CURRICULUM VITAE

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PERSONAL DATA:
Citizenship: U.S.A.
Spouse: Dr. Amy E. Anderson

EDUCATION

B.A. 1962	Carleton College - Biology
Ph.D. 1967	Stanford University - Biology

PROFESSIONAL EXPERIENCE

2008-current	Associate Director—Hopkins Marine Station
2005-current	Senior Fellow—Woods Institute for the Environment, Stanford University
2000-2008	Director—Hopkins Marine Station, Stanford University
1995-current	David and Lucile Packard Professor of Marine Science, Stanford University
1991-1995	Wayne and Gladys Valley Professor of Marine Biology, Oregon State University
1980-1991	Professor, Scripps Institution of Oceanography, University of California, San Diego
1984-1989	John Dove Isaacs Chair in Natural Philosophy, Scripps Institution of Oceanography
1983-1989	Chair, Marine Biology Research Division, Scripps Institution of Oceanography
1976-1980	Associate Professor, Scripps Institution of Oceanography
1970-1976	Assistant Professor, Scripps Institution of Oceanography
1967-1970	Postdoctoral Fellow, University of British Columbia
1963-1966	Member-U.S. Antarctic Research Program

AWARDS
National Science Foundation Predoctoral Fellowship
National Science Foundation Postdoctoral Fellowship
Isaac Walton Killam Postdoctoral Fellowship
John Simon Guggenheim Memorial Fellowship
Member of U.S. National Academy of Sciences
Fellow of the American Association for the Advancement of Science
Honorary Doctor of Science Degree-Carleton College
Helsinki Medal-University of Helsinki
Member of California Academy of Sciences

EDITORIAL BOARDS
American Journal of Physiology, Journal of Comparative Physiology, Journal of Experimental Biology, Comparative Biochemistry and Physiology

GOVERNMENT PANELS
National Science Foundation—Panel on Ecological and Evolutionary Physiology (1992-1995)
National Research Council—Ocean Studies Board (1997-1999)
National Research Council—Committee on Evaluation, Design, and Monitoring of Marine Reserves and Protected Areas (1998-2000)
National Research Council—Frontiers in Polar Biology (2002)
National Research Council—International Polar Year committee (2003)
National Research Council—Committee on Ocean Acidification (chair: 2012)

OTHER SERVICE
Board of Directors—Monterey Bay Aquarium Research Institute (MBARI)(2001-present)
Board of Trustees—The Big Sur Land Trust (2005-2012); Chair of Board in 2008-2012
Board of Directors—Monterey Institute for Technology and Education (2009-present).

Ph.D. STUDENTS SUPERVISED: Dr. Bonnie J. Davis, Dr. Philip S. Low, Dr. Paul H. Yancey, Dr. Joseph Siebenaller, Dr. R. David Bowlus, Dr. Michael Castellini, Dr. John E. Graves, Dr. Sarah L. French, Dr. Gary Lopez, Dr. Patrick J. Walsh, Dr. Kathleen Sullivan, Dr. Kathryn Dickson, Dr. Robert R. Swezey, Dr. Victor Donahue, Dr. Mark A. Powell, Dr. Susan J. Roberts, Dr. Mary Sue Lowery, Dr. John O'Brien, Dr. Allen Gibbs, Dr. Elizabeth Dahlhoff, Dr. Tzung-Horng Yang, Dr. Jen-Jen Lin, Dr. Jonathon Stillman, Dr. Lars Tomanek, Dr. Rachael Ream, Dr. Caren Braby, Dr. Cheryl A. Logan, Dr. Brent Lockwood, Dr. Nishad Jayasundara, and Dr. Aaron Carlisle [total Ph.D. students supervised: 30]

POSTDOCTORAL ASSOCIATES-LAST 5 YEARS. Dr. Tyler Evans, Dr. Yunwei Dong, Dr. W. Wesley Dowd, Dr. Jody Beers [total postdoctoral associates supervised: 33]

GRADUATE ADVISOR: Dr. Arthur C. Giese (deceased)

POSTDOCTORAL ADVISOR: Dr. Peter W. Hochachka (deceased)

RESEARCH INTERESTS: The unifying theme in our research is adaptation of organisms to the environment. We seek to determine how different environmental factors, notably temperature and the threat of desiccation, affect organisms, and how organisms respond adaptively to these perturbations. Proteins are a primary study system in most of our work. We are documenting how adaptive change in protein sequence (primary structure) achieves the conservation of critical functional and structural characteristics of enzymatic and structural proteins. These studies exploit homologous (orthologous) proteins from differently adapted species, frequently congeneric species adapted to only slightly different temperatures. We are using these comparative studies not only to examine adaptation to environment, but also to deduce basic structure-function relationships in proteins. For example, we are delineating the sites in the primary and higher orders of protein structure where adaptive change is permissible. Mapping of adaptively important changes in orthologs of closely related congeners supports the hypothesis that much of the protein molecule contributes to the energy changes that accompany catalysis.

Our studies of proteins are performed in solution conditions that mimic the intracellular conditions encountered by the proteins. The use of *in vitro* media that simulate *in vivo* conditions has enabled us to demonstrate that the "micromolecules" of the cell, that is, the small solutes that bathe macromolecules, contribute importantly to the establishment of the functional and structural properties of proteins. Macromolecular and micromolecular evolution play complementary roles in adaptation to environment.

Our field studies focus on "real world" effects of temperature on protein systems. A primary focus of these studies is to determine how changes in environmental temperature affect

the latitudinal and depth distribution patterns of marine organisms. We are analyzing how thermal stress affects protein turnover by monitoring the synthesis of heat shock proteins (indices of reversible damage by heat) and ubiquitinated (irreversibly damaged) proteins. These studies demonstrate that many organisms live close to the upper thermal limits of protein structure and function, and suggest that global warming may have pronounced effects on ectothermic ("cold-blooded") animals.

Studies of thermal effects at the molecular level are complemented by physiological investigations, for example, of heart function. The results of the physiological studies also indicate that only slight increases in maximal habitat temperature are likely to have profound negative effects on many marine animals. Paradoxically, the most warm-adapted species appear in many cases to be the most threatened by further increases in temperature, such as those that may result from continued global climate change. Our physiological studies also focus on an invasive species of mussel which has replaced a native mussel along much of the California coast. We have identified differences in cardiac function and enzymatic activity that may account for the competitive advantage of the invader and allow predictions to be made of how effectively it will colonize habitats to the north of its present distribution range.

We are using DNA microarray ("gene chip") technology to monitor shifts in gene expression in response to environmental change (alterations in oxygen availability, salinity, and temperature). Among our goals in using these new approaches is the elucidation of the molecular bases of the different capacities of species to respond adaptively to environmental changes. To this end we are comparing gene expression patterns in stenotolerant Antarctic fishes with those of eurytolerant temperate and tropical species that have exceptionally wide tolerance ranges for temperature, oxygen content, and salinity. These studies are beginning to reveal the genetic basis of the wide differences found among species in capacities to respond to environmental change. Our gene expression (transcriptomic) studies also focus on rhythmic patterns of gene expression in intertidal animals, which undergo periods of immersion and emersion on a frequent basis. We discovered that hundreds of genes show rhythmic expression patterns in intertidal mussels (genus *Mytilus*). Interestingly, certain classes of genes, for instance those involved in regulating the cell cycle, exhibit peaks of expression at times when many other genes, e.g., those involved in energy metabolism, show minimal expression. We are extending our field studies to examine how fine-scale variation in physical conditions (sun exposure, time of emersion) is reflected in physiological properties of sessile marine invertebrates like mussels. We have discovered that wide variation in physiological condition is found among specimens separated by distances on the scales of meters—this variation equals that found over wide latitudinal ranges and illustrates how micro-habitat properties influence the capacities of organisms for metabolism and growth. This work, too, has implications for climate change, e.g., by helping to define which zones within a habitat will continue to be permissive to survival.

Representative Publications

Somero, G.N. (2012). The physiology of global change: Linking patterns to mechanisms. *Annu. Rev. Mar. Sci.* 4: 39-61.

Somero, G.N. (2011). Comparative physiology: A "Crystal Ball" for predicting consequences of global change. *Am. J. Physiol. Reg. Integr. Comp. Physiol.* 301: R1-R14.

Logan, CA and Somero, GN (2011). Effects of thermal acclimation on transcriptional responses to acute heat stress in the eurythermal fish *Gillichthys mirabilis* (Cooper). *Am. J. Physiol. Reg. Integr. Comp. Physiol.* 299: R843-R852.

Logan CA, Somero GN (2010) Transcriptional responses to thermal acclimation in the eurythermal fish *Gillichthys mirabilis* (Cooper 1864). *Am. J. Physiol. Regul. Integr. Comp. Physiol.* 299: R843-852.

Lockwood BL, Sanders JG, Somero GN (2010) Transcriptomic responses to heat-stress in invasive and native blue mussels (genus *Mytilus*): molecular correlates of invasive success. *J. Exp. Biol.* 213: 3548-3558.

Somero, G.N. (2010). The physiology of climate change: how potentials for acclimatization and genetic adaptation will determine "winners" and "losers." *J. Exp. Biol*. 213: 912-920.

Buckley, B.A. and G.N. Somero (2009). cDNA microarray analysis reveals the capacity of the cold-adapted Antarctic fish *Trematomus bernacchii* to alter gene expression in response to heat stress. *Polar Biol.* 32:403-415.

Dong, Y. and G.N. Somero (2008). Temperature adaptation of cytosolic malate dehydrogenases of limpets (genus *Lottia*): differences in stability and function due to minor changes in sequence correlate with biogeographic and vertical distributions. *J. Exp. Biol.* 212: 169-177.

Evans, T. and G.N. Somero (2008). A microarray-based transcriptomic time-course of hyper- and hypoosmotic signaling events in the euryhaline fish *Gillichthys mirabilis*: osmosensors to effectors. *J. Exp. Biol.* 211: 3636-3649.

Dong, Y., L.P. Miller, J. G. Sanders, and G.N. Somero (2008). Heat-shock protein 70 (Hsp 70) expression in four limpets of the genus *Lottia*: Interspecific variation in constitutive and inducible synthesis correlates with *in situ* exposure to heat stress. *Biol. Bull.*215: 173-181.

Gracey, A.Y., M. Chaney, J. Boomhower, W. Tyburczy, K. Connor and G.N. Somero (2008). Rhythms of gene expression in a fluctuating intertidal environment. *Curr. Biol.*, 18: 1501-1507.

Somero, G.N. (2008). Clifford Ladd Prosser, A Biographical Memoir. National Academy of Sciences, Washington, D.C.

Pörtner, H.O., G.N. Somero, and L. Peck (2007). Thermal limits and adaptation: an integrative view. *Proc. Roy. Soc. Lond. B.*, doi:10.1098/rstb.2006.1947.

Buckley, B.A., A.Y. Gracey, and G.N. Somero (2006). The cellular response to heat stress in the goby *Gillichthys mirabilis*: a cDNA microarray and protein-level analysis. *J. Exp. Biol.* 209: 2660-2677.

Braby, C.E., and G.N. Somero (2006). Ecological gradients and relative abundance of native (*Mytilus trossulus*) and invasive (*M. galloprovincialis*) blue mussels in the California hybrid zone. *Mar. Biol.* 148: 1249-1262.

Fields, P.A., E. Rudomen and G.N. Somero (2006). Temperature sensitivities of cytosolic malate dehydrogenases from native and invasive species of marine mussels (genus *Mytilus*): sequence-function linkages and correlations with biogeographic distribution. *J. Exp. Biol.*, 209: 656-677.

Somero, G.N. (2005). Linking biogeography to physiology: Evolutionary and acclimatory adjustments of thermal limits. *Front. Zool.* 2: 1-9.

Stenseng, E., C. Braby, and G.N. Somero (2005). Evolutionary and acclimation-induced variation in the thermal limits of heart function in congeneric marine snails (genus *Tegula*): Implications for vertical zonation. *Biol. Bull*. 208: 138-144.

Johns, G.C., and G.N. Somero (2004). Evolutionary convergence in adaptations of proteins to temperature: A_4-lactate dehydrogenases of Pacific damselfishes. *Mol. Biol. Evol.* 21: 314-320.

Podrabsky, J., and G.N. Somero (2004). Changes in gene expression associated with acclimation to constant temperatures and fluctuating daily temperatures in an annual killifish *Austrofundulus limnaeus*. *J. Exp. Biol.* 207: 2237-2254.

Ream, R.R., J. Theriot, and G.N. Somero (2003). Influences of thermal acclimation and acute temperature change on the motility of epithelial wound healing cells (keratocytes) of tropical, temperate, and Antarctic fish. *J. Exp. Biol.* 206, 4539-4551.

Sanford, E., M.S. Roth, G.C. Johns, J.P. Wares, and G.N. Somero (2003). Local selection and latitudinal variation in a marine predator-prey interaction. *Science* 300: 1135-1137.

Hochachka, P.W., and G.N. Somero (2002). *Biochemical Adaptation: Mechanism and Process in Physiological Evolution*. Oxford University Press. 466 pp.

Gracey, A., J. Troll and G.N. Somero (2001). Hypoxia-induced gene expression profiling in the euryoxic fish *Gillichthys mirabilis*. *Proc. Natl. Acad. Sci. USA*., 98: 1993-1998.

Stillman, J., and G.N. Somero (2001). A comparative analysis of the evolutionary patterning and mechanistic bases of LDH thermal stability in porcelain crabs, genus *Petrolishthtes*. *J. Exp. Biol.* 204: 767-776.

Tomanek, L., and G.N. Somero (2000). Time course of synthesis of heat-shock proteins in congeneric marine snails (genus *Tegula*) from different thermal habitats: relationships to severity of thermal stress and tidal period. *Physiol. Biochem. Zool.* 73: 249-256.

Hofmann, G.E., B.A. Buckley, S. Airaksinen, J.E. Keen, and G.N. Somero (2000). Heat- shock protein expression is absent in the Antarctic fish *Trematomus bernacchii* (Family Nototheniidae). *J. Exp. Biol.* 203: 2331-2339.

Stillman, J. and G.N. Somero. 2000. A comparative analysis of thermal tolerance limits in porcelain crabs, genus *Petrolisthes*. *Physiol. Biochem. Zool*. 73: 200-208.

Somero, G.N. (2000). Unity in diversity: A perspective on the methods, contributions, and future of comparative physiology. *Ann. Rev. Physiol.* 62: 927-937.

Tomanek, L., and G.N. Somero (1999). Evolutionary and acclimation-induced variation in the heat-shock responses of congeneric marine snails (genus *Tegula*) from different thermal habitats. *J. Exp. Biol*. 202: 2925-2936.

Fields, P.A., and G.N. Somero (1998). Hot spots in cold adaptation: Localized increases in conformational flexibility in lactate dehydrogenase A_4 orthologs of Antarctic notothenioid fishes. *Proc. Natl. Acad. Sci. USA* 95: 11476-11481.

Holland, L.Z., M. McFall-Ngai, and G.N. Somero (1997). Evolution of lactate dehydrogenase-A homologs of barracuda fishes (Genus *Sphyraena*) from different thermal environments: Differences in kinetic properties and thermal stability are due to amino acid substitutions outside the active site. *Biochemistry* 36: 3207-3215.

Fields, P.A., and G.N. Somero (1997). Amino acid sequence differences cannot fully explain interspecific differences in thermal sensitivities of Gobiid fish A_4-lactate dehydrogenases (A_4-LDHs). *J. Exp. Biol.* 200: 1839-1850.

Roberts, D.A., G.E. Hofmann, and G.N. Somero (1997). Heat shock protein expression in *Mytilus californianus*: Acclimatization (seasonal and tidal-height comparisons) and acclimation effects. *Biol. Bull. (Woods Hole)* 192: 309-320.

Somero, G.N. (1997). Temperature relationships, In: *Handbook of Physiology: Environmental Physiology*, pp. 1391-1444, ed. W. Dantzler, Oxford University Press.

Somero, G.N., and P.H. Yancey (1997). Organic osmolytes, In: *Handbook of Physiology: Cell Physiology*, pp. 441-484, eds. J. Hoffman and J. Jamiesen, Oxford University Press.

Stillman, J., and G.N. Somero (1996). Adaptation to temperature stress and aerial exposure in congeneric species of intertidal porcelain crabs (Genus *Petrolisthes*): Correlation of physiology, biochemistry and morphology with vertical distribution. *J. Exp. Biol.* 199: 1587-1596.

Somero, G.N. (1995). Proteins and temperature. *Annu. Rev. Physiol.* 57: 43-68.

Kültz, D. and G.N. Somero (1995). Ion transport in gills of the euryhaline fish *Gillichthys mirabilis* is facilitated by a phosphocreatine circuit. *Am. J. Physiol.(Reg. Int. Comp. Physiol. 37)* 268: R1003-R1012.

Hofmann, G.E., and G.N. Somero (1995). Evidence for protein damage at environmental temperatures: seasonal changes in levels of ubiquitin conjugates and HSP70 in the intertidal mussel *Mytilus trossulus*. *J. Exp. Biol.* 198: 1509-1518.