Table 2. A comparison of relative responsiveness to photoperiodic treatments of leaf and bud combinations from Los Angeles and Chicago *Xanthium*.

Treatment	Av. flowering response
A. Chicago bud grafted to Los Angeles leaf	0.0
B. Los Angeles bud grafted to Chicago leaf	2.0
C. Los Angeles bud grafted to Los Angeles leaf	0.0
D. Chicago bud grafted to Chicago leaf	4.4
E. Los Angeles bud defoliated	0.0
F. Chicago bud defoliated	0.0
G. Chicago plant (not grafted)	13.4
H. Los Angeles plant (not grafted)	2.8

either the length or the frequency of the dark period resulted in a corresponding increase in floral development. It is of interest to note that alternation of noninductive day length and short-day treatment (Table 1) effectively lowered the flowering response. This is in accord with the results of Lincoln *et al.* (*6*).

In explanation of the low level of flowering response of the Los Angeles *Xanthium*, as compared with the floral development that would be expected in the Chicago stock under comparable conditions of illumination, two possibilities were considered: (i) The buds of the Los Angeles plants may require a greater amount of stimulus to initiate flowering, and (ii) the leaves of the Los Angeles plants may produce less stimulus than the leaves of the Chicago type produce under comparable photoinductive conditions.

The following experiment was designed to test the validity of these postulates. The plants were germinated in flats and 1 week after emergence were transplanted singly to 4-in. pots. The individual plants of the Los Angeles and Chicago types were trimmed and debudded, a single leaf being retained on the donor plant and a single terminal bud on the receptor plant. The plants were grafted 4 weeks after transplanting, and the first short-day illumination was provided 3 days after grafting. All other conditions were the same as those described above.

The data listed in Table 2 indicate that five inductive cycles involving dark periods of 16 hours' duration do not initiate flowering in either a Chicago or a Los Angeles bud in association with a Los Angeles leaf. A Chicago leaf, however, under the same photoinductive treatment will cause floral initiation in either bud type. The intact control plants of both the Chicago (treatment G) and the Los Angeles (treatment H) types flowered in response to the photoinductive treatment. As would be expected from the data given in Table 1, the Los Angeles plants were less responsive to short-day treatment than the Chicago plants. The graft apparently restricted to some extent the amount of stimulus moving from the leaf to the scion bud. It is apparent that the low response of the Los Angeles plants can be attributed in some measure to the small amount of stimulus supplied by the leaf. The response of the Los Angeles bud to a Chicago leaf was less than that of the Chicago bud to a leaf of the same type. The Los Angeles bud therefore may have a somewhat higher requirement for comparable floral initiation.

Variations in natural day-length conditions may exert a selective influence on the photoperiodic responses of a plant. A single plant species distributed over a wide longitudinal range may exhibit differences in photoperiodic sensitivity corresponding to the gradation in longitudinal distribution (*7*). The observed difference in the response of Los Angeles *Xanthium* to photoperiodic induction may represent a similar pattern of natural selection.

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29 September 1958

Hetero Blood Types and Breeding Performance

Abstract. The phenomenon of hybrid vigor apparently depends to some extent upon the degree of diversity between the genes of the two parents. Results are presented which suggest that diversity of cellular antigens might be used as an indicator of general genetic diversity between mates.

In livestock breeding, the phenomenon of hybrid vigor is often manifested by vigorous offspring with a relatively high rate of survival. Generally, the more different the parents are genetically, the more pronounced is the phenomenon of hybrid vigor (*1*). The absence of means to measure the genetic diversity between animals to be used in a breeding program aimed at utilizing hybrid vigor is a deterrent to a widespread exploitation of this phenomenon. The cellular blood antigens of cattle are controlled by genes located on at least 11 different chromosomes, and it has been demonstrated that the frequencies of the blood types vary between different breeds and strains (*2*). A study was made of breeding results in dairy cattle in which the cellular antigens of the mates were known.

Table 1. Data on matings between 310 females and 32 males of the Holstein-Friesian breed.

No. of antigens in which mates differed	No. of matings	No. of offspring	No. of offspring that survived (%)
1– 5	305	140	46
6– 7	433	212	49
8– 9	357	176	49
10–15	169	101	60
Total	1264	629	50

In order to study whether similarity or dissimilarity of mates influences the probability of survival of the young, a tabulation was made of 1264 matings between 310 females and 32 males of the Holstein-Friesian breed, in which the presence or absence of 20 different cellular antigens had been determined (*3*). Only matings between supposedly fertile animals were included in the tabulation shown here.

The matings were classified on the basis of the number of cellular antigens in which the two mates differed. The results are presented in Table 1.

The rate of survival increased as the difference in antigens increased. The chi-square of 8.72 is significant at the 0.05 level.

No claims are made that cellular antigens are responsible for fertility and successful embryonic development. However, dissimilarity of antigens may be used as an indicator not only of dissimilarity of genes affecting blood antigens but of dissimilarity of other genes affecting productive traits as well. Further studies on other productive traits seem justified in order to determine whether differences manifested with respect to blood antigens might be used as a guide in mating for "hybrid vigor" (*4*).

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Use of an Organic Carbon Dioxide Buffer in vivo

Abstract. The compound 2-amino-2(hydroxymethyl)1,3-propane diol was administered intravenously to apneically oxygenated dogs over a 1-hour period. Arterial blood *p*H remained normal, and an estimated 18 to 28 percent of the CO_2 produced during apnea was recovered in the urine.

Pardee (*1*) and Krebs (*2*) have shown that in vitro "CO_2 organic buffers" can maintain pCO_2 constant in the gas phase according to the equation:

$$R\text{-NH} + H_2O + CO_2 \rightleftharpoons HCO_3^- + R\overset{+}{N}H_2$$

One of these compounds, $(CH_2OH)_3C—NH_2$, was utilized in the apneically oxygenated dog to combat the increase in pCO_2 and the concomitant rise in H^+ concentration.

"Apneic oxygenation" (*3*) is a condition of ventilatory arrest, induced with succinylcholine chloride, following a 1-hour period of ventilation with 100-percent oxygen (denitrogenation), and during which the trachea is connected to a reservoir containing 100-percent oxygen. In this condition oxygenation of the blood is maintained but CO_2 accumulates. After 1 hour of apnea one typically observes (*4*): (i) a 50-percent fall in arterial oxygen saturation and a fall in oxygen uptake to 60 percent of the control value; (ii) a rise in arterial pCO_2, (for example, to 376 mm-Hg), in total plasma CO_2 (to 41.4 mmole/lit.), and in plasma HCO_3 (to 31.0 mmole/lit.); (iii) a fall in arterial blood *p*H (for example, to 6.56) and a drop of the plasma HCO_3^-/H_2CO_3 ratio to 3. Signs of severe hypercapnia are present: wide fluctuations in systemic blood pressure, bradycardia, cardiac arrhythmia, a 200-percent increase in intracranial pressure, a rise in serum potassium level, and anuria. It has been established (*4*) that 40 percent of all dogs maintained under such conditions die within the hour of apnea. Reestablishment of spontaneous ventilation in the survivors required at least 1 hour of mechanical ventilation with pure oxygen.

Six mongrel female dogs were subjected to "apneic oxygenation" for periods of 1 hour to 1 hour and 20 minutes. At the onset of apnea an intravenous 0.33*M* infusion of 2-amino-2(hydroxymethyl)1,3-propane diol (*5*) in 0.2-percent NaCl was administered at the rate of 1 ml/kg min—a quantity deemed sufficient to bind the estimated amount of CO_2 produced by the animal (approximately 0.33 mmole/kg min). After 1 hour of apnea, (i) arterial oxygen saturation was 100 percent and oxygen uptake was at preapneic levels; (ii) average arterial pCO_2 was 89 mm-Hg, total plasma CO_2 was 52.9 mmole/lit., and plasma bicarbonate was 50.1 mmole/lit.; (iii) arterial blood *p*H was maintained within 0.2 *p*H unit of the control preapneic level and after 1 hour of apnea averaged 7.37; the HCO_3^-/H_2CO_3 ratio was 19. Mean blood pressure remained close to that of the preapneic control period and heart rate decreased, but no arrhythmia occurred, and cerebrospinal fluid pressure did not change significantly from normal (Fig. 1). Serum potassium levels remained constant, and instead of renal shutdown there was profuse diuresis.

The urinary *p*H averaged 7.54, the HCO_3^- concentration was 89 mmole/lit., and 26 percent of the estimated total CO_2 produced by the animal during apnea (*6*) was recovered in the urine. The dogs resumed spontaneous breathing between 15 and 20 minutes after the end of the procedure, and all of them survived, without any apparent ill effect. Two animals in this series underwent successfully a second period of 80 minutes of apnea, 16 and 23 days, respectively, after the first one.

This organic buffer base appears to combat the deleterious effects of CO_2 retention in two ways. The compound's CO_2 buffering capacity maintained *p*H within the normal range and limited the rise in pCO_2, even though the total amount of CO_2 produced and retained by the body was considerably greater than it was in the control group of apneically oxygenated animals. (The lesser production of CO_2 by the control animals, as compared with that of the experimental group, probably reflects a depression of metabolic function.) In addition, 18 to 28 percent of the estimated total amount of CO_2 produced during apnea was excreted by way of the kidney.

Although the amount of CO_2 retained within the organism is high, it would appear that the living organism can tolerate it well when its two fractions, bicarbonate and free carbonic acid, are in suitable proportion to maintain the acid-base balance of the blood within normal limits.

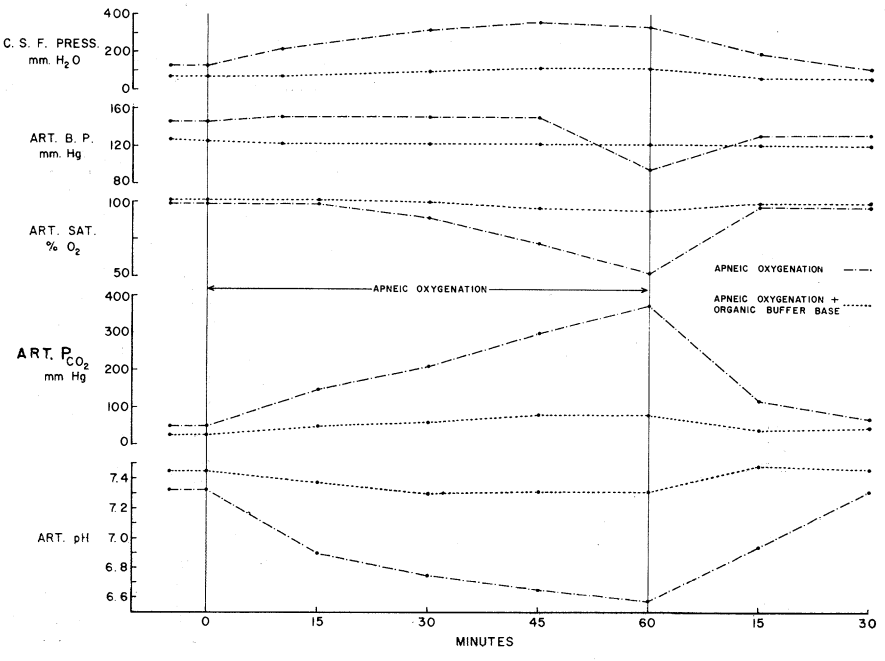

Fig. 1. Effects of intravenous administration of organic buffer base [$(HOCH_2)_3—C—NH_2$] in a dog during a 1-hour period of "apneic oxygenation." While extreme changes are observed during a similar period of apnea in a control animal (dot-dashed line), in the test animal (broken line) there is little or no change in cerebrospinal fluid pressure (CSF), in percentage of oxygen saturation of arterial blood, or in arterial blood *p*H, and there is a 45 mm-Hg rise in arterial pCO_2.

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