

Effect of season and breed on the survival of *B. microplus* on bulls (5 animals per treatment) at Amberley was shown by percent survival of ticks to maturity following artificial infestations with about 20,000 larvae during 1974 and 1975. Bulls were held in open yards and were fed lucerne hay ad libitum (means \pm SE)

Amberley	1974 January	April	July	October	December	1975 May
Zebu \times European	3.1 \pm 0.7	8.7 \pm 1.6	2.2 \pm 0.5	1.6 \pm 0.5	2.3 \pm 0.9	4.6 \pm 1.1
European beef breed	8.7 \pm 2.0	17.9 \pm 1.6	6.1 \pm 0.8	4.2 \pm 0.6	3.4 \pm 0.6	9.0 \pm 1.5
European dairy breed	17.2 \pm 3.3	28.3 \pm 3.0	11.2 \pm 2.6	9.3 \pm 2.1	8.1 \pm 1.7	13.9 \pm 2.3

capacity of cattle to mount an effective immune response against the parasitic tick.

Tick resistance began to wane well before the winter coat was fully developed and resistance increased again prior to the shedding of the winter coat, and so the characteristics of the coat per se did not control the changes in resistance.

Nutrition can affect the expression of resistance to ticks^{8,9} but in our experiment tick resistance began to wane in early autumn when the protein content and digestibility of native and improved pastures are usually high²², and more significantly, resistance increased again in winter or early spring when nutritional value of pasture is lower than at other times of the year²³. This suggests that the seasonal change in tick resistance in the steers cannot be explained by seasonal changes in nutrition. This is in accord with the results of a concurrent experiment in which crossbred and European bulls were maintained in tick free yards and

allowed to feed ad libitum on lucerne hay. This demonstrated that the seasonal changes in resistance occurred in bulls maintained on a constant diet of high nutritional value (table).

In conclusion, our results confirm those^{5,6} which demonstrate a seasonal cycle in the expression of acquired resistance to *B. microplus* in cattle with previous tick experience. The cycle occurs irrespective of breed and the nutritional state of the cattle. There were differences in the magnitude and timing of the seasonal cycle of resistance between bulls and steers at Amberley and between the steers at the 2 localities. These may have been due to differences in nutrition and/or latitude. The seasonal cycle in resistance is of obvious importance in understanding the population dynamics of the cattle tick, and is relevant to control strategies, particularly in regions where tick populations build up to a maximum in winter months²⁰.

- 1 W.A. Nelson, J.F. Bell, C.M. Clifford and J.E. Keirans, J. med. Ent. 13, 389 (1977).
- 2 L.L. Callow and N.P. Stewart, Nature 272, 818 (1978).
- 3 J.R. Salisbury and J.H. Arundel, Aust. vet. J. 46, 267 (1970).
- 4 R.D. Hall and W.G. Gross, J. Parasit. 61, 1096 (1975).
- 5 K.B.W. Utech, G.W. Seifert and R.H. Wharton, Aust. J. agric. Res. 29, 411 (1978).
- 6 R.W. Sutherst, K.B.W. Utech, J.D. Kerr and R.H. Wharton, J. appl. Ecol. 16, 1 (1979).
- 7 K.B.W. Utech, R.H. Wharton and L.A. Wooderson, Aust. vet. J. 45, 414 (1969).
- 8 J.C. O'Kelly and G.W. Seifert, Aust. J. biol. Sci. 23, 681 (1970).
- 9 W.J. Gladney, O.H. Graham, J.L. Trevino and S.E. Ernst, J. med. Ent. 10, 123 (1973).
- 10 G.W. Seifert, Aust. J. agric. Res. 22, 159 (1971).
- 11 R.H. Wharton, K.B.W. Utech and H.G. Turner, Aust. J. agric. Res. 21, 163 (1970).
- 12 L.K. Lightner and M.J. Ulmer, Expl Parasit. 35, 262 (1974).
- 13 K.B.W. Utech, R.H. Wharton and J.D. Kerr, Aust. J. agric. Res. 29, 885 (1978).
- 14 J.A. Roberts, J. Parasit. 54, 663 (1968).
- 15 B.M. Wagland, Aust. J. Agric. Res. 29, 395 (1978).
- 16 J.A. Roberts and J.D. Kerr, J. Parasit. 62, 485 (1976).
- 17 M. Brossard, Acta trop. 33, 15 (1976).
- 18 P.R. Wilkinson, Aust. J. agric. Res. 13, 974 (1962).
- 19 R.H. Wharton and K.B.W. Utech, J. Aust. ent. Soc. 9, 171 (1970).
- 20 R.W. Sutherst, R.H. Wharton, I.M. Cook, I.D. Sutherland and A. Bourne, Aust. J. agric. Res. 30, 353 (1979).
- 21 J.C. Bonsma, Fg S. Afr. 19, 71 (1944).
- 22 J.H.G. Holmes, M.C. Franklin and L.J. Lambourne Proc. Aust. Soc. Anim. Prod. 6, 354 (1966).
- 23 C.W. Christian and N.H. Shaw, Proc. Br. Commonw. off. Conf. Spec. Conf. Agric. p.225 (1949).

The effects of histamine dihydrochloride on blastocyst implantation in the laboratory rat

D.J. Dudzik and H.H. Vallowe

Biology Department, Indiana University of Pennsylvania, Indiana (Pennsylvania 15705, USA), 27 December 1979

Summary. This investigation studied the effects of intrauterine injections of histamine dihydrochloride on blastocyst implantation in the laboratory rat. Results of this study lend support to the idea that histamine is the initiator of implantation through the induction of decidualization in this species.

Shelesnyak¹ and Shelesnyak and Kracir² were the first to suggest a role for histamine in implantation and proposed that a surge of estrogen produced by the ovaries on the 5th day of pregnancy was responsible for histamine release. Histamine, in turn, sensitized the uterine cornua to respond to the implanting blastocyst by acting as an inducer of decidualization. Additional evidence in support of this hypothesis was that uterine histamine content was found to

increase in decidualomata³ and that the induction of decidualization was inhibited by antihistamine⁴. Also, Riley⁵ concluded that a reduction in endometrial mast cells could be correlated with the release of histamine and these observations taken together suggested a role of estrogen via histamine release in the uterus. In our study, we were interested in establishing a dose-response relationship between histamine dihydrochloride levels and viable implan-

tation sites and thereby allow for successful predictions of implantation frequency.

Methods and materials. A total of 46 virgin female rats of the Charles River CD outbred albino strain were mated and divided into 3 groups designated as uninjected controls, saline-injected controls and histamine dihydrochloride-injected animals. The number of individuals within these groups varied with 18, 7 and 21, respectively. Histamine dihydrochloride was administered as 7 dose levels in concentrations ranging from 0.05 mg/cornu to 2.0 mg/cornu. Injections were given between 14.00 and 16.00 h on the 5th day of pregnancy; the injected fluid was maintained at 37°C, pH 7.4 and 0.05 ml volume. The injections were accomplished by passing a 25-gauge hypodermic needle through the antimesometrial surface into the lumen of the left uterine cornu approximately midway between the tubouterine junction and the cervix. The right uterine cornu remained uninvolved in surgery and thus served as a contralateral control. On the 18th day after copulation, the animals were autopsied and examined for viable implantation sites.

Results. The results of the present study indicate that there is no inherent unilateral bias in the number of implantations per cornu in this strain of laboratory rat ($p < 0.005$). The trauma induced by surgery and injection of the left cornu had no significant effect on the right cornu of the same animal ($p < 0.05$), but significantly reduced the number of implantations in the left cornu of the saline-injected group ($p < 0.05$). The effect of histamine dihydrochloride was observed to be localized in the left cornu and did not significantly affect the contralateral cornu ($p < 0.005$). Reductions in the number of implantations were also observed in the histamine dihydrochloride-injected group at concentrations ranging from 0.05 mg/cornu to 1.2 mg/cornu. Only the 2 highest concentrations of histamine dihydrochloride (1.5 mg/cornu and 2.0 mg/cornu) were

observed to significantly increase the number of implantations as compared to the left (surgery-involved) cornu of the saline-injected group ($p < 0.005$).

Discussion. The reductions in the number of implantations observed in the histamine dihydrochloride group (0.05 mg/cornu – 1.2 mg/cornu) are suggested as being caused by the initiation of artificially-induced deciduomas which may have altered the intrauterine environment necessary for normal blastocyst implantation. Vascular constriction due to the proliferation of decidual tissue may have increased competition between blastocysts for nutritive and hormonal support and thereby increased implantation failure. Apparently, the implantation promotive effect at the 2 highest concentrations of histamine (1.5 mg/cornu and 2.0 mg/cornu) was sufficient to surpass the inhibitory effect thought to be caused by the induced deciduomas. A linear regression analysis provided a description of the relationship and was found to be $Y = -0.0126 + 3.393 X$. The strength of association (r^2) between Y (number of viable implantations) and X (histamine dihydrochloride dose level) was found to equal 0.5315. The results of this study show that pharmacological doses of histamine dihydrochloride injected intraluminally induced deciduomas (all concentrations) and significantly increased implantations (1.5 mg/cornu and 2.0 mg/cornu).

- 1 M. Shelesnyak, *Rec. Prog. Horm. Res.* 13, 269 (1957).
- 2 M. Shelesnyak and P.F. Kracir, in: *Delayed Implantation*, p.265. Ed. A.C. Enders. University of Chicago Press, Chicago 1963.
- 3 H.C. Cecil, F.R. Wrenn and J. Bitman, *Endocrinology* 71, 960 (1962).
- 4 M. Shelesnyak, *Am. J. Physiol.* 170, 522 (1952).
- 5 J.F. Riley. *The mast cells*. Livingstone, Edinburgh and London 1959.

Evidence for an involvement of acetylcholine in self-stimulation of the prefrontal cortex in the rat

F. Mora, F. Vives and F. Alba¹

Department of Physiology, School of Medicine, University of Granada, Granada (Spain), 2 January 1980

Summary. The effects of injections of antagonists of muscarinic and nicotinic receptors on self-stimulation of the prefrontal cortex in the rat were studied. The results of this investigation suggest that acetylcholine is involved in self-stimulation of the prefrontal cortex through activation of muscarinic receptors, and also suggest a possible interaction between acetylcholine and dopamine in mediating self-stimulation of this area of the brain.

The neurochemical properties of the prefrontal cortex are currently of great interest because of its functional involvement in a variety of types of behaviour (see references cited by Mora et al.^{2,3}). At present, there is considerable evidence for an involvement of dopamine in self-stimulation of the prefrontal cortex (medial and sulcal areas), although, as shown recently, this neurotransmitter does not seem to be the exclusive neurochemical substrate^{4,5}. Since noradrenaline, also present in the prefrontal cortex, does not seem to participate in self-stimulation of this area of the brain (Mora et al. unpublished results) it would be possible that other neurotransmitters, different from catecholamines, are also involved⁶.

Recently it has been reported that acetylcholine, substance P and dopamine terminals coexist within the same deep layers in the medial prefrontal cortex⁷. This coexistence suggest that acetylcholine and/or substance P may partici-

pate in the mediation of self-stimulation in this area of the brain together with dopamine.

In the present series of experiments we have investigated the possible participation of acetylcholine in self-stimulation by studying the effects of subcutaneous injections of muscarinic and nicotinic receptor antagonists.

Material and methods. Monopolar stainless steel electrodes, insulated except for 0.5 mm at the tip, were implanted in the medial prefrontal cortex of male albino rats. After recovery from surgery, the animals were trained for self-stimulation by lever pressing. Stimulus parameters were: 0.3 sec trains; 100 Hz square pulses; 0.3 msec pulse duration; and a current intensity that varied among animals from 0.08 to 0.3 mA. Current intensity was kept constant for all experiments performed on a given animal. Spontaneous motor activity was measured via contacts lining the floor of a 26 × 29 × 36 motility chamber^{8,9}.