



## Biomechanics Summary

### WHY USE SONOMICROMETRY TO STUDY MUSCLE FUNCTION?

There is a growing body of scientific literature citing the use of sonomicrometry as a method to study musculoskeletal function. The technique is being recognized as a valuable means of obtaining information about muscle function *in vivo*. As Richard Marsh of Northeastern University in Boston recently wrote, sonomicrometry allows his lab to “look inside the black box”<sup>(1)</sup> and answer questions about the details of the strain cycle in individual muscles during movement. Although sonomicrometry dates back to the late 1960’s, the technique was used almost exclusively to study cardiac function in large animals by measuring ventricular and myocardial diameters. By improving key elements of transducer and electronic design, Sonometrics Corporation has opened the door to a broader group of applications including those in the Biological Sciences.

The principles of operation are actually quite simple. Sonomicrometry utilizes piezoelectric transducers (commonly called “crystals”) to measure distances within an aqueous medium. These crystals are sequentially energized at high repetition rates, generating waves of ultrasound that travel at known velocities in biological tissue. Distances between the networked crystals are calculated by the time taken for a wave to travel between an acting transmitter and its corresponding receivers. Crystals manufactured by Sonometrics are unique in that they act as both transmitters and receivers and can send and receive signals in all directions. This eliminates the need to align crystals to ensure satisfactory signals (typical of older analog sonomicrometers) and allows for the acquisition of more data with fewer transducers (no more transmitter-receiver pairs).

Other devices used to study biomechanics include the strain gauge and high-speed video cameras. The strain gauge has historically been used to measure muscle strain and force in isolated tissue models. These preparations, however, only evaluate muscle function under arbitrarily chosen isometric conditions, which may not necessarily reflect the native physiologic condition. High-speed video recording can measure angles and motion qualitatively, but is expensive and requires time consuming post-processing to convert video data into quantified muscle movement. Sonomicrometry quantifies contractility and length changes of muscle in real-time and *in vivo* allowing the researcher to design a more physiologically relevant experiment.

Sonomicrometry has a wide range of research applications in the field of biomechanics and comparative biology and can be used to study function in a variety of organisms including mammals, amphibians, reptiles, fish, and birds. Applications range from muscle function in galloping horses, jumping frogs, and flying pigeons to feeding mechanics of fish. Please see a list of current Sonometrics customers as well as a few representative publications in the References section on the back.

The Sonometrics digital sonomicrometry system provides an affordable and exciting technique to measure real-time dimensional data that is accurate and reliable. Systems can be configured to acquire, view and analyze all research data simultaneously such as EMG and force recordings, and as such, can be used as a central piece of equipment in the research lab. Please contact us today to find out how Sonometrics can help you enhance the quality of your research.

1. Marsh, Richard L. (2000) Feature Application. Sonometrics Corporation Newsletter: Information Waves,2:1:1.

## **REFERENCES**

### **Sonometrics Customers**

*Miriam A. Ashley-Ross.* Department of Biology, Wake Forest University, Winston-Salem, NC.  
*Andrew Biewener.* Department of Organismic and Evolutionary Biology, Harvard University, Bedford, MA.  
*Bruce Jayne.* Department of Biological Sciences, University of Cincinnati, Cincinnati, OH.  
*Louis Gainey.* Department of Biology, University of Southern Maine, Portland, ME.

Website: <http://www.usm.maine.edu/~gainey/currentresearch.html>

*Franz Goller.* Department of Biology, University of Utah, Salt Lake City, UT.  
*John Gosline.* Department of Zoology, University of British Columbia, Vancouver, BC.  
*Walter Herzog.* Faculty of Kinesiology, University of Calgary, Calgary, AB.  
*Donald F. Hoyt.* Department of Biological Sciences, California State Polytechnic University, Pomona, CA.  
Website: <http://www.is.csupomona.edu/~dfhoyt/Methods.htm>

*Stan L. Lindstedt.* Department of Biological Sciences, Northern Arizona University, Flagstaff, AZ.  
*Richard L. Marsh.* Department of Biology, Northeastern University, Boston, MA.  
Website: <http://www.dac.neu.edu/biology/marsh.html>

*Thomas Roberts.* Department of Zoology, Oregon State University, Corvallis, OR.  
*Adam P. Summers.* Department of Integrative Biology, University of California at Berkeley, Berkeley, CA.  
*Douglas A. Syme.* Department of Biological Sciences, University of Calgary, Calgary, AB.  
*Johan L. van Leeuwen.* Department of Applied Physiology, Leiden University, Leiden, Netherlands  
*Peter Wainwright.* Section of Evolution and Ecology, University of California at Davis, Davis, CA

### **Sample Sonomicrometry Literature**

Biewener, A.A., Corning, W.R., and Tobalske, B.W. (1998). In vivo pectoralis muscle force-length behavior during level flight in pigeons (*Columba livia*) [In Process Citation]. *J.Exp.Biol.*, 201:3293-3307.

Coughlin D.J., Valdes L., Rome L.C.(1996) Muscle length changes during swimming in scup: sonomicrometry verifies the anatomical high-speed cine technique. *J Exp Biol.*,199:459-63

Franklin, C.E. and Johnston, IA. (1997). Muscle power output during escape responses in an Antarctic fish. *J.Exp.Biol.*, 200:703-712.

Gregersen, C.S., Silverton, N.A., and Carrier, D.R. (1998). External work and potential for elastic storage at the limb joints of running dogs. *J.Exp.Biol.*, 201:3197-3210.

Hammond, L., Altringham, J.D., and Wardle, C.S. (1998). Myotomal slow muscle function of rainbow trout *Oncorhynchus mykiss* during steady swimming. *J.Exp.Biol.*, 201:1659-1671.

Katz, S.L., Shadwick, R.E., and Rapoport, H.S. (1999). Muscle strain histories in swimming milkfish in steady and sprinting gaits [In Process Citation]. *J.Exp.Biol.*, 202:529-541.

Roberts, T.J., Marsh, R.L., Weyand, P.G., Taylor, C.R.(1997). Muscular force in running turkeys: The economy of minimizing work. *Science*, 275:1113-1115.

Scott, S.H., Brown, I.E., and Loeb, G.E. (1996). Mechanics of feline soleus: I. Effect of fascicle length and velocity on force output. *J Muscle Res Cell Motil.*, 17:207-219.

Weytjens, J.L.F., Viberg, D.A., Caputi, A.A., Kallesoe, K. and Hoffer, J.A.(1992). New transducers for measuring muscle length in unrestrained animals. *J. Neurosci. Methods*, 45:217-22.