Dairy Stockmanship – Reconnecting the People with the Cows

Paul Rapnicki[1], DVM, MBA, Margaret Perala[1], DVM. Don Höglund[1], MS, DVM, Gordon A. Jones[2], DVM

[1]University of Minnesota College of Veterinary Medicine
[2]Central Sands Dairy, LLC, N15927 Cty G, Nekoosa, WI 54457
Email: gordon.a.jones@att.net

■ Introduction

At the University of Minnesota, College of Veterinary Medicine, we have taken a strong interest in dairy stockmanship and the interactions that occur between people and cows. Mr. Bud Williams (Independence, KS) has been a leader in establishing many of the basic principles and practices of good cattle stockmanship and has been teaching these concepts to beef cattle audiences around the world for over thirty years. The authors have attended multiple Bud William's stockmanship schools over the last three years. Our initial goal was to improve our personal stockmanship skills with dairy cattle. Since we began working with Mr. Williams in 2008, we have become firmly committed to successfully implementing dairy stockmanship on commercial dairy operations. The daily management of a dairy operation requires personnel to interact with the cattle many times a day. Dairy stockmanship is the implementation of low-stress cow handling techniques to improve the outcomes for both the people and the cattle.

■ Dairy Stockmanship

In stockmanship terms, stimulation of any kind on livestock is referred to as a form of pressure. In discussions on stockmanship or cattle handling people frequently refer to flight or safe zones of an animal as an arbitrary measure of how much pressure or encroachment an animal will endure prior to fleeing or fighting. Conceptually, the flight zone can be thought of as being an animal's personal space and when that space is violated the animal may determine that it is no longer safe and react. In practical terms, as a human approaches livestock the animal begins to feel pressure from human encroachment. The exact flight distance and the extent of the response to human presence may vary animal to animal or within the same animal depending on the various factors influencing the animal, such as, prior animal experiences, previous

human interaction, the distance between the human and animal, natural or artificial boundaries, husbandry practices, age of the animal, other competing environment stimuli, health and well-being of the animal(s) in general, and even the time of day. By closely observing the response of the animal approached, livestock handlers can be able to observe and learn from the effects of the pressure on animal behavior. Alternatively, by moving away from animals some or all of the pressure may be relieved and understanding this animal behavior will also be useful to livestock handlers. The key point is that handlers can induce animals to move, turn, or stop by exerting and manipulating pressure.

Every interaction between people and cows shapes the future behavior of both. These interactions can be positive or negative but are very rarely neutral. The concept of stockmanship, or low-stress handling of livestock helps people become aware of human behavior and the impact it has on livestock. With proper handling cattle are easier to work and move and that creates a desirable environment for both cattle and people. In the dairy industry people interact with cows several times a day and these situations present opportunities to create positive human and animal interactions.

■ General Stockmanship Concepts

There are a few general concepts about cow behavior stock handlers should keep in mind. Livestock derive information from the environment through their five senses: sight, hearing, smell, touch and taste. Cows do not use language to communicate with people so stock handlers must communicate with cows by stimulating the senses of the animal. The two most important senses a cow uses to understand what is going on in her environment are sight and hearing.

Cows consistently look at what is pressuring them. Because the eyes and ears of the cow are positioned on the side of the skull, cows have excellent peripheral vision and hearing. There is a narrow blind spot directly behind her rump. A good general rule is that if the handler can see the cow's eyeball she can probably see the handler. Therefore, the human should approach the animal from a position where her eyeball can be seen, in this manner she can probably see and hear the handler. Surprising livestock is never a good idea, so let them see the handler if possible and if not, let them gently hear who approaches them.

Cows tend to move in an arc around whatever they perceive as pressure. This allows them to keep an eye on what is pressuring them as they move around or away from it. Cows tend to follow other cows. These two concepts are invaluable when emptying a cattle pen or loading a transport with cattle. If the handler can create positive motion at the front of the herd and then avoid doing anything to slow or stop the flow, cows will tend to move in the direction

they are facing while following the cow in front of them. If, for example, handlers are moving animals into the parlor, the task will be accomplished more efficiently if the handler induces the animals to face the opening into the parlor. If the handler causes the animals to turn back toward the crowd gate, flow stops and the cattle tend to bunch. Handlers need to pay close attention to their position in relationship to the direction of cow movement. It is most important not to over-pressure or to apply pressure in an unpredictable manner to the animal. Extreme examples of over-pressure are shouting, arm waiving, and hitting animals or using electric prods to get them to move. Cows do not respond positively when over-pressured, they exhibit agitation and may run away from the over-pressure potentially leading to harm. These examples of over-pressure would be called high-stress cow handling techniques.

Pressuring a cow properly involves the right approach angle, speed, and timing. There is no complicated or magic formula. The cow's behavior will inform the handler if the angle, speed, and timing were correct. If she didn't respond as the handler intended, then the handler should back along the same line as the approach, and change the angle and the speed of approach. However, one concept has universal importance in moving cattle and it is that driving cattle from directly behind them, in their blind spot, causes the animal to turn and face the handler in order to get at least one eye on the pressure. That handling mistake stops the forward motion of cattle because a cow tends not to walk far with her head turned. Cows seem to follow their eyes.

Cows walk at about two-miles per hour (mph) while people tend to walk about three to four mph. Handlers walking at their normal pace and parallel with cows will eventually overtake the cow, first slowing them and then stopping forward motion altogether. Handlers need to recognize this and slow their walking speed in order to move at the same pace as calm cows. Since it generally takes more pressure to start a cow moving than it does to keep her moving, once cow motion begins the handler should slow or pause momentarily in order to create some distance between themselves and the moving cow. The handler then continues to apply only the pressure needed to keep the cow moving calmly. Over-pressuring in order to start motion or during movement frequently causes cows to over-react and run. This is often seen when moving heifers.

Walking parallel against the flow of cows tends to speed them. This works because cows want to go the direction they are facing and they want to get away from the human pressure; especially the human face and eyes. Walking parallel against the flow of cattle can help load or unload a chute, transport, or parlor, and is valuable when encouraging cows to exit the return alley. If more than one person is in the vicinity of the same animal or group of animals, it is best that one person pressure at a time. With two or more handlers, it is very easy to apply conflicting pressures to the cattle. Understandably, this would result in conflicting stimuli to the cows and results in poor communication to

the animal. Consistent handling methods allow the cows to know what will happen next and that seems to have a calming effect on herd animals.

A good time to work animals is when they first arrive to a new pen or facility. Examples of this are during weaning of heifers from hutches into group pens or immediately after springing heifers arrive at a facility new to them. Spending 10-20 minutes allows handlers to develop a calm relationship with the new cattle while introducing the animals to the new environment. This also creates a great opportunity to examine those animals for any health problems.

As people learn to apply stockmanship skills on cattle operations a frequent question arises about what to do with new cattle? As simple as it may sound, the answer is that the behavior of the animals will tell handlers what should done with them. For example, if cattle run back and forth or circle non-stop, the handlers need to slow that motion. If the cows bunch in a corner and have no movement, a handler or at most a few handlers should create slow movement that involves teaching new cattle to accept human pressure. This also helps animals learn the boundaries of their new confinement while teaching them where food and water exists. Each time cattle are worked properly they learn and become easier to work the next time. That is to say that animals learn calm handling if handled calmly. When livestock operations only consider working cattle if specific tasks are to be accomplished (such as vaccinating) a negative impression of handling can be imprinted in the cows' memory. Naturally, negative interactions can make cows become harder to handle over time. Frequently, we find that the older cows in a herd can be difficult to move. We must understand that their current behavior is the sum total of the interactions with humans over her lifetime; positive and negative. Dairy stockmanship is about reconnecting people with dairy cows for positive outcomes and it is fundamentally about learning how cows respond to the behaviors of people in a dynamic environment.

To summarize the key stockmanship concepts, faculty at the University of Minnesota College of Veterinary Medicine have developed a list of specific stockmanship engagement rules and have made these available in both English and Spanish. These general rules are the foundation for teaching dairy stockmanship to people interacting with cattle. Producers that understand the rules will find many opportunities to lower the handling stress when working with their cattle.

Most commonly, the term "Rules of Engagement" (ROE) is used by military or police units. The ROE's determine when, where, and how force shall be used. Such rules are both general and specific, and there have been large variations between cultures throughout history. The rules may be made public, as in a martial law or curfew situation, but are typically only fully known to the force that intends to use them.

This concept of ROE's can be applied to dairy stockmanship training programs. In dairy stockmanship, the ROE's determine when, where, and how pressure shall be used. Dairy stockmanship rules are both general and specific. The rules may be made public, but are typically only fully known to the stockpeople that intend to use them. Good stockpeople have learned to follow these rules without consciously thinking about them. Stated another way, good stockpeople have learned to very closely observe the behavior responses of the cows.

■ The Concept of Stress in Dairy Cattle

The general concept of low-stress handling is being widely discussed in the dairy industry today. The National Dairy FARM Program: Farmers Assuring Responsible Management™, created by the National Milk Producers Federation (NMPF) with support from Dairy Management Inc. (DMI), specifically states as a best management practice "Employees should be properly trained to handle animals with a minimum of stress to the animal, and the consequences of inhumane handling should be known and enforced." The National Dairy FARM Program is designed to demonstrate that U.S. milk producers are committed to providing the highest standards of animal care and quality assurance. This voluntary program, available to all producers, provides a consistent on-farm animal well-being program that includes education, on-farm evaluations and third-party verification. Whether it be dairy stockmanship training or a program like FARM, the increased usage of the term "low-stress cattle handling techniques" has raised the questions of what exactly is stress, and how do we determine if it is "low" or "high"?

If you ask twelve people to define "stress" you would likely get 12 different answers. This creates an interesting challenge for us if we are going to attempt to determine the level of animal stress on a particular farm and whether the stress level is "low" or "high". If we struggle to define stress, how can we measure it? One of the goals of this paper is to introduce the reader to the scientific study of stress biology and to suggest that farm managers and advisors can utilize this understanding to assist in the evaluation of whether cow handling stress is "low" or "high" on a dairy operation. A list of references is provided in Table 1 for those interested in researching further into the concepts of animal stress biology.

Table 1. References on animal stress biology

Reference	Topic
Brown, 1994	Introduction to neuroendocrinology
Cohen et al., 1997	Measuring stress
Hansen et al., 2007	Welfare of farmed mink
Hayward and Wingfield, 2004	Maternal stress in birds
Herskin and Jensen, 2002	Stress in piglets
Herskin et al., 2004	Effects of stressors on dairy cows
Heistermann et al., 2006	Measuring stress hormones in feces
Jarvis et al., 2006	Prenatal stress programs piglets
Jensen and Toates 1997	Stress and motivation
Jensen and Andersson, 2005	Genomics and ethology
Joels et al., 2007	Mineralocorticoid receptors in brain
Laviola et al., 2008	Environmental enrichment & neural disease
Macri et al., 2004	Effects of neonatal separation in rats
Macri et al., 2007	Stress can reduce variation in mice
Macri and Wurbel, 2006	Review of maternal mediaton hypothesis
Malmkvist et al., 2009	Thermal effects on peripartum sows
Malmkvist and Palme, 2008	Periparturient nest building in mink
Mateo and Cavigelli, 2005	Noninvasive sampling of glucocorticoids
Mellor et al., 2000	Responses to pain as a stressor
Moberg, 2000	Responses to stress: welfare implications
Mormede et al., 2007	Endocrinology for evaluating animal welfare
Morrow et al., 2002	Fecal glucorticoids in dairy cattle
Mostl et al., 2005	Corticosterone in bird's droppings
Parker and Maestripieri, 2010	Early stress experience in primates
Tourna and Palme, 2005	Fecal glucocorticoids in mammals & birds
Weis, 1968; 1971	Coping responses to stress
Wolfer et al., 2004	Cage enrichment and mouse behaviour

A brief history of stress research pioneers will be helpful to understand how the term came into such widespread use. Hans Seyle (1907-1982) is generally recognized for being the first researcher to demonstrate the existence of biological stress. In 1936 Seyle defined stress as "the non-specific response of the body to any demand for change." Seyle demonstrated in his research that a wide variety of noxious stimuli caused a very consistent set of pathologic changes in laboratory rats (Selye, 1936). Seyle's work created much interest and discussion in the scientific community.

The work of Robert Sapolsky is also useful in understanding the concept of biological stress (Sapolsky 2002, 2004). Sapolsky suggests a very useful approach by differentiating a "stressor" from the body's "stress response". Sapolsky defined a stressor as anything that disrupts physiological balance. A

stress response is defined as the body's adaptations designed to re-establish the balance.

Discussions at the 2011 Trends in Stress Biology course taught at Aarhus University suggested some slight refinements to the definitions.

- Stressor = event threatening or potentially threatening the homeostatic balance
- Stress Response = the bodies attempt to re-establish the homeostasis after encountering a stressor.

Stressors can be described by their characteristics such as: duration, frequency, intensity, predictability, and ability to be controlled. It is important to note that while stressors can be physical things (heat, cold, starvation, etc.) psychological factors can also trigger the stress response in an animal in the absence of anything physically threatening to an animal.

Sapolsky in his writings proposes that the stress response evolved as adaptive survival mechanism for animals. It is now increasingly recognized that the consequences of the stress response can be maladaptive and that there is a "biological cost" to the animal for mounting a stress response. It is actually incorrect to state that stress makes an animal sick. To be correct, one should state that the stress response makes you more likely to get diseases that make you sick.

There is no single litmus test for stress because of the multiple ways the body responds to stressors. Since stressors will result in both behavioral responses and physiological responses on the part of the animal, proper assessment of an animal's stress response requires one to look at both. One cannot interpret physiological test results without knowing the behavior.

An understanding of stockmanship principles will help one to be aware of behavior responses in animals. The physiological components of the stress response are significantly influenced by the endocrine system. Broadly speaking, all stressors provoke some degree of cortisol secretion as well as a multitude of other physiologic responses. The exact orchestration of the many hormones involved will vary depending on the stressor. In this way, different stressors have a different "stress signature" that describes the overall stress response. Work in this area is very interesting and in the future will most certainly allow us to improve and refine our evaluation of the physiological response to stress.

It is still our present understanding that glucocorticoids (cortisol) and catecholamines (adrenalin) together mediate most of the changes that form the stress response. Today, measuring cortisol remains the gold standard to evaluate the physiologic response to stressors. Researchers are actively

engaged in searching for additional physiologic measures, but it is clear that cortisol does play an important role. Understanding the Hypothalamic-Pituitary-Adrenal axis (HPA axis) is critical to understanding the physiology of the stress response.

Blood sampling has been the traditional means used to evaluate the cortisol level in an animal. However, plasma cortisol evaluation is not without issues. For example, obtaining a blood sample in itself can be stressful, especially in wildlife or zoo animals. Dr. Rupert Palme (Dept. Biomed. Sciences/Biochemistry, University of Veterinary Medicine, Vienna) and other researchers have been actively looking into alternatives to blood sampling (Palme, 2005; Palme et al., 2000, 2005). Cortisol is metabolized in the liver and cortisol metabolites are excreted in the urine and feces. Measuring cortisol metabolites in the feces (FCM's) has received a significant amount of attention. Since 1997, over 130 publications have used the measurement of FCM's on a wide variety of animal species, including dairy cattle.

In 2011, the University of Minnesota Veterinary Diagnostic Lab (VDL) completed a validation study using a commercially available Radio-Immuno-Assay (MP Biomedicals, Diagnostic Division, 13 Mountain View Avenue, Orangeburg, NY 109062) to measure FCM's in bovine feces at our VDL. We anticipate the ability to measure FCM's will be an important additional tool complementing behavior analysis study of dairy cattle. Measuring FCM's hopefully will assist dairy research projects that are designed to evaluate whether a particular handling technique can be considered low-stress animal handling.

The positive impact of better cow handling has been clearly demonstrated by Australia's Animal Welfare Science Centre, a joint organization with Australia's University of Melbourne, Monash University and the Victorian State Department of Primary Industries. The Centre is internationally recognized as a leading research and educational facility of animal welfare topics. Interested readers are directed to the Hemsworth references included in this paper for more detailed information (Hemsworth, 2007; Hemsworth et al., 1989, 2000).

Dairy veterinarians are frequently involved in on-farm training programs for dairy owners and their employees. Delivering effective training programs for dairy workers is a very valuable production medicine service to offer to dairy clients. At the University of Minnesota College of Veterinary Medicine, our main focus has been working with a few collaborating dairy operations to put stockmanship into practice on commercial dairies. Our long-term goal is to develop useful training resources that dairy veterinarians will be able to utilize to improve their own stockmanship skills as well as use to facilitate on-farm training with dairy clients. In addition, we are actively developing a research program to study the cow behavior responses to stockmanship techniques.

DAIRY STOCKMANSHIP RULES OF ENGAGEMENT

Cow Rules

Cow Brain gets input from her senses: Sight, Hearing, Smelling, Touching, Tasting

1. Cows sense “pressure”
    - Cows look at what is pressuring them
    - Cows tend to go around the pressure
    - Cows stop moving when the pressure is removed
2. Contradictory pressures produce incompatible behavior
    - Single sources of pressure are most effective
3. Cows follow other cows
4. Cows tend to return to where they came from
5. Cows move in the direction they are facing
6. Multiple factors determine behavioral responses
    - “You can never step into the same river; for new waters are always flowing on to you.” Heraclitus of Ephesus quote (Greek philosopher, 540-480 BC)

People Rules

1. The cow is always right
    - Cow behavior is lawful, and cows obey the laws
2. Never cheat, be consistent
3. See everything, look at nothing
    - Every interaction between people and cows is important
    - Be patient
4. Work in the pressure area
    - Work where the cow can see you
    - Work “inside the circle”
5. Do not predetermine your actions
6. Pressure properly
    - Pressure from the side
    - Encroachment = Timing, Angle, Speed, Position
    - Hands in pockets
7. Teach animals in this order
    - Slow them down
    - Stop them
    - Start them
    - Turn them
    - Teach animals to take pressure
8. Greater pressure required to start movement
    - Less pressure required to drive & guide
    - Starting movement properly is very important
    - Avoid constantly stopping motion

9. Rocking Motion
10. Walk straight
11. Walk with cows to slow them down
12. Walk against cows to speed up
13. Walk in a Zig-Zag to create motion
14. “T” to the gate

References

Brown, R. E. 1994. An introduction to neuroendocrinology, chapters 1-4, Cambridge University Press, p. 1-55.

Cohen, S., R. Kessler, and L. U. Gordon. 1997. *Measuring Stress: A Guide for Health and Social Scientists*. Oxford University Press. (ISBN 978-0-19-512120-9).

Hansen, S. W., J. Malmkvist, R. Palme, and B. M. Damgaard. 2007. Do double cages and access to occupational material improve the welfare of farmed mink? Anim. Welf. 16: 63-76.

Hayward, L., and S. Wingfield. 2004. Maternal corticosterone is transferred to avian yolk and may alter offspring growth and adult phenotype. Gen. Comp. Endocrinol. 135:365-371.

Heistermann, M., R. Palme, and A. Ganswindt. 2006. Comparison of different enzymeimmunoassays for assessment of adrenocortical activity in primates based on fecal analysis. Am. J. Primatology 68:257–273.

Hemsworth, P. H., J. L. Barnett, A. J. Tilbrook, and C. Hansen. 1989. The effects of handling by humans at calving and during milking on the behaviour and milk cortisol concentrations of primiparous dairy cows. Appl. Anim. Behav. Sci. 22:313-326.

Hemsworth, P. H., G. J. Coleman, J. L. Barnett, and S. Borg. 2000. Relationships between human-animal interactions and productivity of commercial dairy cows. J. Anim. Sci. 78:2821-2831.

Hemsworth, P. H. 2007. Ethical stockmanship. Aust. Vet. J. 85:194-200.

Herskin, M. S., and K. H. Jensen. 2002. Effects of open field testing and associated handling v. handling alone on the adrenocortical reactivity of piglets around weaning. J. Anim. Sci. 74:485-491.

Herskin M. S., L. Munksgaard, and J. Ladewig. 2004. Effects of acute stressors on nociception, adrenocortical responses and behaviour of dairy cows. Physiol. Behav. 83:411-420.

Jarvis, S., C. Moinard, S. K. Robson, E. Baxter, E. Ormandy, A. J. Douglas, J. R. Seckl, J. A. Russell, and A. B. Lawrence. 2006. Programming the offspring of the pig by prenatal social stress: Neuroendocrine activity and behaviour. Horm. Behav. 49: 68-80.

Jensen, P., and F. M. Toates. 1997. Stress as a state of motivational systems. Appl. Anim. Behav. Sci. 53: 145-156.

Jensen, P., and L. Andersson. 2005. Genomics meets ethology: a new route to understanding domestication, behavior, and substainability in animal breeding. Ambio 34:320-324.

Joëls, M., H. Karst, R. DeRijk, and E. R. de Kloet. 2007. The coming out of the brain mineralocorticoid receptor. Trends Neurosci. 31:1-7.

Laviola, G., A. J. Hannan, S. Macrí, M. Solinas, and M. Jaber. 2008. Effects of enriched environment on animal models of neurodegenerative diseases and psychiatric disorders. Neurobiol. Disease 31:159-168.

Macrí, S., G. J. Mason, and H. Würbel. 2004. Dissociation in the effects of neonatal maternal separations on maternal care and the offspring's HPA and fear responses in rats. Eur. J. Neurosci. 20:1017-1024.

Macrí, S., P. Pasquali, L. C. Bonsignore, S. Pieretti, F. Cirulli, F. Chiarotti, and G. Laviola. 2007. Moderate neonatal stress decreases within-group variation in behavioural, immune and HPA responses in adult mice. PLoS One 2: e1015. 1-9.

Macrí, S., and H. Würbel. 2006. Developmental plasticity of HPA and fear responses in rats: A critical review of the maternal mediation hypothesis. Horm. Behav. 50:667-680.

Malmkvist, J., B. M. Damgaard, L. J. Pedersen, E. Jørgensen, K. Thodberg, H. Chaloupkova, and R. M. Bruckmaier. 2009. Effects of thermal environment on HPA-axis hormones, oxytocin and behavioral activity in periparturient sows. J. Anim. Sci. 87:2796-2805.

Malmkvist, J., and R. Palme. 2008. Periparturient nest building: implications for parturition, kit survival, maternal stress and behaviour in farmed mink (Mustela vison). Appl. Anim. Behav. Sci. 114:270-283.

Mateo, J. M., and S. A. Cavigelli. 2005. A validation for extraction methods for noninvasive sampling of glucocorticoids in free-living ground squirrels. Physiol. Biochem. Zool. 78:1069-1084.

Mellor, D. J., C. J. Cook, and K. J. Stafford. 2000. Quantifying some responses to pain as a stressor. Chap. 9 in GP Moberg and JA Mench (eds.), The biology of animal stress, CAB international, p. 171-198.

Moberg, G. P. 2000. Biological response to stress: Implications for animal welfare. Chapter 1 in GP Moberg and JA Mench (eds), The biology of Animal Stress, CAB international, p. 1-21.

Mormede, P., S. Andanson, B. Auperin, B. Beerda, D. Guemene, J. Malmkvist, X. Manteca, G. Manteuffel, P. Prunet, C. G. van Reenen, S. Richard, and I. Veissier. 2007. Exploration of the hypothalamic-pituitary-adrenal function as a tool to evaluate animal welfare. Physiol. Beh. 92:317-339.

Morrow, C. J., E. S. Kolver, G. A. Verkerk, and L. R. Matthews. 2002. Fecal glucocorticoid metabolites as a measure of adrenal activity in dairy cattle. Gen. Comp. Endocrinol. 126:229-241.

Möstl, E., S. Rettenbacher, and R. Palme. 2005. Measurement of corticosterone metabolites in birds' droppings: An analytical approach. Ann. N.Y. Acad. Sci. 1046:17-34.

Palme, R. 2005. Measuring fecal steroids: Guidelines for practical application. Ann. N.Y. Acad. Sci. 1046:75-80.

Palme, R., S. Rettenbacher, C. Touma, S. M. El-Bahr, and E. Möstl. 2005. Stress hormones in mammals and birds: comparative aspects regarding metabolism, excretion and noninvasive measurement in fecal samples. Ann. N.Y. Acad. Sci. 1040:162-171.

Palme, R,, C, Robia, W, Baumgartner, and E. Mostl. 2000. Transport stress in cattle as reflected by an increase in faecal cortisol metabolite concentrations. Vet. Rec. 146:108-109.

Parker, K. J., and D. Maestripieri. 2010. Identifying key features of early stressful experiences that produce stress vulnerability and resilience in primates. Neurosci. Biobehav. Rev. 35:1466-1483.

Sapolsky, R. M. 2002. Endocrinology of the Stress-Response. Chapter 11 in J. B. Becker, M. Breedlove, D. Crews, M. M. McCarty, Behavioral Endocrinology. 2nd edition. MIT Press, London, UK.

Sapolsky, R. M. 2004. *Why Zebras Don't Get Ulcers,* 3rd Rev. Ed, Holt/Owl (ISBN 978-0-8050-7369-0).

Selye, H. 1936. A syndrome produced by diverse nocuous agents. Nature 138:32.

Touma, C., and R. Palme. 2005. Measuring fecal glucocorticoid metabolites in mammals and birds: The importance of validation. Ann. N.Y. Acad. Sci. 1046:54-74.

Weis, J. M. 1968. Effects of coping responses on stress. J. Comp. Physiol. Psychol. 65:251-260.

Weis, J. M. 1971. Effect of coping behaviour in different warning signal conditions on stress pathology in rats. J. Comp. Physiol. Psychol. 77:1-13.

Wolfer, D. P., O. Litvin, S. Morf, R. M. Nitsch, H.-P. Lipp, and H. Würbel. 2004. Cage enrichment and mouse behaviour. Nature 432:821-822.