HAEMOPHILUS SOMNUS: ANTIGEN ANALYSIS AND IMMUNE RESPONSES

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INTRODUCTION

*Haemophilus somnus* causes several disease syndromes in cattle and sheep but is also carried asymptotically, especially on the genital mucosa. The factors involved in determining whether disease or asymptomatic carriage result are only beginning to be defined. Both host and bacteria contribute to the outcome of the dynamic interaction. To gain some insight into *H. somnus*/host interactions, it is necessary to consider what is known of the disease or asymptomatic conditions seen as well as current information on virulence factors and host immune response. This review constitutes the biased synthesis of the reviewers' thoughts on available data relative to *H. somnus* infection.

NATURAL HISTORY OF INFECTION

In cattle, *H. somnus* was first noted to cause thrombotic meningoencephalitis (TME) (Stephens *et al.*, 1981). Now it is known to also be involved in the etiology of upper respiratory infection, pneumonia, septicemia, abortion, arthritis, myocarditis and infertility (Corbeil, 1990; Harris and Janzen, 1989, Humphrey and Stephens 1983, Kwiecien and Little, 1991; Miller *et al.*, 1983). It is also carried asymptomatically on the prepuce of most bulls (Humphrey *et al.*, 1985; Slee and Stephens, 1985; Ward *et al.*, 1983) and the vagina of some cows (Corbeil, 1986; Kwiecien and Stephens, 1991; Ward *et al.*, 1983). An upper respiratory carrier state has also been reported (Humphrey and Stephens, 1983) but appears to be much more rare than the genital carrier state. However, it may be that the organism persists longer in the lower respiratory tract than in the upper tract. In a study of experimental pneumonia with 5 calves, we showed that clinical pneumonia was present for less than a week but the organisms could be isolated from bronchial lavage fluids for 5 to 10 weeks or more, even when nasal swabs were culturally negative (Gogolewski *et al.*, 1989).

Sheep also may carry *H. somnus* in the genital tract generally without clinical signs, or may have *H. somnus* induced disease (Lees *et al.*, 1994). Ovine *H. somnus*, has been called *Histophilus ovis* or *Haemophilus agni* in earlier literature but several recent reports indicate that *Histophilus ovis, H. agni*, and *H. somnus* should be considered as one taxon (McGillivery *et al.*, 1986; Stephens *et al.*, 1983; Walker *et al.*, 1985). The carrier state is
primarily preputial (Lees et al., 1990; Walker and LeaMaster, 1986) but the organism may also be found in the vagina of ewes (Higgins et al., 1981). Epidydimitis in young rams is one of the more frequently reported disease syndromes (Bulgin and Anderson, 1983; Walker et al., 1986 and 1988). In addition, vulvitis (Ball et al., 1991), lower reproductive rates (Lees et al., 1990), mastitis (Beauregard and Higgins, 1983), septicemia, arthritis, meningitis and pneumonia (Rahaley, 1978) have been reported. Rahaley (1978) produced septicemia by intravenous or intranasal inoculation of isolates from the ovine vagina or from lamb septicemia. Recently we reproduced meningitis (Lees et al., 1994) with isolates from septicemia and preputial carriers by intracisternal inoculation, but not all preputial isolates were capable of producing disease.

**VIRULENCE ATTRIBUTES**

Several virulence factors have been reported which may help to explain why disease occurs in some cases and not others. Obviously host factors may also be involved but this will be discussed later. Attachment to host cells is one of the bacterial functions involved in the first step of pathogenesis. *Haemophilus somnus* has been shown to adhere to several host cell types including bovine turbinate cells (Ward et al., 1983) and bovine endothelial cells (Thompson and Little, 1981). More recently, we (Stephens LR and Corbeil LB, unpublished data) showed *H. somnus* attaches in large numbers to bovine vaginal epithelial cells (VEC). It may be significant that the organisms adhered primarily to the large flat more differentiated cells (Figure 1). Most of these cells were covered with *H. somnus*, reminiscent of clue cells which are characteristic of human bacterial vaginosis. Since human bacterial vaginosis is associated with abnormal outcome of pregnancy (McDonald et al., 1991, Holst et al., 1994), the finding that *H. somnus* covers epithelial cells in clue cell like fashion may be significant. In our experience, nearly all of more than 100 *H. somnus* strains tested adhered in large numbers to primary bovine VEC. Isolates of other bacterial species did not adhere in large numbers to VEC. Most but not all of the adherent isolates of *H. somnus* also autoagglutinated. Thus auto-agglutination and adherence appear to be linked but probably not closely. Although the molecular basis of adherence was not defined, hydrophobic interactions were implicated. Identification of the molecules involved in adherence could be a fruitful approach to an understanding of virulence mechanisms and as a target for immunoprophylaxis.

![Figure 1](image_url). Attachment of *Haemophilus somnus* to bovine vaginal epithelial cells. Note that the larger cell is almost covered with *H. somnus* whereas the smaller cell has no more *H. somnus* than in the background.