Metabolic Responses of Livestock to Hematophagous Arthropod Invasion

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ABSTRACT Neurosensory, hematologic, and metabolic responses of livestock to hematophagous arthropod attack are discussed in relation to food energy partition and energy balance in the host, using as examples biting flies (*Haematobia irritans* [L.]), resident ectoparasites (Anoplura), and ticks (Ixodidae), respectively. Primarily from research already published, it is shown how arthropod attack can affect feed intake, digestibility, metabolizable energy, energy retention, and nitrogen balance. It is concluded that, in the future, those setting protocols for metabolic research on host–parasite systems must recognize the dynamic nature of these systems in the field; they should standardize host test groups by selection from larger performance-tested herds and acquire results by measuring as many carefully selected parameters as possible. Cooperation between the entomologist and animal nutritionist is encouraged for maximum research productivity.

IN THE PAST 15–20 yr, funding for research on livestock pests has depended increasingly on the ability of the researcher to produce cost–benefit analyses for pest control activities and threshold levels of parasites above which control is mandatory for maximum productivity. The task has not been easy, nor will it become any easier. Simple attempts to demonstrate losses in body weight, milk, or wool have sometimes produced equivocal results. We have often failed to get the maximum out of our research effort because our knowledge of the fundamentals of host–parasite interaction has not been sufficient to develop intelligent pest management strategies (Steelman 1976, Sutherst 1983, Haufe 1985).

In these days of mathematical modeling and its attendant computer analyses, acquiring this knowledge should be easier except for the fact that many have actively avoided the study of mathematics throughout their education (Sutherst 1983). The ability to express biological systems in terms of mathematical symbolism is an art not given to all. This is indeed the loss of those untrained in these techniques. The other problem is knowing the proper biological data to get, then knowing how to acquire them. Despite my lack of mathematical inclination, in this paper I attempt to present a fresh look at some of the research information already existing in the literature from the perspective of a scientist no longer active in research.

The complex mosaic of stressors that may be imposed on host animals in their environment elicits from these host animals an even more complex array of responses. The stresses are the presence of the parasites (flying, feeding) and the blood loss, injected toxins, immunoallergic response, and chronic irritation produced by them; undernutrition, either direct or indirect; and meteorological conditions.

Host responses include behavioral (neurosensory), such as avoidance (including gadding, rubbing, tossing, kicking), group response (crowding, milling, stampeding), adaptation (grazing, tolerance), and grooming; hematologic, either direct (blood loss or cellular changes), or indirect (nutritional or toxic); metabolic, such as immunoallergic, anorectic, endocrine (pituitary, adrenal, gonad, thyroid), and hyperthermic (environmental, toxic, allergic).

It should be obvious that all these responses are metabolically interrelated and ideally should be understood and accounted for in any model we attempt to set up. Because of the complexity of the subject, the entire outline of responses cannot be discussed properly in the space allotted here; therefore, I discuss those aspects on which the most work has been done. Food energy partition is briefly addressed, followed by the neurosensory response, blood loss, and productivity loss, using as examples biting fly, resident ectoparasite, and tick–host systems, respectively.

Food Energy Partition

It is useful to consider productivity simply in terms of energy balance or as total energy ingested − energy excreted or lost = energy retained for maintenance, growth, and productivity. The first call on food energy is for the mechanical and biochemical work constituting maintenance. In the fasting animal, the energy required for this is obtained by catabolism of glycogen, fat, and protein (in that order); the quantity of heat produced equals the quantity of chemical energy expended, and its measurement constitutes the