

CLINICAL DISEASE AND FERTILITY  
ASSOCIATED WITH LOW PHOSPHORUS SUPPLY IN WATER BUFFALOES

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During the implementation of a clinical animal health service in the province Punjab (Pakistan), 16% treatments of all general diseases in adult buffaloes were either hemoglobinuria or a condition associated with stiff gait labelled OSTEOMALACIA. Both diseases were reported from India (Arneja et al. 1987, Pandey and Misra 1987) and osteomalacia from Egypt (Abdou et al. 1986). Because hemoglobinuria occurred mainly during lactation, the disease was called postparturient hemoglobinuria or RED WATER. The "stiff-gait" disease was suspected to be OSTEOMALACIA. The objectives of subsequent investigations were to confirm the hypothesized association between the two diseases and low phosphorus levels in daily rations and blood serum as well as subclinical effects on conception rates.

#### Study Material and Methods

Out of 266 treatments carried out against either of the two diseases over a period of two years, 131 were against hemoglobinuria and 135 against osteomalacia. Sera of 38 REDWATER and 20 OSTEOMALACIA cases and 24 controls were tested for anorganic phosphorus in a case-control study. Controls were matched for sex, age and herd of origin. Subsequently, a subsample of the same population of approx. 30.000 buffaloes in 40 villages was screened for fertility, reproductive diseases, forage rations, nutrient contents of various fodder plants, and management parameters. A total of 1349 female buffaloes in breeding age on 226 herds stratified for farm size were monitored over 2 years. Feed rations and nutrient contents in forage plants were measured in 30 of these herds by fortnightly visits over a period of 12 months. Additionally, forage crops were sampled from a larger number of farms to derive more valid estimates of the nutritive value of traditionally cultivated feed types. In total 1088 feed samples were processed in the laboratory for dry matter, crude protein, metabolisable energy (gas production of ruminal fluid), crude fibre, and minerals.

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## Associations with Clinical Disease

Among 131 REDWATER cases, 84% occurred during December-March and 84% were during the second or higher lactation. Breeding females in reproductive age were 7.4 times more likely to get REDWATER between December-March and 12.4 times more likely to get OSTEOMALACIA during the subsequent period of March to July as females in other seasons (table 1). Both risk periods were after the main calving season and started at the end of the breeding season. The season of disease coincided with the period of the year during which egyptian clover (berseem) was the main feed component containing a wide calcium/phosphorus ratio of 6:1. The stratification of REDWATER cases by reproductive status resulted in 15% being 7-10 month pregnant, 51% during 0-3 month and 34% 4-12 months after calving. The comparison with the respective frequencies in the sample population (n=1349) showed that early post partum buffaloes were at higher risk than other cows while, disease frequency in late lactation was significantly lower (OR=0.3). Risk of disease at late pregnancy was equally high when compared to lactation at any stage. OSTEOMALACIA also occurred during second or higher lactation (85% of all cases, OR=4.3). Lactation stages at onset of symptoms were not observed because cases had histories of gradually increasing severity of 1-6 months thus, chronic in nature.

Serum anorganic phosphorus below an arbitrary cut point of 0.97 mmol/l (=3mg%) was 33 times more frequent in REDWATER cases and 20 times in OSTEOMALACIA than in the matched controls (table 2). Only 17% of the controls and 7% of the population subsample were below this level. Average serum values were 0.52 mmol/l in REDWATER cases, 0.68mmol/l in OSTEOMALACIA cases, 1.26 mmol/l in matched controls, and 1.85 mmol/l in the population subsample. The reason why matched controls had lower serum phosphorus than herd-mate cases under similar management and feeding regimes is seen in different milk production and possibly selective addition of concentrates to the feed ration of high producing females. Among 503 lactating buffaloes of the survey sample, average serum phosphorus during the risk period (Dec.-Mar.=winter) was significantly lower than means of either summer (Apr.-June) or fall (July-Nov.). If it is assumed that 60% of all REDWATER cases that occurred in the area were brought forward for treatment, the estimated annual incidence of this disease were 2% among females of reproductive age or approximately 0.4% in the population.

## Association with Fertility

Climate or total nutrient intake were poorly correlated with monthly conception rates. Better correlations were obtained between conception and relative amounts of feed intake, ie. the protein/energy-ratio and the Ca/P-ratio in the daily ration (figure 1). Both lines appear to be inversely related to conception. Multiple linear regression using monthly conception as dependent variable and monthly means of feed components as predictor variables explained 54% of the total variation. The Ca/P ratio, the

energy concentration, the proportion of straw in dry matter intake, and Magnesium intake were more important predictors than total nutrients, total dry matter, total crude protein or relative crude protein in dry matter, total crude fibre, and total energy. The role of the mineral complex (Ca, P, Mg) and particularly the Ca/P ratio were of primary importance in predicting fertility. It was concluded that wide Ca/P-ratios in the forage is inhibitive of adequate phosphorus uptake and that this is associated with the occurrence of clinical hemoglobinuria esp. during early lactation. The Ca/P-ratio may have greater impact on fertility than other nutrients or climate. A causal role of phosphorus as component of the sufficient cause for REDWATER, OSTEOMALACIA and conception in water buffaloes is strongly hypothesized.

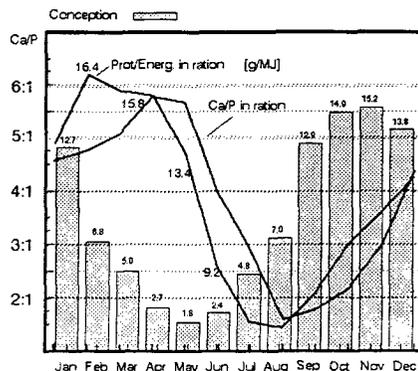


Fig 1 Monthly Conceptions Relative to Nutrient Ratios

Table 1. Odds Ratios for Risk Factors Associated with 131 REDWATER, 135 OSTEOMALACIA Cases and 1349 Controls (95% Conf.Int.)

Risk Factors	RED WATER	OSTEOMALACIA
Season	7.4 (4.6, 12.0)	12.4 (7.0, 22.0)
Parity (>1)	4.0 (2.5, 6.4)	4.3 (2.7, 7.1)
<u>Lact.Stage:</u>		
7-10 m.pregn.	1.2 (0.7, 2.0)	n.a.
0-3 m.lact.	3.4 (2.4, 4.9)	n.a.
4-12 m.lact.	0.3 (0.2, 0.4)	n.a.

Table 2. Proportions of Cases and Controls Below or Above the Cut Point of 0.97mmol/l Anorganic Phosphorus in the Serum

Animal Category	n	< 0.97	> 0.97	Odds Ratio
Survey Cows	1349	7%	93%	
Matched Controls	20	17%	83%	
Red Water	38	87%	13%	33 (8,138)
Osteomalacia	24	80%	20%	20 (4, 93)

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