancestral repression of wing formation imparted by a member of the *Hox* gene family, which sculpts the number and pattern of appendages.

So how did this apparent appendage evolve into such a morphologically diverse helmet? Prud'homme et al. convincingly propose that, in contrast to wings, the helmet escaped the stringent functional requirements imposed by flight. If the helmet is accepted as a pair of appendages equivalent to wings, then this will be the exception to a pattern that has existed for 250 million years!

References

[1] B Prud'homme, C Minervino, M Hocine, JD Cande, A Aouane, HD Dufor, VA Kassner, and N Gompel, *Nature* 473 (2011) 83–86.

[2] The author gratefully acknowledges Dr. Benjamin Prud'homme for reviewing this article.

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