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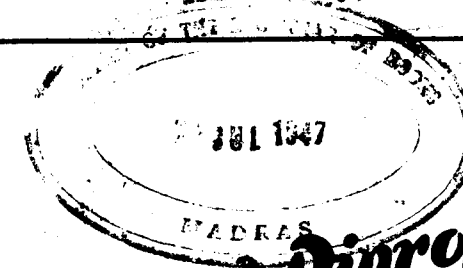
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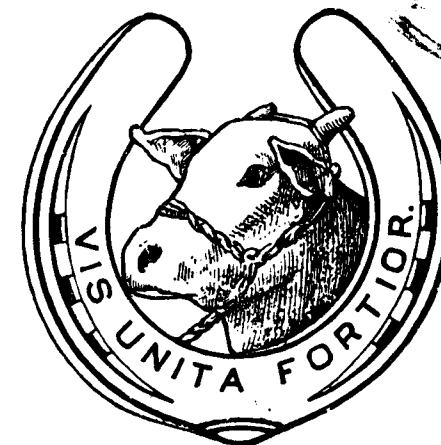
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THE INDIAN VETERINARY JOURNAL

(The Journal of the All-India Veterinary Association)



Editor:

P. SRINIVASA RAO, G.M.V.C.

Veterinary Surgeon, Madras.

Office: 26, Wallajah Road, Mount Road, Madras 2, (S. India)

NOTICE

The Indian Veterinary Journal

A Bi-monthly Record of Veterinary Medicine and Surgery
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EDITOR:

P. SRINIVASA RAO, G.M.V.C.



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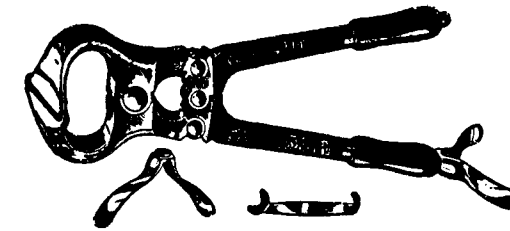
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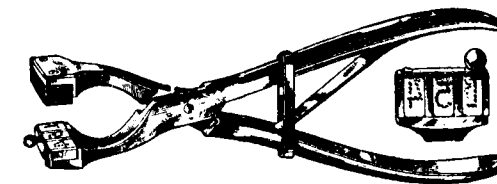
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CONTENTS

PAGE

I. General Articles

- Racing Joints.—By Rao Bahadur R. Swaminatha Ayyar, B.A., G.M.V.C. ... 1
Some Recent Developments in Artificial Insemination of cattle.—By K. P. Chandrasekharan Nair, B.V.Sc. ... 3
Schistosomiasis Among Sheep/Goats in Poona R.I.A.S.C. Butchery.—By Capt. M. V. G. Rao, I.A.V.C. ... 11
The Blood-Group Identifications of Various Indian Breeds of Cattle in India.—By Balwant Singh, G.P.V.C. ... 13
The Comparative Value of some concentrates in the feed of growing cattle.—By N. C. Das Gupta ... 30

II. Editorial

- The Livestock Section—Madras ... 49
New Appointments.—Sri M. Y. Mangrulkar, M.Sc., M.R.C.V.S., D.T.V.M., Rao Sahib T. Vinayaka Mudaliar, G.M.V.C. ... 51

III. Clinical Articles

- Canine Tick Fever.—By Capt. G. Venkata Narasu, G.M.V.C., P.G. ... 52
Poisoning of Barium Carbonate in a Hen.—By R. N. Srivastava ... 54
Coccidiosis in calves.—By A. Moberly, G.M.V.C. ... 55
A clinical investigation of an outbreak of Anthrax among Cattle with special reference to the sub acute form.—By K. A. Padmanabha Menon, G.M.V.C. ... 56
Carbachol in Veterinary Practice.—By P. C. Tripathi, B.Sc., G.B.V.C. ... 60
Phenamide Isethionate M. & B. in B. Canis.—By Capt. Venkata Narasu, G.M.V.C. ... 62

IV. Correspondence

- Rinderpest Inoculation during Foot and Mouth Disease and Prophylactic inoculation against Rinderpest.—By Mahendra Chandra Paul, G.B.V.C. ... 63
A case for diagnosis.—From Y. Ramanujam, G.M.V.C., and V. Gurusuri, G.M.V.C. ... 63
Livestock Improvement and Veterinary Aid in Bamra State.—By Niranjan Gountia ... 65
Dehorning of Cattle in the Tanjore Delta.—By George Ebenezer ... 67
Bovine Surra: An Occasional condition—Wry Neck.—By George Ebenezer ... 68

V. Abstracts

- Studies on Antirabic Immunisation with Culture Vaccine.— ... 68
Multiplication of B. Anthracis Cl. Chauvois and Pasteurella in Animal carcasses with a note on the rate of cooling of carcasses.— ... 71
Studies on the composition of the blood of farm animals in India.— ... 71
Bagomolasses as Cattle feed, Digestibility and nutritive value of Bagomolasses ... 72
Transmission of Pasteurellosis by the Flea (Ctenocephalides Felis) ... 73
Studies on Newcastle (Ranikhet) Disease Virus Strain differences in amenability to attenuation ... 73
The Occurrence and spread of Fowl Cholera in India ... 74
Animal Nutrition Problem in Bengal ... 74

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THE INDIAN VETERINARY JOURNAL

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General Articles.

RACING JOINTS

BY

RAO BAHADUR R. SWAMINATHA AYYAR, B.A., G.M.V.C.,

Madras.

Among race horses in this country, a condition is very frequently met with which commonly goes by the name of Racing Joint. This condition does not appear to have been met with in any other country as no mention of it is found in any of the text books on Veterinary Surgery. MacGregor in this country is the only author who makes a reference to it in his book 'The Examination of horses for soundness' published as early as 1929. Even he makes only a casual mention of this condition and hence it is thought that the following note would interest the profession.

Racing joint is an apt and expressive term to denote the condition. It is found only amongst race horses and nearly 20 per cent of them are found affected with this condition. During a fairly extensive practice of over three decades, I have not met with this condition in any other type of horses. Even among race horses, it is found only in the fore-legs, either one or both, and never in the hind legs. The only other condition which bears a near semblance to it is the "Cab-horse disease", described by Dollar in his text book on Veterinary Surgery. It may be considered as the ring-bone of the fetlock joint and can be defined as an osteoperiostitis of the Metacarpo-suffraginal joint.

The condition starts early in the racing career of the animal. Animals between the ages of 3 and 5 are very susceptible to it. All breeds of horses—Australian, English and Indian breeds—get it, although the Arabs do not appear to develop it quite so frequently.

The predisposing factors are in the confirmation of the animal. Light and medium horses with upright pasterns are very prone to it; so also animals with contracted high heels.

The exciting factor is concussion. Horses are put into training at a very young age when the bones are yet in the formative stage. If the training is very gradual and judicious, and given on a fairly soft ground, then the concussion is not so seriously 'felt' and very little damage is done to the bones and ligaments. If, on the other hand, the training is injudiciously intensified on a hard ground then, as should be expected, the concussion is increasingly 'felt,' and the bones and ligaments are subjected to great stress and strain. The fetlock joints of the front limbs appear to take this jar in greater force than the other joints in the limbs.

The first thing that draws the attention of the trainer and the rider is the 'feeling bait', of the animal and the absence of a free action. If both the legs are affected, then the action becomes decidedly cramped and restrained giving the impression of a 'tied-in' shoulder. If only one limb is affected, lameness becomes perceptible. Examination shows a certain amount of warmth and tenderness over the fetlock region, particularly the anterior and antero-internal aspects. Manipulation of the joint is resented and it is kept 'eased' while the animal is at rest.

In the early stages, the fetlock joint shows a distinct puffiness which gradually leads to thickening and enlargement. In course of time which may extend to some months, the part becomes hardened with exostosis of varying extent.

The mobility of the joint gets gradually limited with the progress of the disease until finally ankylosis locks the joint.

In the initial sub-acute stage, the lameness is perceptible but intermittent. When the condition becomes chronic, as it invariably does, the animal starts lame, or stiff, as it is very often expressed, but after warming up, goes sound. In cases where callous formation has taken place and the part had become hardened, even the initial stiffness is not noticed. This improvement of the lameness after exercise has been a characteristic feature of the condition and it has been mainly responsible for many an affected animal being kept at work without adequate rest. All the same, in a good percentage of cases, the performance of the animal on the course is not affected and an animal with 'racing joint' continues to win races. This, however, does not last long and the animal falls off gradually. Then it becomes a profitless proposition to be kept on the track any longer. Off racing, such an animal has been used either as a hack or a hunter fairly satisfactorily for some years.

PHOTOS ILLUSTRATING RACING JOINT



Fig. 1
NORMAL LEG

Fig. 2
AFFECTED LEG

METACARPO-SUFFRAGINAL JOINT



Fig. 3
NORMAL

Fig. 4
RACING JOINT

The anatomical changes that take place in the joint are practically akin to those found in cases of ring bones. Consequent on concussion there is periostitis and ostitis of the Metacarpus and suffraginis bone. The strain on the metacarpo-suffraginal joint leads to a certain amount of sprain of the ligaments of the joint. The ensuing inflammatory exudate gradually gets organised resulting in osseous formation around the joint. The osseous formations, though more prominent on the anterior and antero-internal aspect of the joint, are found all round the joint to a varying extent. The articular surfaces of both metacarpas and suffraginis bones have invariably been found to be intact and the deposits of the bone have been only peri-articular. A few cases have been noticed where the new osseous deposits have been so big and prominent as to be frequently struck by the other leg.

The treatment of this condition has been on the lines indicated for Ring bone, viz rest, hot and cold applications, blister with or without firing and absorbents. But the results have been very unsatisfactory. The main reason for this has been the difficulty, as explained already, of enforcing the required amount of rest for the animal.

It need hardly be said that, from a soundness point of view, the condition is a definite unsoundness.

The enclosed photos for which, I am very grateful to Sri K. S. Nair, the principal of the Madras Veterinary College illustrate the condition in a living animal as well as on Post-mortem.

**SOME RECENT DEVELOPMENTS IN ARTIFICIAL
INSEMINATION OF CATTLE.***

BY

K. P. CHANDRASEKHARAN NAIR, B.V.Sc.
Madras Veterinary College.

Artificial insemination as an aid to livestock breeding has made rapid progress in recent years in Russia, America and Denmark. Researches in the technique and semen preservation, essentially by Russian and American workers, have made possible wide application of this method to livestock breeding. The extent to which artificial insemination is made use of in different countries depends mainly on the quality of available sires and the realisation of its genetic and economic possibilities. In Russia, the acute shortage of bulls and the need for rapid improvement of livestock, are responsible for the wide application of this method to livestock breeding. Aggregation of stock on collective farm, greatly aided the application

(*Read at the Provincial Conference of Madras Veterinary Association in September, 1946).

of this method in U.S.S.R. In 1938 according to Neumann (1939) 1.2 million cows were artificially inseminated. But the outbreak of war has greatly impeded the progress of artificial insemination in that country as shown by the figures given by Milovanov (1945). He reports that in 1944 there were 4160 inseminating stations dealing with 3.3. millions of sheep and 2,30,000 cows, representing fivefold decrease compared with 1940. In America and Denmark artificial insemination is employed chiefly for exploiting to the full the use of proven sires for improving dairy cows. In America, the first artificial insemination Association was started in 1938 and since then rapid progress in this field has been noted. Edwards and Richie (1944), state that in March 1943, there were 93 artificial insemination Societies in U.S.A., dealing with 182,524 cows and 574 bulls and the Societies provide service four times the 35 year-old Bull Association movement. In Denmark, since the starting of artificial insemination in 1936, a steady progress has been maintained. In 1944 there were 96 associations inseminating 343,000 cows which represents about one-fourth of the whole cattle population of the country. In England the start was made rather late, the first centre being opened in 1942, but since then a steady progress has been maintained, as shown by the fact that in 1945 there were nine centres for artificial insemination. This steady progress in artificial insemination all over the world shows the growing confidence of the dairy industry in this type of breeding.

Technique:—For semen collection artificial vagina is still the best instrument, though of recent years certain modifications have been introduced by various workers. The original Russian model consists of a thick rubber cylinder fitted with an inner rubber tube of 'latex' type, the ends of which are turned over the ends of the cylinder. At one end of the rubber cylinder there is an inlet for allowing water at the required temperature into the jacket formed by the outer hose and the inner rubber tube. The semen collecting cup is attached to one of the ends of the vagina. In the American model devised by Perry and Bartlett (1939) the semen collecting cup is replaced by a rubber cone with a small test tube. This has the advantage of using a much shorter artificial vagina and the bull ejaculates directly into the test tube, thus minimising the danger of contamination of the semen. Another type of artificial vagina has been described by Salisbury and Willeke (1940) wherein care is taken to ensure that semen is not subjected to any variation in temperature at the time of collection. This type of artificial vagina consists of a water jacket long enough to extend over the test tube which is held at the temperature of the water. It is made from a 28" length of auto-radiator hose $2\frac{1}{4}$ " in diameter and two pieces of 3" flat rubber band tubing. The water jacket is made on the lines of the conventional type, but in addition a second inner lining is used which is tapered at one end by cutting out a V-shaped piece and cementing the edges together leaving an opening just enough to

accommodate a small test tube for semen collection. The larger end of the rubber sleeve is doubled back over the end of the water jacket. Additional advantages of using this type of artificial vagina are that it gives effective cushioning owing to double inner liner and that no heed need be paid to the water pressure. Rauson (1944) advocates the use of a double walled semen cup to prevent chilling of spermatozoa at the time of collection. In actual insemination, the Russian workers still make use of the speculum, whereas in America and England almost universally the use of speculum has been dispensed with for insemination. In the latter method, the cervix of the uterus is grasped by the left hand passed through the rectum, and a glass pipette, introduced through the vagina, is passed into the cervix and the semen slowly injected. A straight glass capillary tube holding a little over 1 c. c. of fluid and an all-glass 2 c. c. syringe is used. The syringe is connected to the capillary tube by means of rubber connection and at the time of insemination, the diluted semen is drawn only into the glass tube and does not come in contact with the rubber connection and glass syringe. Thus the syringe could be used over and over again, whereas a fresh pipette is used for every cow. This method, though difficult for the beginner, has many advantages. The operation is finished quickly with minimum of instruments. There is little chance of semen flowing back into the vagina as often happens in the case of the method with speculum. Further, since for every cow a fresh sterile pipette is used, there is no chance of spreading infection by means of the inseminating instruments.

Semen dilution.—In the field of semen dilution, great progress has been made in recent years. Dilutors are generally divided into two classes; those that act as dilutors only and those in addition serve to prolong the sperm life. The dilutors of the first class prove their worth only if insemination is performed within a few hours of dilution. The dilutors of the second class could in addition be used for preservation of semen. Dilutors are used mainly to increase the volume of the ejaculate, so that larger number of females could be inseminated from one sample. Milovanov (1933, 1934) considers that the evaluation of dilutor should not be based merely on the time of survival of spermatozoa at some arbitrary degree of dilution, as is commonly held. He holds the view that the evaluation should be based on the optimum and the maximum degrees of dilution, since the adverse effect of certain chemicals in the dilutions are not apparent until a high degree of dilution is reached. He states that the ordinary physiological solution such as Ringers, Locke's Tyrode's etc., in spite of views to the contrary, are not suitable as dilutors. These physiological salt solutions as well as accessory gland secretions exert a deleterious action on the mammalian sperm capsules and as such obviously they cannot in any way serve as good dilutors for semen and the only approach to this problem is to be found in the study of the characteristics of the sperms themselves. •Of the

various dilutors described by workers, the common ones in use are the sulphate, the tartarate and the citrate. Gelatinised diluents are also found to be satisfactory.

The sulphate and tartarate diluents contain sodium sulphate and potassium-sodium tartarate respectively with glucose peptone and distilled water. The concentration of the chemicals varies with the species involved. By far the most satisfactory diluting fluid for bull semen is the egg-yolk phosphate buffer described by Lardy and Phillips (1939). It consists of 0.2 gm of K_2HPO_4 , 2.0 gm of Na_2HPO_4 , 12 H₂O and 100 c. c. of distilled water and equal quantity of fresh egg-yolk. One great disadvantage with this otherwise excellent dilutor is the presence of fat globules which interfere with the proper examination of sperms under microscope. To overcome this short-coming Salisbury and co-workers (1941) introduced the egg-yolk citrate dilutor. This medium consists of equal parts of egg-yolk and a M/15 solution of Sodium citrate which has the property of clearing the yolk and thus facilitating easy observation of individual spermatozoa under the microscope. At present egg-yolk phosphate and citrate are the two dilutors in general use. Very recently Mayer and Lasley (1945) have succeeded in isolating a fraction of the egg-yolk that increased the resistance of the sperm to 'cold shock'. In the light of this finding, it is possible to expect a highly efficient dilutor if further work is done in this direction. Knoop (1941) using a gelatin contain dilutor has shown its great superiority over the non-gelatinised dilutor. Milovanov (1938) has also investigated fully the use of gelatinised diluents. He made use of glucose-phosphate and glucose-sulphate diluents to which certain amount of gelatin has been dissolved, giving on setting a jelly-like consistency.

Rate of Dilution:—The common range of dilution is 1:4 to 1:10. It is important that the ratio between the semen and the dilutor is not less than 1:3, as in lesser dilution, the semen is not properly buffered. Recent work of Salisbury and co-workers (1945) shows that semen could be diluted much more than hitherto thought of. They found no significant difference in fertility of samples at dilution rates of one part of semen to 8, 12, 16, 24 and 50 parts of egg-yolk citrate buffer. The total number of inseminations involved in this experiment is 3296 inseminations. This only proves to show that total number of females that can be inseminated without impairing the fertility of the bull is very large and require further investigation.

Preservation and Transport of Semen.—Enormous amount of work has been done in recent years on this aspect of artificial insemination. Elaboration of methods for conservation of sperm life is the chief problem in the development of artificial insemination. Milovanov (loc.cit) states that the death of the sperm outside the body is due to three causes.—(1) destruction of the spermatozoon itself, (2) expenditure of nutritive

materials and (3) auto-intoxication of metabolic products. The cells undergo senescence and their resistance decreases; glycolysis occurs with decrease of glucose, accumulation of lactic acid and there is intake of oxygen and formation of Carbon-di-oxide. Storage of semen involves the bringing of the sperms into a reversible state of activity, to slow down metabolic processes and delay senescence. Since sperm in that state, termed 'anabiotic state' by Milovanov, is still living, it is necessary to ensure supply of energy material and to render the metabolic products harmless. Conditions in the epididymus are most favourable for sperm life and Milovanov (loc. cit) is of opinion that the aim in storage is to reproduce in vitro the anabiotic conditions prevailing in the epididymus. Obviously it is easier with rams and bulls semen in which epididymal contents at the time of collection are slight compared with the semen of boar, stallion and dog. In general, storage of semen depends on (1) gradual cooling to the temperature at which its functional activity is reduced to a low, in a but in a reversible state (2) addition to semen of various substances which supply nutrients and control to some extent metabolic reaction and (3) removal of accessory secretion and concentration of semen. A layer of medicinal paraffin oil recommended by Walton (1933) is probably to reduce gaseous exchange to the minimum and to help the retention of CO₂ which in turn helps to keep the medium from becoming unfavourably alkaline. For storage it is important to see that only good semen samples are used. Herman and Swanson (1941) observed that generally speaking the initial motility gave an indication of storage potentialities. The storage temperature rate of cooling and dilutor used for preservation are all factors, which influence motility of the spermatozoa on storage. Rapid cooling causes what is called "Cold shock" and might lead to death of the spermatozoa and very slow cooling causes death of the spermatozoa from auto-intoxication. The optimum storage temperature is affected by rate of cooling and time of exposure. It is generally agreed that the optimum storage temperature of bulls semen is 5°C, although many workers have given a much lower optimum storage temperature. Willett and co-workers (1940) found a rate of cooling of 5°C per 5 minutes to a storage temperature 5°C most satisfactory for bull's semen. Undoubtedly, the best preservative for storage is the egg-yolk phosphate or egg-yolk citrate dilutor. For storage, the reduction to temperature of 15°C could be done rapidly, but further cooling to storage temperature must be done slowly. Rawson (loc.cit) found that the addition of egg-yolk phosphate would accomplish the rapid cooling of semen to the storage temperature of 5°C without injuring the sperms. Gradual warming of the semen before use is not necessary as was once thought.

For storage and transport of bull-semen, Walton (1942) advocates the use of Vacuum collecting flask to prevent rapid cooling. The flask with the semen is placed in a series of cooling chambers of thermos jars at

15°C and 10°C 5°C for half an hour and one hour respectively. The semen is transferred to stoppered test tubes and stored or transported in thermo flasks with ice. For short distance transport the method devised by Salisbury (1943) is very satisfactory. Here semen vials are properly cooled to 40° F, labelled and wrapped in several layers of ordinary paper. The vial is next placed along with a toy balloon of solid ice. The two are then wrapped together in heavy insulating paper and package inserted into a thick card-board box surrounded inside by two layers of corrugated card board. For long distance transport Swanson and Herman (1944) have improvised the commonly used ice-cream shipping package. It is provided with ground cork as insulating material and a gallon can be accommodated inside this. The cooled semen vials are well-wrapped in finger stalls and inserted into $\frac{1}{2}$ pint thermos bottles with water at 40°F. Small pieces of 'excelsior' are placed at the bottom of the thermos to prevent wobbling of the vials in transport. Cracked ice is packed all around the thermos and for extra refrigeration a small column of lime is kept at the top of the can. This type of shipper was found to maintain a temperature of not less than 50° F. for 84 hours.

Evaluation of semen quality.—The best and infallible criterion of fertility of the sperm is the actual breeding result which unfortunately takes at least over 9 months. Meanwhile in the actual working of the artificial insemination units, it is essential to assess the potential fertility of Semen samples. In spite of considerable amount of research in this direction, no single quick and reliable test closely related to fertility has yet been described. The following points should be included in the examination.—(1) appearance, (2) volume, (3) motility, (4) sperm density, (5) pH of the semen and pH after incubation, (6) proportion of abnormal spermatozoa (7) respiration rate of spermatozoa and methylene blue reduction time, (8) longevity of sperm under storage condition, (9) freedom from bacteria, parasites and cells. The examination should be made as complete as possible and if the bull is used intensively the examination should be periodically done. Since variations exist between different ejaculates of the same bull, the evaluation for fertility of the bull could be done only after study of a good number of samples. Besides periodic clinical examination of the genital organs should be made.

On an average a bull gives about 5 c.c. of semen per ejaculate. When bulls are in regular use, the volume of the second ejaculate is usually greater than the first. The colour and thickness vary with the concentration of the semen; the higher the concentration the whiter or more creamy or thicker the semen. Examination of the semen for motility should be done immediately after collection on a warm stage. Of the various types of motility exhibited, the progressive type is most important in semen

evaluation. The method of estimating motility consists of some arbitrary scale for denoting and the proportion of sperms exhibiting it. Thus the relative number of sperms showing progressive movement may be expressed as percentage or in fifths or tenths of the total number of spermatozoa.

The bull semen on an average contains 1,000,000 cells per m. m. Generally speaking fertility increases with the sperm density. Usually a haemocytometer or a photo-electric colorimeter is used for accurate measurement of sperms density. Recently Salisbury and associates (1943) and Kyaw (1944) have described a rapid method of estimating sperm density. The method consists of making use of opacity tubes on the lines of estimation of the concentration of bacteria in suspension. Though the method is less accurate, it is quick and sufficiently accurate to estimate the density of the sperm at the time of insemination. The pH of semen is found to have some bearing on the motility and concentration of semen. In general according to Anderson (1945) semen of good bulls are slightly acidic; of infertile bulls slightly alkaline, probably due to increased accessory secretion in the latter case. Alkalinity of semen is associated with decrease in sperm activity and density. In general the pH of good semen sample varies from 6.5 to 6.8. Anderson (1944) has noted a significant relationship between pH change on incubation at 37° C. and other characteristics of semen. He found that the greater the initial motility and sperm density and the lower the initial pH, the greater the decrease on incubation. This was found true in general although there were some exception to this, but however it was suggested that determination of the initial pH and the pH change of incubation at 37° C may prove a valuable method of evaluating semen.

Sperm abnormality is invariably present in almost all the semen samples and most workers consider that semen containing anything more than 20% of abnormal forms as evidence of pathological conditions of testicles—Sperm abnormality may be due to faulty spermatogenesis or due to change in the sperm after full formation. The latter is easy to rectify, but not the former.

Measurement of metabolic rates are among the most reliable tests that indicate the quality of the semen. Edwards and Walton (1938) noted that there is a definite relationship between the number of services per conception and the respiratory rate of bull semen. They found that in case bulls do less services for conception, the average initial respiration rate of semen is much greater. Ely (1942) found higher oxygen consumption in ejaculates that keeps longer on storage. A simple and rapid method of measuring metabolic rate has been described by Beck and Salisbury (1943). They have noted significant correlation between the methylene blue reduction time and sperm density and duration of motility on storage.

It was found that good semen samples decolourise methylene blue in shorter time and *vice-versa*.

Another property of semen most nearly correlated with bull fertility is the time of survival of vigorous motility under storage conditions. This relationship is to be reasonably expected because time is consumed in the journey of the spermatozoa to fallopian tube and in the release of the ovum and only those spermatozoa that are alive and vigorous after such time have a chance of fertilising the ovum. According to Herman and Swanson (1941, 1944) semen from a bull of good quality should show a high percentage of vigorous motility for at least 30 hours, on storage at 40° F. in an undiluted state.

From the above, it is clear that for evaluating semen no single test is of much value, and the judgment should be based on the maximum number of tests, the most important and simple being sperm motility, motility on storage and methylene blue reduction test.

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SCHISTOSOMIASIS AMONG SHEEP/GOATS IN POONA R. I. A. S. C., BUTCHERY.

BY

CAPT. M. V. G. RAO, I.A.V.C.,
R.I.A.S.C., Butchery, Poona.

Schistosomes seem to be fairly common in sheep/goats of Marwar, Rajputana. From 20th January to 28 February 1947 approximately 8,948 sheep/goats have been slaughtered in this butchery. Out of these, about 2,000 animals appear to have arrived from Marwar. Of these again as many as 926 Livers have been condemned as being Cirrhotic. Schistosomes have been detected in 436 Livers slaughtered and as many as 92 Livers were affected with Schistosomes.

Owing to the severity of Liver infections and also because a sister species of the Schistosome viz. *Schistosoma haematobium* has been reported in human beings, it may not be out of place to mention further details on this subject.

Contrary to the usual opinion that a blood sucking parasite causes anaemia with accompanying loss of weight, etc., the affected sheep appears to be well fed and in good condition, but the goats are markedly anaemic and are very poor in body weight. The carcasses of these latter animals are usually emaciated.

In severe infections the Liver undergoes complete degenerative processes, with extensive manifestation of chronic inflammation of the entire Liver tissue. A section of such a Liver on microscopical examination revealed "Generalised cloudy swelling with a few areas of early necrosis". It is easy to pick up a Liver thus affected. It appears enlarged and presents an uneven surface; is lumpy, lustreless and feels firm to touch. The edges are rounded. In less severe cases the edges are serrated and are dark brown in colour. In still less severe infections, however, the Liver appears normal in colour and consistency. One can easily miss the detection of parasites in such a liver when the carcass is cold.

If a severely affected liver is incised one cannot miss the fibrous thickening of the hepatic vessels. The important predilection seat appears to be the portal veins. The parasites are also detected in hepatic veins and Mesenteric veins. A search was also made for the same in kidneys and lungs without any success. If, in a freshly slaughtered animal, the liver is incised at the 'Porta', close inspection will not fail to reveal the presence of these parasites. In some cases they are found in clusters and can be brought into sight by pressing the liver at the entrance of these vessels into the substance of liver. In a cooled carcass, where animals are slaughtered one or two hours before inspection, these parasites are found entangled in blood clots in these veins. If such a clot is teased in normal saline solution, in most cases living parasites are liberated which can be examined under low power. The parasites have been identified as "*Schistosoma indicum*".

Conclusion:—1. *Schistosoma indica* has been found extensively in the animals slaughtered in the Poona R. I. A. S. C. Butchery. Though the liver is severely affected, the condition of the host, particularly sheep, is not affected to a great extent. Goats, however, show severe anaemia. This is a very interesting feature to note.

2. Though animals from Marwar (Rajputana) seem to be grossly infected, sheep and goats of Bombay Presidency are not entirely free of this parasite.

3: It is considered important in Meat Inspection as a sister species (*S. haematobium*) has been recorded in human beings.

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Reference:

H. O. Monniß—Veterinary Helminthology and Entomology.

THE BLOOD-GROUP IDENTIFICATIONS OF VARIOUS INDIAN BREEDS OF CATTLE IN INDIA *

BY

BALWANT SINGH, G. P. V. C.,
Imperial Veterinary Research Institute, Izatnagar.

Since the inception of organized thought, it has been known that no two individuals are alike; hence have originated the systems of classification based on these differences. Morphological characteristics have formed the basis for classification into groups of similar animals or species and in each species the differences of lesser degree, such as body contour and other qualities, have brought further subdivisions into breeds. The problem of the identification of various breeds of Indian cattle has recently been receiving much attention [Olver, 1938; Ware, 1939, 1941]. Ware recognizes 28 breeds of Indian cattle belonging to five main groups. This classification, as with other animals, has been carried out on the basis of morphological characteristics alone. The work detailed in this and a previous article [Singh, 1942] represents an attempt to approach the problem from another angle and to supplement the morphological findings by serological features with the special object of elucidating the origin and evolutionary relationship of the breeds.

The group classification of Indian cattle has been provisionally fixed after Little [1929] on an international basis with certain modifications, as follows.

Group 1 (International O). Serum agglutinative, cells not agglutinable; that is, cells with O isogen and ab isonin.

Group 2 (International A and B mixed). Serum agglutinative, cells agglutinable; that is cells with A isogen and B isonin or cells with B isogen and A isonin.

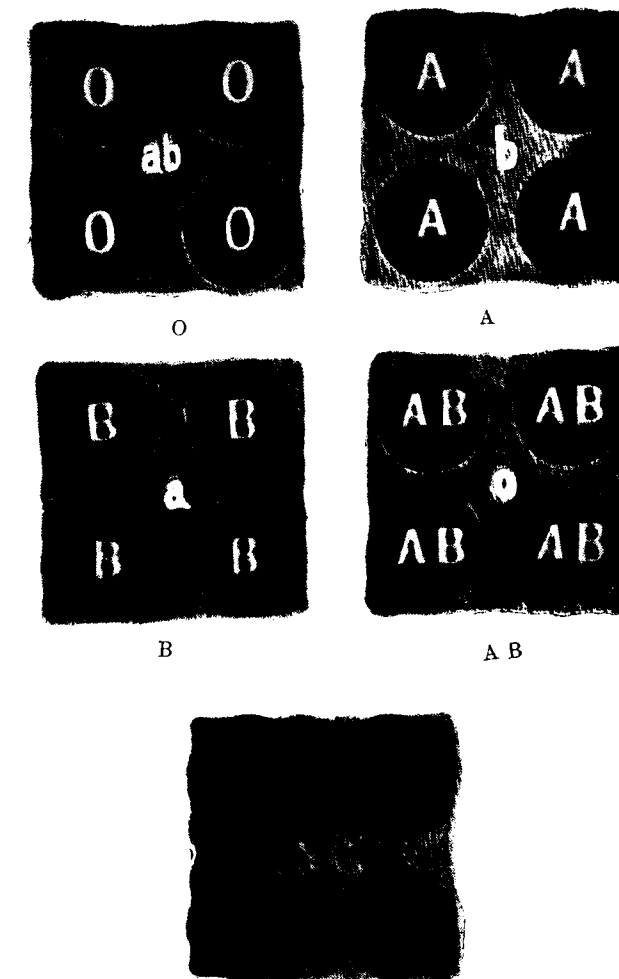
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Group 3 (International AB). Serum not agglutinative, cells agglutinable; that is cells with isogen O or AB and serum without isonins.

Group 4 (Negative or N), Serum not agglutinative, cells not agglutinable. (In this group are included all cattle that have shown no reaction with the present method of testing).

In the previous article [Singh, 1942] some account was given of attempts that have been made to define the blood-groups of domesticated animals. In this paper a few examples are given to show how by blood-grouping the origin of certain races of mankind may be discovered.

Parr [1929] provides data by which Armenians, Arabic Muslims and Arabic Christians can be assigned their racial indices. Goodner [1930] in tests on 223 pure Mayas and 202 Mayas with mixed Spanish blood in Mexico found practically all of the former to belong to group O, and in this way was able to differentiate pure Mayas from those of mixed blood. Shanklin [1935] found Rwala Arabs to have a high percentage of group O, and on this account he suggests that these Arabs are related to American Indians, who have a similar blood-grouping. Postmus [1934] found that type N was more frequent among the indigenous people in Netherland Indies than among Europeans. Edward *et al.* [1941] studied the racial distribution of blood-groups among Papas Indians in Arizona (U.S.A.). Out of 600 individuals examined 93.8 per cent were of group O while only 6.17 per cent were group A and groups AB and B were absent. The authors conclude that a high incidence of group O and the absence of groups AB and B suggest racial purity. Elsdon Dew [1939] in a blood grouping expedition in East Africa tested individuals of 46 tribes, and found groups A and B only. He interprets the distribution on the basis of mutation and suggests that the Bantu does not descend from the Negro but is rather a pure example of the common stock. An Egyptian origin is suggested for Hottentots. Thomas [1939] reports on blood-group distribution in England. Out of 5,000 people, 2,233 were of group O, 2,162 of A, 444 of B and 161 of AB group. Haldane [1940] studied the blood-group frequencies of 75 European population groups. A striking variation was discovered in the frequencies of A and O groups, among the peripheral population of Western Europe, there being a low proportion of group B in Scandinavia, Iceland, Spain, Portugal, Sardinia and the British Isles. Populations with low B are regarded as remnants of a primitive European civilization. In India, Malone and Laheri [1929] studied three types of people, (1) Turko-Iranians, (2) Indo-Aryans and (3) Dravidians. They confirm the findings of Hirschfeld in concluding that these people are characterized by a high incidence of group B. The Dravidians are also characterized by a high incidence of group A. Macfarlane [1938] studied the blood-group distribution in Bengal. Data from lower Bengal show



The Blood-group Identifications of various Indian Breeds of Cattle in India.

that the frequency of groups A and B increases as one passes from higher to lower castes, the highest frequency of group O being found among caste Hindus. Bengalee depressed classes have the highest percentage of group B so far found in India. Bengalee-Muslims have a blood-group distribution similar to that of their low-class Hindu neighbours. Macfarlane [1940] also studied the problem in Bastar State and found a high frequency of group B among the Bhils, this being regarded as due to in-breeding. Almost all the Chenchus of Bastar State belonged to groups O and A and in this respect resemble the hill tribes of the Western Ghats and the Malyali lower castes, so sharing the distinction of being the only Indian tribe with more group A than B, Sarkar [1940], in 96 tests on certain primitive people of India, Huyani naḡas (Assam and Bihar), showed the predominance of group A over B, excepting among the Thado-Kukis. Greval and Chandra [1940] tested Hindus, Muslims and Anglo-Indians of Calcutta. A high frequency of groups O and B was found in Hindus and Muslims, whereas group A was the highest and B the lowest among the Anglo-Indians. Sheshadhari-Nathan and Timothy [1942] carried out a similar investigation in Madras. Group O was the highest and B lowest among the Anglo-Indians. Pandit [1934] found a high frequency of group B among Tēdas (Guindy, Madras).

The technique used in the blood-grouping tests was the same as that described in the author's previous articles [Singh, 1942]. It consisted of mixing in a small tube about four drops of serum and an equal amount of 2 per cent washed red cell suspension, gently mixing and exposing the mixture at 37°C. (dry incubator) for 30-60 minutes.

Cattle of the following breeds were selected for study: Kumauni (hill), Sindhi, Gir, Sahiwal, Tharparkar, Haryana, Kankrej, Amritmahal, Kanḡayam, Onḡole, Dhanni, Afḡhar and Friesian. The distribution and location of these breeds can be seen in Fig. 1 from which it is evident that they are subject to a wide range of climatic and other environmental factors.

In this work there are three main sources of difficulty: (a) the low and quickly deteriorating titre of the serum. (This difficulty does not arise in blood-group work with human sera, which with cold storage can be used for some days), (b) the necessity of carrying out the tests at 37°C. and (c) the number of antigenic components in the erythrocytes of cattle. The location of some of the cattle in places where there are special transport difficulties was an additional hindrance. For these reasons the results recorded here are not as detailed as might be desired and the object has rather been to determine certain broad facts regarding the blood affinities.

The usual practice was to bleed 12 animals in the morning, test the 144 combinations of serum and cells, and read the results the same evening.

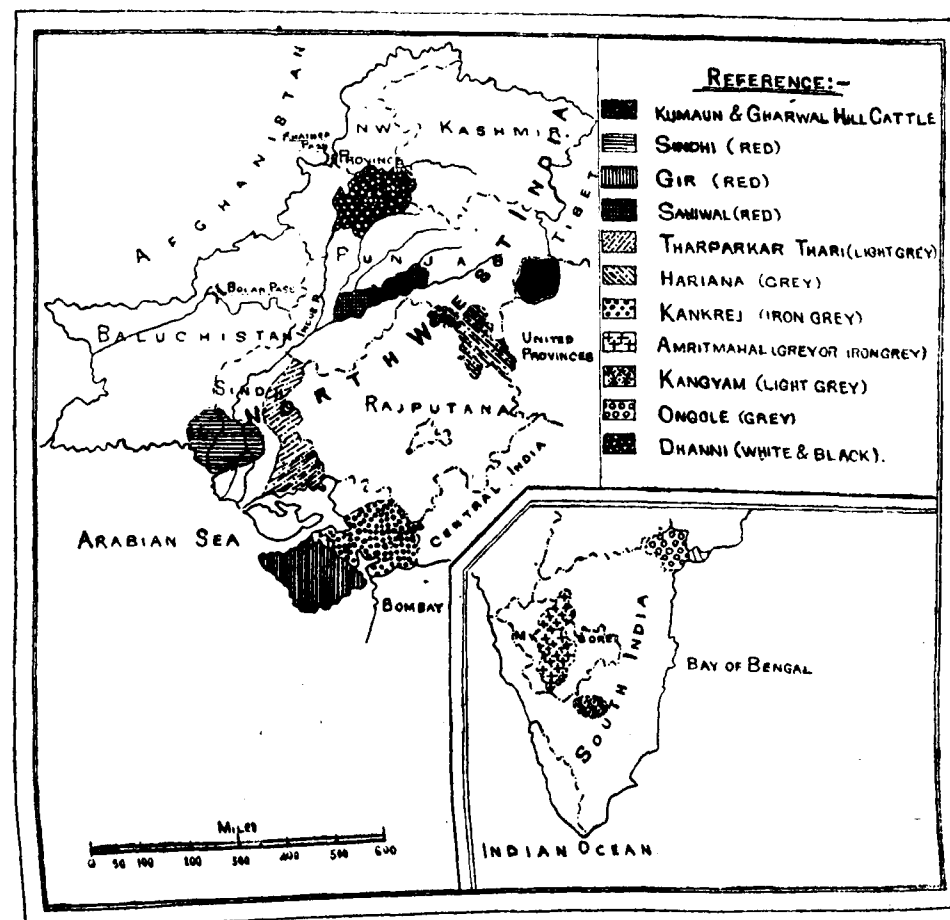


FIG. 1. Map showing the location of various cattle breeds in India.

The results largely depended on the particular antigenic components present in the blood of individuals of the group tested on one day. Occasionally, cells and serum from an animal found to be a good reactor on the previous day were included, in order to increase the chances of obtaining positive reactions. The reason for this is that a few cattle, giving no reactions with serum and cells from one lot of animals, may exhibit positive reactions with iso-gen or isonin* or with both these components when tested with serum and cells from another lot. In this way the group classification first recorded had to be altered after a further test, though this was not frequent.

RESULTS

The results of the tests will be found in Tables I-V and in Fig. 2.

* Isohaemagglutinins and Isohaemagglutinogens will be termed isonins and iso-gens, after Greval *et al* [1941].

1. *Kumauni hill cattle.* The home of this breed is the Kumaun foot-hills of the Himalaya. It is one of the smallest breeds of Indian cattle with short horns and a thoracic musculo-fatty hump. The poll and hump are usually covered with coarse hairs; the sheath is tight and the legs are short, thick and bony. The colour is generally deep-red or jet-black, and an admixture with white is regarded as indicating crossing with grey cattle of the plains.

The experiments were conducted at Mukteswar, where many pure Kumauni cattle are available. The animals were collected from various Kumauni hills and may therefore be regarded as of divergent strains.

In order to differentiate A and B groups, 24 of the reactors were selected and their isonins were cross-tested with their iso-gens. The results are given in Table I.

According to the reaction found in these tests, 13 animals were classified as groups A and B mixed. Of these, 12 animals (1, 2, 3, 5, 6, 7, 8, 12, 17, 20, 21 and 23) were then selected and their isonins and iso-gens cross-tested. The results, given in Table II, indicate eight animals belonging to A group and four to B group.

It is also noticed that the animals of both groups showed reactions against animals of their respective groups, thus suggesting the presence of sub-groups or several antigenic components of cattle cells. The problem was further studied by an absorption test conducted in the following way.

Equal quantities of packed cells from group A animals and serum from group B, and *vice versa*, were well mixed in a tube, left at room temperature for 30 minutes, then at 37°C. for an hour and finally at room temperature for 30 minutes. Since the serum titre was found to be very low, the amount of serum was subsequently increased to two, four and nine times the volume of packed cells. From this it was found that the optimal ratio for complete absorption of homologous isonins was 1:5. By absorption tests the following distribution of groups was found.

Groups	Hill bulls
A	1, 6, 7, 20.
A ₁	5.
A ₂	17, 23.
A ₃	8.
B	2.
B ₁	3, 12.
B ₂	21.

Thus in Kumauni hill cattle the ratio of groups A to B appears to be as 2:1.

TABLE II

Analysis of bloods with A and B mixed groupings selected from Table I

(1) Isozen from hill bull	(2) Isonin from												(3) Grouping
	1	2	3	5	6	7	8	12	17	20	21	23	
1	-	±	+	+	-	-	±	+	+	-	+	+	A
2	+	-	+	+	±	+	+	-	+	±	+	+	B
3	±	-	-	+	-	±	+	-	±	-	-	±	B ₁
5	-	+	+	-	-	-	-	-	-	-	-	-	A ₁
6	-	+	-	+	-	-	-	-	-	-	-	-	A
7	-	+	+	-	-	-	+	+	+	-	±	+	A
8	-	+	-	+	-	+	-	-	-	±	-	-	A ₃
12	±	+	-	+	+	+	+	-	±	±	-	+	B ₁
17	-	+	-	+	-	-	+	+	-	-	-	-	A ₂
20	-	-	+	+	-	-	-	-	+	-	-	+	A
21	+	-	+	+	±	+	+	-	+	-	-	+	B ₂
23	-	-	-	+	-	-	±	+	-	-	-	-	A ₂

2. *Red Sindhi*. The home of this breed is the province of Sind about Karachi, Hyderabad, the coastal line and the Indus river banks, including the Las Bela areas of Baluchistan. The animals are of red or fawn colour, frequently with some white on the face and dewlap. They are among the best milch type cattle of India and the bullocks are useful for draught. The animals are short-horned.

The tests were made in January and February, 1942 on 96 cattle (92 cows, 4 bulls) at the Imperial Dairy Institute, Bangalore, where a suitable herd of Sindhi cattle is maintained. It is a self-contained herd and the

animals are therefore regarded as inbred for the purpose of this study. The results obtained with this and most of the other breeds are given in Table III.

3. *Gir*. The home of this breed is the Gir forest in Junagadh State (Kathiawar), where these cattle are found in a pure state. The breed is also spread over a large part of Bombay either pure or crossed with local cattle. The animals have short horns. The colour is generally mottled-red or black and of various shades of these colours. In some strains the body is mainly white with red or black spots, but entire reds and blacks are also met with. The cows are generally good milkers but the bulls are slow and lethargic in work. The Gir is reported to be the best beef animal in India.

The blood group investigations were also carried out at the Imperial Dairy Institute, Bangalore, where a small herd of these cattle is maintained and at the Palace Dairies of Bhavanaagar and Junagadh States. Most of the animals were farm-bred and may therefore be regarded as inbred for our purposes.

4. *Sahiwal*. These are essentially milch cattle and are generally raised in large numbers in the dry central and southern areas of the Punjab. They are long, deep, rather fleshy cattle, short on the leg, comparatively lethargic and heavily built, with fine skin, especially in heavy milking strains. The bullocks are not good for draught. They are short-horned. The colour is red but some are dun. Investigations were carried out at Jahanگیرabad Farm (Multan). The animals were mostly farm-bred and are therefore, regarded as inbred.

5. *Tharparker*. The home of these cattle is in the arid, semi-desert tracts of south-west Sind, but they are also bred in the adjoining Indian States of Kutch, Jodhpore and Jaisalmer. They are medium-sized animals, the cows have good milking capacity while the bullocks are good workers. They are lyre-horned and have straight limbs and hard feet. The colour is entire grey or light red in young bulls, while in cows and bullocks it is generally lighter grey. The colour tends to become white with age.

The investigations were conducted on a total of 96 animals at the Agricultural College Farm, Sakrand and at the Agricultural Farm, Lundo (Nawabshah Distt.), Sind. The animals in these farms had been recently purchased from various sources and may therefore, for the purpose of this study, be regarded as of divergent strain.

6. *Hariana*. The home of this breed is in the Rohtak, Hissar, Karnal and Gurgaon districts of the Punjab and in Delhi province. Hariana

TABLE III
Combined table of the 12 Indian and Afghan Breeds of Cattle

Serial No.	Name of breed	Grouping of Ware [1941]	No. of animals tested	O	Distribution of groups		Negative
					A & B	AB	
1	Kumauni (hill)	V	108	—	40 (37.04)	67 (62.04)	1 (0.92)
2	Sindhi (red)	III	96	36 (37.5)	7 (7.3)	47 (49.0)	6 (6.2)
3	Gir	III	120	50 (41.7)	5 (4.1)	50 (41.7)	15 (12.5)
4	Sahiwal	III	117	57 (48.7)	3 (2.6)	32 (27.4)	25 (24.3)
5	Tharparker	I	96	31 (32.3)	15 (15.6)	26 (27.1)	24 (25.0)
6	Hariana	II	132	16 (12.1)	4 (3.0)	34 (25.8)	78 (59.4)
7	Kankrej	I	120	27 (22.5)	3 (2.5)	25 (20.8)	65 (54.2)
8	Amritmahal	IV	96	18 (18.8)	9 (9.4)	43 (44.8)	26 (27.0)
9	Kançayam	IV	100	24 (24.0)	3 (3.0)	41 (41.0)	32 (32.2)
10	Onçole	II	96	18 (18.8)	2 (2.0)	24 (25.0)	52 (54.0)
11	Dhanni	—	99	36 (36.4)	8 (8.1)	36 (36.4)	19 (19.1)
12	Afghan	—	19	8 (42.1)	2 (10.5)	7 (36.9)	2 (10.5)
Total			1,199	321	101	432	345
			Percentage	26.8	8.4	36.0	28.8

NB.—Figures in brackets indicate percentages.

bullocks are powerful draught animals and are extremely useful for heavy ploughing and transport. The cows are fairly good milkers. They are short-horned cattle. The coat colour is white, a grey admixture being regarded as due to crossing with other breeds such as Kankrej.

The experiments were carried out at the Government Cattle Farm, Hissar, most of the animals tested being farm-bred and therefore to be regarded as inbred animals.

7. *Kankrej*. This breed resides in the country south east of Kutch, extending from the south east corner of the Tharparker districts of Sind to Ahmedabad in Bombay and from Deesa in the east to Radhanpur State in the west, particularly along the Banas and Saraswati rivers. They are fast and powerful draught cattle. In the past they have been exported to South America and other tropical countries in order to maintain the constitution of the local cattle by introduction of Zebu blood. The Kankrej has been said to be instrumental in the formation of beef breeds in these countries. They are lyre-horned cattle. Cows are fairly good milkers. The Kankrej is a thoroughly well established breed which has been maintained pure for generations. They carry the head in a raised position, hence the name 'Proud Kankrej'. The colour is generally grey to iron grey, growing white with age.

The blood-grouping experiments were conducted at the Northcote Cattle Farm at Chharodi. Most of the animals were farm-bred and may be regarded as inbred cattle for the purpose of this study.

8. *Amritmahal*. This is a breed of Mysore State, where the animals are bred under Government control and their sale usually restricted. Subsistence is entirely by forest grazing. They are among the best and fastest draught cattle in India, and are particularly useful for army transport.

They have long and pointed horns arising close together and extending backwards and upwards. They belong to Ware's group IV. The colour varies from light to deep iron-grey, with a darker almost black shade over the shoulders and hind quarters in the case of bulls. Bullocks and especially older ones appear white, while the cows are generally white or at times light grey. Calves at birth are mostly red or light-red.

The tests were carried out at the Cattle-Breeding Station, Ajjampur, Mysore State.

9. *Kançayam*. This is a breed of the south-eastern taluks of Coimbatore, Madras. Animals of this breed are bred on scientific lines at the Live-stock Research Station, Hosur. There is also a long-established herd

maintained by a private breeder, the Pattaḡar of Palayakottai. The breed is suitable for light plough and transport work and is economical to maintain. The cows are generally poor milkers. The horns arise fairly close together and extend slightly backwards and upwards. The colour is generally light-grey but changes to white with age. Bulls sometimes show iron-grey patches over the front and hind quarters. Calves when born are red but later change to light-grey colour.

One hundred adults were tested at Hosur. Most of them were farm-bred and are thus inbred for the purpose of this work.

10. *Ongole*. The home of this breed is the Guntur district and neighbouring area of Madras. It is one of the large breeds of Indian cattle and greatly resembles the Haryana. The animals are, however, comparatively lethargic, and useful for heavy plough and transport work. The cows are fairly good milkers. They have short horns. In colour, they are mostly white but a small proportion are of a light grey colour. The bulls generally show a light shade of grey over the quarters. Ninety-six adults were tested at the Livestock Research Station, Guntur. Most of them were farm-bred and so inbred for our purposes.

11. *Dhanni*. This breed lives in the northern Punjab, in an area of undulating valleys at an average altitude of 1,500 feet. The climate is generally very cold during the winter and fairly hot in summer. It is a fast and light plough animal and fetches high prices. The cows are generally poor milkers. The horns are short. The coat colour of the body of the so-called pure Dhanni-bred animal is white with black spots, while the skin colour and tuft of the tail are invariably white. Ninety-nine animals were tested at Chakwal, Daulatala and Gujarkhan. As they had been collected from different sources, they may be regarded as of divergent strain.

12. *Friesian and Friesian-Sahiwal cross*. Tests on 86 animals were made at the Military Farms at Sialkot and Lahore. Some were pure-bred and recently imported from Europe, others were pure Friesians born in India. The remainder were crossed with Sahiwals. Results of the tests have been given in Table IV. The frequency of A and B groups in pure-bred Friesians is much higher than usual.

13. *Afghan*. The original home of this breed is Afghanistan. A few of these cattle were presented by the Afghan Government to H. E. the Viceroy and have since been kept at the Imperial Veterinary Research Institute, Mukteswar, where they have developed into a small herd. Nineteen cattle could be brought under experiment. The results are given in Table V.

TABLE IV
Grouping of Friesian and of Friesian-Sahiwal cross cattle

No. of ex- peri- ments	Date	No. of animals	Group I (O)	Group II (A&B)	Group III (AB)	Group IV (Negative)	Remarks
1	11 April 1943	12	2	5	4	1	Friesian
2	12 April 1943	13	2	4	2	5	Friesian-cun Sahiwal
3	13 April 1943	12	...	3	4	5	Do.
4	14 April 1943	12	3	...	4	5	Do.
5	17 April 1943	12	1	4	6	1	Do.
6	17 April 1943	13	...	6	6	1	Do.
7	18 April 1943	12	1	4	5	2	Do.
TOTAL		86	9	26	31	20	TOTAL
Percentage			10.5	30.2	36	23.3	

TABLE V
Mukteswar—Blood-grouping of Afghan breed of cattle

Cells from	Age of animals (years)	Serum from											Group distribution	Remarks
		1	2	3	4	5	6	7	8	9	10	11		
Afghan Cow 1	7	+	+	+	+	+	+	+	+	+	+	+	A & B	
" 2	6½	+	+	+	+	+	+	+	+	+	+	+	AB	
" 3	5	+	+	+	+	+	+	+	+	+	+	+	O	
" 4	5	+	+	+	+	+	+	+	+	+	+	+	O	
" 5	4	+	+	+	+	+	+	+	+	+	+	+	O	
" 6	5	+	+	+	+	+	+	+	+	+	+	+	O	
" 7	5½	+	+	+	+	+	+	+	+	+	+	+	AB	
" 9	8	+	+	+	+	+	+	+	+	+	+	+	O	
" 10	9	+	+	+	+	+	+	+	+	+	+	+	O	
Afghan Bull 2	7	+	+	+	+	+	+	+	+	+	+	+	AB	
" Heifer 16	2½	+	+	+	+	+	+	+	+	+	+	+	O	
" 14	2½	+	+	+	+	+	+	+	+	+	+	+	AB	
" Bull-calf 18	2½	+	+	+	+	+	+	+	+	+	+	+	Negative	
" 17	2½	+	+	+	+	+	+	+	+	+	+	+	"	
" Cow 8	4	+	+	+	+	+	+	+	+	+	+	+	AB	
" Heifer 12	2½	+	+	+	+	+	+	+	+	+	+	+	AB	
" Calf 10	2½	+	+	+	+	+	+	+	+	+	+	+	O	
" Bull 1	5½	+	+	+	+	+	+	+	+	+	+	+	AB	
" Heifer 11	2½	+	+	+	+	+	+	+	+	+	+	+	A & B	

Percentage:—
Group O . . . 42.1%
Group A & B . . 10.5%
Group AB . . . 30.9%
Group Negative . 16.5%

Discussion.

The value of blood-grouping for determining questions of heredity has been established by various workers. It has been found that in any race in the absence crossing the proportion of groups remains constant from one generation to another. By crossing, a definite change in the normal proportion of groups is brought about. Before discussing the results obtained in this study, it is worth while repeating Snyder's [1930] postulates on the subject, which are as follows:

1. Any people whose blood-group distribution is studied shows blood-group frequencies similar to those of other people known to be related to it.
2. If any people shows blood-group frequencies different from those based on the frequencies of peoples known to be related to it, the conclusion may be drawn that the former has undergone racial crossings which the latter have not undergone or *vice versa*.
3. If any people shows blood-group frequency similar to a group of people not known to be related to it the conclusion may be drawn that the former traces back to the latter somewhere in its ancestry or the former has undergone crossing with the latter group or some similar people.
4. If any people lacks one or both of the blood-group mutations as evidenced by an extremely low value of *p* or *g* it may be assumed that this

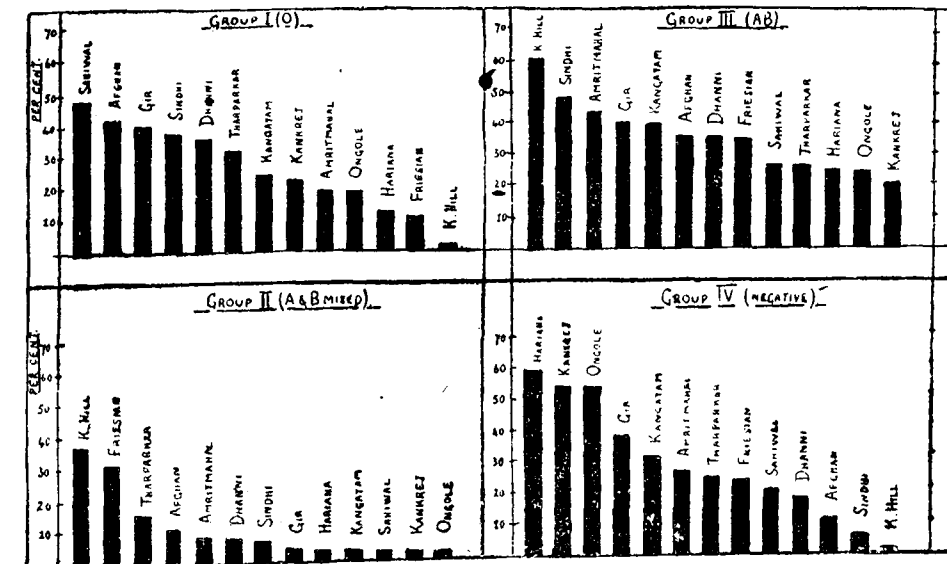


Fig. 2. Blood-group distribution of 13 breeds of cattle in India.

people became isolated from the rest of mankind before the respective mutations took place or before they spread very far.

Limitations of time and space preclude the possibility at this stage of our work of drawing a thoroughly comprehensive picture of the relationship of the various Indian cattle. It is hoped that data provided here will form the basis for further work and indicate lines of research. Nevertheless, certain interesting points emerge, which may be discussed briefly.

Kumauni hill breed.—The blood-group frequencies of this breed reveal striking differences from those of the other Indian breeds so far tested. The absence of relationship to any other Indian breed, particularly in the non-appearance of group O, suggests a distinct origin. The Mongolian wave of immigration (Census of India, 1931 I(1)) from the Chino-Tibetan border into the Himalaya, Assam and Burma may have been instrumental in introducing these cattle into these ranges.

These small cattle are confined to the Himalayan sub-ranges and these are connected with the Tibetan ranges. It would be interesting to study the blood-groupings of Tibetan and other Mongolian breeds of cattle, or at least other Himalayan hill cattle in India, to see whether geographical proximity has provided the means of importation, adaptation and spread of these cattle in the Himalayan ranges. Their blood-group similarity with Friesians is suggestive, but no solid hypothesis is possible because few of the latter could be tested. It is intriguing however to find that both Friesian

and Kumauni cattle are decidedly more susceptible to rinderpest than other breeds.

Sahiwal, Afghan, Gir and Red Sindhi.—These breeds reveal a striking preponderance of group O, and an equally low frequency of groups A and B (mixed). This, clearly establishes a close inter-relationship among those breeds and supports Olver's hypothesis, that the Sahiwal and Sindhi breeds are derived from contact with Afghan and Gir cattle. It is further established that their origin is distinct from the white-grey cattle of India.

Kankrej, Ongole and Hariana. In all these breeds there is a very low frequency of group O, whereas AB frequencies are fairly high and there is great similarity as regards group IV (negative). The Hariana cattle, tested at Hissar, it is understood, have a small admixture of Kankrej blood. In spite of this, there is a greater affinity between the Hariana and Ongole as regards group O and AB. Geographically, these two breeds are widely separated, the Ongole being confined to a small tract near the eastern coast of south India. These animals have no morphological similarity with any of the neighbouring breeds. Hariana cattle are situated well to the north, but show marked resemblance to the Ongole breed. The blood-group findings again provide support to the views of Olver and of Ware, as to the common origin of these breeds.

The Dhanni breed. This breed shows a fairly high frequency O. This factor and the location of these cattle, on the route from Afghanistan to India, suggest the incorporation of blood from Afghan or some allied breed during their evolution.

The Tharparker breed. This has a fairly high frequency of group O and A and B (mixed), and this suggests that the breed is a cross between the grey and Gir types of cattle. Observations on a large number of cattle of this breed revealed much variation in cranial formation. On morphological and serological grounds, these cattle cannot be granted the rank of a regular breed. Further investigations, however, may throw more light on the matter.

Amritmahal. This famous breed falls into a group comprising the Kanayam, Ongole and Kankrej breeds. The blood-group relationships to these three breeds are too close to be ignored, and this raises the interesting possibility that the breed may not after all have been imported in a separate migration wave, but may be the outcome of the magnificent efforts of the rulers of Mysore to evolve an army transport beast by the crossing of local south India cattle (Kanayam breed) with grey-white cattle (Ongole-Kankrej). Otherwise, there must be some common ancestry in their original home.

Summary

1. The blood-group distribution of 11 Indian and two foreign breeds, comprising 1,199 head of cattle, has been studied. With the exception of Friesians, all the cattle tested were of Zebu type.

2. The final blood grouping by percentages is: group O, 26.8; group A and B (mixed), group AB, 36 and group IV (negative), 28.8. The blood-group frequencies for each breed behave as independent units and indicate possible origin and relationship with other breeds.

3. Gir, Red Sindhi, Sahiwal and Afghan cattle show a similarity in blood-grouping, especially in respect of the frequency of group O, so that these four breeds may be regarded as related.

Haryana, Ongole, Kankrej and Amritmahal were also very similar to one another and so may be from the same stock or closely related.

Dhanni, Tharparker and Kanayam breeds represent intermediate types.

Kumauni hill cattle appear to be a separate entity in India. Their blood-group similarity to that of Friesian cattle and the high susceptibility of both these breeds to rinderpest has been pointed out.

4. A blood-grouping classification for Indian cattle has been provisionally fixed, and a differentiation of A and B groups by absorption tests has been made. The ratio of groups A and B in Kumauni hill cattle was 2 : 1.

5. Attention has been called to the geographical distribution and morphological characters of Indian breeds.

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THE COMPARATIVE VALUE OF SOME CONCENTRATES IN THE FEED OF GROWING CATTLE*

BY

N. C. DAS GUPTA,

Research Officer, Cattle Feeding Research Station, Bharari, Jhansi

Concentrates can be broadly classified into three groups according to the composition. Linseed cake, decorticated undecorticated groundnut cakes, *til* (*Sesamum indicum*) cake, rape cake, cottonseed cake and *guar* (*Cyamopsis psoralioides*) are the common concentrates of India, having a protein content of over 30 per cent. Coconut cake, cotton seed, pulses (legume seeds) and pulse by-products are moderately rich in protein and have nutritive rations similar to the standard required for production. Cereal grains make the third group of concentrates which are comparatively rich in carbohydrates but low in protein content.

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This paper deals with the feeding value, for the production of growth, of five oil cakes, viz. linseed cake, decorticated and undecorticated groundnut cakes, rape cake and *til* cake and four legume seeds or their by-products, viz. *guar*, gram (*Cicer arietinum*), *arhar* (*Cajanus indicus*) *chuni* and *munğ* (*Phaseolus mungo*) *chuni*. The *chuni* is the by-product from the manufacture of split pulse (*dal*) for human consumption. It contains chiefly the hulls, along with the germs and broken particle of the seed. In all the tests of this series, linseed cake was used as the control, because it is one of the most popular protein supplements for cattle and produces good results even when used as the only concentrate.

Feeding Trail with Linseed Cake, Undecorticated Groundnut Cake, Gram and Arhar *chuni*. (1940)

In August 1940, tests to find out the comparative feeding values of linseed cake, undecorticated groundnut cake, gram and *arhar chuni* for growth were started with 20 Hissar heifers. The basal ration, which consisted of wheat straw *ad lib.*, 11 lb. *jowar* (*Sorghum vulgare*) silage, 1.55 lb. wheat bran and linseed cake for protein supplement, was fed to all the animals for a period of eight weeks and thereafter they were distributed into four comparable groups according to age, liveweight and rate of growth during the basal period. For the experimental feeding, group I was allowed to continue the basal ration and groups II, III and IV received groundnut cake, gram and *arhar chuni* respectively in place of linseed cake, the quantity being regulated to maintain the same level of protein for different groups. Records of daily liveweight and food consumption for each animal were maintained during the test which lasted for a period of 21 weeks. The distribution of animals for the different treatments and their liveweight increase during the experimental period have been recorded in Table I.

Rate of growth with the different rations. The rate of growth by the different treatments has been statistically analysed and the summary of the results is shown in Table II. Undecorticated groundnut cake produced the lowest average growth rate. Linseed cake came next and, though the average growth rate is very significantly higher than that with groundnut cake, it is lower than that with gram and *arhar chuni*. The difference between gram and *arhar chuni* is not significant. The fall in the growth rate from gram to linseed cake is 19.48 per cent, from gram to groundnut cake is 53.60 per cent, and from linseed cake to groundnut cake 34.12 per cent, the critical difference at 5 per cent level being 12.97 per cent. Similarly, between *arhar chuni* and linseed cake and between *arhar chuni* and undecorticated groundnut cake the differences in the average growth rates are 23.35 and 57.47 per cent respectively, the critical difference being 14.50 per cent.

Feeding Trail with Linseed Cake, Decorticated Groundnut Cake, Rape Cake and Mung *chuni* (1941)

Sixteen Hissar heifers were selected for this test in September, 1941. The basal ration was the same as in the previous test, except that rape cake was fed instead of linseed cake during this period as it was found that animals do not relish a change from linseed cake to rape cake. The basal feeding lasted for three weeks, after which the animals were distributed into four comparable groups. One group was allowed to continue the rape cake ration, and for the other three groups rape cake was replaced by either linseed cake, groundnut cake or *mung chuni*. The procedure was the same as in the previous test. The distribution of the animals for the different treatments and the gain in their liveweights during the 18 weeks of experiment are shown in Table III.

Rate of growth. The results of the statistical analysis have been summarized in Table IV. Decorticated groundnut cake has produced significantly the lowest average growth rate. Rape cake and linseed cake come next in order the difference between them is not significant, but both produced significantly lower growth rate than *munḡ chuni*, the average growth rates per week with these feeds being 4'96, 6'30, 6'84 and 8'72 lb. respectively. The fall in the growth rate from *munḡ chuni* to rape cake is 36'03 per cent, from *munḡ chuni* to groundnut cake is 56'04 per cent, and from rape cake to groundnut cake 20'01 per cent, the critical difference at 5 per cent level being 19'64 per cent. Similarly from *munḡ chuni* to linseed cake and from linseed cake to groundnut cake, the average growth rate is 27'90 and 28'14 per cent respectively. The variation due to treatments in the average rate of change of growth rate is also significant.

Feeding test with linseed cake, til cake and guar (1942)

The experiment to study the comparative feeding values of linseed cake, *guar* and *til* cake was started in April, 1942 with 15 Hissar heifers. The constituents of the basal ration were the same as those during the first test of the series. The experiment was conducted for 16 weeks after a preliminary feeding for four weeks. There were five replications for each treatment. The distribution of the animals in three groups and their live-weight increase during the experiment have been recorded in Table V.

Rate of growth. The summary of results of statistical analysis for the rate of growth is given in Table VI. It is observed that the rate of growth with *til* cake is significantly lower than that with linseed cake or *guar*. The fall in the rate of growth from linseed cake to *til* cake is 25.49

Distribution of animals into groups and their average liveweight (lb).

Distribution of animals into groups and their average liveweight (lb).

	Linseed cake				Groundnut cake (decorticated)			
	1	2	3	4	5	6	7	8
Age on 11 October 1941 (year, months and days)	1-7-28	1-7-4	1-6-15	1-6-11	1-7-18	1-7-12	1-6-21	1-6-15
Average age of group	407	432	363	416	414	376	403	430
Average liveweight at the start of the experiment on 11 October 1941		1 year 7 months				1 year 7 months 1 day		
Average liveweight of the group		404	497	533	509	471	506	513
Average liveweight at the close of the experiment on 14 February 1942	530	582			95	95	103	83
Total increase	123	150	134	117		94		
Average increase of the group		131						
	Rape cake				Mung chuni			
	9	10	11	12	13	14	15	16
Age on 11 October 1941 (year, months and days)	1-7-18	1-7-3	1-6-27	1-6-2	1-7-24	1-7-7	1-6--9	1-6-14
Average age of group	437	401	396	376	380	440	427	395
Average liveweight at the start of the experiment on 11 October 1941		1 year 6 months 27 days				1 year 7 months 1 day		
Average liveweight of the group		402	533	496	549	404	583	552
Average liveweight at the close of the experiment on 14 February 1942	541	498			169	587	156	157
Total increase	104	97	137	120		173		
Average increase of the group		115				164		

TABLE IV

Summary of results (rate of growth by different treatments)

Treatments	Linseed cake	Groundnut cake (decorticated)	Rape cake	Munḡ chuni	Mean	Critical difference at 5 per cent
Average increase per week (lb)...	6.84	4.96	6.30	8.72	6.705	1.317
Percentage of the mean ...	102.10	73.96	93.97	130.00	100.00	19.64
Rate of change of growth rate ...	-0.1591	-0.0438	-0.0913	-0.2479	-0.1355	-0.1339
Per cent rate of change of growth rate ...	117.40	32.32	67.39	183.00	100.00	98.45

per cent and from *guar* to *til* cake 43.18 per cent. *Guar* has produced the highest rate of growth and the fall in the rate of growth from *guar* to linseed cake is 17.69 per cent, but it is not significant being less than the critical difference of 24.59 per cent.

Comparative rate of growth with the different concentrates

Striking differences in the average growth rates due to the different treatments can be seen when the experimental data are plotted on the graph (Fig. 1). The curves for groundnut cakes, both decorticated and undecorticated, rape cake and *til* cake are less steeply inclined than those with linseed cake. Better rates of growth are to be found with *arhar chuni*, gram, *munḡ chuni* and *guar*. These findings are substantially confirmed by the statistical analysis. The data obtained during the three years of experiment have been analysed to study the comparative feeding value of the concentrates. The summary of the results is shown in Table VII.

The differences in the rates of growth obtained with linseed cake during the three experiments are not significant yet they are not the same which may be due to seasonal variations or other factors during the three different years. It is observed from Table VII that the average rates of growth with undecorticated and decorticated groundnut cakes are not significantly different from that with *til* cake but are significantly lower than that with the remaining concentrates. The growth rate with *til* cake is not significantly different from that with rape cake, but is lower than those with linseed cake, *guar*, gram, *arhar chuni* and *munḡ chuni*. The growth with rape cake is not significantly lower than that with linseed cake, but is lower than the figures obtained for *guar*, gram, *arhar chuni* and *munḡ chuni*. The rate of growth with linseed cakes is not significantly different from

TABLE V
Distribution of animals into different groups and their liveweight (lb.)

	Linseed cake					Til cake					Guar				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Age of 21 April 1942 (year, months and days)	1-8-12	1-5-9	1-4-21	1-4-8	1-3-23	1-6-2	1-5-27	1-5-12	1-4-48	1-4-2	1-7-17	1-5-13	1-5-4	1-4-14	1-3-22
Average age of the group	1 year 5 months 8 days					1 year 5 months 6 days					1 year 5 months 8 days				
Average liveweight at the start of the experiment on 21 April 1942...	429	346	395	316	354	383	369	426	317	341	427	388	372	300	360
Average liveweight of group			368					367		394			369		496
Average liveweight at the close of the experiment on 11 August 1942	535	422	503	449	465	457	487	508	418		556	509	503	452	
Total increase	106	76	108	133	111	74	118	82	101	53	129	121	131	152	136
Average increase of the group			107					86					134		

TABLE VI
Summary of results for rate of growth

Feeds	Linseed cake	Til cake	Guar	Mear	Critical difference at 5 per cent
Average increase per week (lb)	6.85	5.15	8.03	6.67	1.64
Percentage of the mean.	102.70	77.21	120.39	100.00	24.59

that with *guar*, but is lower than those with gram, *arhar chuni* and *munḡ chuni*. The differences obtained among *guar*, gram, *arhar chuni* and *munḡ chuni* are not significant. The results can be symbolically represented as follows :

Groundnut cake (undecorticated)	...	...	4'58
Groundnut cake (decorticated)	...	...	4'96
<i>Til</i> cake	...	...	5'15
Rape cake	...	...	6'30
Linseed cake (1942)	...	...	6'83
Linseed cake (1941)	...	...	6'87
Linseed cake (1940)	...	...	7.13
<i>Guar</i>	...	...	8'03
Gram	...	...	8'77
<i>Arhar chuni</i>	...	...	8'79
<i>Munġ chuni</i>	...	...	9'83

The variations observed in the growth rate may be due to higher consumption, better digestibility of the total ration on account of the presence of certain concentrates or superior value of the nutrients of some concentrates.

Consumption of total ration as influenced by the different concentrates.
The average consumption per animal per day in all the treatments and the intake per 100 lb. of liveweight have been tabulated in Table VIII. The average composition of the feeds during the experiment is given in Table IX.

Smaller quantities of concentrates richer in protein were fed to maintain the same level of protein for all the treatments, and it is noted that the consumption of total dry matter was also lower in these groups. Concentrates and coarse fodders were fed separately. Where the quantity of concentrate was comparatively higher, as with *arhar chuni* and *mung chuni* the intake of wheat straw was slightly lower, but in most of the treatments its intake, though fed *ad lib*, did not appreciably increase with the lower amount of concentrates, which indicates that the animals were usually

TABLE VII
Summary of results of combined analysis

Average increase per week (lb)	1940			1941					1941		Mean	Critical difference 5 per cent			
	Linseed cake	Groundnut cake undecorated	Gram	Arihar chuni	Linseed cake	Groundnut cake decorated	Rape cake	Mung chuni	Linseed cake	Til cake		Guar	Treatments with 4 animals	Treatments with 5 animals	Treatments with one and the other animals
7.13	4.58	8.77	8.79	6.87	4.96	6.30	8.83	6.83	5.15	8.03	6.91	1.50	1.35	1.43	
103.18	66.28	126.92	127.21	99.42	71.78	91.17	127.79	98.84	74.53	116.21	100.00	21.71	19.54	20.69	
Percentage of mean.															

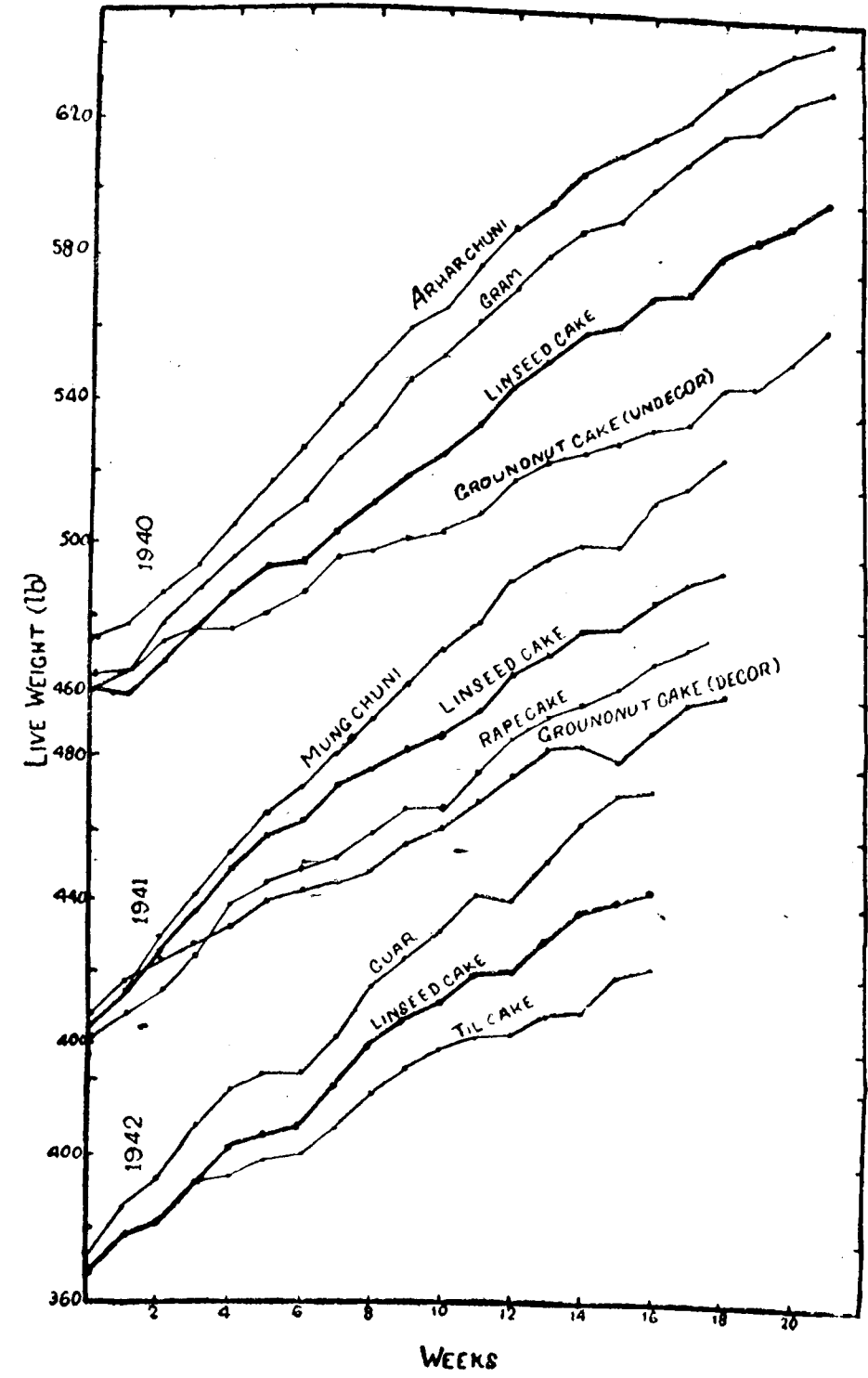


FIG. 1. Rate of growth with different concentrates

TABLE VIII
(Intake of total dry matter per day with the different concentrates) lb.

Treatments	Wheat straw	Silage	Wheat bran	Concentrates	Total	Average live-weight	Intake per 100 lb. live-weight
1940							
Linseed cake	2.92	4.08	1.40	2.95	11.35	530	2.14
Groundnut cake (undecorticated)	2.70	4.07	1.40	2.98	11.15	512	2.18
Gram	2.67	4.06	1.40	4.39	12.52	546	2.29
Arhar chuni	2.49	4.07	1.38	5.34	13.28	560	2.37
1941							
Linseed cake	2.45	4.28	1.41	2.82	10.96	470	2.33
Groundnut cake (decorticated)	2.42	4.27	1.41	1.48	9.58	452	2.12
Rape cake	2.39	4.25	1.41	2.45	10.50	460	2.28
Mung chuni	1.64	4.26	1.41	5.31	12.62	486	2.60
1942							
Linseed cake	1.73	4.41	1.41	2.21	9.76	427	2.29
Til cake	1.82	4.39	1.37	1.61	9.19	415	2.21
Guar	1.67	4.37	1.39	3.05	10.48	444	2.36

TABLE IX
Average percentage composition of feeds on dry basis

Feeds	Organic matter	Protein	Ether extract	Fibre	N-free extract	Total carbohydrates
1940						
Wheat straw ...	91.2	2.01	0.675	39.9	48.7	88.5
Jowar silage ...	88.3	3.27	0.618	36.1	48.2	84.3
Wheat bran ...	93.6	15.06	3.163	11.2	64.2	75.4
Linseed cake ...	92.3	31.05	7.033	8.4	45.1	54.5
Groundnut cake (undecorticated)	87.0	31.57	9.279	20.9	25.3	46.2
Gram ...	96.0	21.90	4.015	9.5	60.6	70.1
Arhar chuni ...	91.6	19.36	1.542	19.0	51.7	70.7
1941						
Wheat straw ...	90.4	2.37	0.865	39.3	47.9	87.2
Jowar silage ...	88.4	5.30	1.702	31.6	49.8	81.4
Wheat bran ...	94.6	12.50	3.397	13.0	65.7	78.7
Linseed cake ...	90.0	33.03	3.082	9.0	44.9	53.9
Groundnut cake (decorticated)	92.5	52.90	7.647	6.7	25.2	31.9
Rape cake ...	90.6	37.74	8.121	8.1	36.7	44.8
Munḡ chuni ...	89.1	22.24	1.253	15.0	50.6	65.6
1942						
Wheat straw ...	92.1	3.04	0.510	42.8	45.8	88.6
Jowar silage ...	88.4	5.11	1.426	32.5	49.5	82.0
Wheat bran ...	92.0	14.53	3.459	11.8	62.2	74.0
Linseed cake ...	93.1	36.56	3.910	9.4	43.3	52.7
Til cake ...	87.0	46.78	7.364	5.0	27.9	32.9
Guar ...	95.4	30.56	2.940	10.0	51.9	61.9

satiated with the average total dry matter consumed in the oil cake treatments. Thus it appears that on an average 2.22 lb. total dry matter per 100 lb. liveweight is necessary for Hissar heifers between one and two years of age and weighing between 400 and 500 lb., but the rate of consumption may be higher if the ration consists mostly of palatable feeds. In the *munḡ chuni* treatment, the average consumption per 100. lb. liveweight was as high as 2.60 lb. The higher intake of dry matter must have influenced, to some extent, the better growth rate with *guar*, *gram*, *arhar chuni* and *munḡ chuni*.

Effect of the concentrate on the digestibility of the total ration. Digestibility trials were conducted with three animals under each treatment during 1940 and 1941 and with two animals in 1942. The average digestibility coefficients of the nutrients of the total ration for each treatment have been recorded in Table X.

When *gram*, *guar* or pulse by-products are present in the ration both organic matter and total carbohydrates are better digested, whereas the digestibility of protein is superior when concentrates richer in protein are fed.

This indicates that the concentration of a nutrient in the total ration plays an important role in its digestibility. The level of protein was the same in all the treatments, but due to a lower intake of total dry matter the concentration of protein was higher in the treatments with feeds richer in protein, resulting in its better digestibility. The same tendency is noticed with the digestibility of ether extract. Similar observations were made by the author [1943] on a previous occasion. The lower digestibility of protein of the total ration with *gram*, *arhar chuni* and *munḡ chuni* might also have been influenced by the presence of more easily digestible carbohydrates.

Gain in liveweight in relation to the intake of digestible nutrients. The increases in liveweight per unit of digestible protein and total digestible nutrients have been calculated (Table XI) to compare the feeding value of the nutrients from the different concentrates. The pulses and pulse by-products have always given higher increase in liveweight per unit of digestible protein. This greater increase cannot be attributed only to the quality of protein, as more carbohydrates also had to be ingested as a result of maintaining the same level of protein in these treatments. Balancing of both protein and carbohydrates, which is necessary for such experiments, is only possible by supplementing purified diets, but this is not practicable specially with dairy cattle, in long period feeding trials. In the experiment during 1940, the actual amount of protein digested was lower than the calculated quantity given to the animals of *gram* and *arhar chuni* groups, and hence, the level of protein supplement was lower for these two treatments. But the increase in liveweight per unit of total

TABLE X
Digestibility of total ration with the different concentrate (per cent)

Treatments	Organic matter	Protein	Ether extract	Fibre	N-free extract	Total carbo-hydrates
1940						
Linseed cake ...	59.2	62.8	77.3	56.2	55.7	55.7
Groundnut cake (undecorticated) ...	55.3	63.2	79.6	51.2	54.7	54.5
Gram ...	65.0	59.7	72.6	61.8	66.6	65.0
Arhar chuni ...	62.7	50.9	65.1	71.0	60.9	65.0
1941						
Linseed cake ...	61.2	61.9	61.7	59.7	59.9	59.9
Groundnut cake (decorticated) ...	59.9	63.1	65.3	59.4	56.3	57.4
Rape cake ...	60.5	63.1	73.5	58.7	58.1	58.3
Munḡ chuni ...	62.1	56.5	47.4	58.5	63.9	62.1
1942						
Linseed cake ...	60.1	68.2	58.6	56.0	60.6	59.0
Til cake ...	58.2	68.3	71.5	54.2	56.8	55.9
Guar ...	64.0	68.3	63.7	57.9	66.0	63.2

digestible nutrients was the same even with this lower protein supplement. *Munḡ chuni* and *guar* in 1941 and 1942 respectively have produced decidedly better rate of growth per unit both digestible protein and total digestible nutrients. Thus it appears that for growing animals protein from gram, *arhar chuni*, *munḡ chuni* or *guar* is superior to that from the oilcakes.

TABLE XI

Gain in liveweight in relation to the intake of digestible nutrients (lb.)

Treatments	Live-weight increase	D. P. intake	T. D. N. intake	Increase per lb of D. P.	Increase per lb of T. D. N.	Average live-weight
1940						
Linseed cake ...	140	121.9	911.8	1.15	0.15	530
Groundnut cake (undecorticated) ...	101	124.4	868.3	0.82	0.12	513
Gram ...	172	119.1	1132.8	1.44	0.15	546
Arhar chuni ...	170	106.6	1132.8	1.60	0.15	560
1941						
Linseed cake ...	131	108.6	770.9	1.21	0.17	470
Groundnut cake (decorticated) ...	94	97.3	663.6	0.98	0.14	452
Rape cake ...	115	110.0	741.5	1.05	0.16	460
Munḡ chuni ...	164	115.4	886.5	1.42	0.19	486
1942						
Linseed cake ...	107	98.6	616.2	1.09	0.17	427
Til cake ...	86	94.1	559.7	0.91	0.15	415
Guar ...	134	107.6	707.7	1.25	0.19	444

Relative economy of the concentrates

The cost for production of 100 lb. liveweight with all the concentrates is shown in Table XII.

The tests were carried out for three consecutive years and the prices of feeds varied from year to year. Hence, to compare the cost of production with the different concentrates, the prices of all the roughages and bran have been taken as the same as in 1941 and those of the concentrates have been modified and brought to the 1941 level on the basis of variation of the price of linseed cake from year to year. The comparative cost of the total ration for the production of 100 lb. liveweight (Table XII) show that for production of the same liveweight rape cake is the cheapest amongst all the concentrates, next in order come groundnut cake (decorticated), *guar*, *munḡ chuni*, linseed cake, *til* cake, *arhar chuni*, groundnut cake (undecorticated) and gram.

TABLE XII
Relative economy of the concentrates

Concentrate	Gain in liveweight	Quantity of concentrates fed	Prices per 100 lb. during experiment	Cost of total ration for 100 lb. increase in liveweight	Prices per 100 lb. on the basis of 1941 rate	Comparative cost of production of 100 lb. liveweight on the basis of 1941 rate	Equivalent quantities
	Lb.	Lb.	Rs.	Rs.	Rs.	Rs.	Lb.
1940 (21 weeks)							
Linseed cake	140	433.6	2.745	17.34	2.745	14.67	100
Groundnut cake (uncorticated)	101	438.0	1.829	19.34	1.829	16.53	135
Gram	172	645.4	3.354	20.35	3.354	17.22	120
Arhar chuni	170	784.8	2.256	17.78	2.256	15.04	137
1941 (18 weeks)							
Linseed cake	131	372.9	2.745	14.67	2.745	14.67	100
Groundnut cake (decorticated)	94	192.9	1.829	13.21	1.829	13.21	77
Rape cake	115	324.3	1.829	12.87	1.829	12.87	99
Mung chuni	164	705.3	2.073	14.01	2.073	14.01	138
1942 (16 weeks)							
Linseed cake	107	266.7	3.659	25.4	2.745	14.67	100
Til cake	86	196.4	3.049	27.3	2.288	14.75	93
Guar ...	134	370.5	3.659	22.9	2.745	13.92	104

The comparative economic value of a feed cannot be assessed only by the market prices which always vary. Therefore the quantities of different concentrates which produce the same increase in liveweight have been shown in the last column (Table XII). But for true economy the time factor should also be taken into account as with better rate of growth, the period of unproductiveness is shortened. It appears that when the rate of growth is taken into account *guar* is definitely more economical than the oilcakes, and both *arhar chuni* and *munḡ chuni* may also prove cheaper in the long run.

Summary

Trials were conducted to study the comparative feeding values of linseed cake, decorticated and undecorticated groundnut cakes, rape cake, *til* cake, *guar*, gram, *arhar chuni* and *munḡ chuni* with Hissar heifers. The tests were carried out in three sets during 1940, 1941 and 1942. Linseed cake was used as control in all the sets. Varying quantities of the different concentrates were fed to maintain the same level of protein in all the treatments.

In the first test, it was found that gram and *arhar chuni* produced better growth than linseed cake, while undecorticated groundnut cake proved inferior. Among the concentrates tested in the second year, *munḡ chuni* gave the highest rate of growth, followed in order by linseed cake, rape cake and decorticated groundnut cake. The difference in the growth rates with linseed cake and rape cake was not significant. In the third set, the growth rates were in the decreasing order of *guar*, linseed cake and *til* cake.

On comparing the data for all the concentrates, it was found that under the conditions of these experiments groundnut cakes both decorticated and undecorticated resulted in the least favourable rate of growth. *Til* cake and rape cake come next in order of increasing value, followed by linseed cake. Linseed cake was of about the same value as *guar* and was inferior only to gram, *arhar chuni* and *munḡ chuni* which gave the best results.

The digestibility of organic matter and total carbohydrate was higher when pulse or pulse *chuni* was present in the ration, while that of protein was superior when the concentrates richer in protein were fed. This variation appears to be due to the concentration of the nutrient in the total ration.

Protein of gram, *arhar chuni*, *munḡ chuni* and *guar* appears to be of superior quality as compared to that of the oilcakes for growing Hissar cattle. *Munḡ chuni* and *guar* produced the best rates of growth per unit of

total digestible nutrients as well. For the production of the same liveweight rape cake has been found to be the cheapest. Next in order come decorticated groundnut cake, *guar*, *munḡ chuni*, linseed cake, *til* cake, *arhar chuni*, undecorticated groundnut cake and gram. But when the rate of growth is taken into account, which determines the period of unproductiveness the feeding of *guar* is definitely more economical than the oilcakes and both *arhar chuni* and *munḡ chuni* may also prove cheaper in the long run.

With normal feeds, the consumption of dry matter for Hissar heifers weighing between 400 and 500 lb. is, on an average, 2.2 lb. per 100 lb. liveweight.

Acknowledgements

Acknowledgement is due to the Imperial Council of Agricultural Research for financing the Cattle Feeding Research Scheme, U.P., which offered scope for this work. The author desires to express his thanks to Mr C. Maya Das, I.A.S., Director of Agriculture, United Provinces and Mr. Sultan Singh, Deputy Director of Agriculture, Bundelkhand Circle, Jhansi, for the facilities provided and the keen interest taken in these investigations. The author also acknowledges with thanks the help received from Mr K. Kishan, Statistician, Agricultural Department, United Provinces, in the statistical analysis, Dr S. P. Srivastava and Mr I. N. Sharma, Research Assistants, for the analytical work and the compilation of the experimental data and Messrs V. R. Singh and R. S. Gupta, Farm Superintendents, for providing the animals and making arrangements for the fodders.

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"Veterinary medicine must be brought back from the laboratory to the stable and byre. The clinician is the most important man in the profession. If all the laboratories were closed, the profession would live. If the clinicians were removed, the profession would die."

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Editorial

THE LIVESTOCK SECTION—MADRAS

We are glad to learn that the Government of Madras have refused to be hustled into taking a hasty decision on the question of separating the Livestock Section from the Veterinary Department. The matter is to be taken up again at the next meeting of the Provincial Livestock Improvement Board for consideration. What we have been pleading for is only a just and careful study of all aspects of the question, not so much in the interest of the Department itself as in the interest of the country.

We are given to understand that facts and figures are being manipulated to discredit the work of the Veterinary Department. Comparisons are sought to be made between pre-war period and the periods of war and post-war depression. Does it require much imagination to state that the latter period will certainly compare unfavourably with the pre-war period, when everything was in plenty and easily available?

Several factors go to make up the data of a Livestock Research Station—in particular, the age of the animals, the number of animals under each group, the number of animals in lactation, the number of lactation of each animal in the groups, the feed that was available, favourable and unfavourable seasons, the skilled or un-skilled labour available etc., etc., before one can

think of comparing either the milk-yield of cows, the weights of animals or the birth-weights of calves, etc. These data can still further be subjected to the "pick and choose" method to suit one's object in view. Our contention therefore is that too much value should not be attached to such *produced* records by way of propaganda. Photos of a few bad-doers in animals are taken and advertised—so, we are informed. We refuse to believe that such propaganda is tolerated by Government.

On the other hand, we are told that, as a result of the sound breeding programme followed on approved scientific lines by the Veterinary Department, most of the heifers which have calved recently and have come into milk, are proving such heavy milkers that they promise to break all previous records. By introduction of fresh blood and through proper selection of stud bulls, it has been possible to produce better calves amongst the Kangayams and Hallikars which were showing signs of deterioration previously. Space prevents us from publishing the long list of improvements effected on the Farms both at Hosur and Lam. All these have been achieved within the short space of eight years. But such records will not see the light of day, for they do not serve the purpose in view of the propagandist.

True it is that it fell to the lot of the Veterinary Department to start managing the Livestock work mainly during the period of war and after. Break-downs in the supply of cattle-feed were common due to scarcity and transport difficulties; labour was scarce; fodder-fields were ploughed up and converted into vegetable garden to supply vegetables to the Army; three times the number of Livestock normally stocked on the Farm had to be maintained to supply nearly 1500 to 2000 pounds of milk and 35 pounds of butter daily to the Army; the failure of monsoons in three consecutive years, which has had such disastrous consequences on the entire country, had not failed to affect the hay position on the Farm and also the water supply; water had to be baled out from improvised wells and 1500 head of cattle kept going without any mortality. It was a herculean task for the Officers concerned. Instead of showing appreciation on the

Department for the excellent work done under the most trying circumstances, it is a strange irony that it should be assailed in this manner.

We are sure that, when the matter is fully gone into, it will be a matter for surprise that the claim for separation should have been entertained at all. We know its genesis. We feel confident that the present Ministry will decide the question without fear or favour.

NEW APPOINTMENTS

We are glad that Sri M. Y. Mangrulkar, M.Sc., M.R.C.V.S., D.T.V.M., who was Lecturer in Pathology and Bacteriology at the Madras Veterinary College has been appointed as the Principal of the newly opened Veterinary College and Livestock Research Institute at Jubbulpore, C.P.

We are also glad that the services of Rao Sahib T. Vinayaka Mudaliar, G.M.V.C., who retired recently as Livestock Development Officer, Madras, have been requisitioned by the Government of India to organise the Central Cattle Breeding Station at Jubbulpore.

We congratulate the above officers on their new appointments and wish them all success.

We cannot but express our regret that the Madras Province which is already in need of experienced Veterinary *personnel* should lose the services of such experienced officers who are experts in their own line. While it is true that Madras Government is very clever in selecting officers suitably for important posts, it is cleverer still in losing their services at the opportune moment. It is a great pity that such things should happen when the administration is in the hands of a popular Ministry

Clinical Articles

CANINE TICK FEVER—SOME OBSERVATIONS ON THE SEQUELAE OF.

BY

Capt. G. VENKATA NARUSU, G.M.V.C., P.G. (MUKT.)
Gwalior Kennels, Gwalior, C.I.

It is well known to veterinary practitioners in India that 'Tick fever' in dogs is a complex syndrome, in which any of the three causative factors or any combinations of them may operate viz. *B. canis*, *Pattonellidae gibsoni*, and *Rickettsia canis*. In this short note, I wish to record some of the sequelae which I have observed during a severe outbreak of 'Tick fever' in dogs about a year back. The inmates of the Kennel included Cockers, Alsations, Fox-Terriers (smooth and wire coated), Setters, Great Danes, Borzois, and also toy breeds such as Poms and Pekes. As the construction of the Kennel was not absolutely tick-proof then, the multiplication of these arthropod vectors was so rapid, that in spite of all our efforts to eradicate and destroy them, they were seen in great numbers on these animals.

The clinical symptoms presented by these cases in general were pyrexia, inappetence, lassitude, pallor of the mucous membranes, haemoglobinuria and enlargement of the spleen which could be easily palpated in the left hypochondriac region. The pulse was accelerated while the respirations were laboured with the characteristic 'puffing' of the cheeks at each respiration. Only in some dogs were these symptoms accompanied by progressive anaemia and recurrent type of fever.

Many chemo-therapeutic agents such as Trypanblue, Trypaflavin, Tryparsamide, Sulphapyridine, Salvarsan, N. A. B. and Sulphathiazole were used. The last mentioned drugs namely N. A. B. (intravenously in doses of 0.01 gms. per lb. body weight) and Sulphathiazole (in doses of 1 gr. per lb body weight orally) have given very good results. But the effects of these drugs and the subsequent recovery of these dogs appeared almost transitory in nature. For, after a full course of treatment with the drugs referred to, out of 30 infected dogs, only 10 could survive. And even these ten recoveries developed the following serious complications in the course of a month:—(1) Paraplegia, (2) Chorea, (3) Encephalitis.

1. *Paraplegia*. Five Cockers and a Pomeranian were the victims of the malady, of which the Pom was the most interesting. This little Pom had a mild attack of 'tick fever' and recovered with Acaprin treatment (0.2 c. c. subcutaneously). After a couple of months, she developed a tilting gait during progression and began to tumble over after walking a few steps. In about a week, she developed definite Paraplegia. The temperature was normal; so also urination and defaecation. She never refused feed till her last moments and recorded no elevation of temperature either. The diet consisted of milk, biscuits, boiled minced mutton and fried fish.

To start with, a course of Pot. Iodide mixtures was given. Then she was put on para-thyroid and calcium tablets alternated with Vitamin B₁ (Binerva Roche). Aricyl and Tonophosphan injections were undertaken later. But no appreciable improvement was noticed. Thereafter diathermy and ultra violet-ray therapy was given a trial; as this also was not yielding any satisfactory result, the galvanic current was tried with no material benefit. It was then decided to take an X-ray photograph of the animal. As it was only a miniature Pomeranian weighing 4 lbs, the whole body was X-rayed in the dorso-lateral position. Calcification of the intervertebral discs between the 10th, 11th and 12th thoracic vertebrae was noticed on radiography. In about a month, her condition worsened. Her head and neck became very stiff, and all efforts to bring the head to the normal position always failed. Slowly, she was reduced to a cripple and died.

2. *Chorea*. A Pekingese and a Tibetan Lhasa were the two dogs that developed this trouble. The disease was first confined to the temporal region, but gradually extended to the neighbouring muscles. In the course of a fortnight, the clonic spasms were seen throughout the body with the head nodding up and down without any respite. Aricyl, Tonophosphan injectable Luminol, sodium and Metatone were some of the drugs used. Then iron-arseno-strychnine compound (Glaxo) was injected without any benefit. Ultra violet ray therapy was then given a fair trial. Lastly, a course of Sodium Cacodylate injections was given. A course of bromides to induce sleep and comfort to the patient during extreme stages of excitement was also adopted. But the disease proved practically incurable. Both the patients died after three months.

3. *Encephalitis*. A wire-haired Fox-Terrier and a Pom, suffered from this complication. The dogs were found in an excitable and irritable condition with staring and vacant looks. At short intervals, the patients were seen to lie semi-comatosed; but became wild and delirious with an altered facial expression and locomotor incoordination. The most conspicuous symptom observed in this complication was that the dog was seen always moving in circles and that too in one particular direction, and more often than not, the patients used to walk in a backward direction. Sulphadiazine

internally and Sodium salt of Penicillin intramuscularly were found to have some beneficial effect to allay the severity of the symptoms, but could not bring about a radical cure. The animals had to be eventually destroyed on humanitarian grounds.

Acknowledgement. It is my pleasant duty to thank Lt. Col. Dr. Mehar, M. R. C. V. S. (Lond.) Director, Veterinary Department, for the valuable suggestions given to me from time to time during the course of treatment of these cases, and for permitting me to record these observations.

POISONING BY BARIUM CARBONATE IN A HEN

BY

R. N. SRIVATSAVA

Vety. Asst. Surgeon Veterinary Hospital, Hata, U. P.

A very interesting case of poisoning in a hen by barium carbonate was admitted in the hospital on 12-12-46 with the following history:—

The owner got some barium carbonate to kill rats and mice in his house. He mixed the above powder with wheat flour and made several pills of it. He scattered these pills in his house and accidentally the said hen took about 14 or 15 pills of this poisonous stuff at about 5 P. M. on 11-12-46. The hen—a Desi breed about one year old—was found next morning in a comatose stage and it was brought to the hospital with following syndrome:—

Temp. 101.2 F., eyes closed, but opened when the bird was made to wake up, pupils dilated, phallanges of the foot crouched inwards, head hanging down, legs, body and wattle very cold, crop highly tympanic. The bird could not support itself.

Treatment:—Adrenalin Hydrochloride (1 in 1000) $\frac{1}{2}$ c. c. was injected subcutaneously. Simultaneously, a glycerine and hot water enema was given to evacuate the bowels. Some balckish-white material was voided with a very foetid odour. Next, the crop was opened out, emptied of its contents, washed thoroughly with a saturated solution of Sodii sulph. solution, and then sutured.

A dose of mag sulph. 15 grs. dissolved in 2 drs. of water was given as an antidote.

The injection of Adrenalin was repeated after 15 minutes and every effort was made to prevent the collapse of the bird; these were of no avail and the bird died about 2 hours after.

Post-Mortem Findings:

1. Lungs—highly congested. 2. Liver—normal. 3. Heart—enlarged ventricle—empty, auricles contained black clots of blood. 4. The whole digestive tract was inflamed; and there were erosions and haemorrhagic patches all over the mucous membrane of the tract.

COCCIDIOSIS IN CALVES

BY

A. MOBERLY, G. M. V. C.,

Veterinary Assistant Surgeon i/c Veterinary Dispensary,
Devakottah.

Among the protozoal diseases of cattle, coccidiosis in calves plays a great part in the mortality of young calves in certain areas.

During a period of 5 months from November 1940 to March 1941, eleven cases of coccidiosis were treated at this Institution.

Class of animal.	Breed.	Age				Total.
		Under 1 month.	One month.	Two months.	Three months.	
Calves	Local	1	2	5	3	11

All these calves were not at pasture and probably they were infected by suckling infected teats or licking infected areas. It was found that only young calves below six months of age were affected.

Symptoms:—In three calves, only diarrhoea of a dark green nature was present while in all the others, diarrhoea with quantities of blood mostly fluid, and not in clots, was observed. Straining was observed in all the cases. In two calves straining occurred for more than three minutes at a time and the calf fell down during the act. Prolapse of the rectum was noticed in one case. One calf had no appetite at all for two days, three calves for one day and the rest had moderate appetite during the course of the disease. One calf was brought at a very late stage and was reported to have died the same night.

The clinical symptoms were quite characteristic and sufficient for diagnosis. Still, the motions were examined and, in all the cases, oocysts were present, in some of them in large numbers.

Treatment :—Copper sulphate, one per cent solution, in one to two ounces doses, was given internally and an enema of the same solution was also given on the first day. Tinctures of opium and catechu in carminative mixture were given subsequently. In one case which had diarrhoea without blood, treatment was given only for three days with success. In five cases, treatment was continued for 5 to 10 days; in two calves for two weeks and in one calf for three weeks. As regards the other two calves, one discontinued treatment after two days when improvement was noticed, and the other which was brought in the last stage was reported to have died the same night.

All the above 11 calves were of cows only and no buffalo calves were brought for treatment. As buffaloes yield milk without calves, the same attention is not paid when buffalo calves are affected and they are very rarely brought for treatment.

Summary and conclusions :—As nearly all the affected calves maintained a fairly good appetite in spite of the alarming symptoms exhibited, prompt treatment with good nursing, intestinal disinfectants and demulcents generally gave a high percentage of recoveries. When treatment is adopted in early stages, there is no fear of fatal termination. All the above treated calves did not return for the same complaint again for a year afterwards.

Acknowledgment :—My thanks are due to Sri K. R. Lakshminarayana Ayyar, G. M. V. C., District Veterinary Officer, Ramnad at Madura, for his guidance in writing this article.

ANTHRAX AMONG CATTLE—A CLINICAL INVESTIGATION OF AN OUTBREAK WITH SPECIAL REFERENCE TO THE SUBACUTE FORM.

BY

K. A. PADMANABHA MENON, G. M. V. C.
Touring Veterinary Assistant Surgeon,
Nellore.

Introduction.

The purpose of this article is to give a detailed record of the existence of sub-acute cases of anthrax among cattle and to record the symptoms of the affected animals. In my experience of ten years in the field I have attended many outbreaks of Anthrax, but the type of anthrax among cattle to be recorded below has not been noted by me hitherto. The disease as it existed and recorded by me at other places was of

Anthrax Among Cattle—A Clinical Investigation of an Outbreak 57

a sporadic nature with a few animals getting the attack and all of them ending fatally. The disease has been known to exist in the acute and the per-acute forms and in both cases the disease terminates fatally in from 24 to 36 hours. From the onset of the attack which is marked by high temperature the disease has always been noted to take a turn towards a fatal end, and the successive symptoms of heavy breathing, restlessness tympany, colic, and in some cases slight diarrhoea, adds only to the quick end of the animal which generally takes place in about 24 to 36 hours.

Details of the outbreak.

This outbreak occurred in Thottapalli-Gudur village of Nellore taluk, about 12 miles from Nellore.

Source of infection.

The source of infection could not be traced out. There was no disease reported to be prevailing then among sheep and goats, from which species of animals the disease generally spreads to cattle.

Season of the outbreak.

The outbreak occurred during the hottest part of the year viz., June and July 1946.

Animals affected.

The animals affected were only cows, bulls and bullocks. It was particularly noted that the attacks were more among working bullocks and bulls and, even amongst them, only animals above the age of four years were found to have been affected.

Period of illness.

The affected animals suffered from 24 hours to 4 days before they either died or recovered.

Symptoms recorded.

The symptoms recorded by me are not as a result of personal observation of the cases but on what the owners detailed out. In as much as the results of enquiries made from different individuals about the symptoms shown by the animal or animals were so closely similar, there need be little doubt about the correctness of their statements. The disease is known in the villages as "narani" meaning enlarged spleen in Telugu and the one feature in all the dead animals when cut open was as given by the ryots, a marked enlargement of the spleen.

The affected animal is reported to be first going off feed and putting on a staring coat denoting rise in temperature. Most of the animals were

reported to have been shivering. It was noted that in some animals the staring coat was observed only on the left side of the body. Some animals had tympany which was recurring but none of the animals were reported to have had any colicky pains. These symptoms were reported to be shown by the affected animals for only 24 to 36 hours after which there was an apparent improvement. They became a bit bright and even start eating a little and ruminating at intervals. At this stage it was reported that the tympany disappeared but some animals were reported to have passed hard dung and strained a bit. Some animals were reported to have been turning their head very often towards the left flank. This apparent improvement was said to be maintained by the animals only for 12 to 24 hours when the animals showed a set-back. They again became off feed, showed staring coat and recurrent tympany; some animals had colicky pains, straining often and passing small quantity of dung, sometimes hard, sometimes semisolid and in some cases blood and mucous-stained. Some animals were reported to have been continuously grinding the teeth. The animals during the later stages of the disease, *i.e.*, at the end of the third day of the attack, developed heavy breathing and were also reported to have had marked jugular pulse. The animal often turned towards the left flank and showed a peculiar arching of the spine. During the terminal stages *i.e.*, by the beginning of the fourth day, the tympany was reported to be very acute and persistent, the animal becoming restless, lying down and getting up; some animals straining continuously, and passed loose motions sometimes tinged with blood. They become completely prostrate, had great dyspnoea and die after a few violent struggles. In some animals it was reported that there was haemorrhage from the nose after death.

Diagnosis.

Unpreserved skins were collected from nine dead animals and submitted to the Veterinary Investigation Officer, Madras for biological test against anthrax. The result of the test was reported *positive for anthrax*.

Local Treatment.

This is recorded as a matter of interest since the rationale behind the same could not be explained. The treatment given by the local quack to the affected animal was to make a small perforation on the left side midway between the fourth and the fifth ribs (counting from behind) with a small exploring needle and introduce hot oil (coconut or gingelly oil) into it, say about two to four ounces. The oil was poured into a cup-like enclosure, prepared out of dung around the exploring needle and it was slowly introduced in by the rotatory movement of the exploring needle. The idea behind this treatment as explained by the ryots, was to blister the spleen by means of the hot oil to prevent its enlargement! The percentage of recoveries, if it could be attributed to this treatment, worked up to 3 per cent in this outbreak.

Summary.

1. An outbreak of sub-acute Anthrax among cattle in a regular epidemic form is recorded.
2. Detailed symptoms of the sub-acute form of the disease is given.
3. No cases were recorded among buffaloes, sheep, goats or pigs.

Details of animals affected & died.

Description of the animal	Age.	Date of attack	Date of death
1. Bullock.	6. Years.	26-6-46.	29-6-46.
2. "	7. "	"	"
3. "	7. "	30-6-46.	2-7-46
4. "	6. "	"	"
5. "	5. "	"	"
6. "	6. "	1-7-46.	1-7-46.
7. "	7. "	2-7-46.	2-7-46.
8. "	6. "	"	"
9. "	7. "	16-7-46.	18-7-46.
10. Cow.	5. "	"	"
11. Bullock.	6. "	"	"
12. "	6. "	19-7-46.	23-7-46.
13. "	8. "	21-7-46.	25-7-46.
14. "	8. "	22-7-46.	"
15. "	6. "	"	"
16. "	5. "	"	"
17. "	8. "	"	"
18. "	7. "	24-7-47.	27-7-46.
19. "	7. "	"	"
20. "	7. "	"	28-7-46.
21. "	10. "	25-7-46.	"
22. "	9. "	"	"
23. Bull.	4. "	"	"
24. "	4. "	"	"
25. Bullock.	7. "	26-7-46.	"
26. "	8. "	28-7-46.	30-7-46.
27. "	8. "	"	"
28. "	7. "	29-7-46.	1-8-46.
29. "	8. "	"	1-8-46.

All the animals detailed above were of the local breed and all of them were reported to have shown all the symptoms detailed above except animals Nos. 6 and 7, which were reported to have died within 24 hours:

'CARBACHOL' IN VETERINARY PRACTICE.

BY

P. C. TRIPATHI, B. Sc., G.B.V.C., P.G. (LAH.),
Veterinary Assistant Surgeon, Shahjahanpur, U. P.

Carbachol is a proprietary preparation of May & Baker's containing Carbamylcholine chloride, an analogue of Acetyl-choline, with almost similar pharmacological activity but with more pronounced parasympathetic stimulation. Further, this preparation is a more stable substance and more persistent in action, prepared for use in 0.1% w/v solution.

According to the manufacturers, Carbachol is indicated in cases where increased glandular and muscular activity of the alimentary tract is desired. It can also be employed successfully for 'toning up' an atonic pregnant uterus. Unlike Physostigmine and Arecoline, Carbachol does not produce any secondary effects on the heart but is contra-indicated in cases complicated with pulmonary affections like broken wind in horses and lung-worms in cattle.

The author has had great opportunities of using this agent in both equines and bovines with very encouraging results. A few cases treated at the Civil Veterinary Hospital, Shahjahanpur are detailed below:—

Case No. 1.—A young Indian-bred pony, in good condition, was brought for treatment with acute impaction of the colon. After giving an enema, an injection of Carbachol 2 c. c. was given, followed by another 1 c. c. after about 20 minutes. Immediately the animal evinced excessive salivation and some sweating. Within the next ten minutes, the bowels started acting slowly. The bladder also was emptied. The effects persisted for quite a long time resulting in almost total evacuation of the bowels. The animal had complete relief and was fit for work the next day.

Case No. 2.—A grown up, well-bred mare in fair condition suffering from flatulent colic was brought for treatment in a serious condition after about 14 hours of the onset of the complaint. Carbachol 4 c. c. was injected subcutaneously followed immediately by an enema. Profuse glandular secretions were seen within a few minutes. The bowels began to act and the animal was relieved of the flatulence in about 20 minutes. The mare appeared quite alright in about three hours, though somewhat exhausted.

Case No. 3.—An I.B. gelding, aged 4 years, with a history of acute constipation for about three days associated with slight colicky pains and scanty and high coloured urine. Full dose of oily purgatives administered earlier appeared to have had no effect; so also copious enemas. The animal

had a temperature of 103.2° and was occasionally looking towards the flank. The conjunctivae were rather dirty and the gait slightly unsteady at times. The animal was otherwise in good physical condition.

Carbachol 2 c. c. was injected subcutaneously, followed by another dose of 2 c. c. in about 15 minutes. The animal soon showed signs of intestinal action. It took just over two hours for the first small constipated mass to be evacuated. Copious enemas were then given and these were followed by gentle exercise. The horse had complete relief in 7 to 8 hours.

Case No. 4.—A local-bred cow, aged about 5 years, with symptoms of acute oesophageal obstruction.

Carbachol 2 c. c. 'injected subcutaneously' produced profuse salivation within a few minutes. About 4 oz. of 01. Lini was given to the animal but hardly an ounce got in owing to the obstruction. In about 25 minutes, the animal was relieved of the obstruction and thereafter took plenty of water.

Case No. 5.—A local-bred cow, primipara, aged 4 years, in good health, had difficulty in calving owing to uterine inertia. The presentation was normal.

Carbachol 3 c. c. was injected subcutaneously. Within ten minutes the animal had strong labour pains and, in 15 minutes, the calf was thrown out with a jerk, alive and in perfect condition. The after-birth also was expelled within another half an hour.

Case No. 6.—A fine local-bred draught bullock, aged 7 years, with acute impaction of the rumen, consequent on an accidental heavy feed of grams the previous day.

Carbachol 4 c. c. was injected subcutaneously. At first, apart from excessive glandular secretions, no immediate apparent relief was evinced. After 3 hours, the hard impacted mass in the rumen appeared much softer on manipulation and some feeble ruminal movements were also discernible. In about another hour, the bowels started moving and the evacuations lasted about 6 hours. During this time the animal appeared thirsty and was given water in small quantities frequently. There was complete relief to the animal within 24 hours.

Case No. 7.—A young milch-cow with history of chronic dyspepsia extending over a long period and recurring at frequent intervals. Routine hospital medication did not succeed beyond affording temporary relief; condition of the animal was steadily going down.

An injection of Carbachol 2 c. c. subcutaneously was given the first day. This was followed after an hour with a moderate dose of saline

ative dose. The owner was advised to feed the animal judiciously on easily digestible laxative food for a few days till the treatment was complete. The injection was repeated the next day and also the salines in smaller doses. On the third day, Carbachol 1 c. c. was again injected followed by a still smaller dose of salines as before. The treatment was stopped thereafter. Beyond careful attention to diet nothing more was done.

Information received after three months showed that the animal had greatly improved in general health with no recurrence of the complaint.

In many other similar cases, and more especially in the various forms of colic in horses and impaction of rumen in cattle, the drug was extensively used and results obtained were very satisfactory. In cases of tympanities in cattle, however, the results have been variable.

PHENAMIDINE ISETHIONATE, M. & B, IN B. CANIS.

BY

CAPT. G. VENKATA NARSU, G.M.V.C., P.G. (MUKT.)
Veterinary Officer, Gwalior Kennels, Gwalior.

Phenamidine, a recent preparation of May & Baker's, has been tested by Lourien and Yorke and found to be very effective in B. Canis. It is supplied by the makers in 5 percent solution for parenteral administration. This preparation was tried on a case of B. Canis with good results. The subject of the case was a smooth-coated Fox Terrier dog and the blood examination proved positive for B. Canis.

A subcutaneous injection of 4 c. c. of this drug was given on the first day, the dosage being calculated at the rate of 9.3 c. c. per kgm-body weight of the animal. The drug was well tolerated by the patient without any local reaction and no toxic effects were noticed. The temperature dropped to 102° F the next day, but appetite remained in abeyance. The general condition of the patient was however fairly good. On the third day, the temperature was 103° F throughout and the bowels were costive. A dose of Hydragery Subchloride with Sodii Bicarb was administered. On the fourth day, another injection of 4 c. c. Phenamidine Isethionate 5 per cent solution was repeated as the patient recorded a temperature of 104° F. The dog refused milk bread and broth that day, but a saucer of custard pudding was found an appetizing dish. On the fifth day, the patient appeared quite lively with a normal temperature and with signs of general improvement towards recovery. The treatment thereafter consisted of a tonic mixture containing Acid Hydrochlor dil, Nux Vomica and Gentian for a couple of days, with careful and judicious feeding and nursing during convalescent period.

Correspondence

[The views expressed in letters addressed to the Editor represent the personal views of the writer and must not be taken as expressing the opinion or having received the approval of the A.I.V.A.]

Rinderpest Inoculation during Foot and Mouth Disease and prophylactic inoculation against Rinderpest.

Sir,

On 6th February 1938 after having arranged for vaccination of cattle against Rinderpest, I arrived at village Karḡam under Jaintia Police Station in the Sylhet District. On arrival I found that Foot and Mouth Disease had broken out in the area and that 15 per cent of the cattle of the area Karḡam, and challain were actually suffering from the disease. The owners of animals however pressed me for Rinderpest vaccination on the ground that protection of animals against Rinderpest was badly needed. I therefore vaccinated on 7th February 1938, all the animals that had not become affected with Foot and Mouth disease, numbering 360 in the two villages (Karḡam and Challain. I re-visited the village on 17-2-43 and found that 30 per cent of the vaccinated cattle had reacted but none of them had any attack of Foot and Mouth disease. This was rather interesting and, with a view to test it again, I vaccinated 575 cattle in the village Kandigam, Shahpur and Turbhaḡ on 22-2-43 and 23-2-43 in the face of Foot and Mouth epidemic. Here also I found the result to be same viz, that the animals vaccinated with Goat Tissue vaccine against Rinderpest did not contract the Foot and Mouth disease which was prevailing in the locality at the time.

Mahendra Chandra Paul, G.B.V.C.,
Sylhet. }
15-2-47 } *Itinerant Veterinary Assistant Surgeon, Sylhet, Assam.*

A CASE FOR DIAGNOSIS.

We were called in recently to see an Ongole bullock, aged about 11 years, suffering from a thick hard swelling (not pitting on pressure), extending from about the middle of third of the dewlap to the scrotum and down to the knees. The swelling developed gradually starting from the brisket and in about ten days time, the swelling increased to the above mentioned extent. The animal had been off-feed and the bowels were constipated. During these ten days the animal was under treatment by the Go-Vaidyas of the village. At the time of our visit, the animal was dull and depressed with inability to shift from its standing posture.

The temperature was 103.2° F and the respirations more abdominal. The urine was high-coloured and passed in small quantities and at frequent intervals. The animal was cast down slowly for an examination per rectum, and this recumbent position, even before securing the limbs, caused acute dyspnoea. Microscopical examination of blood smears and dung was negative.

Treatment.—With a grave prognosis, the animal was given the following mixture and powders after an intramuscular injection of 20 c.c. of Lugol's Iodine.

R/			R/
Pot. Iodide	dr VI	Mag. Sulph.	oz III
Tr. Digitalis		Ammon. Chlor	
Tr. Nucis Vomica	oz I	Pot. Nitrates aa	dr II
Tr. Calumba	" II	Hexamine	" H
Aqua ad	" XVI	Ft. Pul. 1 Mitte 4, Sig. One powder	
Ft. Mist. Sig. ½ part B.I.D.		B.I.D. as electuary.	

The swelling got reduced considerably by the third day. The animal was able to pass urine freely and was having loose dung. There was slight rumination and the animal was able to lie down and get up, though with difficulty. The following mixture was given and was repeated once:—

R/	
Ammon. Carb.	oz I
Pot. Acetas	dr IV
Pot. Iodide	" IV
Tr. Digitalis	" VI
Tr. Nucis Vom	" IV
Tr. Gentian Co.	
Tr. Zingiber aa	oz II
Aqua Chloroformi ad	" XVI
Ft. Mist. ½ part B.I.D.	

The animal is now quite healthy but still weak for work.

Bapatla, }
20-5-47 }

Y. Ramanujam, G.M.V.C.
V. Gurumurti, G.M.V.C.
Agricultural College, Bapatla.

LIVESTOCK IMPROVEMENT AND VETERINARY AID IN BAMRA STATE

Sir,

It is a matter of great pleasure that though Bamra state is a very small one with a limited income, good work has been done towards the improvement of the livestock and the rendering of veterinary aid through the patronage of the Ruler.

The Veterinary Dispensary is, I think, one of the oldest institutions in Eastern States Agency and has been in existence with a skeleton staff since 1896. It has now been given a new lease of life by the present Ruler who has expanded and equipped it well.

The present veterinary staff consists of one veterinary surgeon, one trained compounder, one dresser and six stockmen with the usual office orderlies and menials. The stockmen who were appointed last year on the proposal of the Veterinary Assistant surgeon are located in six thanas on the outskirts of the state boundary with necessary medicines, instruments and inoculating outfit. Their duties are to tour within their allotted jurisdiction, whether there are epidemic diseases or not, and to instruct the villagers on matters of Animal Husbandry, especially on housing, feeding and breeding and also to inoculate all the animals with Goat-Tissue-Vaccine. Two veterinary outposts have been established in two sub-divisions and they are in charge of the stockmen. Quarantine houses have also been constructed to keep the animals under observation during epidemics. A three-year plan has been drawn up to inoculate all the animals of the state with Goat-Tissue-vaccine and thus put an end to outbreaks of Rinderpest. To supervise and check the work of the stockmen, the V.A.S., is on tour for 15 days in a month. By this arrangement, the work is going on efficiently and there are already signs of the epidemics coming under control; this year there were only two outbreaks of Rinderpest with only very small mortality as against 10-12 outbreaks in previous years with a high degree of mortality.

Finance.—The finances of the department have also been quadrupled. Before the year 1940, the allotment was Rs. 1893 with only Rs. 500 for medicines but now it is Rs. 5386 with Rs. 2000 for medicines.

The people of the state have begun to realise the benefits of the department and are becoming very interested in its activity.

On the Animal Husbandry side, a dairy was established in the year 1938 under the direct charge of the veterinary surgeon. 20 Sindhi and 5 Haryana cows and 4 Sindhi bulls were purchased while one Haryana bull was presented by the Viceroy Lord Linlithgow to the Ruler of the State for

improving the breed of cattle in the State. Out of these bulls, 2 were stationed in 2 sub divisions and 2 Sindhi bulls and Haryana along with the 25 cows were kept in the dairy farm. As a result of this, the cattle in those 2 sub divisions and in the *sadar* have been graded up and, in my present tour in those two sub-divisions, I had an ocular proof of it. This naturally led to a demand for good breeding bulls from the other sub-divisions. 10 bulls were distributed to local people in the year 1941 and they were placed in a central village under the care of the headman of the village for the use of the cows of the surrounding villages. Unfortunately, 5 bulls died for lack of care. To reduce the strength of the farm and also to help the state subjects, 23 heifers and 10 bulls were distributed to local people. 5 bulls were replaced in those 5 centres which had lost the animals while the other five were located in fresh centres.

Some bulls which were unfit for breeding were castrated and were used in the State-garden. Again in the year 1946, 10 bulls were distributed for breeding purposes. Thus the total number of breeding centres at present, besides the *sadar* and in two sub divisions, is 25. The local breed of cattle has been improved by these measures and cross-Sindhi cows and heifers and bulls can be found throughout the State. In the year 1945, 6 Murrah buffalows were purchased for improving the buffaloes in the State. The present strength of the farm is 102 and is running very smoothly and efficiently. The milk yield per day is $1\frac{1}{2}$ maunds.

A scheme has been approved to start a State-Breeding Farm in a place with plenty of pasture land. The site has been selected and the work will be undertaken after the rainy season is over. The farm will undertake to breed good stock and distribute the seed bulls in the villages.

Great credit is due to the Development Member Mr. H. P. Deb for his live interest in livestock work. He has been responsible for putting forward the various improvements to the Ruler and for carrying them out.

Niranjan Gountia,
Veterinary Assistant Surgeon, Bamra State, E.S.A.

DEHORNING OF CATTLE IN THE TANJORE DELTA.

This article is written with a view to make the Veterinary Surgeons interested in the operation of dehorning of cattle and to put it on a scientific basis from its present stage of quackery.

It is extensively carried out in Tirutturaippundi Taluq, the birth-place of the famous Umblachery breed, although it is practised widely in the whole of the delta area from a long time past. The chief objects for which the operation is carried out, are to minimise the danger caused by these animals when they are in a herd. Ordinarily these animals are fiery tempered and easily cause injuries by their horns as well as to their horns. To avoid this they are dehorned at an early age. It is also said that dehorning improves the build of the animal, and to give a better shape to the head in an otherwise ugly head with a symmetrical horns. How far these claims are true can be judged by the fact that only males are dehorned and the female stock is left with the horns intact! The operation is done when the animals are nine months old, although occasionally it is done on older animals. The animal is cast and secured, a red hot iron is applied over the seat of the horn and the part thoroughly singed. The after treatment is only to keep the part free from flies and maggots and, to encourage the healing, *Neem oil* is the common dressing used. Common complications are extensive inflammation of the cauterised area, maggot infection, and opening out of the frontal Sinus. These take weeks and months to get healed and the animal suffers a lot meanwhile.

To avoid all these sufferings and complications, it is my earnest suggestion that the Veterinary Surgeons in the Deltaic tract, should undertake to do this operation themselves and take it out of the hands of the quacks. The calves to be dehorned should undergo the operation during the first week or fortnight after birth and the seat of horn should be cauterised with caustic potash. This method is practically painless and causes no suffering to the animal. No complications are likely to ensue and the part will heal in a very short time leaving very little blemish behind.

In grown up animals where the chemical cautery cannot be used thermal cautery may be applied judiciously after nerve blocking.

George Ebenezer.

BOVINE SURRA: AN OCCASIONAL CONDITION—WRY NECK

A detailed study of the disease has been published in the *Indian Veterinary Journal*, January issue by two eminent workers.

In this brief note I desire to draw attention to a condition of "wry neck" exhibited by bovines suffering from surra. In about 20 sub-acute cases of surra, I have observed the "wry neck" during the febrile stage and in some after Antimonium Tartaratum injections.

Treatment:—These cases have been treated successfully by administration of Calcium chloride in addition to an usual Antimony Tartarate treatment. I have been using for this purpose, Calcium Chloride in doses of 2 to 3 drachms in 40 to 60 c. c. of distilled water intravenously three to four hours after the Antimonium injection. Usually the wry neck is relieved in six hours after the calcium injection. Sometimes where the condition persists, it has been found necessary to repeat the calcium on successive days.

The mortality in these animals treated with calcium is much less than those cases that did not receive such a treatment.

The incidence of wry neck in Surra has not been encountered by me in other districts.

Tiruthuraiipoondi.
27-4-47 }

George Ebenezer,
Veterinary Assistant Surgeon.

Abstracts

STUDIES ON ANTIRABIC IMMUNIZATION WITH CULTURE VACCINE

BY

N. VEERARAGHAVAN

(Abstract from *Indian Journal Medical Research*. Vol XXXIV, p. 225-236)

One of the problems in rabies is to evolve a refined Vaccine of a greater immunizing value that could be given in smaller doses over a shorter period of time and which would be free from possible by-effects such as paralytic accidents. The chief defects with the present 5% Semple's Vaccine used in India are the following:—(1) the virus content of the vaccine is not known and shows a considerable degree of variation, (2) the antirabic vaccine contains a large amount of nerve tissue which is unlikely by itself to have any antigenic value but believed to be the cause of

neuroparalytic accidents, and (3) the vaccine is administered in large doses over a relatively long period and it is therefore cumbersome both to the patient and the medical attendant. Most of the defects of this Vaccine could be remedied if the virus could be obtained in high concentration in cultures in vitro. Although attempts have been made to use a culture virus, from a practical point of view it has been considered so far not a satisfactory source of rabies vaccine mainly due to the low virus content obtained in cultures.

The author has recorded elsewhere that it is possible to obtain high concentrations of the virus in cultures with a medium containing sheep brain extract, sheep serum, glycine and peptone, with or without the addition of young guinea-pig nerve tissue. This paper deals with the technique and experimental data connected with the preparation and standardisation of a culture vaccine utilising the above medium. A comparative study of this vaccine with the existing method was also made.

For the various immunity experiments described, the vaccine was prepared by using a culture medium for which the addition of young guinea-pig nerve tissue was necessary. The author shows that the maximum concentration of the virus that could be obtained by this method is not more than 75,000 m.l.d. per m.l., estimated by biological assay with guinea-pigs. But an improved method is evolved later by which it is possible to obtain a concentration as high as 2,500,000 m.l.d. per m.l. in cultures, with a medium containing 1.5% sheep brain extract, 2% sheep serum, 2.5% glycine, and 0.15% peptone without the addition of fresh guinea-pig nerve tissue. The following is the method by which the vaccine was prepared:—

Thirty m.l. of 10 per cent sheep brain extract, 4 m.l. of sheep-serum, 25 m.l. of 20 per cent glycine, 20 m.l. of 1.5 per cent peptone and 101 m.l. of distilled water were placed in a flask. Thirtysix m.l. of the supernatant from a centrifuged 20 per cent suspension of fixed virus sheep brain were added to the flask. The flask was incubated at 37° c. under strict anaerobic conditions in a McKintosh and Fildes' Jav. After 24 hours incubation the virus content of the culture was titrated in guinea-pigs. Adequate amount of 10 per cent carbolic acid were then added to the culture so that the final concentration of the acid was 0.5 per cent. After the addition of carbolic acid, the culture was incubated at 37° c. for 72 hours. After 72 hours incubation, the undiluted culture was inoculated subdurally into at least two guinea-pigs in order to find out if the virus was killed.

The preparation of the vaccine is not difficult and all the ingredients used in the culture medium can be readily obtained. It is pointed out that the virus content of the inoculum used, should be high to obtain satisfactory concentration of the virus and the author records uniformly high concentration of virus by utilising the supernatant from a centrifuged 20 per cent suspension of a fixed virus sheep brain which is also the basis for the Semple's vaccine. Instead of one per cent carbolic acid used for inactivation of virus in Semple's vaccine, only half per cent carbolic acid is employed for killing the virus in the culture vaccine. It has been shown that the virus content of the infected sheep brain used for Semple's vaccine exhibits a marked variation ranging from 10,000 m.l.d. per m.l. to a

maximum of 100,000 m.l.d. per m.l. and the author points out that it is possible to obtain a consistently high concentration of 2,500,000 m.l.d. per m.l. in the cultures. While there is no sound method of standardisation of the virus content of the Semple's vaccine, the virus content of the culture vaccine can be determined by biological assay and can be expressed in terms of m.l.d. per m.l. All the virus in the culture vaccine is in a relatively free state and is readily available for exerting its antigenic value. The protein nitrogen content of undiluted culture in spite of its high virus content is only 80 % that of the phenol vaccine and the non protein nitrogen content of the culture vaccine is about 37 times more than the Semple's vaccine which is mainly due to its high glycine content. The glycine present in the vaccine is considered to have only a beneficial effect, since it is administered in large doses in muscular dystrophies with good results. Experimental evidence cited in the article reveals that the culture vaccine with its virus content adjusted to be equal to that of 5% phenol vaccine will produce a fairly satisfactory production against the disease, while further dilution to half this level shows a marked decrease in the immunological response. The immunising value of undiluted culture vaccine containing about 3.5 times the virus content of phenol vaccine has not appeared to be superior to that of the phenol vaccine. This indicates that after a certain limit the immunological response of an animal cannot be increased by increasing the amount of virus given.

The author cites evidence to show that when 5 times the comparable doses per gramme of body weight of phenol vaccine a culture vaccine with the same virus content is given intraperitoneally to guinea pigs and rabbits, considerably higher degree of immunity is produced than by the existing dosage. If a proportionate increase in the dosage of 5% phenol vaccine to produce a greater degree of immunity is contemplated, then the dosage of the vaccine for human beings will be 700 m.l., which from a practical point of view is not feasible. But with the culture vaccine containing 100 times the virus content of phenol vaccine it is possible to administer the whole quantity of virus in 7 m.l. Although the exact dosage and the duration of the treatment have not been worked out, it is suggested that it is possible to reduce both the duration and the dosage by utilising the culture vaccine. The nerve tissue proteins which are generally held to be responsible for the post-vaccinal paralysis with the phenol vaccine, from only 1/50th in the culture vaccine of that present in one course of phenol vaccine.

The culture vaccine is claimed to be apparently free from any toxicity even when administered intra peritoneally to experimental animals and the author points out that the local reaction of redness and in duration at the site of injection frequently observed after administration of phenol vaccine is not shown by using the culture vaccine.

Since it is possible to prepare 30 m.l. of culture vaccine from one gram of fixed virus sheep brain, with the reduction in dosage as indicated above, it is possible to prepare thirty times as many courses of culture vaccine from one sheep as that of phenol vaccine, which would mean a marked reduction in the cost of production.

(D.K.M.)

Multiplication of *B. Anthracis*, *Cl. Chauvoei* and *Pasteurella* in Animal carcasses with a note on the rate of cooling of carcasses.— By F. C. Minett.

In the case of *Pasteurella* and *Cl. chauvoei*, the organisms continue to multiply in the body for some hours after death. Some quantitative data to this effect are provided, based on cultural examination of tissues removed immediately after death and again after the carcass had been stored at air temperatures of 60-70° F. or above. The tissue mostly used was bone-marrow, since it can be easily manipulated. With black-quarter, the microscopical examination of such materials agrees with the cultural findings.

With black-quarter in sheep guinea pigs, at the time of death the organisms outside the lesion of inoculation are usually in the vegetative state. After some increase in numbers—of variable degree but some times 50-to 230-fold—they sporulate. If death is delayed, some may have already sporulated before death. The fresh local lesion contains enormous numbers of spores; a culture may develop from an amount estimated at 0.000001 gm.

With acute pasteurellosis in rabbits the organisms continue to multiply in the bone-marrow during the first six hours, after which their numbers appear to remain stationary up to about 48 hours when they begin to decline. At the peak, the numbers may run to over 2,000 million per gm.

With anthrax, cultural results were erratic and there was no evidence that post-mortem multiplication is a constant feature.

Multiplication of pathogenic bacteria in the carcass is no doubt favoured by a warmer atmosphere, since body cooling will be retarded. Some data on the rate of cooling of carcass of different sizes are provided.

Indian J. Vet. Sci. & Anim. Husb. Vol. XV, Part II.

Studies on the composition of the blood of farm animals in India.—By A. K. Pal, S. A. Momin and D. N. Mullick.

Whole-blood and serum of a group of normal cows were analysed for morphological and chemical constituents over a period of 12 months.

Oxalated blood was examined for red cells, white cells, haemoglobin, cell-volume, iron, inorganic phosphorus, sugar and cholesterol. Calcium, magnesium, protein and non-protein nitrogen were determined in serum. Different corpuscular values were calculated from red cell counts, haemoglobin and cell volume. In the morphological series, haemoglobin and cell-volume exhibited significant seasonal variations, whereas in the chemical series monthly averages for iron, calcium and magnesium showed significant differences. In the former series, the average values were highest in winter, whereas in the latter series they

The occurrence and spread of Fowl Cholera in India.—By S. Ganapathy Iyer and Z. A. Hashmi.

A three years' survey of the incidence of fowl cholera in India suggests that fowl cholera occurs far less frequently than is usually believed and that widespread epizootics are not a feature of the disease.

In one outbreak, the disease was observed to run a typically enzootic course. The presence of carriers to the extent of 4.06 per cent among apparently healthy fowls was established and they were even found in seemingly unaffected pens.

Pathogenicity tests showed that about one-quarter of the strains of *Pasteurella* isolated from carriers were virulent for the fowl and nearly one-half for the rabbit. Examination of another lot of fowls from the same farm, 21 months after the last clinical case of fowl cholera, again revealed the existence of carriers to the extent of 1.4 per cent.

Indian J. Vety. Sci. & Anim. Husb. Vol. XV, Part II.

Animal Nutrition Problem in Bengal.—By Indubhusan Chatterjee, M. Sc. (Agr.), L. Ag.

The limitations forming the special feature of Bengal with regard to the problems of animal nutrition have been discussed.

The general feeding value of rice straw has been dealt with.

Since the straw is highly unbalanced, it is not properly utilized unless it is fed with more nutritious supplement.

The soil condition and environment exercise a profound influence on general as well as specific characters of the straw in an area.

In order to get dependable results, feeding and metabolic tests should be conducted with local animals under local conditions of feeding.

Rice straw contains an appreciable amount of oxalic acid which has the property of keeping lime in an insoluble form. This substance has been found to vary according to soil and climate. A large amount of potash as found in raw rice is another factor causing disturbance in lime metabolism. In order that removal of these substances could be effectively carried out several methods have been suggested.

Mustard cake in combination with raw rice straw gave satisfactory results as regards protein and many other components. But the excess drainage of potash under its combination is an unsatisfactory feature. An excess drainage of potash will be avoided by feeding raw rice straw with other concentrates than mustard cake.

Preliminary work on the utilizability of rice-kura and rice by-products as cattle feed was also undertaken.

Indian J. Vety. Sci. & Anim. Husb. Vol. XV, Part II.



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TABLE I
Blood-grouping of Kumaun hill cattle on 24 previously reacting bulls

SERUM FROM HILL BULL																										
LOT I													LOT II													
Cells from hill bull																									Provisional grouping	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24		
1	-	±	+	-	+	-	-	+	-	-	-	+	-	-	+	-	+	-	-	-	±	-	+	-	-	A & B
2	+	-	+	-	+	±	+	+	-	-	-	-	-	-	-	-	+	-	-	±	+	-	+	-	-	A & B
3	±	-	-	-	+	-	±	+	-	-	-	-	-	-	+	-	±	-	-	-	-	-	±	-	-	A & B
4	±	-	+	-	+	±	-	+	-	-	-	-	-	-	+	-	+	-	-	+	-	+	-	-	-	AB
5	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	+	-	+	-	-	-	A & B
6	-	+	-	-	+	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	A & B
7	-	+	+	-	+	-	-	+	-	-	-	+	-	-	-	-	+	-	-	-	±	-	+	-	-	A & B
8	-	+	-	-	+	-	±	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	A & B
9	+	+	+	-	+	+	+	+	-	-	-	-	-	-	+	+	+	-	-	+	-	+	+	-	-	AB
10	-	+	-	-	+	+	+	+	-	-	-	-	-	-	+	+	+	-	-	+	-	+	+	-	-	AB
11	±	-	-	-	±	±	+	+	-	-	-	-	-	-	+	+	±	-	-	-	-	+	+	-	-	AB
12	±	+	-	-	+	+	+	+	-	-	-	-	-	-	+	+	±	-	-	-	-	+	+	-	-	A & B
Lot I																										

Lot I

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Lot II

Inoculation of isogen and isonin of lot I was done on 29 July 1942 (isogen isonin fresh).
 Inoculation of isogen of lot I and isonin of lot II was done on 30 July 1942 (isogen 24 hour old in cold and isonin fresh).
 Inoculation of isogen and isonin of lot I was done on 31 July 1942 (isogen isonin fresh).
 Inoculation of isogen of lot II and isonin of lot I was done on 1 August 1942 (isogen 24 hour old in cold and isonin fresh).
 The result of the tests was as before, except that with Nos. 15, 17 and 23, the grouping was previously recorded as O.

TABLE I
Distribution of the animals into different groups and their liveweight (lb.)

	Linseed cake					Groundnut cake (undecorticated)				
	1	2	3	4	5	6	7	8	9	10
Age on 28 August 1940 (year, months and days) ...	1-8-24	1-8-18	1-7-9	1-7-13	1-8-13	1-8-27	1-7-29	1-9-5	1-7-3	1-6-29
Average age of the group ...	...	1 year 7 months 3 days	...	...	...	...	1 year 7 months 1 day	...	...	...
Average liveweight at the start of the experiment on 28 August 1940 ...	519	452	450	422	457	483	486	443	472	425
Average liveweight of the group ...	...	460	...	...	...	...	...	462	...	...
Average liveweight at the close of the experiment on 21 January 1941 ...	627	595	623	552	604	559	595	539	587	535
Total increase ...	108	143	173	130	147	76	109	96	115	110
Average increase of the group ...	...	140	...	...	...	...	...	101	...	...
Gram										
Age on 28 August 1940 (year, months and days) ...	11	12	13	14	15	16	17	18	19	20
Average age of the group ...	...	...	...	...	...	...	...	...	...	...
Average liveweight at the start of the experiment on 28 August 1940 ...	1-8-5	1-7-3	1-9-9	1-7-19	1-8-24	1-8-0	1-8-7	1-8-12	1-8-3	1-7-14
Average liveweight of group ...	489	473	451	460	427	513	492	413	424	472
Average liveweight at the close of the experiment on 21 January 1941 ...	684	672	634	596	575	662	682	475	598	636
Total increase ...	195	199	183	136	148	149	190	...	174	164
Average increase of group ...	...	172	...	...	...	...	...	170	...	...
Arhar chuni										

TABLE II
Summary of results (rate of growth by different treatments)

Treatments	Linseed cake	Groundnut cake (undecorticated)	Gram	Arhar chuni	Mean
Average increase per week (lb) ...	7.11	4.66	8.51	8.79	7.19
Percentage of the mean ...	98.94	64.82	118.42	122.29	100.00
Critical difference at 5 per cent ...	0.93	0.93	0.93	1.04	...
Per cent critical difference of mean ...	12.97	12.97	12.97	14.50	...
Rate of change of growth rate ...	—0.0806	—0.0109	—0.1416	—0.1916	—0.1017
Percentage of mean ...	79.21	10.74	139.23	188.43	100.00
Critical difference at 5 per cent ...	0.0757	0.0757	0.0757	0.0846	...
Per cent critical difference of mean ...	74.39	74.39	7.349	83.18	...