ENERGY - SAVING CHARACTERISTICS OF BUFFALOES

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ABSTRACT

Three physiological characteristics of buffaloes; wallowing behaviour, body temperature lability and efficiency in oxygenation of the blood were reviewed from the viewpoint of energy economy in comparison with cattle. Wallowing behaviour, which is lacking in cattle, greater body temperature lability associated with the changes of the ambient temperature, and higher efficiency in oxygenation of the blood, as well as lower body temperature in buffaloes may contribute to the improved efficiency of energy utilization in these animals compared with cattle under high temperature conditions.

INTRODUCTION

In the fields of the humid tropics and subtropics of South-East Asia and South Asia, thin cattle are commonly seen but it is rare to see a protruding rib on buffaloes even though they feed on the same source of forage. Thus, it is considered that buffaloes may be more efficient than cattle in digesting crude fibers. This assumption, however, has not yet been substantiated hitherto.

During the last nine year's studies on the environmental physiology of swamp buffaloes, we observed some energy-saving characteristics which may be associated with the sturdiness of the animal compared with cattle under poor feeding conditions. These are (1) lower body temperature,(2) wallowing behaviour, (3) greater lability in body temperature and (4) higher efficiency in oxygenation of the blood. Since it is well established that the body temperature of buffaloes is lower than that of cattle (Mason 1974), the purpose of this paper is to review and outline the other three characteristics which appear to be very important from the viewpoint of buffalo production.

WALLOWING BEHAVIOUR

It is well known that at high environmental temperatures buffaloes are able to dissipate the excess heat through wallowing. Fig.1 (Chikamune, et. al. 1987) shows the changes of physiological conditions in buffaloes when they were exposed to direct solar radiation (580 kcal/ m^2/h). The rectal temperature and respiration volume in the exposed buffaloes (Group 1)began to increase rapidly just after the onset of exposure. After one hour of latent period, heat production also started to increase and finally reached a value twice as high as the initial one. On the other hand, heat production remained relatively constant in both the water-sprayed (Group 2) and the control (Group 3, kept in shade) animals, indicating that

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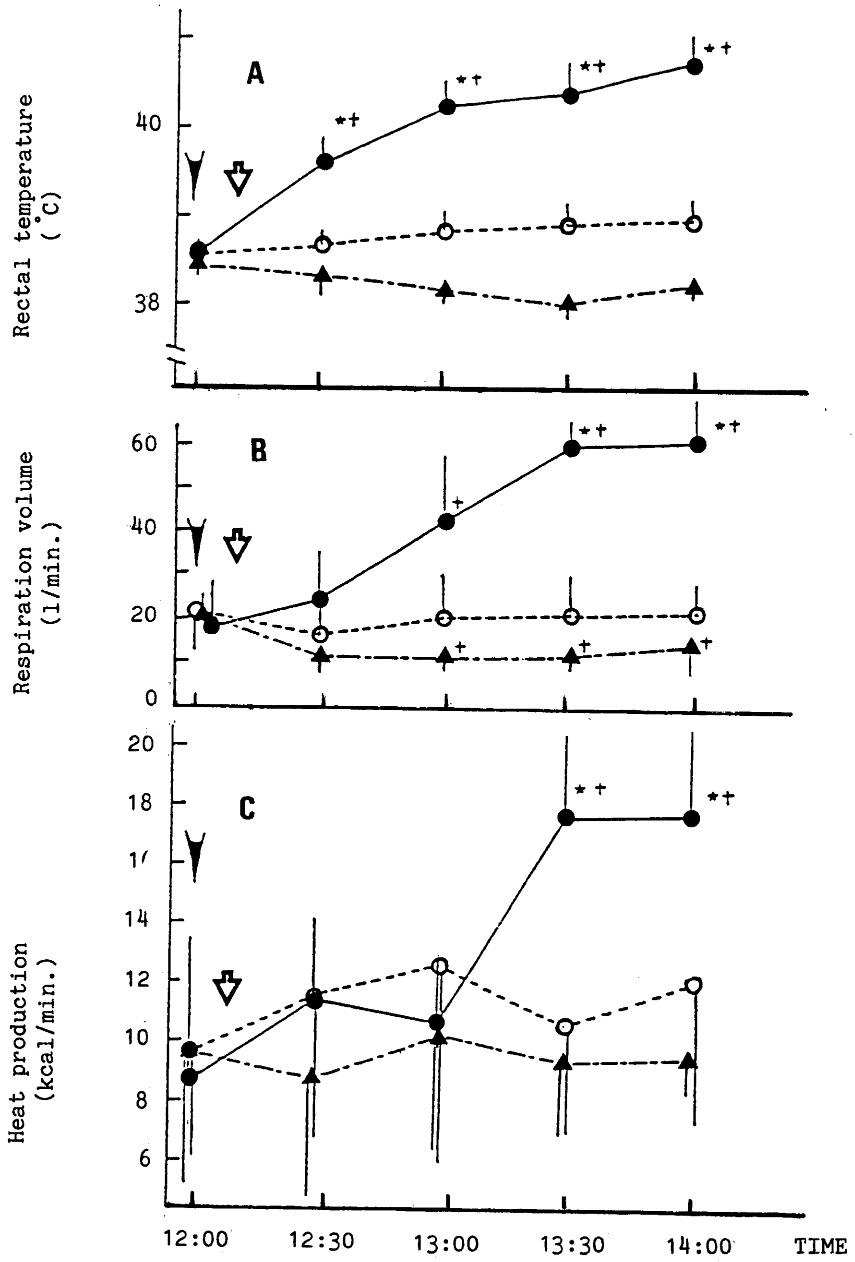

Fig. 1 Changes in rectal temperature, respiration volume and heat production in buffaloes subjected to 3 different treatments; exposed to solar radiation (Group 1, ●—●), sprayed with water during exposure (Group 2, ▲--▲) and kept in shade (Group 3, ○---○). (M±SD;n=3)

*: significant difference from Group3 (P<0.05)
†: significant difference from 12:00 (P<0.05)
▼: Onset of exposure to direct solar radiation (Groups 1 and 2)
⇩: Onset of spraying of water (Group 2)

water-spray was very effective in decreasing excess heat production due to heat load. Since the lowering effect of wallowing on body temperature and respiration rate in buffaloes is more significant than that of spraying (Chikamune and Shimizu 1983), wallowing is very important not only for the physical well-being of buffaloes but also for saving wasteful heat production under heat load.

BODY TEMPERATURE LABILITY

Body temperature lability associated with the seasonal and diurnal changes of air temperature are greater in buffaloes than in cattle. Fig.2 (Chikamune, 1987) shows the effects of abrupt transfer from a normal (18.7°C) to a high environmental temperature (35°C, fixed) on body temperature and thermoregulatory responses in swamp buffaloes and Holstein cattle. The abrupt rise in the ambient temperature caused increases of the rectal temperature by 0.3°C both in buffaloes and cattle during the first 0.5 h of exposure. In cattle this increase was associated with the rise of the respiration volume, oxygen consumption and sweating rate, and from then onwards the rectal temperature remained constant. In contrast, the rectal temperature in the buffaloes continued to increase thereafter, but no marked changes in other physiological parameters were observed, even when the rectal temperature reached 38.4 C, indicating that exposure to a high temperature was less effective as a stimulus initiating thermoregulatory mechanisms in this species. The thermoregulatory activities especially via respiratory vaporization,as observed in cattle in Fig.2,easily lead to an increase in heat production. It is expected, therefore, that the rise in body temperature without thermoregulatory activities will have an advantageous effect on the energy economy of buffaloes. The buffaloes dispense with these expensive activities because they can at any time achieve effective evaporative heat dissipation by utilizing ectosomatic water instead of endosomatic water.

EFFICIENCY IN OXYGENATION OF THE BLOOD

The haematocrit and red blood cell counts were greater in buffaloes than in Holsteins (Chikamune and Shimizu, 1984). The oxygenation of the blood was also more efficient in buffaloes than in cattle. Fig.3 (Chikamune et al. 1986) shows the seasonal changes in the oxygen consumption volume and the percentage of oxygen consumption in buffaloes and cattle. These results indicate that buffaloes inhaled only 70% as much air as did cattle, though the two species consumed similar amount of oxygen. If it is assumed that the energy consumption of the respiratory muscles and the heart together account for roughly 20% of the total energy consumption (Whittow and Findlay, 1968), and that the use of this energy is proportional to the amount of inhaled air, then, when compared to cattle, the economy of energy consumption of the buffaloes amounts to 6%. More superficial respiratory movements with a lower frequency, which are associated with a higher percentage of oxygen consumption and lower respiration volume in buffaloes, may contribute to an improved efficiency of energy utilization in this species.

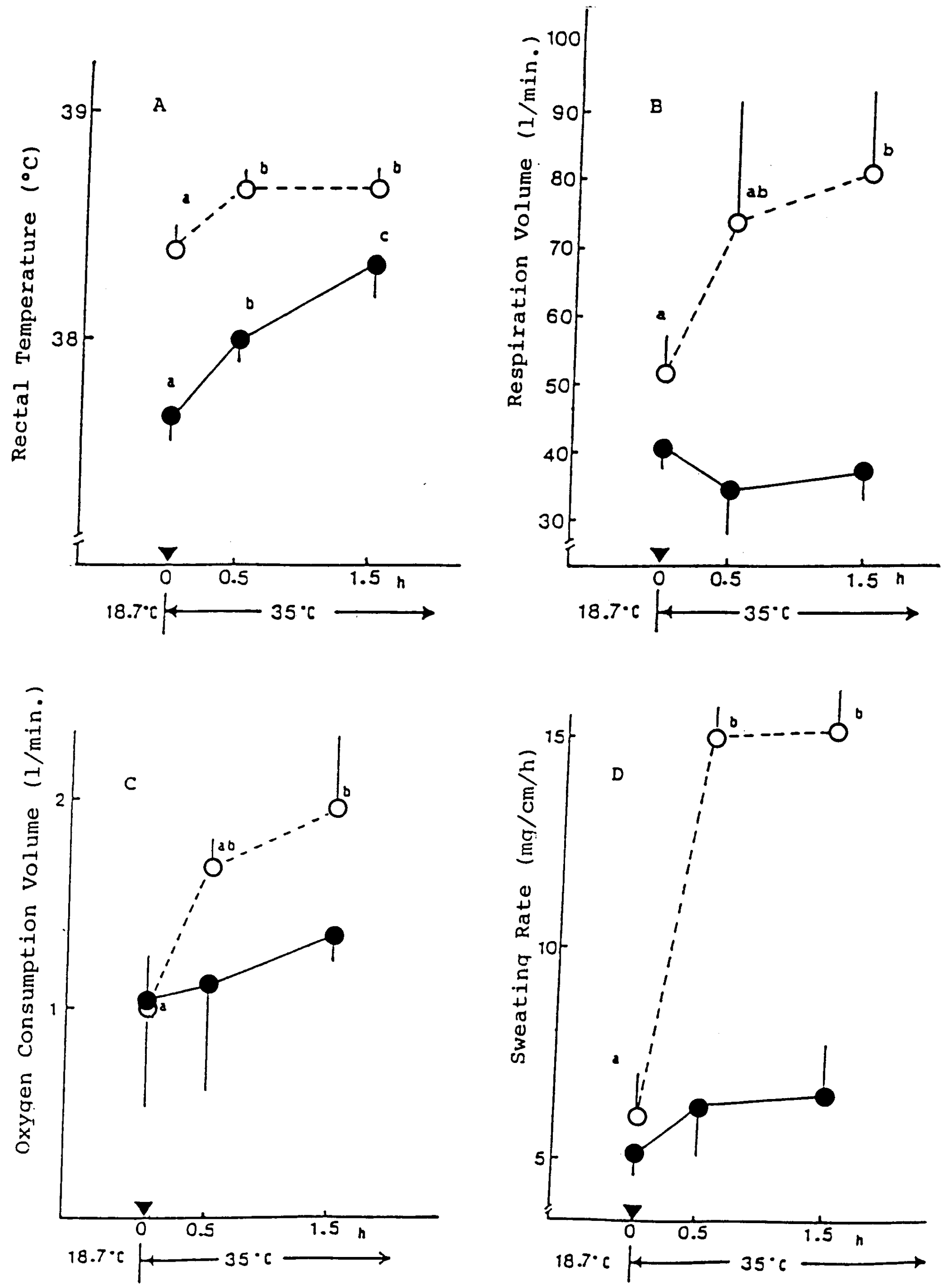

Fig. 2 Changes in rectal temperature (A), respiration volume (B), Oxygen consumption volume (C) and sweating rate (D) in buffaloes(●—●) and Holstein cattle (○----○) by abrupt exposure to high environmental temperature (M±SD, n=3).

▼ : Onset of exposure to high environmental temperature.

abc : Numerals in the same species that do not have at least one superscript in common differ ($P<0.05$).

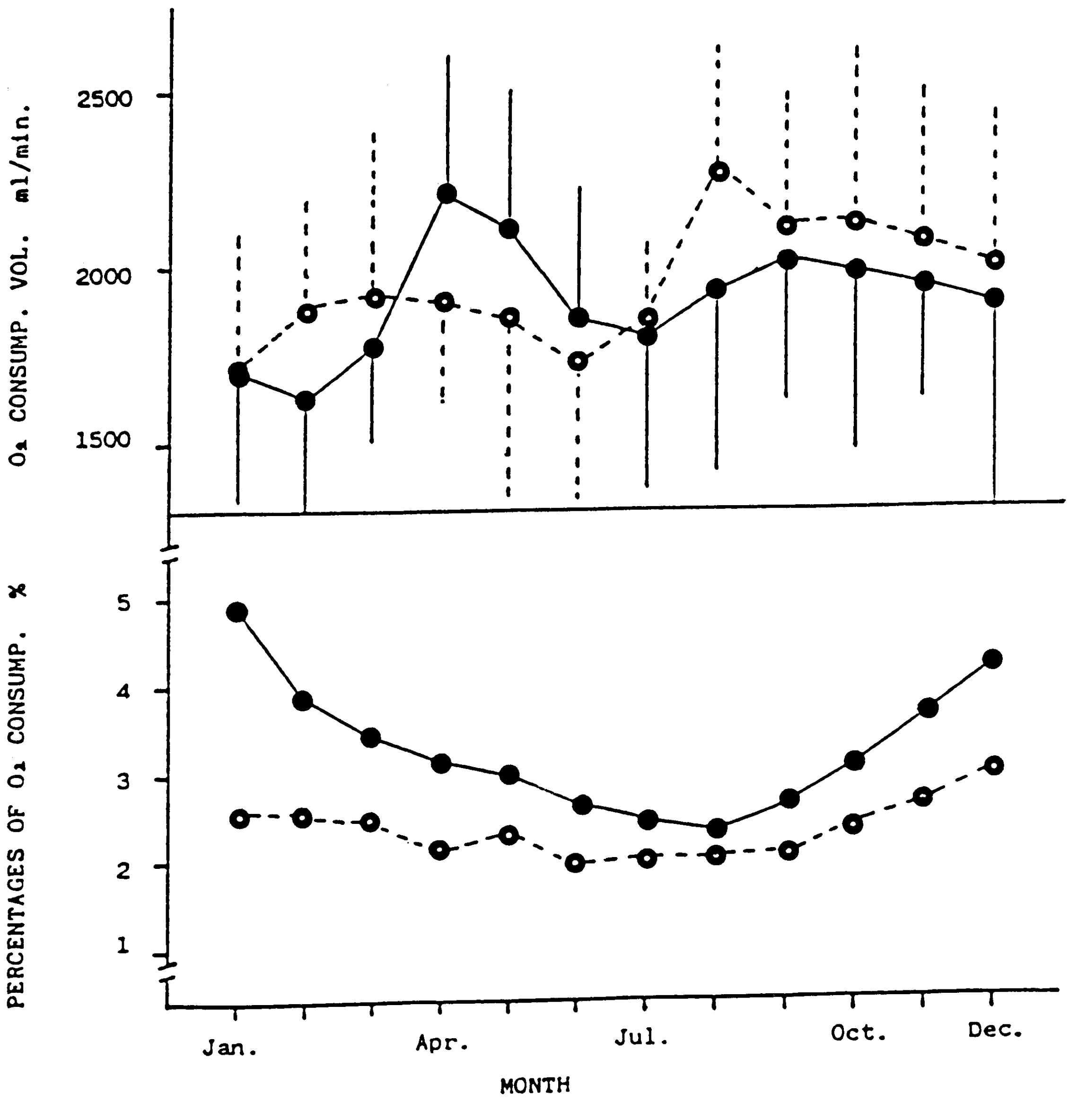

Fig. 3 Seasonal changes in oxygen consumption volume and percentages of oxygen consumption in the inhaled air volume in buffaloes (●—●) and cattle (○----○). (M±SD, n=4)

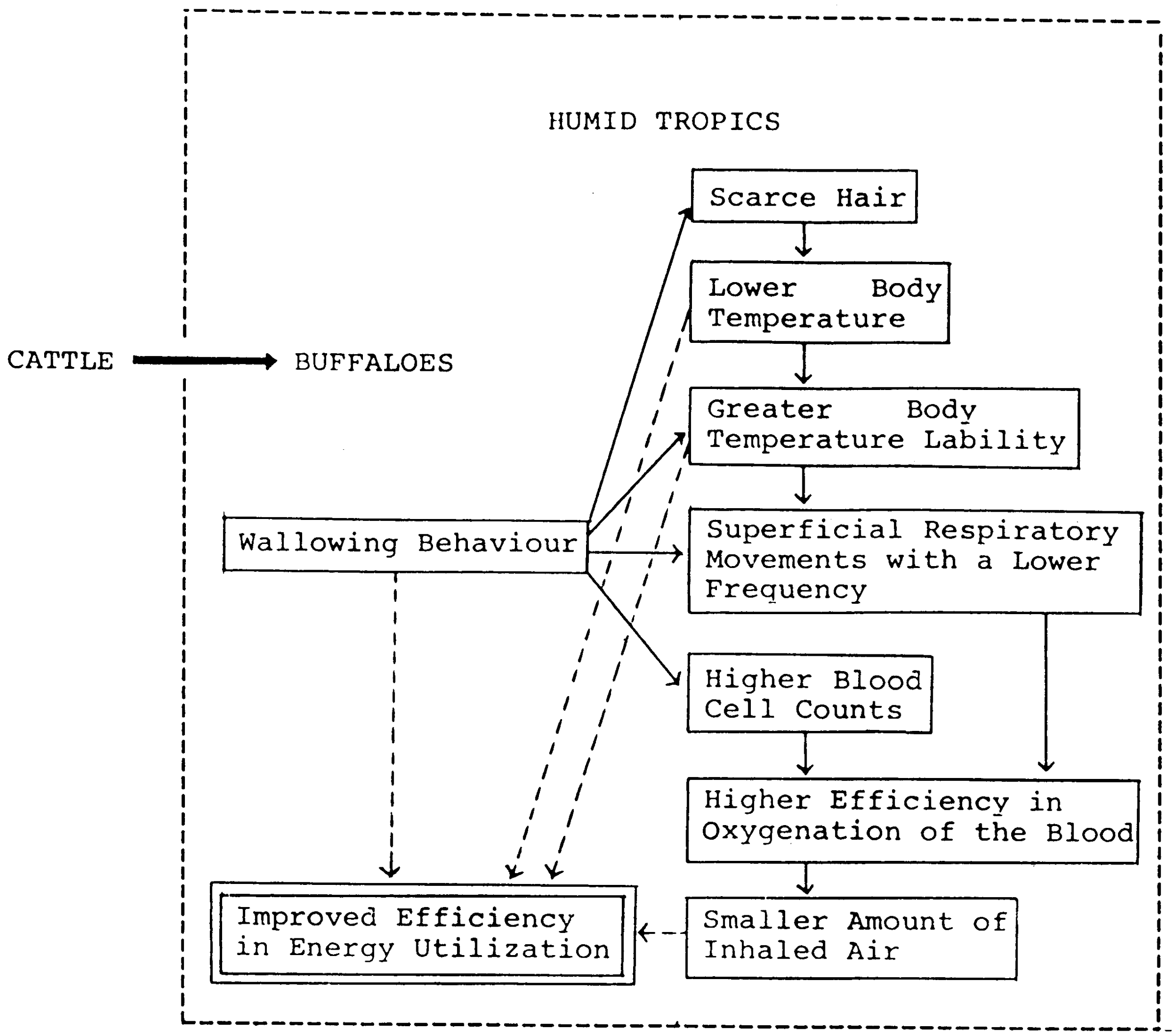

Fig. 4 Schematic diagram of the hypothesis on the mutual relations of the characteristics in buffaloes from the viewpoint of evolution.

MUTUAL RELATION OF THE CHARACTERISTICS

Fig.4 illustrates a schematic diagram of the hypothesis on the mutual relations of the above-mentioned characteristics from the viewpoint of evolution. In ancient times, when cattle or the common ancestors of cattle and buffaloes advanced into the humid tropics, some of them, through their adaptive ability to survive, learned to wallow in available pools under heat load. They acquired, as a result, many characteristics, i.e., scarce hair, greater body temperature lability, superficial respiratory movements with a lower frequency and higher blood cell counts, during the course of evolution. The mean value of body temperature also decreased due to scarce hair. Superfical respiratory movements with a lower frequency and higher blood cell counts ensured higher efficiency in oxygenation of the blood, and this resulted in a smaller amount of inhaled air. Thus, the wallowing behaviour, lower body temperature, greater body temperature lability and smaller amount of inhaled air are all characteristics that contribute to the improved efficiency in energy utilization in buffaloes under high temperature conditions.

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