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Stress and Reproduction in Domestic Animals.
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Introduction:
Although the general concept of stress is relatively easy to grasp, difficulties soon appear when greater definition is required. One definition of stress is that it represents an inability of the animal to cope with its environment (Dobson and White 2000). In turn, this inability may be reflected in terms of behaviour, physiology or failure to achieve genetic potential (e.g. growth, milk, disease resistance or reproduction). On the other hand, stress may result in positive outcomes (e.g. puberty), or accompany a successful event (e.g. service). Differentiation should be made between stressor (i.e. an external effect) and stress (i.e. an individual’s response to this effect). In addition, stress may have positive (“eustress”) or negative manifestations (“distress”).

Reproduction, in entirety and part, is particularly susceptible to the deleterious effects of stress. In domestic animals, most of which evolved as prey species, reproduction can impede survival in the immediate sense of the word (“fight or flight” does not imply courtship!). In this discussion, we will focus on stress effects on reproduction using a number of examples, or effects, as illustrations whereas subsequent presentations will help contribute to a better understanding of the basic mechanisms at work.

Examples of Stress Effects on Reproduction

1. **Heat stress.**
Dairy cows inseminated during the hot months of the year experience decreased fertility. Here elevated temperature/humidity indices are associated with decreased oestrus expression as well as lowered appetite and dry matter intake. The utilization of cooling systems may have a beneficial effect on fertility but dairy cows cooled in this way are still unable to match fertility levels achieved in winter (De Rensis and Scaramuzzi 2003).

A number of physiological effects have been associated with heat stress in dairy females (Stockholm–Wolfenson et al 2000), including:
- Suppression of the dominant follicle
- Compromised steroidogenic capacity of theca and granulosa cells,
- Lowered P4 secretion,
- Impairment of oocyte quality, embryo development,
- Increased embryo mortality, and
- Compromised endometrial function.
In addition, delayed effects include compromised follicular dynamics and the development of low quality oocytes and embryos. Britt (1994) demonstrated that compromised ova could reflect damage that occurred during follicular recruitment, as early as 2 months prior to ovulation.

Methods employed to alleviate the deleterious effects of heat stress in dairy cattle have included the following (Hansen and Arechiga 1999):
- Traditional cooling systems; eg fans, sprays and cooling ponds.
- Timed artificial insemination (A.I.) to minimize heat detection problems;
- Embryo transfer (E.T.) to bypass the period when embryos are particularly susceptible to heat stress (i.e., d1 to 2 after breeding).
- Use of antioxidants to reduce oxidative damage associated with heat stress and,
- Use of bovine somatotropin to extend lactations and avoid A.I. during periods of heat stress.

Males are also susceptible to adverse effects of heat stress, with most domestic species employing complex systems to ensure that spermatogenesis occurs at optimal temperatures; a relatively mild temperature increase of 2-3°C can result in lasting adverse effects on the sperm produced (Saacke 2000). Spermatogenic epithelium reacts in a stereotyped manner to a wide variety of insults, indicating a common pathogenic mechanism. One of the major characteristic features of this response is the development of the diadem/crater defect of sperm. Theories concerning the etiology of this defect include the deleterious actions of reactive oxygen species (ROS) during a critical phase of chromatin condensation in the early spermatid.

The severity and length of thermal insult can determine the incidence of damaged sperm, and both the degree and duration of damage involved. Although chromatin damage may be indiscernible using conventional methods, in many cases obvious abnormal sperm morphology is associated with chromatin damage. One caveat here is that diadem and apical vacuoles were not associated with abnormal SCSA findings in one study (Acevedo et al 2002). Many sperm abnormalities previously considered as discrete entities may now be regarded as part of a continuum within a spectrum of standardized responses to spermatogenic stress (Larsen and Chenoweth, 1990; Vogler, 1990). Such abnormalities include pyriform and unripe (undeveloped) sperm heads, various manifestations of craters and vacuoles, and knobbed acrosomes. On a practical note, Metterhoeffer and Coleman improved semen quality by approximately 25% in yearling Angus bulls during summer in Oklahoma simply by providing shade.

2. Social Stress
Social ranking in livestock can influence reproductive success, both in males and females. Dominance rank, assessed in all-male groups when they were released from tie stalls into pens, was negatively correlated with libido in one study with yearling Bos taurus bulls (Ologun et al. 1981). Here, two methods of calculating dominance value were employed (Beilharz and Mylrea 1963; Arave and Albright 1976) with similar results. If dominance and sex-drive are, in fact, different (or even antagonistic) traits, then the dominant bull (or bulls) could reduce herd fertility both through failure to service females, and by preventing less dominant bulls from serving available females. This apparently occurred in at least one study (McCosker et al. 1989). Such effects are probably most evident when older and younger males are combined within the same mating groups (Blockey 1979). Dominance is more difficult to determine with young bulls (1- to 2-year-old) particularly when kept as a single group from weaning onwards. Conversely, the proximity of other bulls can improve both service responses and semen quality as was evident in early US work in AI centres.
In females, decreased social ranking of dairy cows was associated with both increased calving to conception intervals and inseminations per conception (Dobson and Smith 2000). In beef cattle, Landaeta-Hernandez et al (2004) reported that social order influenced oestrus behaviour following PGF2α administration.

3. Pain and Disease
The fact that pain and/or disease are associated with compromised reproduction is not surprising, although the effects of conditions such as non-clinical acidosis are difficult to quantify. When Dobson and Smith (2000) paired dairy cows which had selected clinical conditions (eg milk fever, cystic ovary, “sick” and lameness) with “healthy” herdmates, the latter were superior in calving to first service and conception intervals as well as in the number of inseminations per conception.

Increased lameness in livestock is associated with the accelerating trend to intensive production systems. In dairy cows, lameness was associated with a longer interval between calving and first service and a longer interval between calving and conception (Lucy et al 1986). Lameness was associated with delayed ovarian activity in Holstein cows during the early postpartum period. Garbarino et al (2004) reported that cows classified as lame had 3.5 times greater odds of delayed cyclicity, compared with non-lame cows. Attributable proportion analysis indicated that delayed ovarian cyclicity in lame cows would be reduced by 71%, if lameness had been prevented.

4. Handling and Fear
Negative handling reduced pregnancy rate in pigs (Hemsworth et al., 1986), fear of humans reduced the attraction of oestrous sows to boars when in the presence of humans (Pedersen et al., 2003) and has also been positively associated with stillborn piglets (Hemsworth et al. 1999). A chronic stress response is the likely mechanism responsible for adverse effects of high fear on the productivity in pigs. In many handling studies, treatments which resulted in fear also produced either a sustained elevation in free cortisol concentrations or an enlargement of the adrenal glands, together with depressions in growth and reproductive performance. In laying hens, Barnett et al. (1994) found that unexpected human contacts increased plasma corticosterone concentrations and reduced egg production. Stress associated with breeding has been associated with lowered AI fertility results in beef cattle, leading to strategies such as confined “breeding boxes” and pre-conditioning females to the AI facility.

5. Conclusions
Stress, manifest in many forms, can compromise reproduction in domestic animals, with adverse effects occurring in both males and females. Strategies to alleviate stress include recognition of both the strategic windows of susceptibility in the reproductive process and those stressors most likely to cause harm and, where practical, minimizing the effects of the latter.
Selected References:


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