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IMMORTALISED.

Never before in history did such a catastrophe overtake Mankind as when on Friday, the 30th January 1948, at 5-12 p.m., the Great Apostle of Peace, the very embodiment of Ahimsa and the wonderful personification of Love and Truth, Mahatma Gandhi, was fatally shot by an insensate assassin. The Father of the Nation, Bapuji, as he was affectionately known to us, is dead and gone. The news has descended on us with sweeping suddenness. The shock has, indeed, been terrible and it has overtaken the world with the impact of a thousand atom bombs dropped simultaneously. Humanity is stunned beyond expression. A vacuum has been created. Oh! What a calamity to our country, no, not only to our country, but to the whole world! Is there any other to fill up this void? In a warring and weary world, where hatred, violence and cruelty has become a creed, where virtues have lost their values and vices are exhalted, and where God has been dethroned from human hearts, this frail old man of eighty, held aloft his gospel of Peace and Love, Truth and Non-violence and preached sanity and sobriety, charity and good will with his simple living and high thinking. He lived and worked to save mankind from the terrible abyss to which it has been rushing headlong. He was straining every ounce of his energy to arrest the moral degradation which was overtaking humanity. His efforts in this direction during the past half a century and more were just nearing fruition. Now, more than ever, we, in this country especially, are in need of him and his guidance. That, however, was not to be! Alas! the cruel hand of Fate has descended on him and smitten him. The purest living soul has, in the twinkling of an eye, been removed from our midst. Friend of all and enemy of none, Mercy and Compassion incarnate, he was a comfort and a solace to millions and millions of men, women and children. His removal at this juncture plunges all of us into darkness and leaves us forlorn! Truly, has it been said God's ways are mystifying and inscrutable. We doubt not that the cause he has been championing—Peace and Love - love thy neighbour, love thine enemy—is to flourish and shine all the better now that he has gone from this mundane world and become immortal! Gandhiji dead will be more potent than Gandhiji alive. His frail body may perish and get reduced to ashes, as indeed, it has been on the banks of the sacred Jumna. His undying spirit, ever watchful and solicitous to our welfare, is hovering over us and guiding our thoughts and actions. He is enshrined in our hearts. And so, we will strengthen and fortify ourselves: practise his precepts, by deeds, and not by words by action and not by inaction: above all, not give way to despair and distress - the thing which will not be to his liking.

GANDHIJI IS DEAD LONG LIVE GANDHIJI.

Plate No. 9 Vol. XXIV

MAHATMA GANDHI

THE APOSTLE OF TRUTH AND NON-VIOLENCE

[Born October 2, 1869.] Died January 30, 1948.

PRIME MINISTER NEHRU'S BROADCAST TO THE NATION.

"WE MUST HOLD TOGETHER"

The Prime Minister, in a voice trembling with emotion, said, "Friends and comrades, the light has gone out of our lives and there is darkness everywhere. I do not know what to tell you and how to say it. Our beloved leader, Bapu as we called him, the Father of the Nation, is no more. Perhaps I am wrong to say that. Nevertheless, we will not see him again as we have seen him for these many years. We will not run to him for advice and seek solace from him and that is a terrible blow not to me only but to millions and millions in this country. And it is a little difficult to soften the blow by another advice that I or anyone else can give you.

"The light has gone out, I said, and yet I was wrong. For the light that shone in this country was no ordinary light. The light that has illumined this country for many more years and a thousand years later that light will still be seen in this country and the world will see it and it will give solace to innumerable hearts. For that light represented something more than the immediate present; it represented the living truth, the eternal truth, reminding us of the right path, drawing us from error, taking this ancient country to freedom.

"And this has happend when there was so much more for him to do. We could never think that he was unnecessary or that he had done his task. But now, particularly, when we are faced with so many difficulties, his not being with us is a blow most terrible to bear."

"FACE THE POISON IN PUBLIC LIFE"

"A mad man has put an end to his life, for I can only call him mad who did it and there has been enough of poison spread in this country during the past years and months and this poision has had effect on people's minds. We must face this poision, we must root out this poison and we must face all the perils that encompass us, and face them not madly or badly but rather in the way that our beloved teacher taught us to face them. The first thing to remember now is that no one of us dare misbehave because we are angry. We have to behave like strong and determined people, determined to face all the perils that surround us, determined to carry out the mandate that our great teacher and our great leader has given us, remembering always that if, as I belive, his spirit looks upon us and sees us, nothing would displease his soul so much as to see that we have indulged in any small-minded behaviour or any violence.

"So we must not do that. But that does not mean that we should be weak but rather that we should in strength and in unity face all the troubles that are in front of us. We must hold together and all our petty troubles and difficulties and conflicts must be ended in the face of this great disaster. A great disaster is a symbol to us to remember all the big things of life and forget the small things, of which we have thought too much. In his death he has remined us of the big things of life, that living truth, and if we remember that, then it will be well with India."

NOTICE

The Indian Veterinary Journal

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Devoted to the Cause of Veterinary Profession.

PUBLISHED FOR THE ALL-INDIA VETERINARY ASSOCIATION

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

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General Articles

SOME ANIMAL HUSBANDRY PROBLEMS*

By

T. J. HURLEY, O.B.E., M.R.C.V.S, D.V.S.M., I.V.S.,

Director of Veterinary Services, Madras.

I am very pleased to have been given an opportunity of meeting representatives of your Association this morning and I intend taking advantage of it by saying a few words on some of the Animal Husbandry problems that confront us and the lines on which as a Department we might progress and expand As you are all aware the present organisation for dealing with Animal Husbandry matters consists of a Veterinary College for the training of the required staff, a Serum Institute for the manufacture of the biologicals used in the prevention and control of contagious diseases, Veterinary Hospitals and Dispensaries for the treatment of surgical and non-contagious conditions and Government farms which are primarily required for the production of pure-bred male breeding stock. Specialist officers both on the disease and developmental side are also included among the Technical staff.

To appreciate and deal with the problems that confront us, it is very desirable to have a highly trained technical staff and we have endeavoured as far as possible to provide a training in the Madras Veterinary College suitable for the purpose. In addition to the ordinary lectures, students are given ample opportunities of acquiring a good practical knowledge of Laboratory technique, clinical work and practical farm work. Those of you who have been qualified for some time and have had experience of 'field' work will appreciate our limitations and the enormous amount of investigation work that requires to be done to enable us to come to grips with some of the disease problems confronting us. Our work to-day embraces a very wide variety of subjects. There is not only the treatment and control of disease but also the general improvement of the various types of animals by improved breeding methods, better feeding and management.

* Address at the Conference of the Madras Veterinary Assistant Surgeons' Service Association on 24th December 1947.

The study of animals in health and the essentials necessary to keep them healthy is to my mind more important than the study of diseased animals and the essentials necessary to cure them. The Veterinary Graduate of to-day must have a good knowledge of Genetics, he must be able to give sound advice on nutritional requirements and general management of the various animals and be in a position to make intelligent observations and carry out preliminary investigation work on the various disease problems met with. Among the staff in the present administration, the Touring Veterinary Assistant Surgeon is the person in the best position to appreciate our present limitations in dealing with disease problems. The nature of his work brings him into contact constantly with the ryots and their animals and from his observations and enquiries he should be largely responsible for initiating investigation work. There are, of course, his ordinary routine duties to be carried out such as the attendance and control of the well known contagious diseases, inspection of livestock and systematic castration but he should in addition endeavour to find if what I might call "hidden diseases" are prevailing which may be of protozoan, helminthic or nutritional origin. Even among the well known contagious diseases, the information available on many points is not very clear. Take for example Rinderpest, Blackquarter and Haemorrghagic Septicaemia; there are many questions about these diseases which still require an answer. For example—do young animals get Rinderpest?—is there any difference in susceptibility or immunity between the progeny of an immune dam and a susceptible dam?—Is Rinderpest in cattle transmitted under natural conditions to sheep and goats? If so, are they just as susceptible as cattle—less so or more so?—Is Rinderpest transmitted in the 'field' from sheep and goats to cattle? and, if so, is the disease then in cattle less or more virulent than normal, less or more contagious? In the case of Haemorrhagic Septicaemia and Blackquarter, is there any correlation between rainfall and the incidence of the disease? Are there more outbreaks during wet years than dry years? Has nutrition anything to do with the incidence of the disease? In years when there is an acute shortage of fodder, do we get more or less outbreaks? These are general questions which I should like to see being kept constantly before the minds of the staff and each member should be able to supply the answer as far as his own jurisdiction is concerned. I should therefore like to see every member of the staff thinking on those and similar lines and, by so doing, we shall be advancing our professional knowledge and will be in a better position to give better service to the ryots. These examples I have mentioned are straightforward ones and only require a little enthusiasm on the part of the staff to supply the answers. Others, however, are more difficult. Take for example, the under-development or stuntiness of many of the animals in various parts of the Presidency—Why is there such a vast difference in the size and type of the animals in the different parts? In the wet coastal

areas such as the West Coast, the animals are small and puny. In the highly irrigated areas such as Tanjore, the animals are small but sturdy in hilly forest areas, where there is good deal of pasture and one would expect to find better developed animals, they are usually small and puny, whereas in some of the drier tracts like Coimbatore and Ongole, the animals are larger and better developed.

What is the cause of this difference? Is it due to climatic conditions, nutritional, obvious starvation or a deficiency in the food, protozoan, intestinal parasites etc.?—one factor or all combined? These are problems which the Veterinary Assistant Surgeon must keep constantly before his mind and from observations, enquiries and preliminary investigation, he may perhaps suspect a particular factor. He should then bring it to the notice of the Department when the question of having further investigation carried out would be considered.

Each Veterinary Assistant Surgeon working and thinking on these lines would not only keep the Department alive professionally but would result in the creation of highly trained investigators to meet the demand for unravelling the problems encountered.

Human nature being what it is, it is very easy for all of us to fall into the ordinary routine way of carrying on and if we all do that, then the department carries on in a routine way with the result that there is no progress and instead of advancing we shall start retreating. I would therefore urge upon you all the importance of thinking and working on the lines I have suggested. You are the men who come into contact with the animals and their owners, you are the men who should know the lines on which research work is required.

You are all aware of the proposals made for the expansion of the Department in the post war period, but unfortunately very little headway can be made. One of the proposals is to have a Veterinary Institution as well as a Touring Veterinary Assistant Surgeon with a Stockman-compounder in each taluk This proposal can only be given effect to as and when technical staff become available, and every endeavour is now being made to train the maximum number possible. Another proposal is to have all Veterinary hospitals constructed with type design buildings and avoid the necessity of having to carry on hospitals in rented buildings which for many reasons are unsatisfactory. This proposal is being kept in abeyance owing to the high cost of building materials at the present time.

In connection with Livestock Improvement work there is a proposal to have a Livestock Farm as well as a Poultry Farm in each district to make available pure bred male stock for breeding purposes. Progress is being made in this direction and it is hoped that a few farms will be opened in the near future.

When these proposals are completed there will be a Veterinary Hospital according to type design in each taluk—a Touring Veterinary Assistant Surgeon with a Stockman-compounder in each taluk and a cattle farm and a poultry farm in each district. These proposals may be considered under the ordinary routine expansion of the Department but with the staff working and thinking on the lines I have suggested, expansion on the investigation side will automatically follow. There should be at least one fully staffed section carrying out investigation work on the needs of the Province on all Animal Husbandry subjects—Bacteriology, Genetics Nutrition, Physiology, Toxicology, Parasitology, to mention some of the important ones and, as I visualise it, all these sections should be engaged in not only their own investigation and research work but should be kept busy in answering queries sent to them by the 'field' staff as well as examining material for diagnostic purposes. A time may come when this work may develop to such an extent that it may be necessary to have a small laboratory in each district where material could be examined and which would relieve the central laboratories of much of the routine work. This picture of the future department which I have tried to place before you depends very largely on the enthusiasm of the 'field' staff and before closing I should like to stress upon you once again the desirability of each man thinking and working on the lines I have suggested.

DISTEMPEROID VIRUS—CLINICAL OBSERVATIONS ON ITS VALUE IN DOGS IN THE PHILIPPINES

By

L. M. Yutuo,

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Canine distemper is common among dogs in the Philippines. It is safe to state that about one-half of the canine population succumb from distemper yearly. In the control of the disease, vaccine and sera together with sulfa preparations and good nursing have been used extensively. Although the use of Laidlow-Dunkin vaccine especially the triple-injection-method has been quite successful, the results recorded on the use of homologous serum in distemper have been, at best, uncertain. Moreover, it is expensive. In certain cases met with and treated with serum the good results obtained seem to indicate that good nursing bore more credit in recovery of cases than the serum alone.

Since the termination of the second World War and the liberation of the Philippines, a new agent became available through the Winthrop Chemical Company, Manila in the control of canine distemper. The agent

is a modified virus of canine distemper obtained by repeated passage through ferret. To Robert G. Green (1939) of the University of Minnesota belongs the credit of having evolved this biological agent. It is a by-product of his investigation on the control of fox distemper in the fox-farm of the From Brothers of Hamburg, Wisconin.

As a preventive measure, distemperoid virus has been tried on a great number of dogs in the Philippines. In my personal cases, no untoward sequelæ have been noted beyond a slight rise in temperature. Some of the dogs treated prophylactically belong to such breeds as Dobbermann Pincher, Irish setter and German Police dogs Moreover a number of the dogs treated were puppies of approximately 8 weeks old. In two other veterinary hospitals in the city of Manila, information gathered tends to support my finding. The results thus far recorded, however, do not mean to give the impression that the biological product is 100 per cent effective. In fact, one veterinarian had the bad luck of having his first two cases coming down with distemper after prophylactic vaccination. Such cases are few and far in between the good effects of the virus as a preventive measure. A number of contra indications should be observed before giving the virus. For example dogs showing symptoms of rickets, avitaminosis, malnutrition, internal parasites, convulsions and so on are considered poor risks for any potent vaccination. Therefore, a thorough examination to determine the presence of any of the adverse conditions should be made. In the first few cases, I had the good fortune to vaccinate, the dogs were observed for a period of a week, the temperature, pulse and respiration being noted together with fecal examination for internal parasites, before the virus was given. This observation was further extended for another three weeks thereafter for possible post-vaccination after-effects. The prescribed dose is 25 milligrams of the virus in horse-serum and diluted with 2 cc sterile distilled water shortly before use. It is important to point out at this instance, that the bigger the dose of the virus the lesser is the reaction of the vaccinated animal.

The curative value of the distemperoid virus had also been exploited in a number of cases kept in the small animal clinics of the College of Veterinary Science, University of the Philippines, Pandacan, Manila. For the sake of brevity, only a few cases will be presented here.

The first case was a male, native dog, brown color, seven months old and of about 18 pounds in weight. It was presented for treatment on 2nd May, 1947 with the complaint of loss of appetite and trembling.

Clinical examination revealed the temperature to be 40·6°C and there was purulent discharge from the eyes and pustular skin eruption abundant especially in the abdominal region. Condition of the dog at the time of the examination was fair.

The case was diagnosed as distemper.

Treatment:—Given two tablespoons of milk of magnesia.

May 3. Temperature 39·6°C; injected 25 milligrams distemperoid virus subcutis. Fed milk.

May 5. Temperature 39·2°C; one multivitamin tablet given; milk diet.

May 6. Temperature 38·6°C; skin eruption dusted with sulfanilamide powder; one tablet of sulfaguanidine; milk diet and bread.

May 7 & 8. Temperature 38·4°C; multivitamin tablet.

May 12. Thirteen days after admission, the case was declared cured. A week thereafter, the dog developed spasms of clonic type in one of the upper eye-lids. It, however, disappeared spontaneously after an elapse of 60 days.

The next case was a grade German Police dog, one year old and weighing about 20 pounds. It was admitted on July 29, 1947 with the history that it was off feed and depressed. It had also lost weight considerably.

The symptoms noted at the time of examination were: temperature 41·3°C; watery discharge from the nose and eyes; animal greatly depressed.

Diagnosis—Distemper.

Treatment:—Two tablespoons of milk of magnesia; after an hour-injected distemperoid virus.

July 30.—40·1°C; given suds enema; milk diet.
July 31.—40·7°C; multi-vitamin one tablet; milk diet.
Aug. 1.—39·4°C; sulfaguanidine one tablet; milk diet.
Aug. 2.—38·0°C; multi-vitamin and milk diet.

Aug. 3-15.—Treatment as above repeated. On the tenth day the animal sent home with instruction to give the dog, milk and toasted bread as diet. Multi-vitamin to be continued for another week. After a month the dog was seen in a good condition.

The third case of Distemper was a female dog of about 10 months old; breed, mongrel; weighing about 18 pounds. Admitted July 25, 1947 with history of loss of appetite and coughing. The owner stated that she lost a dog recently with symptoms very suggestive of canine distemper.

The dog had cutaneous eruptions in the abdominal region and the inner aspects of both the thighs. Temperature was 39·6°C.

Treatment.—Milk of magnesia; injection of distemperoid virus. Externally sulfanilamide powder. The day following, multi-vitamin; diet milk. This line of treatment was continued until temperature went down

and the appetite returned to normal. After two weeks the case was discharged cured. Unfortunately, after another month the same animal returned with rabies, from which the dog died two days later. Laboratory examination of the brain revealed Negri bodies.

The fourth case was a 3 month old pup, female and weighed about 8 pounds. Admitted September 8, 1947 with the history—loss of weight and poor appetite. Symptoms: Temperature 39·4°C; bowels loose, chocolate color with an offensive odor; pustular skin eruptions almost all over the body; purulent discharge from eyes and nose; condition poor. Faecal examination revealed eggs of hookworm.

The case was diagnosed as distemper with hookworm infestation.

Treatment.—Milk of magnesia two teaspoonfulls; distemperoid virus 12 milligrams.

September 9. Temperature 38·9°C; multi-vitamin; sulfanilamide powder externally; milk diet.

September 10 to 13. Temperature ranged 38·6°C to 39·0°C; multi-vitamin daily alternated with sulfaganidine tablet; milk diet.

September 14 to 25. Animal progressively improved until discharged, cured.

The fifth case was a mongrel, male, black pup of 5 months old. Weight about 6 pounds. Admitted September 8, 1947. The owner complained of bloody diarrhoa with poor appetite.

The animal had a temperature of 39·9°C; at the time of examination. The pup was much emaciated; the mucous membrane was pale and there was purulent discharge from eyes and nose. From time to time the pup sneezed out a good amount of nasal exudate. Bowel evacuation bloody; skin eruption purulent in character and generalized. Foecal examination revealed heavy infestation of hookworm. The case was diagnosed distemper with hookworm infection.

Treatment.—The case was treated in almost the same manner as the above cases with the exception that the distemperoid injection was repeated after a week. When the appetite was sufficiently restored, the pup was given one cubic centimeter of tetrachlorethylene in a gelatin capsule followed three hours later with milk of magnesia to rid the animal of hookworm. Thereafter, the improvement was rapid. The temperature dropped to normal after 10 days hospitalization. The animal was discharged twenty days later.

The sixth case was a Dalmatian male pup of about 4 months old. The owner told us that the dog would not eat for about four days and that it had loose bowel evacuation. Moreover, she added that she lost one dog, a companion of the pup from what appeared to be canine distemper.

Clinical manifestations were pustular eruptions with a temperature of 39.9°C; muco-purulent eye secretion and dejected appearance. The treatment instituted was essentially the same as for the above described cases with complete recovery in three weeks period.

These six cases illustrate the good merit of the virus as a curative remedy against canine distemper. In the fourth and fifth cases, the puppies were concurrently affected with hookworm and yet both of them recovered completely from distemper. The value of proper nursing and the use of sulfa drugs should be exploited during the course of the treatment. In the private veterinary hospitals in Manila, Penicilin is also used together with the virus with satisfactory results. The use of sulfa preparations or Penicilin as an adjunct treatment in distemper in dogs is with a view to combating the secondary organisms developing in the course of the disease, as these preparations are known in general to be of little value in virus diseases both in man as well as in animals. Lastly, the results presented in this short communication furnished an added data supporting the findings of Green and Swale (1939), Schlothaeur (1943) and Khuen (1945) on the value of distemperoid virus both as a preventive and curative agent against distemper.

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DICHLORO DIPHENYL TRICHLOROETHANE (D.D.T.)*

A Complete Review of Literature

By

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GENERAL

History:—It was Othman Zeidler, a German Chemist, who, in a search for dye intermediaries, synthesised D.D.T. for the first time in 1874, in Strasburg, though he could not have even dreamt of its remarkable potentialities as an insecticide. Paul Lauger and Paul Muller, the two Swiss Chemists of the Swiss dye-stuffs firm of J. R. Geigy, S.A., Basle, Switzerland, found in 1939 that this substance was toxic to bugs and Colorodo potato beetles and subsequently in 1940-41 used it effectively to control a plague of Colorado potato beetles in Switzerland and saved the Swiss potato crop. The firm took out an initial patent in Switzerland in 1940. In 1941, Geigy firm notified their United States as well as United Kingdom branches that the new insecticide was found effective against the Colorado potato-beetle, and they, in their turn, brought this compound to the notice of their respective Governments. In 1942, they took out patents in both the countries and published the scientific details. Towards the end of 1942, in the trade, an insecticide containing D.D.T. as an active ingredient was marketed in United States as "Gesarol" and in Great Britain as "Neocid" by the Swiss firm. This came very handy and at a welcome moment for the allies during the World War II when they were experiencing difficulties in obtaining supplies of established insecticides for controlling insect-borne diseases.

In the early part of the war, the allied powers had to face a serious handicap in the absence of a wholly synthetic insecticidal substitude for the plant products—pyrethrum and derris of established repute. Japan's entry into the war and the subsequent occupation of Malaya, not only cut off completely supplies of derris and 70% of pyrethrum, but also resulted in the extension of the conflagration into the tropical jungles where the insect menace, and consequently the need for effective insecticides, were the greatest. To make matters worse, the 1942 pyrethrum crop in Kenya was poor. A limited supply of rotenone, inferior as an insecticide to that derived from derris, was available in South America from the plant *Lonchocarpus* but even this supply was unequal to the demand. So in 1942 the demands of the Allied services were for increased supplies of insecticides for use against the malarial mosquito and typhus carrying louse. Scientists were called upon to work on the problems

* Read at the Annual General Body Meeting of the Madras Veterinary Assistant Surgeons' Service Association, on 25th December 1947.

of evolving a suitable and effective synthetic insecticide both in United Kingdom and United States and that on mass production scales. More attention was therefore concentrated on D.D.T. towards this object.

In the Orlando Laboratory in U.S.A. experimental studies were undertaken with "Gesarol" which revealed a wide field of usefulness. In England the results of some of the earlier tests made in Buxton's department at the London School of Hygiene were astonishing, since the chemical proved lethal to lice and bed bugs. When a British mission of which Buxton was a member went to America, early in 1943, to reach an agreement on the conservation of pyrethrum supplies, it came to be known that Americans had made preliminary tests with the same results. Further researches were carried out rapidly and throughly by entomologists, chemists, medical and veterinary men at a number of laboratories both in England and America. Collaboration in this work between the two countries resulted in the production of D.D.T. on a large scale to meet the pyrethrum deficit. Methods of manufacture were improved and the various impurities in commercial samples were isolated and examined. The composition of active principle was determined by Haller in U.S.A. and Martin and Wain in England in 1943 and the same was synthesised. This in brief, is the history of the evolution of D.D.T. which has proved to be one of the wonder drugs which World War II has helped to achieve.

The Allied Army vigorously made use of D.D.T. with signal success. The first full scale use of D.D.T. in a war sector was in Italy—to protect fighting men against Typhus. In the control of Typhus outbreak in Naples. in January 1944, 1,300,000 civilians were dusted with D.D.T, powder and, within 3 weeks, the outbreak was completely under control. This was the first occasion in the history of Medical Science when a Typhus outbreak was arrested in mid-winter in a City full of dirty, homeless lousy refugees. An outbreak of plague in Algiers was also dealt with successfully by D.D.T. in 1943. Symes and Hadaway of Colonial Insecticide Research of Great Britain performed some striking experiments in British Guiana in 1944, and found that, under suitable conditions, the mosquito population in houses could almost be completely annihilated by means of this new insecticide and the number of larvae in breeding grounds could be greatly diminished. Later D.D.T. was successfully used to augment the forceful drive against malaria around the globe and notably wide use of it was made in the Far-Eastern Theatre of War to save the fighting forces from the dreadful toll of malaria. Most novel methods of using this insecticide, as for instanse, by spraying it from aeroplanes, were also employed.

On the cessation of hostilities much of the work carried out under the aegis of various governments which were still then kept confidential was published. D.D.T. was released for civilian use and the gift of science is now available for a wide range of insecticidal applications. Further researches were carried out in various fields—medical, veterinary and agricultural—in

almost all the scientifically advanced countries. Besides, many countries have projected the manufacture of D.D.T. Our country also does not lag behind. Alembic Chemical Works already manufacture this synthetic product. The advertising machinery of the Geigy Firm is endeavouring to popularise their "Neocid" through the coloums of several newspapers and periodicals in this country.

Chemistry:—D.D.T. is the abbreviation for the substance Dichloro-diphenyl—trichloroethane and the term "pure D.D.T." designates parapara dichloro diphenyl trichloroethane. The organic chemical is 1·1. bis (p—chlorophenyl) 2·2·2. trichloroethane. An alternative is 1·1. bis (4 chlorophenyl) 2·2·2. trichloroethane. The figures "1" and "2" may also be replaced by α & β respectively. (This chemical is also mentioned as 2·2. bis (p. chlorophenyl 1·1·1. trichloroethane with the alternative mentioned above.) The chemical formula is $(ClC_6H_4)_2CHCCl_3$.

For the synthesis of D.D.T. the raw materials required are chlorine, alcohol and benzene from which anhydrous chloral and chlorobenzene are made. The two compounds are then condensed in the presence of Con. sulphuric acid and from this mixture, when poured into water, D.D.T. is precipitated. The predominant compound of the dried precipitate is $\alpha.\alpha.$ bis (4 chlorophenyl) $\beta.\beta.\beta.$ trichlorethane. An isomer of lower insecticidal potency —"iso" D.D.T. is also present. 14 other compounds have also been isolated from the "crude" D.D.T. The whole precipitate termed "crude" D.D.T. is liable to contain small quantities of the substances used in the manufacture e.g., mano chlorobenzene and sulphuric acid. They can be removed by efficient washing and filtration. Small quantities of chloral may also be present.

Pure D.D T. content of the crude stuff is normally 65 to 80%. "Iso" D.D.T. alone exists to the extent of 10 to 25%. D.D.T. and "iso" D.D.T. account for 85 to 90%. The fourteen substances usually account for 80 to 93·5% of the total. Normally the crude substance should contain at least 70% of D.D.T.

Properties:—D.D.T. is a white powder. It has a faint pleasant smell. It is tasteless. Pure D.D.T. crystalises in the ortho-rhombic system and the crystals are long, tabular needles. The melting point is 107° to 109°C. The melting point of mixtures of D.D.T. and "iso" D.D.T. is 59°C. The substance for insecticidal use should have at least a melting point of 89°C. The density is 1.556. Its vapour pressure is low and is 1.3×10^{-7} mms mercury at 20°C.

It is nonvolatile and resistant to exposure. It is very stable even to chemicals and in most ways inert. It is affected neither by boiling water nor by aqueous acids or alkalis. It can be distilled without decomposition under reduced pressure and can also be distilled in super heated steam. But on distillation at atmospheric pressure it loses one molecule of hydrogen chloride to give the substance, "D.D.T. dehydrochloride". This reaction is also most

readily accomplished by the action of alcoholic potash. This reaction explains the non-toxic nature of D.D.T. when it is used on recently white washed surfaces since hydrated lime neutralises its active components with the formation of non-toxic D.D.T. dehydrochloride.

It is very sparingly soluble in water, less than 0.2. parts per million and soluble in varying degrees in organic solvents. Jones et al, (1945) have studied the solubility of this substance rather extensively. It is moderately soluble in petroleum fractions as Kerosene and Crude oil and fatty oils, readily soluble in common organic solvents as Chloroforum and Ether and freely soluble in Carbon di sulphide. benzene and xylene Pure D D T. does not act on packing materials and on metals generally including those used for containers.

Pharmacology:—D.D.T. is highly toxic to nearly all insects, in fact to most arthropods; and less so to mammals, but cold blooded ones are relatively more susceptable. CH Cl_3 group of D.D.T. is associated with the insecticidal activity. It acts both as a contact as well as a stomach poison. As a contact poison it penetrates the surface of the insect, the tarsi being one of the ports of entry. It attacks the nervous system in a rather functional than organic basis. It affects the nerves controlling the mouth parts with the result that the insects cannot feed and die of starvation. Roeder and Weiant (1946) observed that tremors characteristic of D D T. poisoning were due to an intense afferent bombardment of the motor neurons. Vaz et al (1945) draw the conclusion that the symptoms of D.D.T. poisoning are due to a lowering of serum calcium level. Tobias et al (1946) observe that the high toxicity of D.D.T. applied to the surface of insects contrasting with the low toxicity of D.D.T. applied to the surface of mammals is due to its efficient absorption by insects and not by mammals. The action of D.D.T. can be characterised as a "slow knockdown but sure kill" and the insects coming in contact with the chemical may not die for an hour or more. It is neither a repellant nor is it ovicidal. It does not attack pupae though frequently the adult will pick up a lethal dose during emergence. In some cases it is a larvicide, especially mosquitoes but with other insects as flies the larvae are not affected. Its outstanding feature is its residual toxicity. It clings to objects and remains effective for weeks and months. It is a cumulative poison. It has been found in all tissues examined and the highest concentrations are present in the bile and fatty tissue. The insecticide is eliminated through milk, faeces and urine.

In animals skin absorbtion from the powder form or from aqueous suspension is apparently negligible. But oily solutions of D D.T. and those dissolved in organic solvents are absorbed by intact as well as abraded skin to the extent of producing all the manifestations of toxicity. Absorbtion of the powdered form through the gut though not great is neverthless variable and irregular, probably, depending on the fat content of the diet D.D.T. is absorbed to the extent of 50 to 95% of a single dose administered in oil. Inhalation of D.D.T. spray has also the poisoning effect. The novel method of feeding this chemical to

animals which will become lethal to ectoparasites has also been investigated. Reports of feeding tests with D.D T. to rabbits to kill bed bugs are very encouraging.

Preparations:—As it is, D.D.T. is highly concentrated and very powerful and so it has to be prepared for use with suitable diluents and admixtures. The decision as to which form should be used depends on the requirements. The methods of use also depend upon the admixtures used. Jones et al (1945) have given the various preparations of D.D.T. for insecticidal use. The preparations are classified as follows :—

1. Solutions. 2. Emulsions 3. Suspensions. 4. Oily dressings. 5. Ointments. 6 Soaps. 7. Powders. 8. Paints and distempers. and 9. Aerosols.

Solutions:—Solutions are usually prepared in kerosene, because of its ready availability. Other petroleum products as fuel oil, gas oil, lubricating oil also can be used in conjunction with or in the place of kerosene. D.D.T. is not very soluble in kerosene; a 5% solution is nearly saturated. And therefore, to increase the solubility for higher concentrations, some auxilliary solvents are used such as Cyclohexane, benzene and xylene. Kerosene forms an important constituent in the solution of D.D.T. and 5% solution is the one commonly used. But kerosene is somewhat irritant to the operator and except in very small doses has deletrious effect on foliage and fish population. Because of its poisonous nature and combustible property great care is needed in the use. Animals should not be sprayed and adequate precaution is advisable against contamination of food and fire bazard. Xylene is also inflammable and so precautions against fire and explosion must be taken when it is incorporated.

Since the solvent kerosene is volatile, it is widely used as a residual spray to control disease carrying insects over wide areas. In the form of spray it attacks insects in flight, permeates into the hidden habitations and leaves a deposit which is toxic for days to months. When drops fall on water in the breeding place of mosquitoes they spread on the surface killing the larvae. In India the medical directorate G.H.Q., in collaboration with the Malarial Institute carried out aerial spray of 5% D.D.T. solution in kerosene and found vegetations in those areas considerably scorched

Since the watery areas as the breeding places of the malarial vectors are the main target of the solution in kerosene so extensively used in the form of spray, great care has to be exercised in the use of D.D.T over water stocked with fish since fishes are relatively more sensitive to D.D.T. Ginsburg (1945) by his laboratory experiments showed that it is highly toxic to Gold fish and also observed that this chemical was toxic to three kinds of fishes. Cotton and Higgins (1946) observed that when D.D.T. solution was applied from aircraft for the control of insects, invertebrates and cold blooded vertebrates were more

readily affected than birds and mammals and all concentrations caused mortality of fish. Eide et al (1945) noted that D.D.T. in concentration greater than 0.1. part per million is toxic to Gold fish in laboratory tests but in field tests surface application of D.D.T. as dust and in oils were not harmful to fishes when the lethal dosages for mosquitoes were used.

Emulsions:—The difficulties and defects mentioned in kerosene solution have led to the use of emulsions. They are prepared as solutions usually of high concentrations (25 to 35%) of D.D.T. in an organic solvent with an emulsifing agent added. This can be diluted with water to the final desired concentration. The advantage is that D.D.T. can be delivered in the form of an emulsion concentrate which only requires dilution with water before use. Besides they are less aggressive to the operator than oil solutions.

The solvents must have a low specific gravity and be capable of dissolving large amount of D.D.T. A fairly satisfactory emulsion can be made by stirring together a solution of D.D.T. in an aromatic hydrocarbon and 1% solution of soap in water. The emulsion used by Govinda Rau et al (1947) with good results was prepared in kerosene using liquid soap as an emulsifying agent. The idea of emulsion is lost completely here. Since the undesirable kerosene is still used, it will not in any way improve the sparingly solvent power of kerosene. The following are some of the formulae of D.D.T. emulsion.

1.	D.D.T.	...	25 parts.
	Toluene.	...	33·35 parts.
	Turpentine.	...	33·35 „
	Rectified spirit	...	4·9 „
	Dry soap	...	2·8 „
	Water.	...	0·6 „
2.	D.D.T.	...	16·67%
	Naptha.	...	41·66%
	Fixanol "C"	...	4·6%
	Water.	...	37·5%
3.	D.D.T.	...	25%
	Xylene.	...	68%
	Triton-x—100	...	7%
4.	D.D.T.	...	25%
	Xylene.	...	44%
	Butyl cellulose	...	6%
	Nacconol NRSF	...	12%
	Water.	...	13%

The emulsions are used as residual sprays for premises and can also be used on animals. But its use must be restricted since D.D.T. is in actual solution in the organic solvent and increased absorbtion must be expected. The possible irritating effect of the solvent on the skin and its inflammable nature must be taken into consideration.

Suspensions:—D.D.T. powders in talc. well ground with only water or soapy water to a pasty consistincy, may be diluted with water upto a suspension of 1 to 2 per cent. Wettable D.D.T. powders containing the active principle and a dispersing agent or wetting agent which increases the stability of the suspensions are those commonly used. These suspension powders are mixed with about an equal amount of water into an even thin paste. The paste is mixed with the required amount of water and stirred well. The suspensions tend to settle rapidly but they are quite satisfactory if used immediately after dilution with agitation during use as spray or dip. It is advisable not to make large quantities. Powders of this nature are available with Geigy firm under the name of "Product 1050"—50% suspension powder. Colloidal suspensions prepared by dissolving D.D.T. in a water-miscible solvent with a wetting agent and adding the solution to water are much more stable even at high concentrations. Geigy firm recommends 1% suspension for small animals. For cattle one quart of suspension made from 20 lbs. in 100 gallons of water is recommended as a spray. For use in dip baths 30 lbs. in 1000 gallons of water are indicated.

These suspensions are quite safe and can be used on domestic animals for the control of ectoparasites.

Oily Dressings:—Govinda Rau et al (1947) prepared the oily dressings by mixing D.D.T. powders with sterile liquid paraffin upto 7% and used them in their experiments on dogs.

As vegetable oils are as good as aliphatic petroleum products in their dissolving capacities, oily dressings can be made use of owing to the easy availability of vegetable oils. This can be used in small animal practice. Even taking the possibility of absorption of D.D.T. in this medium, it can be used with care upto a safe limit. But olive oil seems to be the most fatal of all the medium of oils.

Ointments:—Govinda Rau et al (1947) made use of ointments prepared with vaseline as base upto a concentration of 4%. But the absorption of D.D.T. in fatty medium will have to be considered.

In Soaps:—D.D.T. at a concentration of 0·05 to 0·07% is incorporated in soaps and the same is now being used in a limited scale on small animals and success claimed. Even though D.D.T. is harmless in the percentage incorporated in the fatty medium, how far it can retain its toxic property in the combination of the alkali utilised in soap manufacture is yet to be ascertained.

But Hymas et al (1945) reported the efficacy of D.D.T. in soap and on chemical analysis recorded a deposit of 0·05—0·07% on the hair.

Powders:—Dusting powders are prepared by the incorporation of some inert diluent powders as talc, starch, kaolin, prophyllite etc. Fine road dust and condemned flour can also be used. 5% as well as 10% D.D.T. powders containing 5 or 10% D.D.T. and 95 or 90 per cent inert diluent are readily available for use, against ectoparasites of small domestic animals. Addition of calcium stearate and magnesium carbonate facilitates easy grinding and markedly improves the dusting property.

In Paints:—It has also been incorporated in furniture polish and oil paints. In enamel paints and varnishes also it is effective.

Good results are given by white wash containing D.D.T. But lime white wash with D.D.T. cannot be used as D.D.T. is converted into the non-toxic dehydrochloride.

Aerosols:—These are put up from solutions of D.D T. by fine atomisation of solutions or by dispersion of D.D.T. by means of a burning mixture. In the former D.D.T. dissolved in a mixture of nonvolatile solvent and low boiling solvent is allowed to escape into the atmosphere under the pressure of the low boiling solvent which evaporates instantaneously leaving a very fine mist of D.D.T. in the non-volatile solvent. The latter termed "smoke aerosol" appears to consist of liquid droplets of supercooled D.D.T.

Aerosals are recommended for treatment of places which are difficult to be treated by other spray methods but no residual effects can be expected. They are insecticidally efficient at air concentrations of 0.004 to 0·007 mg. D.D.T. per litre. There is enough safety margin in its use as 3000 to 4000 times more than this concentration will have to be used to produce intoxication in animals. Neal (1944) is of opinion that the use of 1% deobase mist and 1 to 5% solution of D.D.T. with cyclohexanone and freon as aerosal are safe insecticides without ill effects to man and animals.

Of all the preparations available the aqueous suspensions and dusts constitute the safest products in Veterinary use. The use of even the harmless dust in cats should be cautioned because of their licking habits and marked susceptibility. The use of other preparations in food producing animals, pet ones and milk cows should be of a cautious nature because of its accumulation in adipose tissue and its concentration in the cream and butter.

Modes of Application:—Liquid forms of D.D.T. are utilised in different ways 5% D.D.T. solution in kerosene has been widely used for attack on mosquitoes over wide areas of tropical forests and swamps by means of aircraft spray. When sprayed in this manner insects in flight get the intoxication besides the subjected areas remaining toxic for various periods killing the

existing susceptible larvae and adults. The common breeding places of insects as well as walls and other frequented places of insect pests can also be sprayed. Emulsions and aqueous suspensions can also be used in the same manner, besides their use on the bodies of animals. Surfaces should not be made wet with spray but merely moistened. For effective spraying various kinds of appliances are in use. For all practical purposes a 'flit-gun' pump spray will suffice. The Malaria Institute hand sprayer developed in India ensures efficient spraying. Stirrup pumps, Knapsack sprayers and power sprayers can also be used.

When large number of animals are to be treated with D.D.T. instead of spraying, dipping can with advantage be adopted. But Radeleff (1947) is of the opinion that the time honoured dipping vat is repidly losing popularity to portable powered spraying units which enable the animals to be treated at their places rapidly and without much disturbance.

Small animals as well as isolated areas in large animals can be treated with the liquid preparations of D.D.T. by sponges or smooth brushes. Oily dressings can also be utilised in the same manner or rubbed by hand. Ointments can be applied by rubbing with hand taking necessary precautions.

D.D.T. powder is sprayed by means of dust guns and the common preparations of D.D.T. powders are usually sold in containers having the facilities for direct dusting.

TOXICOLOGY

Effect on Laboratory animals:—Experiments on laboratory animals reveal that rats have the greatest susceptibility, guinea pigs the least with mice and rabbits intermediate in increasing order of resistance.

Smith and Stohlman (1944) studied the toxicological problems in laboratory animals by giving D.D.T. in olive oil orally. The lethal dose 50 according to these workers for rats is 150 mg/kg body weight or (1 gm/lb), for rabbits it is 300 mg/kg (2 gm/lb); death was delayed for several days. But the experiments of Woodard et al (1944) showed the L.D. 50 as 200 for rats, 400 or over for rabbits, mice 400—500 and guinea pigs 250 to 600 mg/kg body weight. These workers found that D.D.T. dispersed in gum acacia was decidedly less toxic than in oil solution. Cameron and Burgess (1945) by administering D.D.T. in liquid paraffin arrived at the L.D. 50 figures as rabbits 300, guinea pigs 400 and rats 800 mg/kg body weight.

Draize et al (1944) noted that D.D.T. powders when applied to the skin produced no evidence of systemic toxicity or of primary irritation. Even 4 gms/kg of the undiluted drug had no effect on rabbits when applied externally. But in solutions D.D.T is absorbed by both intact and abraded skin and causes severe poisoning. The experiments of Cameron and Burgess (1945) by the skin application of solutions gave the following L.D. 50 figures : rabbits 300,

guinea pigs 1000 and rats 3,000 mg/kg. Taylor (1945) dressed liberally rabbits young and old with 5% D.D.T. solution in acetone and found that a single application was fatal to rabbits. Even a single application of 0.5% D.D.T. solution in acetone to young rabbits was found injurious. But earlier to this experiment Elmes (1945) had succesfully treated psoroptic mange in rabbits by a single application or in some cases by repeated dressings of 5% solution in acetone without any ill effects to rabbits.

Woodard et al's (1944) observation is that when injected intra-muscularly or intraperitoneally the drug is less toxic than when given by oral route. Calvery (1945) injected 150 mg D.D.T./kg body weight daily which caused death in rabbits, rats and guinea pigs after 30 days. The experiments of Cameron and Burgess (1945) give the following L.D. 50 for laboratory animals by subcutaneous injection of D.D.T. either in kerosene or ether: rabbits 250, guinea pigs 900 and rats 1500 mg/kg. The experiments of Konst and Plummer (1946) lead to the same aforesaid conclusions.

Smith and Stohlman (1944, 1945) also studied the cumulative effects by giving repeated small doses and found that 0.05% D.D.T. given daily for 3 months was injurious and 0.1% always killed the rats in 18 to 80 days; rabbits died in 15 to 25 days with a daily oral dose of 50 mg/kg in olive oil, after a total dose of 0.75 to 1.25 gm/kg. Woodard et al (1944) found definite signs of toxicity by levels in the diet of 0.05% in rats and mice and 0.1% in guinea pigs. Calvery (1945) collaborates the above observations in rats, rabbits and guinea pigs. Cameron and Burgess (1945 giving D.D.T. as 5% suspension in liquid paraffin to rabbits and rats with the daily dose of 50 mg/kg have obtained the same results. Other workers as Laug and Fitzhugh (1946) noted the toxic nature of the drug by giving rats 800 to 1,200 p.p.m. D.D.T. in their food for 6 months and less amounts for about 2 years. Solid D.D.T. is relatively non-toxic, some rats survive for a year the addition of 0.1% D.D. T. in their diet.

Absorbtion from the skin was also studied and the results show that D.D.T. is definitely toxic and sufficient is absorbed though not in the powder or in the aqueous form through the skin to cause toxic effects. Draize et al (1944) record the death of rabbits, rats and guinea pigs with doses as low as 0.5 c.c. of a 30% solution of D.D.T./kg/day. (150 mg/kg) after 30 days. Cameron and Burgess (1945) exposed the skin of laboratory animals repeatedly to 250 mg/kg in all forms of powder and found no toxic symptoms. The observations of Draize et al (1944) and others also confirm the above findings.

In inhalation studies of toxicity by Neal (1944) mice were found to be more susceptible than rats. Guinea pigs and rabbits were most resistant. Repeated exposures to heavy mists were without any effects. Small and young animals were more susceptible than large and older ones. The use of 1% D.D.T. deobase mist had no toxic effects on rabbits.

Effect on large domestic animals:—Konst and Plummer (1946) place chicken, cattle, goats and sheep in the increased order of resistance to D.D.T. Orr and Mott (1945) administered large amounts of D.D.T. as 100 mg/kg body weight daily for 3 weeks as a dry powder and in water suspension to cows, horses and sheep and found that the chemical did not produce toxic symptoms. Even a single dose of D.D.T. from 0·05 to 2 gm/kg body weight given to sheep did not result in any serious toxic symptoms. Nelson et al (1944) administered to cows, sheep and horses 100 to 200 mg/kg for 3 weeks and arrived at the same result as Orr and Mott (1945) The extensive use of D.D.T. on these animals so far has not resulted in any adverse effect.

Hitchcock and Mackerras (1947) administered orally 25 and 50 gm. doses of D.D.T. to cattle at repeated intervals without ill effects. 22·5 gm. D.D.T. in oil applied on the skin for 51 weeks, at weekly intervals also did not result in toxic symptoms. Telford and Guthrie (1946) observed that a single dose of 1·5 to 3·3 gm. D.D.T. /kg body weight to goats produced symptoms of toxicity but with ultimate recovery. Higher dosages resulted in deaths within 2 weeks. Goats fed with 0·25 to 0·28 gm/kg showed only the slightest manifestations of toxic symptoms. Goats sprayed daily for 42 days with 150 c.c. of 10% emulsion were not affected. Spicer et al (1947) are of the view that the single fatal oral dose of D.D.T. in vegetable oil for goats is greater than 1,000 mgm/kgm. Such repeated doses killed the goats after a total intake of about 6—11 gm/kgm body weight. Dove (1944) states that several hundred goats dipped in an emulsion containing D.D.T. has not resulted in any impairement of vision.

Effect on Cats:—Smith and Stohlman (1944) gave two cats 50 mg/kg daily or every second or third day and found them developing toxic symptoms and dying, after the intake of 500 mg/kg and 300 mg/kg in 12 to 15 days respectively. Another cat given four doses of 90 mg/kg died within 10 days. The L.D. 50 dosage for cats for a single dose is about 250 to 300 mg/kg which shows that the cat is one of the more susceptible animals. The licking habits of the cat is another factor to be considered when D.D.T. is used. King (1946) records a case of a cat immersed only once in a supposedly harmless dispersible powder of 0·5% suspension of D.D.T. which exhibited toxic symptoms within 12 hours. Helen Neve (1946) also narrates the development of toxic symptoms in a cat four hours after washing it with one part of a 0·5% suspension of D.D.T. in water with a little common soap as lather. Hamilton Kirk (1946) records cases including fatal ones of D.D.T. poisoning in cats even when they are dusted with the quite safe powder. The affected animals exhibited visible symptoms for several days upto more than a week before succumbing. Roberts et al (1947) record fatal cases of cats dipped in 1% aqueous suspension and those dipped in 0·5% suspension becoming sick. Morse (1947) record a mild case of poisoning following the application of 10% powder although the same observer had used D.D.T. on cats extensively with no toxic reactions. Sweetman (1946) noted no harmful effects in 2 cats treated with 50% dust; perhaps the cats were not allowed to lick.

Effect on dogs:—Draize et al's (1944) observation is that dogs are less susceptible to poisoning for cutaneously applied D.D.T. solution, and they are particularly resistant to D.D.T. aerosols. They tolerate comparatively large doses of D.D.T. by intranasal insufflation. But Vaz et al (1945) produced poisoning in dogs by daily doses of D.D.T. at the rate of 10 mg/kg body weight until intense symptoms of poisoning were noticed. Hamilton Kirk (1946) mentions of toxic symptoms in two cases of dogs which had several D.D.T. baths against ecto-parasites. Hill add Robinson (1945) describe two fatal cases in dogs sprayed only once with a 5% D.D.T. in kerosene which were suffering from demodectic mange. Both died two months later.

Effect on Poultry:—Woodard et al's (1944) experiments gave the L.D. 50 doses of chicken as greater than 300 mg/kg. Definite signs of toxicity were produced by levels in the diet less than 0·05% in growing chicken and those fed with 0 05% D.D.T. in their ration died in 4 to 16 days. Kingscote and Jarvis (1946) observe that large quantities of 5 to 10% D.D.T. preparations ingested, inhaled or dusted on birds cause casualties. 1 gm of 75% D.D.T./lb. body wt. in oil orally caused severe symptoms of poisoning but adult birds recovered whereas young ones died of the chemical. Boxes painted with commercial D.D.T. are harmless for fowls. Usually young ones die without marked manifestations. Telford and Guthrie's (1946) experiments show that poultry tolerates a single dose of 0·5 gm/kg without any ill effects but all birds fed on a mash containing 0·1% D.D.T. die within 10 days, half of the birds dying without exhibiting any symptoms. Quigley and Cory (1946) found that oral administration of 200, 250, 300, 350, and 400 mg of D.D.T. in capsules to cockerels weighing 1,325 to 1,770 gms produce slight manifestation of toxic symptoms but no deaths, upto 15 days. Oral administration of 15 mg D.D.T. daily in capsules for 10, 20 and 30 days produce toxic effects only after 20 days but the same amount given daily in the mash for periods upto 120 days produce slight toxic effect for 48 hours only. Roberts et al (1947) encountered deaths in birds treated with 2% aqueous suspension ; egg taint also was reported. D·D·T as 20% dust or 1% emulsion applied to the eggs or 50% D.D·T. used in the incubator did not produce adverse effects on hatchability.

Effect on man:—"Workers in the laboratory, the field and the factory who have handled D.D.T. continuously in a variety of forms and often in large quantities have been submitted to detailed and regular clinical examinations by experts. Provided elementary precautions are observed, such as the wearing of protective clothing and gloves when handling concentrated solutions and dust masks when exposed to heavy concentrations, no cases of intoxication have resulted. Most medical specialists subscribe to the view that the danger from D.D.T. is no greater than from other insecticides."

Theresa Lazar (1946) reports the incident of one fellow officer who consumed, as the result of a bet, half a dozen pan cakes made of D.D.T. powder instead of flour. He enjoyed his meal greatly without any

untoward effects. Burn (1945) observes that the "experiments in volunteers show that the human skin is unharmed by the dry substance or by watery suspensions and one scientific worker took as much as 1.5 gm. of D.D.T. in butter without ill effects". Neal et al (1946) orally administered 770 mgs. of D.D.T. in olive oil corresponding to 11 mg. of D.D.T./kgm. body weight to one normal individual who tolerated it without any perceptible toxic effects. Experiments carried out by Cameron and Burgess (1945) using human volunteers led to similar results. Neal (1944) also observed that D.D.T. upto 10% in inert powders, offers no serious consequences. A clinical and laboratory study of 3 men who had several months of continuous occupational exposure to D.D.T. in its various forms as an insecticide, showed no definite toxic effects. The use of 1 to 5% solutions as aerosol should offer no serious hazards. Calvery (1945) is of the opinion that the safety level for man cannot be above 10 p.p.m. D.D.T. so extensively used on human beings either directly in the form of dust, or garments either dusted with D.D.T. or impregnated in D.D.T. solution to control louse infestation, have not so far been reported to have produced any harmful effects. "50 soldiers wore undergarments heavily impregnated with 1% wt. for wt. D.D.T. They exposed their bodies to 70—80 gm. of D.D.T. and had worn garments for from 4 to 6 weeks, with no harm. If D.D.T. with a bland fluid like paraffin is injected subcutaneously in large amounts, no toxicity results. The men who carried out impregnation of garments did not at all suffer except for a slight dermatitis in some of them which quickly disappeared. Yin-ch'ang chin and chi-hsueh T'ant (1946) describe the dressing of 32 students with different concentrations or mixtures of D.D.T. without any ill-effect as if with pain, heat and cold sensations. But the solution of D.D.T. in olive oil or mixture with vaseline has been found to desensitise the tactile sensations.

Wigglesworth (1945) reported the first case of presumed D.D.T. intoxication in a laboratory worker after a heavy and deliberate exposure of his hands to D.D.T. in acetone solution. Here the victim had been exposed to D.D.T. far in excess of levels that might reasonably be met with in the routine use of the insecticide. But Dangerfield (1946) narrates a different story. Exposure of the hands to D.D.T. in acetone was done by volunteers, though the duration and frequency of the exposures used. were probably greater than those of Wigglesworth's case. None of the volunteers suffered any irritating or toxic effects. Many other experiments in which moderate quantities of other preparations of D.D.T. were applied to the skin failed to produce toxic symptoms although in some cases irritation due to the vehicle resulted. Case (1945) narrates D.D.T. poisoning in two army personnel who were deliberately exposed for 48 hours with large skin areas in contact with the oily surface of the distemper containing 2% D.D.T. used on the wall of a room. Mackras

and West (1946) report 4 cases of D.D.T. poisoning observed in New Guiana. The first two were the most severely affected of some 25 men who ate a tart in which D.D.T. was used by mistake for baking powder. The third case was in a man whose right hand had become covered with D.D.T. solution for six days of the week. The fourth man got D.D.T. powder in his eyes and became blind for a fortnight. All of them completely recovered.

Hill and Robinson (1945) record the first fatal case of D.D.T. poisoning in a child aged one year and seven months who swallowed about one ounce of D.D.T. in kerosene. The child died 4 hours after this. From this case, the above authors arrived at the figure of L.D. 50 for man as 150 mg/kg body weight. This figure indicates that the human subject is more sensitive to D.D.T. than the animal. Balban (1946) argues that the fatal case of poisoning recorded by Hill and Robinson might as easily be ascribed to the kerosene as to the D.D.T. since kerosene also is fatal, when taken internally. But Hill and Robinson fed a monkey with D.D.T. in kerosene and another with kerosene alone. The latter survived while the former died. This clearly showed that the cause of death in the child must be due to the D.D.T. and not kerosene. The same workers from their experiment found the L D. 50 for monkey as 236 mg/kgm body wt. "A small group of men (natives of Okinawa) consuming American stores were accidentally and fatally poisoned by eating D D.T. which they mistook for some edible material."

Symptoms:—"Symptoms following administration of D.D.T. are not unlike those of carbon tetrachloride poisoning." (Vaz et al, 1945) But Smith and Stohlman (1944) compare the symptoms of poisoning by D.D.T. with those of poisoning by phenol as observed in experimental animals except that the action of D.D.T. is delayed up to several hours and may persist for several days. With large single doses of D.D.T., however administered, the first signs of intoxication to D.D.T. generally occur in 12 to 24 hours. The symptoms of poisoning in laboratory animals are cold skin, sometimes diarrhoea, loss of appetite, heyperexcitability and sensitiveness to stimuli. Dysfunction of the liver and kidneys may precede the onset of nervous manifestations. When tremors first appear, they are coarse in nature, involve the entire musculature and are particularly marked in the legs and in the muscles over the eyes; muscular weakness sets in especially the hind quarters; generalised fine and coarse tremors develop and movement becomes restricted and staggering which end in flaccid or spastic paralysis. Tonic or clonic convulsions precede death from respiratory paralysis. Anorexia leads to rapid loss of body weight and death usually occurs in 24 to 48 hours. A mild secondary anaemia, toxic in type and pronounced leucocytosis are quite common results.

Repeated small doses produce chronic poisoning by the cumulative effect. Those affected have anorexia, severe loss in weight, hyperexcitability and nervous tremors leading to convulsions. Severely poisoned animals show a moderate leucocytosis with a marked increase in the percentage of heterophiles while emaciated animals are easily affected by secondary infections. The toxic symptoms will begin to decrease as soon as the D.D.T. is withheld. In slight intoxication, anorexia, muscular weakness and fine tremors are the poisonous symptoms. Reduced dosages result in anorexia, impairment of growth and mild anaemia with reduction in haemoglobin values, but without affecting white blood cell counts.

The symptoms observed by Orr and Mott (1945) in cows, horses and sheep are only marked loss of appetite. Nelson et al (1944) also agree with this besides describing slow tremors in the hind quarters of two cows. Telford and Guthrie (1945) observed in fatal cases of goats, tremors, convulsions, prostration and death within two weeks after a single dosage. Single lesser dosages resulted in tremors of varying severity with recovery. Single small dosage resulted in loss of condition and weight. Frequent administration of D.D.T. suppressed milk secretion, the lactation generally ceasing between 21st and 28th day of dosing. These observations are confirmed by Spicer et al (1947) and the manifestations of toxic symptoms usually appeared only after 12—24 hours. Cats show persistent extensor rigidity with muscular twitching especially of the head and neck which may persist for several days following a single dose. Hamilton Kirk (1946) describes the symptoms in the two fatal cases as nausea, hyperexcitability, tremors, extensor tetany, inability to stand and apparent great pain. The above symptoms were observed after several days. But Helen Neve (1946) and King (1946) observed the toxic symptoms within 12 hours, and in one as early as within 4 hours. The symptoms observed were generalised muscular tremors, tail erect and rigid, marked incoordination of limbs, rapid shaking of the head by spasms of neck muscles, continuous blinking of eye-lids and dilated pupils. The temperature was normal. General cutaneous muscular tremors, dilated pupils, wide and starring eyes, and 103·5°F. temperature were the symptoms noted by Morse (1947) in a mild case in a cat. Dogs become ill, loose appetie and die from exhaustion after exhibiting characteristic symptoms. The symptoms of poisoning in poultry are marked dyspnoea and tremors. Young ones die without marked manifestations.

The symptoms of the fatal case of human poisoning of Hill and Robinson (1945) are: within 10 minutes the child began to cough and vomit violently, his general condition worsened and after 1½ hours he became comatose had convulsions of generalised fine tremors and had froth in the mouth. The child died 4 hours after drinking of D.D.T. due to pulmonary oedema probably from paralysis of respiratory centre. The symptoms described by

Wigglesworth in his case of poisoning are: spasm of extreme nervous tension, prostration to such a degree as to confine the sufferer to bed for a fortnight and voluntary muscular twitching over the whole body on atleast 3 occasions. After 10 to 14 days the patient got up although the aching of limbs was severe. Full recovery had not taken place at the end of the year. The symptoms commenced 1 to 10 days after exposure. The observations made by Case (1945) in his experiments with human volunteers are: tiredness, heaviness and aching of limbs, diminution of some reflexes, unilateral slight impairment of heaving, muscular fibrillation, peripheral patchy anaesthesia, weakness of the legs and a curious apprehensive mental state. The symptoms began to appear from the third to fourth day and a return to normality took between 26 to 33 days. Haemotological studies revealed an increase in erythrocytic destruction, a decrease in the mean corpuscular haemoglobin, an increase in reticulocytes, a slight fall in haemo-dynamic index and a diminution of neutrophiles accompanied by the appearance of immature while cells; Indoxyl-sulphate appeared in the urine.

Lesions:—Lillie and Smith (1944) who studied the pathology of experimental poisoning observed most striking changes in the liver. There was hyaline degeneration. In rats and rabbits, hyaline oxyphil masses were found in the central part of the cytoplasm and they were surrounded by vacuoles. There was also a variable amount of fatty degeneration of liver cells, often centrolobular. There was mid-zonal and centro-lobular coagulation necrosis. Sometimes this was accompanied by interstitial and proliferative reaction leading to replacement by new vascular granulation tissue. This process when it was more extensive led to trabaculation. In rats and rabbits, there was focal hydropic degeneration of liver cells. In one rabbit, voluntary muscle necrosis with proliferative reaction was also seen. Nelson et al (1944) also observed the same lesions in their experiments. Besides they noted the thyroid often showing moderate depletion of colloid and less often epithelial desquammation and rarely epithelial hyperplasia. In rabbit, only a focal necrosis of gall bladder and increased incidence of nephritis were noted. Renal lesions were slight and infrequent. Myocardial and adrenal lesions were rare but these might be significant when they occur. There were no significant changes in the bone, bone marrow, testes, pancreas. and spleen.

Inspite of the pronounced neurologial symotoms produced by D.D.T. the histological changes in the C.N.S. are relatively slight. But Lillie and Smith (1944) observed in cats, rabbits and rats, vacuolation round the large nerve cells in the cord and cerebral motor nuclei and in cats and rats trigrolysis and cell vacuolation. Nelson et al (1944) noted in rabbits only an increased incidence of spontaneous types of encephalitis, with no changes in the brain and spinal cord. Laug and Fitzhugh (1946) observed that the

weights of livers and kidneys of the animals receiving D.D.T. showed an average increase of 43% and 19% respectively and the oxygen consumption of the slices of liver tissue were about 40% below normal.

Lesions observed in large domestic animals are relatively slight. Haemorrhages are frequently produced in the sub-endocardium, in the left ventricle and in the lining of the intestines. Slight fatty degeneration of the liver is also present. Opacity of the cornea, contraction of the spleen, fatty changes in the heart and pericellular vacuolation of cerebral cortex, spinal cord etc. were the lesions observed in goats by Spicer et al (1947). Hill and Robinson (1945) noted in fatal cases of chronic poisoning of dogs centrolobular necrosis of liver and tubular degeneration of kidneys (both) with calcification. Konst and Plummer (1946) noted gross pathological changes in the liver only, after administration of large single doses of D.D.T. to birds. The most constant lesion was degeneration of liver of variable character but usually a vacuolar degeneration of the cytoplasm of the cells. Quigley and Cory (1946) noted in the autopsies of birds which did not die of administration of lesser doses of D.D.T. diffuse enteritis, slight necrotic patches in the crop, atony of the gizzard muscles, swelling and mottling of kidneys and some distension of uterus.

The lesions observed by Hill and Robinson (1945) in the fatal case of human poisoning was only pulmonary oedema.

Treatment.—The treatment of D.D.T. poisoning is purely symptomatic. If accidentally eaten, local measures can effectively be taken since absorption is slow. Stomach-wash, either with water or saline can be undertaken. Fat has to be eliminated from the diet for many days. Since liver is the organ usually affected, hepatic insufficiency can be treated by the intravenoul administration of aminoacid mixtures or protein hydrolysates. When nervous symptoms appear, the best antidote appears to be the administration of sedatives. Smith and Stohlman (1944) suggest that narcotics as cyclos hexanone, in general may show a similar antagonism. The same workers (1945) noted good antidotal effects from urethane and to a lesser extent from dilantin. Phillips and Gilman (1946) tried C. N. S. depressants as therapeutic agents, the most outstanding being pheno-barbital which controls the characteristic tremors and convulsions in doses that caused a minimum degree of general C. N. S. depression. Vaz et al (1945) found that intravenous injection of 20 c c. of 10% calcium borogluconate effected recovery in D.D.T. poisoned dogs in 2 to 3 hours, instead of 12 to 24 hours being necessary in the absence of treatment. Preliminary work by Kingscote and Jarvis (1946) indicated that calcium leoulinate given intravenously arrested symptoms of acute D.D.T. poisoning. Further Vaz et al (1945) observed that injection of calcium gluconate for several days before administration of D.D.T. much reduced the severity of intoxication.

Elimination.—Woodard et al (1945) record the storing of unchanged D.D T. in quantities of significance in the body fat of dogs. Laug and Fitzhugh (1946) observed in groups of rats fed with D.D.T. upto 2 years, the drug in all tissues and the concentration in the peritoneal fat was about 50 to 100 times as great as in other tissues. D.D.T. content of tissues other than muscle appeared to be related to their fat contents. The exact amount of D.D.T. present in blood, liver, kidney, brain and spinal cord, bile and urine has been estimated by Smith and Stohlman (1944) and Spicer et al (1947). ***The urianry excretion of D.D.T. is very slow.*** Stohlman (1945) isolated crystalline D.D.T. and a water soluble fraction containing organic chlorine from the urine of rabbits which had been given D.D.T. by mouth. Smith and Stohlman (1945) demonstrated organic chlorine in the urine of rabbits, cats and dogs receiving D.D.T. long in advance of any recognisable symptoms of poisoning. Whit and Sweeney (1945) fed D.D.T. to rabbits which yielded di(p-chlorophenyl) acetic acid in the urine. Neal et al's experiments on man showed that part of the drug was metabolised to D.D.A. (di-(p-chlorophenyl) acetic acid) and eliminated in the urine up to the 10th day in the form of that metabolite but mainly from the second to the fourth day. Spicer et al (1947) also record the distribution of D.D.A. in the excvetary organs. So under biological conditions, hydrolysis of the CCl_3 group in D.D.T. can take place as shown by the isolation of D.D.A. (4-4. dichloro diphenyl acetic acid) from the urine of animals to which D.D.T. has been administered.

From 5 to 50% of the dose administered ***is eliminated in the faeces.*** Stohlman (1945) recovered crystals containing organic chlorine from the faeces.

D.D.T. is found to be eliminated in the milk also. The experiments of Telford and Guthrie (1945) are exhaustive in this problem. When 0.1% of this insecticide was fed in a balanced mash to adult rats each with one day litter, two of the nurslings died within 18 days showing toxic symptoms. Adult rats fed on milk from goats receiving daily oral doses of 1 gm. of D.D.T. per 8 or 9 lb. body wt. died within 2 to 29 days exhibiting typical symptoms of D.D.T. poisoning. Toxic goats' milk fed to recently parturient rats produced symptoms both in the mothers and nurslings. A half grown kitten given milk from a goat under treatment for 25 days died with typical D.D.T. symptoms within 3 days. There is evidence to show that the toxic principle of D.D.T. is concentrated in the fat globules of milk because butter prepared from the milk of treated goats produced typical tremors in rats within 24 hours of their being fed with this butter. Milk became more toxic after an extended period of treatment. But an unweaned kid allowed to suckle *ad libitum* a goat under treatment for 27 days showed no harmful effects. A goat was daily sprayed with 150 c.c.

of a 10% D.D.T. emulsion but the milk from this animal produced no toxic symptoms within 42 days when fed to rats nor within 76 days in a young kid allowed to suckle the sprayed animal. The same authors record later that a kid nursed by a milk goat receiving 1 gm. daily developed normally without symptoms of intoxication. Spicer et al (1947) confirm the above observations by their experiments. The milk of lactating dogs receiving D.D.T. contain appreciable levels of the compound. Woodard et al (1945) determined appreciable quantities of the drug in the milk of dogs receiving D.D.T. orally. All the laboratory raised flies exposed to milk and butter from the treated goats were down within 2½ hours.

Uses of D.D.T. Against Arthropods of Veterinary Importance

D. D. T. is toxic to almost all arthropods. Insecta are more susceptible. The speed of kill varies with different insects; diptera are usually killed in a matter of minutes, anoplura takes several hours, while hemiptera and siphonaptera and acarida which are rather resistent may survive a day or two after contact. The report of U.S.D.A. says that 4% D.D.T. is effective against biting flies, lice and fleas. D.D.T. is not effective for screw worm flies, bot flies or other flies that visit the animal only momentarily to deposit eggs.

Diptera—Nematocera:—Extensive trials, field as well as laboratory have been underlaken in the control of mosquitoes and it is too much to cite the numerous references connected with this work. As mentioned already the demand of the fighting forces for an efficient insecticide to control the malaria carrying insects has resulted in the extensive use of this insecticide with spectacular results. The chemical is extremely effective as a mosquito larvicide and adulticide. Among the culicidae which are more susceptible than flies, *Aedes* alone stands the lethal dose of flies. The minimum lethal dose for the female *Aedes aegypti* is $2{\cdot}4 \times 10^{-11}$ grms. per insect. 5% D.D.T. solution in kerosene is the one commonly used. It is applied by spraying the walls, ceilings of rooms, cattle sheds etc., at the rate of 50 mgms/sq. ft. and this acts as a residual poison up to atleast eight weeks to mosquitoes. This works to about 1·25 c. c. of 5% solution per square foot. The mosquitoes can be completely eradicated with repeated sprayings at intervals of eight weeks. The mosquitoes alighting in the D.D.T. sprayed surfaces are poisoned and they eventally die. For direct attack on flying ones, aerosols and fine mists are used. But since residual action is desired, D. D. T. solution is used as a spray from the air at the rate of 0-2 lb. or 2 quarts of 5% solution in kerosene per acre. This is effective for 1 to 2 weeks. When sprayed from air, besides killing the flying ones, it attacks the breeding as well as the resting places and remains lethal for mosquitoes in such places and thus reduce the mosquito population. In the attack on culicidae, the treatment of water surfaces as the breeding places, is also

an important step. Small areas of water can be treated by ground spray at 1 to 2 quarts of 5% solution/acre. Aeroplane spraying at the same rate is very successful in the treatment of large areas. Kerosene solution spreads very well and is an effective larvicide. But the residual effect on water is negligible and so the breeding places should be treated atleast every week. It is to be emphasised that the kerosene solution is injurious to fishes as well as to foliage. If they are valuble, the emulsion recommended by the Malaria Institute of India is a useful one. (Formula 1) Mosquitoes besides creating a great nuisance and causing painful bites are the intermediate hosts and vectors of parasitic and protozoon diseases of domestic animals. *Aedes* transmits *Plasmodium gallinaceum*–malaria of birds; *culex* transmits *Borrelia gallinarum*-the spirocheate of fowls and *Anopheles* and the former two are the intermediate hosts of *Dirofilaria immitis*-the heart worm of dogs.

The experiments of Hertig and Fisher (1945) prove that D. D. T. is effective against sand flies-*Phlebotomus* and 5% kerosene solution is effective up to 24 days. Sand flies transmit cutaneous leishmaniasis in animals.

Fairchild and Barreda (1945) record the complete eradication of *Simulium* larvae in streams by concentrations of 1 part D.D.T. to 10 million parts of water. Garham and McMahon (1947) eliminated *Simulium neavei* by the periodical application of D.D.T. emulsion to all infested rivers and streams in the locality. *Simulium* causes great annoyance and irritation and keeps cattle from grazing since it bites on legs, abdomen or on the head and ears. These bites which give rise to vesicles, if on the teats are troublesome in milking animals. Besides attacking fowls and making them anaemic from loss of blood, certain species transmit *Leucocytozoon*. It transmits *Onchocerca* also.

Brachycera:—D.D.T. is not definitely effective against *Tabanidae* and no treatment gives any marked reduction in numbers of flies. Since these flies act as mechanical carriers of surra in domestic animals caused by *Trypanosoma evansi*, which is a serious problem in our country more extensive and sustained trials are needed to find out the efficacy of the chemical. Besides spraying or dipping animals with aqueous suspensions, walls and ceiling of stalls and the vegetations overhanging watery areas which are the breeding places should also be sprayed with kerosene solution.

Athericera:—D.D.T. is toxic to adult *Musca domestica*–house flies but not to the eggs, larvae or pupae. D.D.T. sprayed or painted on the walls of stalls, ceilings and furnitures at the rate of 50 to 100 mgm/sq.ft. kills all the flies that alight in those places up to a period of about 90 days. For direct action, D. D. T. is used in aerosols or fine sprays

The dose is the same as is applied in mosquito control from the air. 5% solution of D.D.T. in kerosene is the one commonly employed. Manure pits etc., which are the breeding places of house flies should be sprayed with 1% solution in kerosene. Young ones which emerge out will be killed and adult flies coming for oviposition will also be killed. Bruce and Blakeslee (1946) noted that spraying of cattle sheds with 2.5% emulsion or suspension gave not less than 35 days effective control of *Musca damestica*. Burn (1945) reports that 3% D.D.T. spray applied on windows, walls and lights effectively eliminates flies up to a period of 3 weeks. *Musca domestica* is the intermediate host for *Draschia megastoma* and *Habronema muscae*. It can carry anthrax and surra. Besides, eggs of parasites can also be tranmitted by it. The house fly may play an important part in dissemination of *Echinococcus granulosus*. Hence the importance of D.D.T. in the effective control of house fly breeding.

The adult flies of the sub-family calliphorinae as *Chrysomia*, *Lucilia* and *Calliphora* are also very susceptible to D D.T. as a residual film. *Sarcophaga* also should have the same susceptibility. Matthysse (1946) observed screw worm infestation of wounds in cattle caused by *Chrysomia* was reduced by the inclusion of 8% D.D.T. though it could not be completely controlled since the fly visits only momentarily to lay eggs. *Calliphorine myiasis* in sheep is a serious and vital problem in wool producing countries and experiments in the control of calliphorine myiasis by D.D.T. have resulted in much sustained work in those countries. Cragg (1945, 1947) observed toxic symptoms in *Lucilia sericata* by 30 minutes contact with the treated fleece. Besides, some larvicidal properties of D.D.T. against blow-flies were also observed. Sheep. dipped in a bath concentration containing 0-5% D.D.T. were not struck even 44 days after dipping. Adult flies seeking D.D.T. treated fleece to lay eggs subsequently died. The above results are corroborated by Lyle-stewart (1946), Hughes et al (1946, 1947) and the report of the Council of Scientific and Industrial Research of Australia (1945). Harbour and Watt (1943) advocate spraying sheep as this method of control is easy to apply and more economical than dipping as the amount of D.D.T. used in the spray is less. The experiments show that though D.D.T. dips or sprays give good results, that alone cannot be relied as the sole measure of control since a few treated sheep are also struck. The observation of Cragg (1947) that D.D.T. has some larvicidal action is in variance with the report of the Council of Scientific and Indus. trial Research of Australia (1945) wherein it is stated that fully grown larvae of *Lucilia* were unaffected by D.D.T. The studies by Waterhouse (1947) on D.D.T. against *Lucilia cuprina* are exhaustive and worth going through.

D.D.T. is effective in the control of *Stomoxys calcitrans*-stable flies in 2% concentrations. Investigations of Abrahamse (1944) showed that D.D.T. killed *Stomoxys calcitrans* and was capable of maintaining stalls fly-free for

23 days and reducing fly numbers for 2 months. Bruce and Blakeslee (1946) found that cattle were protected for atleast 2 weeks from *Stomoxys calcitrans* by dipping in 2% emulsion and by spraying the resting places of flies. D.D T. as a spray or dip either with emulsion or aqueous suspension on animals is only effective for a few days that is for about 2 weeks. 2% D D.T. solution in kerosene applied to the wall of horse-barns gave 100% kill of stable flies for about 12 days. Effective control of the fly breeding places in manure was achieved by Blakeslee (1945) by sprays containing 0·5% D.D.T. or 2·5% D.D.T. in residual oil applied at the rate of 2 gallons/100 sq. ft. which caused 90–95% mortality of the emerging adult *Stomoxys calcitrans* though the drug was not effective against larvae *Stom xys* is known to act as intermediate host of *Habronema microstoma* and *Setaria cervi*. It has also been proved that this fly can act as a mechanical vector of surra and anthrax

Since *Lyperosia* are almost always on the body of the animals, they are unaffected by the treatment of walls etc. So spraying or dipping of the animals either with aqueous suspensions or emulsions are the best modes of control. Bruce and Blakeslee (1946) record that spraying cattle with 2·5% emulsion at the rate of 1 pint per animal is effective and keeps down population of *Lyperosia* for about 50 days. This gives better results than dipping in 0·2% emulsion. Legg (1945) reports that with 4% D D.T. in kerosene sprayed on the skin, herds can be kept practically free for periods of 2 to 3 weeks. Actually only one week after treatment, the animals are free from these flies. The toxicity of D D.T. to both the buffalo and horn flies—*L.irritans* and *L.ex gua* has been demonstrated by many other workers, as Legg (1947), Mackerras (1947) and Peairs (1946). These flies do not transmit any disease but keep the animals from grazing or feeding thus causing loss of condition.

Du Toit and Kluge (1947) who conducted a series of experiments with D.D.T. against *Glossina*—Tsetse flies observe that although total elimination has not been achieved, fly incidence has been reduced to a low level which may lead to complete elimination.

D.D T. is not effective against *Oestridae* since they visit the animals only momentarily to deposit eggs. Matthysee (1945) sprayed legs and underside of cattle with D D T. preparations in concentrations of 2-5% which gave no protection against oviposition by *Hypoderma* flies and subsequent penetration of larvae. Telford and Harwood (1945) noted that oral administration of D.D.T. failed to remove the bots-larvae of *Gastrophilus intestinalis* from a horse. Salces and Calvo (1945) found that 5% D.D.T. on nasal mucosa was ineffective against *Oestrus ovis*. But in the fly season the resting places can be sprayed and direct sprays also can be attempted.

Pupipara can be eliminated by treating the hosts only since the flies are blood sucking ones and are found invariably on the bodies of their hosts. No treatment of stalls or of pigeon houses is necessary. Heath (1945, 1946)

dipped sheep in a bath concentration of 0·5% D.D.T. for thirty seconds which rendered the fleece lethal to *Melophagus ovinus* for not less than 36 days. Dipping 3 times a year in 0·5% D.D.T. keeps the fleece perpetually toxic to keds 0·125% D.D.T. renders fleece toxic to keds for a considerable time. Since the keds cannot live off the host for more than about 10 days, a single dipping in 0·125% concentration is adequate for isolated flocks of sheep. With dipping in 0·5% concentration the protection is definitely for 54 days which may go up from 74 to 99 days. Rude and Parish (1945) found that sheep and goats dipped in 0·2% concentration remained free from keds for 90 days. Cobbett and Smith (1945) found that D.D.T. in aqueous suspension of 0·1% is effective up to 3 months and even 1% suspension is harmless to sheep. Kemper et al (1947) found that 0·2% D.D.T. used as emulsions or aqueous suspensions could eradicate sheep ked. Emulsions containing 0·15% D.D.T. or less failed to eradicate the infestation. The report of the Council of Scientific and Industrial Research, Australia (1945) also confirms the highly toxic action of D.D.T. against *Melophagus ovinus*. 1:5000 D.D.T. emulsion kills all keds in a few hours and over 4 weeks elapse before reinfestation can be detected. It is only Matthysse (1945) who found that 5% Neocid dust was ineffective since only 7% of the keds died. *Melophagus ovinus* stains the fleece by its faeces which lowers the value of wool clip. The ked transmits *Trypanosoma melophagium*, a harmless blood parasite of sheep. It produces intense irritation and sucks blood thus reducing the condition of sheep and even causes anaemia. Pigeons can de dusted with a 10% D.D.T. powder to eliminate *Pseudolynchia maura* which transmits *Haemoproteus columbae*. Cattle also can be sprayed with aqueous suspensions of D.D.T. to eliminate *Hippobosca maculata* which transmits *Trypanosoma theileri*. Besides it causes intense irritation to the host and is the mechanical carrier of anthrax.

Spraying of cattle is more economical and practicable than dipping though a bit less effective. But sheep can be dipped with advantage. It is always advisable to use aqueous suspensions and emulsions on animals and solutions in kerosene on the walls and other places. 4-5% D.D.T. is effective against most of the flies which die in about 15 to 30 minutes and remain lethal for about 1-3 weeks Brett and Fenton (1946) are of the opinion that the period of control is extended with decrease in temperature. D.D.T. sprays to control flies need not be applied to extensive areas. The resting places of the flies alone need be sprayed. The duration of control is dependant upon the concentration of D.D.T. used. But D.D.T. alone cannot be employted to control flies. The proper disposal of manure and other accessory factors will also have to be attended to carefully. So, for the complete eradication, the breeding places as manure pits will have to be sprayed with D.D.T. solution in kerosene. Though it is not a larvicide, it is lethal to the flies alighting for oviposition as well as to the newly emerging ones from the pupae. The principles observed in the use of D.D.T. as enunciated by Craufurd Bensen (1945) are (1) The object of residual spray is to

reduce the fly population and not to kill individual insects. (2) It is an insecticide and not a repellant (3) The length of persistent action depends, on the amount of D.D.T. applied, age of residual film and the duration of contact of the fly with the treated surface. Wolfenbarger and Hoffman (1944) observe that spraying poultry houses with a 2% D.D T. solution in kerosene reduces the number of flies very considerably and the effect remains for atleast 6 weeks. Spraying poultry manure with solutions of D.D.T. reduces the population of fly larvae in the manure by 90%. When the flies come in contact with D.D.T. they become intoxicated, show development of nervous phenomena as violent shivers and ultimately die in 30 minutes or more with the appendages extended. In some cases the insects show signs of progressive laziness and paralysis indicated by jerky, staggering movements and inability to have a firm hold on any object. As the paralysis increases the month parts are also affected with inability to feed and ultimately they die of starvaion. Hartzell (1945) studied the histo-pathological preparations of nerve and muscle tissues of adult flies sprayed with D.D.T. It caused slight dissolution of the fibre tracts and degeneration of nuclei both in the brain and in the fused thoracic ganglia but histological changes were relatively slight. The muscles of the fly showed the nuclei clumped into rod-like dense masses due to the clustering of the chromatin.

Hemiptera :—D.D.T. is very effective against *Cimex lectularius*-bed bugs. Madden et al (1944, 1945) got good results with D.D T. solutions and dusts against bed bugs 100–150 mgm/sq. ft gives a toxic surface for 10 weeks Spray will ensure a longer residual effect than dusts which can be easily removed. 5% aqueous suspensions and 10% dusts can be used on beds and 5% kerosene solution can be sprayed on walls, crevices and other hiding places of bugs. Burn (1945) reported that 5% aqueous suspension killed all bugs and retained its effects up to 10 months and the bugs died within 48 hours. 3% D.D.T. in kerosene killed all bugs and showed no signs of reinfestation up to 2 months. The same are the observations of Anon (1945) Apart from being very annoying in human dwellings, *Cimex lectularius* is a common pest of poultry houses. Kulash (1947) completely removed them from poultry houses which had been heavily infested for 15 years and found difficult to exterminate, with one application of 5% D.D.T. in kerosene. This observation confirms the earlier work of Kulash and Maxwell (1945) who noted the residual effect upto two months. Quigley and Cory (1946) reported that bed bugs were easily destroyed in a laying house by a 5% emulsion. *Cimex lectularius* causes severe irritation and anaemia in poultry.

Siphonaptera: D.D.T. is undoubtedly toxic to all fleas, including the human flea-*Pulex irritans*. Lightly dusting the host with a 10% powder and spraying or dipping larger ones with 0.5% aqueous emulsion give prompt and complete control and freedom which may last for about 3–15 weeks. The infested buildings can be sprayed with a 5% kerosene solution which gives freedom from all fleas with protection from reinfestation for about a week or

more. When animals are treated against fleas, with D.D.T. on their bodies, the host animal may be driven into a frenzy of scratching caused by the stimulation of the fleas to increased activity. This subsides in a few hours after the fleas are killed. The fleas are killed within 2 hours. As early as 1943 an out-break of plague in Algiers was controlled by D.D.T. since this chemical was definitely lethal to the rat fleas-*Xenopsylla*. Davies (1945) found that the rat flea-*X-cheopis* was susceptible to D.D.T. and died in 24 hours. Madden et al (1944) report that 10 grm of a 4 to 5% dust has been found effective in eliminating the dog and cat flea-*C-enocephalus canis* and *C-felis* with protection from reinfestation lasting four to seven days. Hamilton Kirk (1946) used 0-5% suspension of D.D.T. upon several badly flea infested greyhounds with complete success. The dogs were merely sponged all over and allowed to run about until dry. He also mentions about another greyhound infested with fleas which resisted all other methods of elimination until D.D.T. suspension was used successfully. It is announced that a concentration of 0-05–0.07% D.D.T. in soap makes a dog bath that will keep off fleas and lice for several months. It not only kills the fleas and lice but also prevents reinfestation. Campbell et al (1945) agree with the above results and report about dogs free for 3 months. Roberts et al (1947) observed dogs remaining free of fleas for 2 weeks when treated with 0.5% suspension. One tea-spoonful of 10% powder is enough for a dog.

In view of their cleansing habits and high susceptibility, cats should not be treated too frequently or with excessive quantities of D.D.T. dusts. Kerr (1946) demonstrated the susceptability of *C-felis*-cat flea to D.D.T. and the activity persisted for 2 days at 0·02 grm/sq, ft. He considered 5% dusts for skin application suitable. Besides, the susceptability of flea larvae was also noticed. Since even 0-5% aqueous suspension was found to be toxic by Roberts et al (1947) it is advisable to use only the dry powders on them. Sweetman (1946) treated places infested with *C-felis* and *Trichodectes canis* with D.D.T. powder successfully. 10% dust was used on cats effectively. But treated cats allowed in untreated premises became reinfested in 3 days indicating a very short residual protection. The report of the Council of Scientific and Industrial Research of Australia (1945) describes the toxicity of D.D.T. to cat flea. D.D.T. in 0·01% concentration destroys newly hatched as well as fully grown flea larvae. Fowls also can be dusted safely with 10% powder to get rid off fleas-*Echidnophaga gallinacea*. Poultry houses can be sprayed either with kerosene solution or aqueous suspension. 2% spray protects the houses for 10 to 28 days. Roberts et al (1947) suggest dipping them in 0.5% aqueous suspension for control and eradication of fleas. The birds, by treatment of 0·1% aqueous suspension, are protected for several weeks.

The fleas are less permanent parasites on their hosts. They suck blood and produce very irritating bites. *C-canis* and *C-felis* are the intermediate hosts of *Dipylidium caninum*. Besides, the domestic animals are made restless.

Echidnophaga gallinacea kills quickly young birds and even adult ones may succumb to heavy infestations.

Anoplura:—The human body louse-*Pediculus humanus caporis* as the carrier of typhus was the main target of attack by D.D.T. which was amazingly effective and the control of the typhus epidemic in Naples with the use of D.D.T. is well known. D.D.T. was blown by a compressed gun, up the trousers, down the sleeves into collars, tucks and folds wherever lice might cling. If well dusted 10% powder of about 1½ oz. will protect the body against all lice for 4–5 weeks. Even the garments can be impregnated by immersing them in a 1-2% solution of D.D.T. dissolved in a volatile solvent. Thereafter they become toxic to lice and remain so for some weeks even after they have been washed. Even the clothing dusted with D.D.T. is lethal for lice for a month even after launderings. 2% emulsion can be used to eradicate the head lice-*Pediculus humanus capitus*. It is believed that D.D.T. is the best method to date, of treatment of head louse infestation. What has been said about the control of fleas in domestic animals can as well be repeated for the control of lice in the domestic animals. 0·5% solution spray or 0·75% solution dip or 10% dust kills all lice within 4 hours. Tests have shown that a light dusting of infested cattle with 10% D.D.T. will completely detroy the lice. Lyle and Strong (1945) used 10% D.D.T. with good results to completely control *Bovicola bovis* and *Linognathus vituli*. Munro and Knapp (1945) dusted cattle heavily infested with *B. bovis* and *Haemotopinus eurysternus* with 10% powder and found them eliminated within 24 hous.

Parish and Rude (1945) observed that *Bovicola caprae, B hermsi* and *Linognathus stenopsis*, the 3 varieties of goat lice were killed by 0·2% emulsion and the goats were freed from the same. Dipped animals were free from reinfestation up to 6 months. *Linognathus africanus* and *L. ovillus*–the blue louse of sheep have been found susceptible to 0·25% spray. The report of the Council of Scientific and Industrial research of Australia (1945) says that adult *Bovicola ovis* are killed by a 1:2500 emulsion. A single application of D.D.T. spray or dip proves effective in ridding swine of heavy infestations of the lice-*Haemotopinus suis*. Kemper and Roberts (1946) record that pigs sprayed with 0 5% emulsion completely got rid off lice, but the larvae hatching from eggs were able to re-establish infection. But pigs dipped in 0·75% emulsion were freed completely of lice, the drug persisting sufficiently to kill all larvae on hatching. Wolfenbarger and Hoffman (1944) observe that dusting poultry with 4% D.D.T. controls the body louse and the shaft louse—*Menopon biseriatum* and *M. gallinae*. Warren (1945) recorded good effects with 10% dust but 3% D.D.T. did not protect reinfestation after 2-3 weeks. Quigley and Cory (1946) dusted laying birds with 2, 10, 20% D.D.T. Lice were removed completely within 48 hours and no reinfestation could be established within 30 days. Dusting litter was not so effective. The satisfactory method was to

dust the roosting birds with 20% D.D.T. twice at two weeks interval. Telford (1945) also observed that D.D.T. gave complete control of chicken louse. All lice and nits on horses were found to be killed within 2 days by D.D.T.

The reviewer dusted a bitch heavily infested with *Trichodectes canis* with 10% D.D.T. powder and found the experimental animal completely freed from lice next morning.

Lice cause intense irritation and loss of condition of the host. *Trichodectes canis* is the intermediate host for *Dipylidium caninum*. *Haematopinus suis* may spread swine fever.

Acarida:—Acarina vary in susceptibility to D. D. T. Among the results for acarina, there are conflicting opinions and claims; perhaps due to difference in dosage and mode of application.

Ticks:—D.D.T. is found definitely toxic to ticks. Sergent et al (1945) applied 200 c.c. of 5% kerosene solution to skins of calves and found that *Hyalomma mauritanicum* did not become attached to treated calf for seven days. Squibb (1945) sprayed 400 c.c. of D.D.T. and rotenone to cattle which killed *Boophilus annulatus* and *B.australis* (microplus). The same author (1946) recorded 85% mortality of ticks with D.D.T alone. The report of the C.S.I.R. Australia (1945) mentions that 0.5-2% emulsions destroyed not only *Boophilus* but also the larvae and protected against reinfestation for 2–13½ days. 2% emulsion was highly efficient against all parasitic stages of ticks and protected against reinfestation for 12 days. Hitchcock and Mackerras (1947) found 0·5% D.D.T. effective against arsenic resistent ticks–*B.microplus*. Parish and Rude (1946) applied 0·5% emulsion to horses at the rate of 2 quarts to 2 gallons and eradicated the winter horse tick–*Dermacentor albopictus*. The average period of protection from reinfestation was 45 days. Legg (1947) observes that arsenic ressistent cattle ticks can be controlled with 0·5% D.D.T. employed in a dipping vat. The same is the opinion of Mackerras (1947). Heath (1946) is of opinion that D.D.T. is only a moderate acaricide Freshly attached females are killed and those attached since 4 or 5 days are unaffected. But 0·5% emulsion dip markedly reduces the infestation of sheep with *Ixodes ricinus*. Govinda Rau et al (1947) studied in a detailed manner the tickicidal action of D.D.T. against *Rhipicephalus sanguineus* in heavily infested dogs. They found that 2 oz. of 1 to 4% powder was lethal to ticks. The ticks began to show toxic signs in about 10-15 minutes. In about 6 days with 1% powder the heavily infested dogs were clean and the residual effect was noted for 17 days. Better results were observed with 2% powder and with 4% Neocid very few live ticks were seen after 21 hours and the residual effect was observed for 13 days. Sergent et al (1945) noted that the application of 180 c.c. of 5% D.D.T. in kerosene gave good results in dogs against dog ticks for 18 days. The observations of Govinda Rau et al (1947) are that 100–200 c.c. of 3–4% D.D.T. emulsion in kerosene is

effective and all the ticks die within 3 to 43 hours and the ticks are noticed to die in 1½ hours itself. The residual effect persists for 13 17 days. 1-4% D.D.T. ointments are found effective and the residual effect lasts up to 13–17 days. 100-200 c.c. of oily dressings form 3–6% are also found effective. The above writers recommend 4% D.D.T. emulsion in kerosene oil which has the residual effect up to 2 weeks, In the eradication of dog ticks. Reedal and Smith (1944) used successfully 5% D.D.T. paste against Gulf coast tick-*Ambylomma maculatum* and Spinose ear tick-*Ornithodorus megnini*. The areas usually infested with *Ornithodorus* and the poultry houses infested with *Argas* can be dusted or sprayed either with 10% powder or 5% kerosene solution or any other emulsion. Poultry also have to be treated for Argas, since the adult feeds often on the blood of birds. Warren (1945) reports the residual effect of D.D.T. on birds to be about 2 to 3 weeks.

Ticks are irritating to their hosts and tick worry results in restlessness, and loss of condition. Some ticks even produce wounds on the skin. The female ones, larvae and nymphs ingest large amounts of blood and thus cause anaemia in their hosts. Besides, they transmit diseases of domestic animals. *Argas persicus* transmits *Borrelia gallinarum* and *Aegyptianella pullorum*. The other ticks transmit *Piroplasmosis*, *Hepatozoon canis* and *Rickettsia canis*.

Ticks are not as spectacularly affected by D.D.T. as it deals with flies. Though it is definitey lethal to ticks, it acts very slowly and ticks survive 1 to 4 days the action of D.D.T. The dosage of the insecticide required is also more. So to get an immediate effect, D D.T. is incorporated with pyrethrum. This mixture combines the rapid knock down action of pyrethrum and the residual effect of D.D.T. So, thig mixture is gaining popularity in the treatment of tick infestations. The signs of toxicity in the ticks observed by Govinda Rau et al (1947) are: the ticks show excitement, roam about leaving the host and later tremors, assume dorsal position–difficulty to resume the natural ventral position, incoordination of the distal limbs and paralysis.

Mites:—At present all the experiments reveal that D.D.T. is ineffective against mange mites although a few reports to the contrary have appeared. Buxton (1945) reported that D.D.T. had little effect on mites. In the discussion, Mellanby (1945) stated that D.D.T. is surprisingly ineffective against human scabies. The same is the observation of Hellier (1945) who showed by statistics that D.D.T. had no preventive action against acquirement of scabies since the same percentage were suffering that had been wearing impregnated shirts or had been using D.D.T. regularly and recently within 2 months as that of others who had not been treated with D.D T. But Elmes (1945) reports the successful treatment of rabbits suffering from sarcoptic mange and psoroptic mange (*Notoedres cuniculi and Psoroptes communis cuniculi*) with a single application of 5% D.D.T. solution in acetone. The rabbits were free from mites in 2 to 4 weeks time Dead *Notoedres* mites were seen after 2 weeks and even they disappeared after one more treatment. The rabbits were

clinically free from the disease after 4 weeks. Krebs (1946) reports that *Psoroptes cuniculi* are destroyed by a 5% solution with applications at 3 days interval. Single application protects the exposed ones from infection. Perhaps rabbits alone respond to the treatment by this insecticide. Moore (1946) treated a case of sarcoptic mange in a dog with D.D.T. powder and found that the powder failed to penetrate and so was not effective against *Sarcoptes* Though the skin regains normality, since the mites are not destroyed, skin lesion again appears. Downing (1947) observed that D.D.T. dips afforded some protection against *Psoroptes* in sheep but the dips were relatively ineffective in curing active scab except at uneconomic concentrations. But penetrating solvents and vehicles which will not prove toxic as vaseline etc., can be incorporated and tried. The application of D.D.T. in penetrating mediums up to a safe level is worth trying in cases of demodectic mange. A U.S.D.A. eport states that D.D.T. is ineffective for the control of poultry mites (persumably the red-mite-*Dermanyssus gallinae*). Schmid (1945) in his laboratory experiments found D.D.T. lethal to poultry mites and stated that practical effectiveness had also been proved. Povar (1946) observed that when the feathers containing the mites were dusted with 10% D.D.T. in vitro the mites died in 3 days. Even the newly formed larvae died after 10 days. But when the bird moderately infested with *Liponyssus sylviarum* was dusted with 10% powder, it was found that the mites were unaffected until 4 days which chose lightly dusted areas. The observation of Davies (1945) also confirms the view that the mites are unaffected by D.D.T. The above experiments clearly prove that D.D.T. is not reliable for the treatment and eradication of mites.

CONCLUSION

D.D.T. is an insecticide of great potentialities Because of its exceptionable toxicity to arthropods with a long residual effect and its easy availability, it is a preferred weapon in the control of animal pests and insect borne diseases and thus becomes a valuble veterinary chemotherapeutic agent. With all the limitations and draw backs, there is a wide margin of safety in its use as an insecticide, provided proper precautions are taken. In the wake of the discovery of D.D.T. and its subsequent extensive use, many new synthetic insecticides have been evolved which also claim our attention since better effects are claimed for them.

Dichloro diphenyl dichloroethane, (D.D.D.) is reported to be one fourth toxic to warm blooded animals as is D.D.T. but more toxic on immediate contact to mosquitoe larvae and more persistent effect. It is also reported that by replacing the chlorine in the D.D.T. molecule with fluorine, its destructiveness to insects is increased greatly.

Benzene hexachloride is another, which promises to be of great value as an insecticide. It was discovered in 1825 by Michael Farraday. But the same was rediscovered during the researches for synthetic insecticides, independently

by Dupire in France and F.J.D. Thomas of Imperial Chemical Industries Ltd., of Britain in 1943. It is comparatively easy to make by the action of chlorine on benzene under the influence of ultraviolet light but chemically the product is a complex mixture of isomers. An isomer—"Gama isomer" of benzene hexachloride has marked insecticidal properties. I.C.I. has put in the market the compound 'Gammexane' which contains the Gama isomer with the proprietory name '666' derived from the chemical formula of benzene hexachloride $C_6H_6Cl_6$. It is said that it has 8 to 10 times the killing power of D.D.T. for arthropods but does not have long residual effect. Because of the slow action of D.D.T. against ticks and the doubtful action against mites, Gammexane gives promise of being the best of the acaricides yet discovered. But it is said that it has a strong musty smell and clings tenaciously to clothing.

A chlorinated hydrocarbon with the formula $C_{10}H_8Cl_8$ which has been introduced with the trade name Velsicol or Octo-klor with the proprietory number '1068' derived from the formula, is claimed to be even deadlier to some species of insects than D.D.T. Its residual effect is not so long lasting as D.D.T but lasts longer than Gammexane.

"Dowklor" chlorodane is reported to be 10 times as toxic as D.D.T. and the residual effect persists several months.

NMRI 448, the insecticide of the Naval Medical Research Institute is reported to kill insects with residual effects up to 2 weeks. It does not irritate the skin.

Het hexaethyl tetraphosphate, a new insecticide brought out of Germany has the property of killing even D.D.T. resistent ones but it has no residual effect being decomposed rapidly.

Now the question may be raised about the position of the natural insecticides–Pyrethrum and derris which will be available in plenty to our country- It is an established fact that the knocking down action of pyrethrum is of spectacular rapidity not shared by any other insecticide including those above mentioned. But the oxidising power of them to non-insecticidal compounds is a handicap in their use. So when the natural insecticides are available, the popularity of D.D.T. or any other synthetic insecticide will not be lost whereas the natural insecticides can be incorporated in the synthetic ones to give an immediate effect thus raising the value of insecticides combining the rapid knock down and long residual effect.

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Bibliography:—"One cannot recall any scientific development not excepting sulpha drugs, penicillin or even the Atom bomb that has resulted in such a sustained flood of factual technical reporting as the discovery and research development of D.D.T." The reviewer during the course of about two years has gone through innumerable references and texts from these references have been freely used in the above article. Space does not permit to refer completely to all the references utilised but an attempt is made to note all the important references. The aim of this review is to bring together in a comprehensive brochure everything known about D.D.T. so as to be of use to the profession and the author will be more than satisfied if this object is achieved in some measure.

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MANUFACTURE OF AGAR-AGAR FROM SEA WEED, GRACILARIA LICHENOIDES.

By

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Introduction:—Agar-agar or the jelly like substance obtained when red coloured sea weed is extracted with boiling water has been long in use as an article of food in the Orient. The crude jelly is made palatable by the addition of milk, sugar and raisins. On the Coromandel coast in South East India the agar-agar jelly prepared from *Gracilaria lichenoides* is much relished. This sea weed, a Rhodophyceae, grows commonly along the east coast, especially in and around the Gulf of Mannar, near Pamban and the small islands nearby. The weed grows in shallow sea on coral rocks and during the North-East monsoon the rough sea pulls up the weed which along with a variety of other plants, is cast on the beach in heaps. It is then a laborious and costly task to separate the gracilaria from other weeds and hence it is useful only as manure. The weed is harvested when the sea is calm by picking out the individual Gracilaria clumps, the red weed being easily distinguishable from the green weeds in the shallow transparent sea.

The jelly is used as an article of food in other Oriental countries also, such as, Ceylon, Malaya Peninsula, Sumatra, Java, China and Japan.

Several species of sea weed are useful for preparation of agar-agar. Most of them belong to the red algae group. Of these probably the Gelidium species is the most common and is also said to yield a very high percentage of agar-agar of superior quality.

Property and Uses of agar-agar:—Agar-agar is marketed in the form of straws, flakes or powder. It is of very light to very deep straw colour depending upon its method of manufacture. A light colour is wrongly associated with greater purity. On the contrary, it is more probably due to the thoroughness with which the weed was bleached in the sun.

Agar-agar is a very light material One to two per cent of it is added to water and heated. At about 60 to 65°C the agar is liquified and forms a highly colloidal, viscous, translucent liquid. At about 40°C it solidifies into a jelly. Well prepared and highly purified agar such as that produced for biological purposes is almost transparent. The jelly is hard enough to be cut with a knife and a slant prepared in a tube can be streaked with bacterial growth with a platinum needle or loop without damaging the surface of the jelly.

Agar-agar is also known as Japanese isinglass. It forms an excellent substrat for cultivation of micro-organisms especially bacteria fungi and actinomyces. The jelly lends itself to different methods of cultural technique since it is liquid

when hot and sets into a solid of the shape of the container when cooled. Hence, cultivation of micro-organisms is rendered extremely easy in Petri-dishes, test tubes, slants, rolled bottles etc. Various food materials required by the organisms can be incorporated in the agar-agar by merely dissolving or dispersing the food materials in the agar when in liquid state.

Agar-agar is also used in medicine, as a laxative and in industry as size substitute. By itself it is an article of diet and also used for giving body to soups, jellies ice cream etc.

Composition of Agar-agar:—The composition varies with the nature of the plant from which it is obtained. The important constituent is a galactan, first referred to by Payen (1) and cited by Fellers (9), as gelose to which he assigned the formula $C_6 H_{10} O_5$. Czapek (2) referred to by Waksman (3), concluded that 1/3rd of the agar consists of galactan and that pentosans are present but in small amounts. Agar-agar can be considered as a hemicellulose complex consisting largely of galactan with an admixture of some pentosans, uronic acid as well as certain inorganic salts (3). Newberg & Ohle (4) and Samec & Sajerie (5) cited by Heilbron (11), concluded that agar is essentially a sulphuric ester of gelose of the formula $(C_6 H_{10} O_5)$ 57 $H_2 SO_4$. Fairbrother & Martin (6) considered that it consists principally of the Calcium salt of an acid sulphuric ester $(ROSO_3)$ 2Ca. Tetsunosuke Yanagigawa (7, 14) compared agar obtained from six different varieties of sea weeds and found that the main organic constituent was galactose.

The complete analysis of agar by Forbes et al (8) and by Fellers (9) is given below:—

Constituents.	Per cent air dry material. Forbes et. al. (1913)	Fellers. (1916)
Moisture.	15·29	16·57
Ash.	4·23	3·85
S	1·77	2·65
Ca.	0·66	0·92
Mg.	0·48	0·57
Na.	0·11	10·25
K.	0·11	0·07
Cl.	0·03	0·22
P.	0·02	0·05
N.	0·30	0·37
Fat.	0·37	0.30
Fibre.	0·89	0·80
N. free extract.	77·34	76·15

Robertson (10) states that the consensus of opinion identifies agar-agar as a galactan or a polysaccaride in whose molecule numerous galactose units are

united in a manner suggestive of the grouping of glucose nuclei in cellulose. A small proportion of other sugars complicates the situation so that agar reactions have not been uniform in all research laboratories.

Combined with the carbohydrate mass is a small proportion, usually nearly 3% of sulphur. This is apparently in the form of organic sulphate. Furthermore Calcium and magnesium form an essential part of the substance. Without these or similar bases the material is useless as a practical colloid. The firm bonding of all this material leads to the present assumtion that the main carbohydrate molecular mass is combined as an ester with sulphuric acid. He has given the general formula, with only one of the two acid groups of

$$R\begin{cases} O-SO_2-O \\ O-SO_2-O \end{cases}Ca$$

sulphuric acid esterified with the second free to form a calcium salt as follows :— He states that the actual chemical composition of agar-agar is still under research and controversy. However the main substances of composition may be taken as established. When the chemical structure of agar is known with certainty it may greatly help in the preparation and utilisation of agar-agar.

Process of Manufacture:—The basic principles underlying the process of manufacture of agar-agar from sea weed are practically the same in all the countries where it is manufactured, viz., Japan, United States of America, Austraiia and South Africa, though there may be alterations and differences in the application of these principles. These consist in :—

(1) Harvesting, washing and drying the material thoroughly after which it can be stored indefinitely.

Harvesting is done by hand all over the world as it is a practical impossibility to harvest the weed by existing machinery although, as stated by Robertson (loc, cit.), a great deal of mechanical ingenuity has been expended on the problem in United States of America. The rough seas beating over coral rocks, in 3 to 6 ft. depth of water, the rocky sea bottom on which the mass grows, and the luxuriant mass of various kinds of moss all growing together render the use of machinery an impossibility. Hence, harvesting is done by human labour, chiefly by fishermen who are adept at it.

Washing is done in sweet water if available or in sea water itself to remove, pebbles, shells, sand and other debris. This is only a preliminary washing to remove the more prominent foreign substances. The weed undergoes another and more thorough washing later on.

Drying is generally done on the sea shore the weed being hung up on frames. When dried to below 20% moisture, the weed keeps well. It is now baled and despatched to the factory.

The collection and supply of dry sea weed is in itself an industry in many coastal areas. Japanese manufacturers, however, employed their own harvesters and their ships carried the necessary personnel and machinery, visited coastal areas, in China Sea, Formosa, Indo-China, Malaya, Indonesian Islands, India, Ceylon and even as far as Eastern Austraila, harvested the moss, dried and transported it to Japan for the manufacture of agar-agar.

The dried moss commands a fair price. Robertson (loc. cit.) quotes $ 180.00 per ton in 1930 in Californian coast. In India, the moss had no sale before the war. In fact it was not an article of trade. However, in 1943 it was quoted at Rs. 30/- per cwt. at Kilakarai, near Ramnad.

(2) *Washing*:—The dried weed is again washed thoroughly in fresh water at the factory to remove the sea salts. It is generally found to be encrusted with lime in the Orient where it grows on coral rocks and when this is found to be so, the deposit is dissolved out first in 1% hydrochloric acid and later thoroughly washed in fresh water. The American weed seems to be free from such encrustations.

(3) *Bleaching*:—The cleaned weed is now sun bleached. This generally takes about two days. It is spread out in thin layer in the sun and sprayed with water, allowed to dry, sprayed again alternatingly for two days by which time it becomes deep cream or light straw coloured. The appearance of the final agar depends to a very large extent on the thoroughness with which bleaching is done.

Chlorine has been tried as a bleaching agent and Ferguson (13) among others, is of opinion that natural sun bleaching is the best as artificial bleaching, though effective, affects setting power.

(4) *Extraction*:—The bleached sea weed is now extracted with boiling water until the extract fails to jell on cooling. To obtain a concentrated extract three successive extractions are made, the last extract being used for the first extraction of the next batch. In some place e.g. Australia, (12) the first extract is set apart for manufacture of high grade agar.

The extraction may be effected in a modern factory with digesters and steam, Robertson (loc. cit.)., or in a mud pot over a wood fire as in the Coromandel Coast in South India. However, the principle is the same in both cases.

(5) *Purifications*:—The hot extract may be treated with both charcoal and filter-cel as in United States of America and Australia or these treatments may be omitted as in Japan (10) and India (15, 16). The material congeals readily as a firm jelly at room temperature. It is then cut up into strips (U. S. A.) or extruded from a hand press, in a macaroni-like form, (Japan) placed in cans and frozen artificially in brine tanks as for ice production, (U. S. A., Australia and India) or naturally overnight in the open in Winter as in Japan. In the morning, the frozen mass may be cut up in small pieces or

thawed out as it is, taking care to keep the temperature low. The thawed liquor containing soluble material is allowed to run out, the jelly washed and dried either artificially or in the sun. The dried substance may be in the form of straws (Japan), flakes (U. S. A.) or ground into fine powder. The moisture is reduced to below 20% when it will keep indefinitely and is packed and marketed as Agar-agar.

Experimental:—When Japan entered the war a great world shortage of agar-agar was felt and in India this became a commodity of urgent necessity especially for the manufacture of cholera and other vaccines for the troops in Assam in Burma. Hence the immediate problem was (1) to search for and obtain an indigenous plant found in abundance and from which agar agar could be manufactured. Gracilaria lichenoides was found to answer the purpose in both respects. It is available in abundance on the Coromandel and Circar coasts, in Chilka lake and near Cape Comorin, and has been found to yield agar-agar of good quality.

(2) In a hot country like India, the cost of purification by freezing and thawing forms a considerable proportion of the manufacturing cost. Hence, a chepaer method of manufacture had to be found.

The methods tried were (a) Heat treatment: It was thought that some at least of the nitrogenous matter in the extract might be coagulated by heat and take down with it various impurities, which may then be filtered off as in the process of clarification with egg albumin. But it was seen that heat treatment did not effect this and had therefore to be abandoned.

(b) Water treatment:—

The method used was as follows: The weed was extracted with boiling water, without enrichment, thrice successively and all three extracts combined and poured in trays and cooled to jell. The jelly was cut up in very small pieces and placed in a tall cylinder and roughly two to three times its volume of water was added and the suspension left undisturbed for 48 hours. The water added was one of very low salt content, containing not more than 10 parts per one hundred thousand. At the end of 48 hours, it was seen that the water became yellow in colour, quite cloudy and emitted very foul odour. It was teeming with many varieties of bacteria, particularly a Clostridium type at the bottom and a long, thin rod, a Bacillus in the upper layers. There was a good growth of Vorticella on the surface. At the end of this period the excess water was removed and the jelly given a rapid wash with clear water and the steeping repeated for two further periods of 24 hour each. For the second and third steepings, inoculum consisting of the liquor from the first steeping was added which was roughly about 10% of the total volume of water added. The jelly was then thoroughly washed in several changes of clear water and finally dried in the sun. The agar-agar obtained by this method was in the shape of thin flakes of light cream colour. The flakes readily disperse in hot water

when desired for use. The agar goes into solution between 60 and 65°C and jelly is almost transparent and practicaliy free from colour. The setting power of this substance was found to be very efficient, being only 1%. Analytical data of agar-agar prepared by this method, "Difco" brand agar, a standard product commonly used in biological laboratories as well as British Pharmacopoeia standards are given below, the last two for comparison.

Heads of Analysis	Average of Several Samples. Our product.	Difco	Hopkins & Williams.	China grass.	B. P. Standards.
Moisture.	16·00	17·48	16·90	17·20	Not more than 18
Nitrogen.	0·17	0·22	0·37	3·83	
Ash.	3·60	3·00	4·02	4·13	Not more than 5
Setting power.	1·0	1·5	1·5 to	2·5	

The yield of agar-agar was about 20% of the weight of Gracilaria lichenoides. The agar-agar produced by this method, was tested along with other similar products available in the laboratory, for their usefulness as a substrat in culture media by plating different kinds of organisms and substances in Petri dishes. The number of organisms on each kind of agar was counted and compared. The results obtained are given below:—

Agar—agar.	Strength of agar—agar in media. %	Staphylo coccus pyogenes.	B Coli.	Milk.	Soils. Tobacco. Field. Meenan-palayam.	Block III. A. R. S. Siru-guppa.	Block VIII A. R. S. Siru-guppa.
Media.		Nutrient agar.	Bile salt agar.	Nutri-ent milk agar.	Sodium aluminate agar		
		millions.	milli-ons.	thou-sands.	hundred thousands.		
Bacto agar	2%	2,280	780	155	61	42	29
"Difco"	5%	2,450	520	86	15	6	5
Chinagrass	1%	2,220	840	134	50	52	29
Our agar 1.	1.5%	2,170	880	144	39	21	16
2.	2%	2,150	760	139	78	39	10
3.							

Discussion:—The agar-agar obtained by this method compares favourably with that produced by the freezing and thawing method. The yield obtained is also comparable.

The method is simple and required no costly equipment or machinery. The only substance required for the process is water of low salt content which is obtainable in many places in the Presidency, as given below:—

	Name of locality.	Total solids at 105°C. parts per one hundred thousand parts.
1.	Coimbatore, Municipal Water suppiy (Siruvani).	6·6
2.	Kasargod, Agricultural Research Station well.	4·5
3.	Nileshwar Station 2. „ „	7·4
4.	Nileshwar Station 3. „ „	9·0
5.	Pilicode Research Station well.	5·8
6.	Cauvery River at Hogenakal falls.	9·4
7.	„ „ at Mettur Stanley dam.	5·0 to 14·8 (seasonal variations)
8.	„ „ near Kodumudi.	5·0 to 15·0 (seasonal variations)
9.	Bhavani River above Koduveri dam.	4·0 to 12·5 (seasonal variations)
10.	„ „ at Mettupalayam.	8·8
11.	Roya Channel at Hospet.	10·3
12.	Tea Estate in Anamalai sample from Tea Estates India Ltd.	2·4
13.	Godur River. Proddatur.	8·6
14.	Godavari River at Polavaram.	10·0 to 13·0 (seasonal variations)

The data presented here do not present the results of a survey made for the specific purpose. There may be many other localities where suitable water may be found. However, even there figures indicate that such localities are distributed all over the Presidency. Of these, possibly, Coimbatore and Mettur may be reckoned to be most suitable, being industrial centres with copious supply of suitable water and electrical energy.

The preliminary clarification with charcoal and filteration through filter-cel, which are both laborious and required costly equipment for pressure filtration can be dispensed with in this method.

The purification effected by steeping the jelly in water appears to be due to two totally different effects. (i) The nitrogen as well as the sugars and other soluble carbohydrates and minerals in the jelly are abstracted by both aerobic and anaerobic micro-organisms and transformed into microbial cells which get washed out and thus removed.

(ii) Some at least of the salts go into solution in the water and are thus removed. The bleached weed contains on an average 2 to 2·5% nitrogen and 8·5 to 10% ash which are reduced to 0·2 and 3% respectively in four days of steeping.

The process is considerably accelerated when 10% crude inoculum, comprising the 48 hours old steeping liquor is added. A final thorough washing in water is absolutely necessary.

The agar-agar thus prepared was tested for its utility as a substrat in a culture medium as compared with other kinds of agar agar commonly used in biological laboratories. The data presented elsewhere shows clearly that this product is as good as the other samples against which it was compared. Further, 1% of this agar was seen to give as firm a jelly as 2% and 5% of the other products which renders it proportionately cheaper.

Samples of the agar-agar were sent to various research officers and laboratories for favour of test as to their suitability as culture substrat. Their reports were as follows:—

(a) The Surgeon General with the Government of Madras, "the sample of agar agar.....was tested and found to be quite satisfactory for cultural purposes".

(b) King Institute, Guindy, "The test conducted shows that the agar is quite suitable for routine bacteriological use for growth and identification of organisms".

(c) The Veterinary Investigation Officer, Madras:—

"It is very pleasing to state that this is one of the best of agars that I have ever used in my experience of last 20 years in the laboratory. It sets rapidly with a lesser percentage and is very transparent. This transparency helps a great deal in studying minute colonies of organisms and at the same time helps in growing sensitive organisms".

(d) The Government Mycologist, Agricultural College & Research Institute, Coimbatore:—

"I have tested the sample of agar prepared in your laboratory. I find that with 1·5% of agar all the media tried solidified satisfactorily over a wide range of *p*H from 3·8 to 7·5. With 1% agar the setting was satisfactory at about *p*H 5 and 8 but not beyond. The performance of this agar was far better than 2% "Difco" agar".

(A short note on this subject had already appeared in "*Current Science*" April 1944, 13, 99.).

SUMMARY

1. Agar-agar of required purity for use for cultivation of micro organisms was prepared from the sea weed, Gracilaria lichenoides, a Rhodophyceae.

2. The purification was achieved by steeping the jelly in water of low salt content for about 96 hours.

3. This method is simple, cheap and efficient.

4. The agar-agar so prepared was analysed and found to conform to standards prescribed by British Pharmacopoeia, to compare favourably with agars commonly used in biological laboratories in point of purity as well as in

setting power than used as a substrat for a variety of media at different levels of pH.

5. Plate counts made with different organisms, milk and soil on different kinds of media prepared with this and other kinds of agar showed that the counts were comparable.

6. Samples of agar-agar prepared in this laboratory were tested by several research officers in the Province who were unanimous in their approval of it.

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Editorial

MIND THE CLINIC.

We draw the attention of our readers to an Editorial entitled "The Clinician is Important" in the *Veterinary Journal* of May 1947, which we have extracted below in this *Journal*. The article is a very opportune one and it is a timely reminder to the Veterinary profession, particularly in this country, which is in a very important stage of its development. As is well known, our profession in this land is still in its infant stage. It started to be organised less than 50 years ago, although the foundation had been well and truly laid earlier by well-known pioneers in the profession like Steel and Holmes, Gunn and Lease. They and their successors were all Clinicians of a very high order. They had not any of the modern equipment and aids for the diagnosis of the various maladies affecting the live-stock, but that was no handicap to them ; at least, that is what appears to us from a study of their writings and works. They must have been men of great skill and talent with acute powers of observation of animals, their habits and modes of living. It is this close knowledge of Animals and Nature that made these early workers such able practitioners and useful members of the profession and the country. A good bit of their observations and findings have stood the test of time and science and they are found to be as true today as they were then. Modern Veterinary Education has made vast extensive strides in many directions and the present day veterinary graduates of this country as well as of other countries possess such complete knowledge

of Veterinary Science that, in the matter of scientific equipment, they are in no way inferior to the members of the sister medical profession. To this extent, the progress has been highly satisfactory. But there appears to be danger ahead. As our contemporary remarks, there are many who think that the pendulum has swung too far and to the detriment of the clinical sense. It also opines that the same fears assail those in the sister profession. This is a warning which we in this country, especially those in charge of Veterinary Education, should take serious notice of in time. It should be borne in mind that, in this country, the modern aids for diagnosis—X-ray and microscopical examinations for instance,—are very scanty even among medical practitioners, and that, for all practical purposes, they are absent and non-existent for veterinary practitioners. While every endeavour must be made, and made with earnestness and energy, to get these equipments, it should be realised that it will be a long time before they could become actually available. Till then, the practitioner is necessarily thrown on his own resources. He has to use his own powers of observation and common sense to interpret the findings and arrive at a correct diagnosis. A study of a number of cases with a close and observant eye to the symptoms exhibited by the patients are very necessary for a true appreciation and understanding of the ailments of our animals. Errors in diagnosis can be avoided to a great extent if opportunities for post-mortems are fully availed of. Experience, of course, counts here as every where else and successful Clinicians are not made overnight. As the *Lancet* put it very correctly, 'To be a first class general practitioner is harder than to be a competent specialist.' If that is the case with regard to the human Doctors what should be the standard for Veterinary Practitioners dealing with dumb animals of varying species and kind? And, therefore, the 'Clinic' must form a special feature in all teaching institutions to which the teacher as well as the taught must give prominent attention.

THE CLINICIAN IS IMPORTANT*

If we study the history of the veterinary profession we find that from time to time there have been profound changes in outlook and endeavour. These changes have influenced greatly the line of employment and public relations. This is noticeable particularly if one considers the story of the last 150 years. Those who laid the foundations of the profession were mainly concerned with the welfare of the horse, and rightly so, for the economics of the world at peace or war depended upon that animal.

Other animals were not considered to be of sufficient merit to warrant the attention of the trained and skilled man. The cream of the profession certainly did not bother much about them and they were relegated to those who might be said to be "below the salt". Co-existant with progress in veterinary science, agriculture was also being re-orientated and establishedas a pursuit more and more dependant upon recognised scientific principles as against the hitherto rule-of-thumb or empirical systems.

As a direct result, attention was focussed upon the other animals of the farm until at the present time the bovine species have almost completely displaced the horse from his supreme position. Concurrently, small animal practice has developed in importance.

In the early days the surgeon was of necessity a skilled clinician who had to depend upon his own powers of observation and deduction. His clinical acumen and skill with his hands were his mainstays. In spite of these limitations, a great fount of knowledge was built up. Much of this information was set down and in no mean style, as those who are familiar with the literature of the nineteenth century can testify. Much of this material is as sound ro-day as it was when it was written. The surgeons of those days had a profound knowledge of basic drugs, their compounding and action, and by their experimental methods of trial and error they laid the foundations of pharmacology. A successful man had to develop a good memory picture for cases; often his diagnosis was arrived at this means, for he had seen a similar case before. He had to develop an astute and logical mind, and train his hands and senses.

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As the years passed on, the pathologist and bacteriologist came to his aid, and many new discoveries were made. Some previously established beliefs were confounded, but on the other hand many received scientific confirmation.

Now we have got to the stage when we can also call on such people as radiologists, biochemists, etc. It is possible to get a specialist report on every aspect of a particular case, so that in many instances a diagnosis could be made without seeing the patient—in fact, a policeman could do the job.

No one will deny that it is perfectly correct to make full use of all possible aids to diagnosis, but there are many who think that the pendulum has swung too far and to the detriment of the clinical sense.

It is interesting to note that the same fears assail those in the sister profession.

There is no doubt that the modern young veterinary surgeon has a more complete academic knowledge of the animal body in health or disease, but there is also no doubt that as a clinician he compares unfavourably with his predecessors when the various aids to diagnosis are not forthcoming.

In the pharmacy he is at a disadvantage. In modern times we have learned to depend so much on proprietary drugs, many being of such a complex nature as to be beyond the ordinary individual's comprehension, that we have to take the maker's information for granted. The art of prescribing, compounding and dispensing basic B.P. products is in danger of being lost.

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.

It is to be hoped that when changes in the curriculum and examinations are being considered these points will be borne in mind, and that our teachers will ever remember that veterinary surgeons deal with living animals.

Clinical Articles

PENICILLIN THERAPY IN BOVINE MASTITIS*

BY

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I have selected for presenting to this Conference this subject of Penicillin Therapy in Bovine Mastitis, because, today, the control of this disease is a very important problem confronting the Veterinarian in the dairy and in the field, both from the economic point of view and the health of the nation at large. The use of many Chemotherapeutic drugs like Neutral Acriflavine 1 in 15,000, Silver Oxide, Phemerol 5% in oil, Sulphonamide in mineral oil, Reazol or (urea sulph-Benzol-Alcohol) and Iodine incorporated in mineral oil have been investigated in the treatment of Mastitis and today these are superceded by Penicillin which has proved to be of outstanding value.

During the past one year, I have tried Penicillin in the treatment of acute and chronic Mastitis, of both Strepto and Staphylococcal origin and this forms the subject of the paper.

Earlier reports of Penicillin in the treatment of Mastitis.

Several workers, have recorded the efficacy of Penicillin in the treatment of Mastitis. Kakavas[1] was the first to use it. The refractory cases of Mastitis that had become "drugfast" to Sulphonamides were first treated with Penicillin and the results were found encouraging. He reported very favourable results, when repeated infusions of low unitage of 5,000 units were made. He asserted that Sodium salt of Penicillin had not got unfavourable reactions manifested by the mammary gland. It had not produced any change in the character of milk and the milk secretion had not decreased during or after treatment. Further in his experiments, he observed that Staphylococcal infection was more resistant than streptococcal infection to Penicillin treatment. Bryan[2], Harwood and Huffman found Penicillin highly effective in the treatment of *Streptococcal agalactiae* infection of the bovine udder. As per their report, affected quarters of six cows were infused with 5,000 units of Penicillin and a single infusion had effected cure in four of them while, the remaining two required an additional infustion to eliminate the infecion. In their further work, sixteen cows were infused with 12,500 units per quarter. Six of these recovered with one infusion, two required two infusions and one was given three infusions to effect a cure. They also recorded that Penicillin

* Read at the Annual General Body Meeting of the Madras Veterinary Assistant Surgeons' Service Association on 25th December 1947.

had no effect on Mastitis when administered by intravenous route. Animals suffering from chronic Mastitis were treated at various stages of the infection with infusion of Penicillin but the results were not encouraging.

Later, reports published by Murphy[3] and Pfau[4] indicated the value of Penicillin in the treatment of Mastitis and in their experiments larger doses and more intensive treatment than previously adopted were used in the eradication of infection from the udder. The following is the summary of their experiments:—

Experiment (1). Fifteen quarters infused with 5,000—20,000 units of Penicillin in 50—300 c.c. of water. Five quarters were freed of infection.

Experiment (2). Ten quarters were treated with five infusions of 10,000 units at 12 hourly intervals. Six quarters were freed from infection.

Experiment (3). Thirty two quarters were treated with five infusions of 20,000 units at 12 hourly intervals—result 100% freed from infection.

According to the authors "The effectiveness of the treatment did not appear to be influenced by lactation period, duration of infection, degree of induration or degree of microscopic changes in the milk at the time of treatment".

In experiments conducted by Barker[4], thirty-two infected quarters of fifteen lactating cows were infused with 25, 000 units in 100 c c. of water, and only 50% were freed from infection. Downham[5] and Christie in their investigations with Penicillin in the treatment of Mastitis have reported that the best and satisfactory method of administration is to infuse 30,000 units of Penicillin on two occasions at intervals of 24 hours. Intermittent treatment was adopted with the same dosage except that it was repeated at 24 hour intervals on two successive days followed by a remission of treatment for two days in the case of chronic Streptococcal Mastitis. They are of opinion that Staphylococcal Mastitis would require a larger dosage of Penicillin for a successful control.

Frank Schofield[6] demonstrated that the strength of Penicillin and the time of effective inhibition had direct relationship to each other. He stated that "in test tube, Penicillin in quantities as low as 0·2 unit per c.c. will inhibit growth; in mammary gland, quantities less than 0·5 unit per c.c. are of doubtful value". He showed also that inhibitory level of Penicillin, must be maintained in the udder at least for three days to get best results. He recommended a higher unitage such as 50,000 units per infusion for three successive days in near-dry lactating cows and 50,000 units every

12 hours for 3 days in the case of heavy milkers. This, as will be mentioned later on, was tried in our experiments.

Reports of Pullin[7] show that 28 quarters infected with *Streptococcus Pyogenes*, 2 with *Streptococcus agalactiae*, 3 Streptocci unidentified of thirteen lactating cows were infused with 40,000 units in 100 c.c. of sterile saline for three days daily and 100% cure was effected with the first course in many and 2nd or 3rd course in the rest of them. Bryan[8] reported on the use of Penicillin in Bovine Mastitis in the form of "mastic". The mastics were slender bougies 25 m.m. long, 4 m.m. in diameter and tapered at both ends. They are made of water soluble base and medicated with 3,000 units of Penicillin They are designed partly enclosed in paper sheath which helps to handle and insert it into the teats aseptically without being touched by the fingers. The administration of bougie is as follows. After disinfecting the teat, the uncovered end of bougie is inserted into the teat orifice, passed gently along the teat canal and then, with further pressure, is passed through the sphincter and into the milk cistern of the udder. This method of administration it was stated would be of great value in the treatment of chronic Streptococcal Mastitis. In my opinion the disadvantage of this method would be the difficulty in passing the bougie in restive animals when there is every chance of the bougie breaking. Barnum[9] who further worked on this method advocated that Penicillin bougie would be an easy and effective method of introducing Penicillin into the bovine udder, that no harmful effect had been noticed, that Penicillin would diffuse throughout the lactating gland and that the concentration of Penicillin in milk would compare favourably with the other methods of using Penicillin.

The reports of Murane[10] show that three doses of 25,000 units of Penicillin in aqueous solution at 24 hours intervals proved very effective in the treatment of Streptococcal Mastitis and that the results were better than the oily suspensions of Penicillin and the concentration of Penicillin is effectively maintained for three days. Murphy[11] who used a combination of Sulphanilamide emulsion and staphylococcal toxoid, and Penicillin in the treatment of Mastitis, concluded that Penicillin is the best and most economical drug in streptococcal infection and in mixed infection of strepto and staphylocci.

Lastly, suspensions of Penicillin in mineral oil 1,000 units per c.c. have also been used by various investigators. The advantages claimed by this method are that a single infusion had a prolonged effect and that it was less irritating than aqueous or saline solutions. According to Plastridge[12], it was found to be very effective. Suspension of Penicillin in mineral oil is made as follows:—3 or 4 c.c. of sterile distilled water is added to the bottle containing the drug and when the powder is completely

dissolved the solution is transferred to another bottle containing a measured amount of oil.

Our Work.

With this review of investigations on the subject, I proceed to note my findings in this work. At the outset, it must be mentioned that, unlike in well organised dairies, the scope for the trial of the drug by me was restricted, becuse the treatment of the cases mostly depended on the co-operation of the clients who themselves had to supply Penicillin for treating their animals. Of the total number of cases of Mastitis admitted during the period from November 1946, when the treatment was first commenced to December 1947, about 90% of the cases were of staphylococcal Mastitis, and the remaining 10% were Streptococcal, mixed Strepto and Staphylococcal and Coliform infections. My trials with Penicillin in the treatment of Mastitis were based on the reports of other workers 1, 4, 6, and 11 viz. that infusions of the udder with Penicillin was the most effective method and that cases of staphylococcal infection required higher dosage for satisfactory results.

Methods of administration of Penicillin.

In my early trials, calcium salt of Penicillin (M & B) was used but from July 1947 Sodium salt of Penicillin became available for use With both the salts the results were encouraging and there was no reactions in the mammary glands as a result of the Penicillin infusion.

Before using, Penicillin was dissolved in sterile distilled water or sterile normal saline which was kept at a temperature of 50°F. by keeping it in ice or in a refrigerator. One important point that has to be borne in mind is that the solution once made should be always kept at this temperature of 50°F. and it should be used before it is 60 hours old, as otherwice the solution becomes inert in a short time even when stored in the refrigerator. It is therefore necessary to make the solution just before use.

Technique adopted.

The following equipment is required.—

1. Penicillin phials.
2. 200 to 400 c.c. sterile normal saline solution.
3. Methylated spirit.
4. Four sterile test tubes for collecting samples of milk for laboratory examination.
5. 20 c.c. Record or Glass syringe.
6. Intravenous injection apparatus (rubber tubing with funnel.) and
7. Four teat syphons and four hypodermic needles which will fit into the teat syphons.

With sterile precautions. a sample of milk from each quarter is milked into the sterile test tubes which are previous labelled with the details of the

case and then sent to the Laboratory for examination. The quarters are then completely stripped before the infusion is given.

After passing the teat syphon, the needles fitted to the needle adopter and the Penicillin solution is allowed to flow into the gland by gravitation. In cases of chronic Mastitis, Hobdays chloroform pump is fitted on to the mouth of the syringe and, then, the solution is forced into the gland. After infusion, the teat syphon with the needle is removed and the teat end is held by the thumb and finger to prevent the escape of the fluid; with the other hand, the fluid in the teat canal is drawn up into the milk cistern and then well massaged to help the penetration of Penicillin. This procedure is repeated for each of the affected quarters using fresh teat syphons and hypodermic needles.

This method of administration seems to be much easier and less troublesome, as compared with the technique adopted by other workers 5 and 11. They have set up their apparatus with a teat syphon which is fitted to a short piece of rubber tubing at the mount. One end of the tube fits into the mount of the teat syphon and the other, on the nozzle of 50 c.c. syringe. It may serve the purpose when the animal is not restive and also when the solution to be infused is only 50 c.c. In the case of restive animals and where 100 and 150 c.c. of solution is to be infused the method adopted here is safer and more effective; mishaps, such as breakage of syringe, wastage of solution etc., are avoided.

The interval between the successive infusions is 24 hours in the case of ordinary milk yielders and 12 hours, in high milk yielders. Intermittent interval of 4 to 8 days between two courses was found effective in two of the cows treated.

As a rule, after the completion of three infusions of Penicillin, a sample of milk was sent for bacteriological examination. If the infection was still present, further treatment with Penicillin was continued till a full course of six infusions was over. Before each infusion milk was sent for bacteriological examination and no animal was said to be cured until the examination of the milk was negative both clinically and culturally. However, it was not possible in all trials to see every case tested in the said manner. Schofield observed that check testing is of great value in the eradication of Mastitis. According to him the milk of the treated animals is to be examined bacteriologically every week for 3 months.

The details of the cases treated are given in the following tables.

TABLE I

Serial No.	Details of quarters affected	Nature of infection	Dosage and dilution of penicillin	Interval between Treatment	Number of infusions	Result after Treatment	Remarks
1	All four quarters	Staphylococcal infection	40,000 units in 125 c.c of sterile Normal Saline	12 hours	Six infusions	Cured	Milk exam. 18/11/46 positive for Staphylococci. 19/11 (after infusions) positive ,, 21/11 (after 5 infusions) negative for staphylococcal organisms
2	Right fore quarter	Staphylococci	50,000 units of penicillin in 100 c.c. S. N. Saline	24 hours	Three infusions	Clinically cured	Milk exam, 21/11 positive for Staphylococci Milk treated by boiling was normal.
3	Left Hind quarter	Staphylococci	50,000 units in 100 c.c S. N. Saline	24 hours	Three infusions	Clinically cured	Milk exam. positive for Staphylococci (after 3 infusions) milk treated by boiling was normal for all appearances.
4	All four quarters	Staphylococci	50,000 units in 100 c.c. S. N. Saline	24 hours	Three infusions	Clinically cured	Milk exam. positive for Staphylococci (after 3 infusions) milk treated by boiling was normal for all appearances.
5	All four quarters	Staphylococci	50,000 units in 100 c.c S.N. Saline	24 hours	Four infusions	Cured	Milk exam. 11/1/47 Positive for Staphylococci ,, 25/1 negative for Staphylo organisms
6	Right Hind quarter	Staphylococci	50,000 units in 100 c c S.N. Saline	24 hours	Four infusions	Cured	Milk exam. 26/1/47 revealed staphylococci 12/2/47 negative for organisms
7	All four quarters affected	Staphylococci	50,000 units in 100 c.c. S.N. Saline	24 hours	Three infusions	Cured	Milk exam. 12/6/47 revealed Staphylococci 18/6 ,, 10/7 negative for the organisms

TABLE I (*Continued*)

Serial No.	Details of duarters affected	Nature of infection	Dosage and dilution of penicillin	Interval between Treatment	Number of infusion	Result after Treatment	Remarks
8	Left fore quarter	Staphylococci	50,000 units in 100 c.c S. N. Saline	24 hours after 4 days 24 hours	4 infusions 3 infusions	Cured	Milk exam. 10/7 positive Staphylococcal organisms 15/7 ,, ,, 17/7 ,, ,, 22/7 negative for organisms
9	All quarters except Right Hind quarter	Staphylococci	50,000 units in 100 c.c S. N. Saline	24 hours	3 infusions	Cured	Milk exam. 3/7/47 revealed Staphylococci ,, 8/7 ,, 10/7 negative for organisms
10	Left four quarter	Staphylococci aureus & albus	50,000 units in 100 c.c S. N. Saline	24 hours	3 infusions	Cured	Milk exam. 4/8/47 micros. Test + for Staphylococci ,, 6/8 organisms still present ,, 9/8 no organisms present
11	Left fore quarter	Staphylococci Reinfection Detected on 17/9/47	50,000 units in 150 c.c S N. Saline	24 hours 24 hours	5 infusions (1/9 to 5/9/47) 4 infusions (18/9 to 20/9)	Cured	Milk exam. 31/8 revealed staphylococci 4/9 ,, 5/9 ,, 11/9 microscopic Test negative for organisms but cultural p. s tive 23/9 positive for staphylococci 25/9 and 8/11 negative for organisms
12	All four quarters	Staphylococci	50,000 units in 100 c.c S. N. Saline	24 hours	four infusions	Cured	Milk exam. 27/10 revealed staphylococci 31/10 negative for organisms 3/11 negative for organisms Milk secretion considerably reduced during and after treatment
13	Left Hind	Staphylococci	50,000 units in 125 c.c S. N. Saline	24 hours after 7 days 24 hours	4 infusions 4 infusions	not Cured	Milk exam. 8/11 positive for staphylococci 14/11 ,, 4/12 ,,
14	Left Hind	Staphylococci	50,000 units in 125 c.c S. N. Sailne	24 hours	4 infusions	Cured	Milk exam. 26/11 staphylococci 5/12 negative for organisms

TABLE II

Serial No.	Details of quarter affected	Nature of infection	Dosage and dilution of Pencillin	Interval between Treatment	Number of infusions	Result after Treatment	REMARKS
1	Right fore quarter	Mixed infection of strepto and Staphylococci	50,000 units in 150 c.c S. N. Saline	3 infusions 24 hours 5 infusions 12 hours	8 infusions	Cured	Milk exam. 16/11/46 positive for strepto and and Staphylococci 18/11 " " 20/11 Positive for Staphylococci only 21/11 Negative for both Milk normal for all appearances
2	Lift Hind quarter	Mixed infection of Strepto & Staphylococci	50,000 units in 100 c.c sterile S. N. Saline	24 hours	6 infusions after 2 days internol 5 infusions	Not Cured	Milk exam. 10/7 Positive for strepto and staphylococci 24/7 " " Later exam. of milk revealed the presence of organisms: clinically milk was not normal.
3	Right fore quarter	Mixed infection of Strepto and Staphylococci	50,000 units in 100 c.c S. N. Saline	24 hours	6 infusions	Cured	Milk exam. 8/9 revealed strepto staphylococci 5/9 negative for organisms
4	Left fore and Hind quarters	Mixed infection of Streptococci and Coliform bacteria	50,000 units in 100 c.c S. N. Saline	12 hours 24 hours	6 infusions 4 infusions	Not Cured	Milk exam. 21/11 revealed streptococci and Coliform bacteria Milk exam. thro' out treatment revealed the presence of these orgamisms.

TABLE III

1	Left fore quarter	Streptococci	50,000 units in 100 c.c S. N. Saline	24 hours	3 infusions	Clinically Cured	Milk exam. 13/2/47 revealed streptococci (after 3 infusions) milk was normal for all appearances.
2	Left fore quarter	Streptococci	50,000 units in 100 c.c S. N. Saline	12 hours 2 infusions 24 hours 3 infusions	5 infusions	Cured	Milk exam. 28/3/47 revealed streptococci " 31/3 negative for streptococci

It will be seen from the tabulations, that about 80% of the cases were cured with 50,000 unit dosage of Penicillin per quarter given successively at 24 hour intervals for 3 to 6 days. It is also found that 12 hour infusion of 50,000 units of Penicillin was not more effective than the 24 hour infusion.

In eradicating an early infection of Staphylococci, three infusions of 50,000 units of Penicillin in 100 c.c. were given and found effective. But in another cow, suffering from chronic Staphylococcal Mastitis, a course of four infusions of 50,000 units each was repeated twice with an interval of 7 days with no response to treatment, while in another case, six successive infusions at 24 hours interval have failed to give a cure. Thus, it is seen that staphylococci depending on the duration of infection are more resistent to Penicillin treatment. It is found that intermittent treatment failed to eradicate the infection in some of the cases. One of the cows suffering from mixed infection of coliform and streptococci infection did not respond to Penicillin treatment; it was also found that even the streptococci were not eradicated in the presence of coliform infection. This shows the inability of Penicillin to act on gram positive bacteria in the presence of gram negative organisms.

Cases of streptococcal infection were treated with 3 to 5 infusions of 50,000 units of Penicillin in 100 c.c. Two cases of mixed infection of strepto and staphylococci were also treated with Penicillin. It was found from the results of the bacteriological examination of milk that staphylococci are more resistant than streptococci to Penicillin treatment.

In some of the cases it was noticed that milk secretion was considerably reduced during treatment.

SUMMARY

1. All cases of Staphylococcal infection and mixed infection of strepto and staphylococci have been treated with Penicillin with udder infusion of 50,000 units in 100 c.c. of sterile normal saline given successively for 3 to 6 days at 24 hour interval.

2. 80% of the affected cows have been successfully treated.

3. It has been found that early affected cases of staphylococci may yield to a lesser number of infusions with the same dosage and interval.

4. Cases of streptococcal mastitis are given 3 to 5 infusions of 50,000 units of each to effect a cure.

5. In some, where continuous treatment fails intermittent treatment is found to be very effective.

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A HIDDEN DISEASE OF BOVINES IN SOUTH KANARA DISTRICT

By

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For the last few years an undiagnosed disease has been prevailing among bovines in South Kanara District and causing a fairly high mortality. White cattle and buffaloes are all susceptible, althrough the calves of the former do not appear to suffer to the same extent as the adult cattle. The disease is prevalent in hill side villages with paddy fields in between. During the year 1947, a number of villages in Buntwal sub-taluk was severely affected.

Geographical Position:—South Kanara District is interspersed, with hills and dales with extensive evergreen vegetations and perennial rivers. The whole district extends about 50—70 miles from the Western Ghats.

Elevation:—Several parts of the District range from sea level to 3000 feet above mean sea level.

Rainfall:—The average rainfall is 150 inches. Rains commence in June and continue till end of November.

Protozoan diseases:—Malaria among human beings and Trypanasomes and Piroplasms among bovines are common in the District.

Symptoms:—(As reported by Sri B. Narasinga Rai, Touring Veterinary Assistant Surgeon, Kasaragod):—

Weakness of hind quarters, animal refusing to walk, and, if forced to do so lying down, and slight rise of temperature in the initial stages. As disease advances constipation, impaction of rumen, tympanitis and oedema under the throat, slowly extending back.

Animals go on feeding till the last and die. Duration of the disease is 20—45 days. A few blood smears revealed T. Mutans and one Trypanosomes.

During the period of 1946-47, 270 attacks and 105 deaths were reported.

A specimen of straw was sent to the Agricultural Chemist. The result was "Nothing abnormal".

As reported by Sri V. Ravivarma Hegde, Touring Veterinary Assistant Surgeon, Coondapoor:—

White cattle are affected but buffaloes do not get the disease, young animals below one year do not appear to contract the disease. Animals develop weakness of hind quarters from the very beginning. There is profuse watering in the eyes. Stringy saliva through the mouth with foaming at the corners of the lips. The muzzle is dry and there is no discharge from the nostrils.

No tympany was observed. The outbreak does not spread like other diseases. It is confined to one shed; nearly 50% of the incontacts get the disease and die.

As observed by Sri Y. Shivappa Rai, Veterinary Assistant Surgeon in charge Veterinary Dispensary, Puttur:—

There is constipation, tympanitis, inability to move, and feeding till death. A few animals showed oedema of dewlap.

Post Mortem:—Apical lobes of both lungs were found consolidated and there was serous fluid in the cavity. 5-10% of the village cattle got affected. A few cases were treated with intravenous injections of N.A.B. (0.5 grams) in 20 c.c. of distilled water and recovered.

As reported by Lt. K. P. D. Nair, Veterinary Assistant Surgeon in charge Veterinary Hospital, Mangalore (Touring Veterinary Assistant Surgeon, Udipi):—

The disease appears after the rains and subsides with the onset of monsoon. Most of the outbreaks are from January to April.

Symptoms :—Impaction, Diarrhoea, weakness of hind quarters, debility, oedema under the dewlap, sternum and abdomen.

Cough or nasal discharge if present went unnoticed by owners. Treatment with N.A.B. disappointing.

Duration of disease :—1 to 2 months. Recovery rare.

Post Mortem findings :—4 to 5 pints of straw coloured fluid in the pleural cavity was found and this began to coagulate almost immediately though it did not form a complete block. 5 c.c. of this fluid was injected into an experimental calf (one year old) subcutis, and the calf did not show any reaction.

As observed by Sri B. Sanjeeva (Touring Veterinary Assistant Surgeon Karkal) :—

The outbreaks were confined to hilly areas, pyrexia and lung symptoms went unnoticed and not reported in any of the affected animals. Diarrhoea that was noticed in affected cases was due to the administration of country drugs by local quacks.

SURRA IN BOVINES—SOME UNCOMMON SYMPTOM*

By

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Surra and Anthrax among bovines are usually characterised by high temperature, colicky pains and convulsions, generally ending in death with bloody discharges from the natural orifices. Microscopical examination of the bood smears confirms the respective diseases.

Many practitioners might have observed in Bovine Surra, intermittent fever, depraved appetite, incoordination of movements of hind quarters, stiffness of limbs, muscular tremors, staring coat, frequent copious micturitions, impaired vision, dropping down with intermittent convulsions, and in later stages, decubitus, diarrhoea, emaciation and finally death. Symptoms of wry neck and high coloured urine have also been observed. The observation of the above clinical symptoms leads one to suspect Surra, though of course, confirmation must be sought by microscopical examination of the blood.

*Read at the Annual General Body Meeting of the Madras Veterinary Assistant Surgeons' Service Association on 25th December 1947.

In Africa, loss of brush and ulceration of tongue are said to be diagnostic features of Bovine Surra.

The following record of some uncommon symptoms observed by me in cases of Bovine Surra will be found interesting.

In a village near Manaparai, Trichinopoly District, heavy mortality in cattle were reported with symptoms of violent fits, muscular tremors and instantaneous death. Examination of blood smears revealed *Trypanosoma evansi.*

A bullock (a fast runner in cart) was reported to be having progressive lameness of the right fore. On examination, urticarial eruptions were observed on the right shoulder-blade. Out of curiosity, blood smears were taken, though there was no rise in temperature. On examination, *T. evansi* were found. The animal was then treated for Surra. The lameness and urticarial eruptions disappeared and the animal was alright in a fortnight.

A second bullock was reported as dull and disinclined to work and going dead lame on the right fore. The coat was staring and the temperature was 105°F. Blood smears were found positive for *Trypanosoma evansi.* The animal was treated for Surra and it recovered. This second case is likely to be mistaken for ephemeral fever. It is also possible that if 2 or 3 animals were to die in a village with such symptoms, the deaths are likely to be taken as Black-quarter by a field worker.

The third case was a cross-bred heifer-calf with the following symptoms:—dullness, anorexia, passing loose motions for a fortnight with occasional tympany of the abdomen, intermittent fever and a doughy swelling throughout the dewlap from the throat to the chest. The report of the examination of blood smears was 'heavy infestation of *T. evansi*'.

The fourth case was a Kangyam bullock. It was not ruminating from the previous evening, the temperature was 97°F, tongue much swollen, mouth emanating foetid odour, motions loose, tarry in colour, with very offensive smell and eye balls sunken with thick purulent discharge from both eyes. Microscopical examination of blood smears was positive for Surra. The swollen condition of the tongue in this case of Surra is a very uncommon symptom of the disease.

The above described unusual symptoms have been observed in one and the same disease—Surra—and the cases would have gone unnoticed if microscopical examination of the blood smears had not been resorted to. The importance of such an examination is therefore quite obvious in all such cases.

My thanks are due to Sri V. Parameswara Menon, Veterinary Assistant Surgeon, Veterinary Hospital, Trichinopoly, for the encouragement and assistance given in the examination of blood smears.

EGG-BOUND IN HENS

By

B. Das,

A.D.I.O., (Poultry),

and

G. Biswal,

R.A. Cuttack, Orissa.

Introduction:—Egg-bound, a condition similar to that of difficult parturition in mammals, is not a rare occurrence in poultry. It is responsible for a good number of deaths in laying hens. At times it becomes difficult to find out the cause of death in birds dying of egg-bound and one has to conduct Post-Mortem examination to detect the real cause. We have had occasions of seeing this condition in a few autopsized hens. In these cases, bacterial and virus diseases were ruled out by bacteriological and biological tests.

Symptoms:—The complaint is noticed more often in the beginning of the laying period of the hen than at the latter part. It is seen mostly in older hens than in pullets and in crossbreds than in pure breds. The symptomatology presented by the poultry-men and seen in a few cases by the writers is more or less as follows. The affected hen sits frequently with an obvious desire to lay an egg and then rises without performing the Act. She strains as if attempting to dislodge some foreign material adhering to her cloaca. When she fails to get the desired relief she becomes restless. She very soon becomes depressed and lies prostrate. Eyes are staring with an expression of agony. She feels thirsty and when water is given she takes only a little quantity of it. After prolonged restlessness and prostration she dies.

Death is not directly due to the obstruction of the egg in the oviduct or in the cloaca but due to secondary causes resulting from the cessation of urination and defaecation. Sometimes, owing to the breakage of the egg inside the abdomen, death occurs from peritonitis.

Cause:—Why and how it occurs in some hens and not in others is very difficult to answer. Under normal circumstances the fully formed egg is retained in the uterus for several hours and then is expelled by the natural peristaltic movement and muscular contraction of the uterus. But when the condition "egg-bound" occurs, inflammation of the oviduct is invariably seen. The hen cannot exert herself due to pain resulting there from. Sometimes owing to paralysis of the duct the egg is not pushed out. An abnormal-sized egg, too big to be expelled through the narrow tube of the duct, is another factor which makes it physically impossible for the hen to lay it. Less frequently, it results from the actual stricture of the oviduct or by the twisting of the oviduct in such a way, as to close it. Accumulation of exudates following severe inflammatory processes either in the cloaca or in the vent prevent the hen from laying. In a few

birds what actually has been found, was a brownish inispissated egg material in the uterus. In such cases severe inflammation of the vent accompanied by extremely offensive odour is invariably noticed. A sequelae of egg-bound is the prolapse of the cloaca which is due to continuous straining.

Treatment.—When this condition occurs in a flock or when the symptoms narrated above are seen in affected hens, artificial help should be given. It is possible to expel the egg by inserting the finger, well lubricated with liquid paraffin, into the cloaca and gently manipulating the abdomen by the other hand. If it is not feasible to do this, then break the egg shell, remove the contents and pieces of egg-shell gradually without injuring the delicate cloacal lining. When this simple procedure, which is similar to that of embryotomy in mammals, is completed, inject saline cold water into the cloaca. Repeat this injection two to four times a day for a few days. Keep the hen as quiet as possible until she regains her normal health. An uneventful recovery may be achieved in such cases.

Association News

Minutes of the meeting of the Managing Committee of the Bombay Veterinary Medical Association, held on 9th January 1948.

The Managing Committee of the Bombay Veterinary Medical Association was convened on Friday the 9th January 1948 at 4 P.M. in the Library Hall of the Bombay Veterinary College, Parel.

Dr. D.S. Laud, President, was in chair.

The following members attended the meeting. Dr. D. S. Laud, Dr. S G. Kshirsagar, Dr. S.B. Hanchlikar, Dr, M R. Redkar, Dr. R.N- Naik, Dr. G.H. Joshi.

Dr. S.R. Chadha and Dr. G.A. Hardikar were kind enough to attend by special request.

The Secretary Dr. S. G. Kshirsagar read last meeting's (Extraordinary Conference) minutes. An article in the form of a plan named as "Reconstruction plan for the development of Animal Science in India" was submitted by Dr. R.N. Naik for being read at the conference, held on 8th October 1947. It remained to be mentioned in the body of minutes, a copy of which was sent to the *Indian Veterinary Journal* for publication. The addition in the minutes was made as 4th article that was regarded as read.

The minutes were passed unanimously.

The Secretary then intimated the Committee, the steps taken by him in respect of the resolutions passed in Annual Conference and the replies received so far, with reference to letters written.

The President thereafter, read the letters received from Messrs. R. R Tavargiri, D. C. Bhambhure and Y. V. Limaye and the letters he had written as an action taken on them. The Committee was satisfied with the action taken.

A letter from Mr. T. R. Khaladkar, Hon. Treasurer, wherein he had expressed his inability to work as Treasurer with a consequent request to accept his resignation was put before the Committee for consideration.

The following resolutions were then adopted:—

1. Resolved to accept the resignation of Mr. T. R. Khaladkar, Hon. Treasurer with a feeling of regret on his decision of resignation. The Committee consequently feels for the loss of his mature advice.

Proposed by S. B Hanchlikar and seconded by R. N. Naik passed unanimously.

2. Resolved that Dr. S. R. Chadha be requested to accept the Hon. work of the Treasurer of Bombay Veterinary Medical Association for the year 1948.

Proposed by R. N. Naik and Seconded by S. G. Kshirsagar passed unanimously.

Dr. S. R. Chadha kindly complied with the request and was declared as unanimously elected Hon. Treasurer for the year 1948.

3. Resolved that the Government of Bombay be requested to revive "Horse Breeding" under the newly reconstructed Animal Husbandry Department; as the tribe "Horse" is an absolute necessity of a nation, and as it is seen in the province, in a depleted condition for want of systematic efforts of multiplication, on the part of the Government. It is also recommended to give a trial of this animal in agriculture in suitable area.

Proposed by R. N. Naik and Seconded by S. R. Chadha passed unanimously.

4. Resolved that no reference should be made to the Director of Animal Husbandry and Veterinary Science for permanent travelling allowance to Veterinary Assistant Surgeons as recommended in the general meeting of the Association, as it is detrimental to the interest of Veterinary Assistant Surgeons.

Proposed by S. G Kshirsagar and seconded by S. B. Hanchlikar passed unanimously

5. "The Committee regrets to note the omission of Veterinary Degree or Diploma holder's recognition in the advertisement by Bombay Public Service Commission in *Times of India* dated 15-12-1947, for a post of Dairy Surveyor. The Committee is of opinion that a Veterinary Graduate is quite competent to discharge the duties in all the spheres of Animal Husbandry and Dairying.

It is further noted with great surprise that even Veterinary graduates having specialised training (Associateship) in Dairying in Bangalore Dairy Institute are also not regarded eligible for the post. We therefore look to it with great concern as barring a Veterinary graduate and more so a Veterinary graduate with specialisation in definite section, will result into disruption of Veterinary Profession. The Committee therefore requests the Government to amend the advertisement and recognise Veterinary Graduate eligible for this post and any other in Animal Husbandry Department.

Proposed by Dr. S. R. Chadha and seconded by Dr. M. R. Redkar passed unanimously.

6. The Committee expresses a general satisfaction in the revision of scales of Veterinary graduates employed in Bombay Corporation and requests the Municipal Commissioner to reconsider the starting salaries of Veterinary Inspectors in Market Department and Junior Inspectors in Slaughter House Department which is kept very low.

Proposed by Dr. S. R. Chadha and seconded by Dr. M. R. Redkar passed unanimously.

7. "Resolved to accord sanction to the expenditure of Rs. 31-8-0 incurred by the Secretary and sanction an amount of Rs. 30/- as typing charges for the year 1947.

Proposed by Dr. S. B. Hanchlikar and seconded by Dr. G. H. Joshi passed unanimously.

Mr. M. R. Redkar then proposed a vote of thanks to the chair for conducting the proceedings and the Principal, Bombay Veterinary College, for giving permission to use the Library Hall for meeting and the meeting came to a close.

S. G. KSHIRSAGAR,
Hon. Secretary.

D. S. LAUD,
President.

Correspondence

[The visws 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.]

Veterinarians in Local Bodies.

Dear Editor,

It is deplorable that the recent enhancement of salary given by the Government to all Veterinary Graduates of the whole province, has not benefitted the poor Graduates serving in Municipalities. It is a pity that they have been completely ignored by the authorities with the result that there is complete dissatisfaction among them. There is nobody to fight for them. There is no one who realises, even in these days of scientific advancement, the importance and usefulness of these Graduates who are the guardians of public health. Their work is as much important to the welfare of the general public as the Government Veterinarians. Ever since I came to this country, I have been crying by writing in the our *journal* for the improvement of Municipal Veterinary work, to increase the status of the Graduates and to adopt an uniform system of meat inspection and slaughter house management in South India. But I am sorry that my cry has been a cry of the wilderness. The Director of Veterinary Services in his advisary capacity could have pointed out boldly to the municipal authorities to improve the present condition of slaughter houses which are in a most miserable condition. The salaries of the Veterinary Officers depend upon the whims and fancies of the municipal commissioners and the councillors. The provincial veterinary association also so far has not taken a bold attitude to rectify these defects. I must in this connection thank the Editor of our *Journal* for the selfless work he has undertaken to raise the status of the Subordinate staff of the Department by his continous agitation through the medium of the *Indian Veterinary Journal*. I hope he will do the same for the Municipal Vets who are ignored unknown, unhonoured and unsung.

Madura
10—7—'47.

M. V. PILLAI, G.B.V.C.

United Provinces Veterinary Association

Sir,

I am surprised to note that a resolution (14) has been brought forward during the 14th annual general meeting of the above association requesting the Government to give a courteous right to prefix "Doctor" before their names as is done in the Medical and Public Health Departments. I regret very much to remark that on the face of it; it is rediculous and out of place. I have been

in close with our *Journal* and other *journals* and I had no occasion to find a resolution of this nature in any of them by any other associations. First of all to get a courteous right of 'Doctor' it is not necessary to approach for the permission of the Government. I don't mind in the least if I am called a "Doctor" or not, but I have found in my 30 years experience that many of my clients used to address me courteously as a 'Doctor' but not officially. In India the term Doctor is very freely and loosely used unlike other countries. Every man can become a Doctor overnight and can boldly use the title publicly. A homeopathy by correspondence course is a Doctor, a sex specialist is a doctor, a dentist is a Doctor and in fact nobody stands in your way of calling you a Doctor. When Doctor's title is so loosely used by any Tom, Dick and Harry, we Veterinarians, having undergone a rigid professional study, should not aspire ourselves to be included among bogus Doctors described above. Our profession is as honorable and useful as any other even without this designation. In this connection, I would like to express the fate of a Doctor who was practising Homeopathy in Singapore by publicly putting his board in front of his house as 'Doctor' without knowing the rules of British Malaya. Poor man was arrested and brought before a judge who questioned about his qualification and college in which he studied. It was finally proved by the detectives that he had only a Homeopathic certificate. He was therefore fined heavily for using the title. He was, previous to this incident, a P.W.D. overseer. He was made to change his title and now he is addressed as a 'Professor.'

Strictly speaking no one is entitled to call himself a Doctor officially unless one possesses the highest academical degree of M.D; D, Sc; LL.D. Ph.D., D.C.L. or D.D. conferred on him by recognised Universities by research work followed by a thesis. A medical man licensed to practice medicine is officially and socially called a 'Doctor' though he is not an M.D. Veterinary Surgeons possessing Doctorate Degree can be called a Doctor. In America every Veterinary Surgeon possesses a Doctorate Degree. But a surgeon having the highest degree of M.S; or F.R.C.S. of England or Scotland is styled himself as Mr. only. He does not loose anything by this nor does he feel sorry for not having the title 'Doctor'. Many of the Surgeons who do purely surgery have their sign boards written as Mr. so and so in Malaya. But if he is not addressed as a 'Doctor' in India, he gets annoyed. It is my firm conviction therefore that we Veterinarians do not loose anything or degrade ourselves in the eyes of the public if we are not called "Doctors."

Madura
10—7—'47.

M. V. PILLAI, G.B.V.C.

Wastage of Straw.

Sir,

Touring in the interiors of my jurisdiction, it has struck me as to how foolish it is to use paddy straw for the thatching of houses instead of using it

rightly as cattle fodder. There are many villages, where nearly 50 per cent of the straw produced in the village is used for the purpose and as a result the cattle of the village do not get enough straw throughout the year.

This practice of, what I call, wastage of the straw, or more correctly the cattle fodder, is prevalent in many districts of Bihar, Bengal, Orissa, and I think there are several other Provinces also where such kind of uneconomical and wasteful use of cattle feed is prevalent to a more or less great extent.

How nice and economical it would be to stop this practice? From ordinary calculations, I know that even the smallest house in a village requires for thatching as much paddy-straw as would be needed for maintaining one animal for nearly a year. And, therefore, if a village is supposed to comprise of 100 huts, then the feed of nearly one hundred cattle is wasted in this uneconomical way in that village. And think of the increased production from this extra feed to the starving cattle in that place? How much more milk, how much more manure, and how much more work and production becomes available then? These if properly managed will go a long way to help the Grow More Food Campaign.

Now the question is—how to check this wastage? In my opinion, the Animal Husbandry Departments of the Provinces concerned should take up this matter and, by intensive propaganda, put a check on this wasteful use of the valuable cattle fodder. They can even legislate and simultaneously grant loans to help poor villagers to purchase tiles, corrugated sheets and such other cheap and lasting materials for their roofing. It should be the task of the Animal Husbandry Departments to make the people know the proper use of the straw and explain to them the benefits they will derive from its proper use.

R. L. MALHOTRA,
Touring Veterinary Asst. Surgeon.

Purulia Bihar.

Civil Veterinary Department, Assam.

Sir,

It is very regrettable that Central Government's money allotted to the Post-war scheme of Assam, lapsing year by year due to the maladministration of Assam Government, in each Department.

In Assam Civil Veterinary Dept. alone about a lac of rupees was lapsed in last year. We are afraid this year also similar amount is going to be lapsed as it appears from the trend of progress of works made this year.

In current year Budget there are provisions for Establishing Four Govt. Hospitals in Assam, including one at Nowgong. Nowgong Municipality handed over 12 bighas of Nowgong Town land valued over Rs. 60,000/—free to the Government for establishment of a Government Veterinary Hospital last year but nothing was materialised though some several thousand rupees were allottted in the last year's budget.

In September 1947, the Executive Engineer, Nowgong, has prepared a Site-Plan for Veterinary Hospital and Veterinary Vaccine Section in the aforesaid land, as directed by the Chief Engineer, Assam, who in fact asked the Executive Engineer to spend the allotted amount before the 31st March 1948.

The said Site-Plan was duly signed by all the authorities:—Deputy Commissioner, Executive Engineer, Civil Surgeon, Chairman Municipality of Nowgong and others and sent it with estimated cost of Rs. 42,000/—to Shillong in September last for formal approval, but it is still rotting in Shillong. We are afraid if no action is taken immediately, the said amount will be lapsed this year as well.

In this connection it will not be out of place to note here that there is a provision of Rs. 75,000/- in the Post-War scheme for the Veterinary Section; but we are tired of hearing plea of non-availability of land and building which prevents starting of the said Vaccine Depot, though all implements are ready at Gauhati.

The above few lines were sent to the Editor, Assam Tribune, and Dainik Assamiya (New Press Gauhati—Tribune Building Gauhati) on 12-12-1947, but up till now no action has been taken. So it has been sent to you for favour of publishing in your issue as soon as possible.

It is to be noted here that for want of Vaccine (G.T.V.) about 200 Veterinary Field Assistants are sitting idle as Assam does not get any Vaccine from Calcutta as a result many cattle die of Rinderpest alone.

RATHA KANTAH BORA, B.L.
Pleader.

Nowgong,
24th. December, 1947.

Non-specific Metritis and Sterility in Bovines.

Sir,

Sterility is one of the biggest problems in a dairy herd. Its causes are many and varied. Congenital, Harmonal, Anatomical anomalies and specific causes all contribute to this and, therefore, are important in their own respective spheres. Their importance cannot be minimised. But the fact remains that non-specific form of metritis by far contributes a very high percentage of incidence.

Metritis generally results from protracted labour, putrid foetus, retained placentae and consequent extensive manipulation. Mild cases may resolve naturally in a period of one to three weeks, but most of them take obstinate course in spite of treatment. This either results in sterility or delayed fertility which are detrimental to dairy interests.

Line of Treatment:—The following treatment is universally adopted in the Military Farms Department in India as ordered by A.D.V.S. (Animal Husbandry). Extract from Re. & Veterinary Directorate Circular 2 of 1947.

" If the retained foetal membranes are there it should not be interfered with until 12 hours after calving in hot weather or 24 hours in cold water. Then, if removal by hand can be carried out easily and without roughness, this should be done; otherwise separate only those cotyledons that can be easily detached and inject one of the following mixtures into the uterus.—

1	Acriflavin	1 part	Inject 100 to 200 c.c. into the uterus.
	Water	100 parts	
	Glycerine	900 ,,	
2.	Lugol's Iodine Solution	10 c.c.	
	Glycerine.	90 c.c.	
3.	Bismuth Subnitrate.	1 oz.	
	Iodoform	1 oz.	
	Cl. Arachis.	500 c.c.	

(Sulphanilamide 1 to 2 oz. may be included with advantage.)

Repeat the antiseptic treatment every second day until membranes can be removed easily or come away of their own accord.

After 5-7 treatments the uterus will have largely regained its tone and decreased in size and should now be washed out with a weak antiseptic solution such as Lugol's Iodine Solution 1 : 1000 on alternate days. It is a bad practice to use large quantities of aquous solutions prior to this stage

If at any stage of treatment the animal is dull or running high temperature, Sulphanilamide should be administered by mouth."

In the *Veterinary Journal* of January 1947, it is recorded that Sulphanilamide may be given in doses of 3 oz. to start with to be repeated by 1½ oz. dose every 5 hours for 5 days.

At least 7-10 days interval may be given before the administration of second course of Sulphanilamide.

In addition to the above line of treatment, I think the use of Pituitary Extract could be made of with advantage. It is a well established fact that post Pituitary Extract (Oxytocic principle) brings about contraction of uterus. This, if given along with the treatment given above, is likely to shorten the organ and thus reduce the surface area for further infection. The greater the surface area exposed, the greater will be the extent of infection involved and consequent severity of the attack.

In addition to this the attempt at contraction tends to hasten the institution of the organ which otherwise would hang down into the abdominal cavity making drainage very imperfect and difficult.

The experiences of Peter Kiddle and E. W. Jones as recorded in the January 1947 issue of the *Veterinary Journal* lends support to this suggestion of using Pituitary Extract in these cases of Metritis.

RIS. DHARAM PAL, I.A.V.C.
Veterinary Assistant Surgeon,
i/c. Military Farm, D. I. Khan.

Lahore,
15th June 1947.

IMPROVEMENT OF SHEEP IN INDIA.

(With a reference to Baroda State)

Sir,

Sheep Breeding and Wool Production is one of the few prominent rural Industries in India. Inspite of this fact, it is a matter of great regret that till very recently the various Governments i.e., Central, Provincial, and Native States, in the country laid little attention for the proper development of this industry. Now it may be observed that almost all the Governments are so to say becoming Sheep and Wool conscious and have started setting apart a quota out of the revenue for the development of this Industry. Mere determination on the part of any Government to spend some money for a purpose will not help it to achieve the desired end. A clear understanding on the part of those who are responsible for developing the industry and of the populace engaged in it is more than essential. The outstanding object of any such scheme should be to improve the breeds of sheep so that such improvement may raise the economic standard of the shepherd and thus the national wealth of the State itself. It should be borne in mind that even the process of such improvement should in no way clash with the immediate interest of the shepherd. In this connection, my own study of the existing conditions in the sheep tracts of the Baroda State, will, I hope act as a guide to others who are similarly engaged in the development of this industry in other parts of the country.

Baroda State has been fortunate enough to possess a natural breed known as the Patanwadi Breed, which is almost the best wool breed in India. Five years ago it was realised by the State that such a potentially rich breed was deteriorating due to lack of any farsighted and scientific breeding policy on the part of sheep owners. For the purposes of preservation and improvement of this breed, a wool improvement section was established. For the last five years this section has been working for the improvement of Patanwadi Breed. The Patanwadi tract is prominently spread over the Mehsana District of Baroda State. There are about three thousand flocks in this area on an average of fifty sheep to a flock. The sheep breeders in this area are known as Rabharis, for whom the flock is the mainstay. A flock of fifty sheep can maintain a Rabhari family through its return and therefore sheep rearing is quite an attractive profession. In the Patanwadi tract, the shepherd realises money by selling the milk and wool of the sheep. The progenies only help him to maintain the strength of his flock at a static level, balancing the losses from old age and diseases. A Rabhari is extremely sentimental and this prevents him from cashing the excessive male progenies by culling them from mutton purposes. In Gujerat, sheep's ghee is used as an adulterant to cow's and buffalo's ghee. This practice has kept the prices of sheep's ghee at quite an attractive level. Thus manufacture of ghee from sheeps milk is a very profitable proposition to the Rabhari. About 85% of the income he gets from the flock, he realises from the milk and the rest through wool. At the present time wool is only of secondary importance to the Rabhari. Ordinarily a sheep is not an animal meant

by Nature for milking purposes. The milk produced in a sheep under ordinary conditions is just enough for nourishing its offsprings. But if any milk is to be drawn after satisfying the lamb, the mother-ewe should be sufficiently fed ; and this a Rabhari cannot afford. The extra feeding, even if given, is not going to be an economically sound proposition for him. So the Rabhari milks the sheep without any special feeding to the ewe and thus snatches away the milk intended for the nourisement of the lamb. That is the reason way in this tract lamb mortalities are every common. So it is of vital importance to immediately put an end to this evil practice of milking of the sheep. Such a recommendation is easy no doubt, but very difficult to enforce. If the Rabhari is to be persuaded to abandon this evil habit, he has to he shown methods and ways to compensate his losses due to such stoppage of milking. He should be made to concentrate his attention more on the production of wool and good progenies. Realisation of money by culling the discarded sheep for mutton purposes should be put before him vividly. Castration of superfluous ram lambs should be popularised. All these no doubt call for a big battle for eradication of sentimentalism in the Rabhari which is not only hitting his interests seriously but also greatly impeding the prosperity of the industry itself.

Rabhari is economically under the clutches of the village Baniya or the money lender. The Baniya, in virtue of his shrewdness and wealth, exploits the Rabhari by lending him small amounts of money at the time of his needs. Through this timely obligation, the Beniya forces the Rabhari to sell his goods to him at low rates. This hinders the sheep-farmer from realising the best price for his products. The conditions for sheep farming are more or less governed by similar factors in all parts of the country. Any scheme aimed at the improvement of Sheep Breeding for various purposes should be undertaken only after thoroughly studying the existing conditions of the sheep, their outstanding characters, the uses they are put to at the present time and the economic condition of the sheep-farmer. It should be further borne in mind that the prosperity of the sheep and the sheep farmer go together. No move intended for the amelioration of the sheep breeds in India, should be tackled in such a way that it upsets the very social life of the shephered himself, as this move will only create suspicion in his mind and makes him evade instructions. Changes should be gradual and steady. In India, as a rule, the shepherd class has been economically and intellectually backward. The main reason for this has been, that his income has not been adequate enough to make both ends meet. This low income is due to the fact that his actions are governed by false economy and rigid and harmful social customs. The breeding policy of the shepherd at the present time is not only superficial but is also very unscientific. The shepherd remains a looser twice. Firstly he does not take proper and necessary care while collecting the 'products', and so, puts himself in a disadvantageous position. Secondly he does not study the market and consequently does not realise the proper price for the 'products'. Thus he is hit both in the collection and in the marketing. If this fact is realised by the undertakers of

sheep-development in the country and due consideration is given to this, the development programme is bound to be successful. As the prosperity of the industry is dependent on production and marketting, modified methods have to be employed for production and marketting the sheep and their products.

The foremost step towards the improvement of sheep and wool industry in India, lies in freeing the shepherd from the clutches of the Baniya. If this is to be done, an organisation should be created to displace the Baniya, the duty of which should be to afford all the facilities that a Baniya extends to a shepherd carefully avoiding the malpractices and exploitations of the Baniya in every form. Such an organisation can only be a sort of a cooperative society run by the shepherds themselves. But the shepherds are basically a backward class that it will be an up-hill task to make them capable of running a cooperative organaistion. So, to begin with the Government should act as the guardian of this institution. The functions of this institution should be to provide the needs of the shepherd charging a nominal profit and market his products for his maximnm benefit. This will create a confidence in the mind of the shepherd and make him alert to the necessity for improving the conditions of his sheep and himself.

This Cooperative Society or Sheep breeders' Association or better called by any suitable vernacular name should be made the neucleus for all activities of development of sheep. This should be a quasi Government body and should also be liasoned with the research work undertaken by the Government. The enrolling of shepherd members to this association is a very big task. Any imposition of fee to members in the beginning will only scare away the shepherds. To begin with the association should be more of a social nature and should be a centre of attraction to popularise it amongst the shepherds who are the back bone of this industry. All these will no doubt require fairly huge sums of money and the Government should not hesitate to spend on such an essential cause as building of the sheep wealth. The choice of place for the location of these activites is a very important matter. It should be as far as possible such a place which is easily accessible to all the flock owners in a particular tract. If the tract is distributed over a vast area more than one centre should be established. The function and aim of this organisation should be, to be always attentive to the reasonable needs of the shepherd and be his guide for the prosperity of himself and his flock.

Sheep Breeding is a science by itself and its methods vary according to the conditions of the areas in which they are to be undertaken. The govering factors for this are climate, availability of pasture, the condition and quality of the already existing breed and the customs and habits of the local breeders. Giving due consideration to all these factors, research has be to undertaken to learn methods for evolving the desired and practicable breed in the shortest period possible. The evolution and preservation of breeds go hand in hand. Before advising any particular breeding policy to the shepherds the methods

should be properly tested and experimented. It should always be borne in mind that as far as the shepherd is concerned, sheep rearing is nothing more than a commercial enterprice to him and as such the methods advised should always be economical and within the means of the shepherd.

The problem for research to be undertaken varies according to regions, their results are to be adopted. For example in Gujrat, milking of sheep is prevalent, whereas it is almost unheard of in other countries. So this is a special problem for study in Gujrat where all its effects on the ewes and lambs have to be studied. In the same way, different tracts of sheep possess their own peculiarities either acting as drawbacks or advantages of these have to be discovered. It is the duty of research workers to realise the harmful effects on sheep of such practices by studying animals kept under observation and control. Existing malpractices should be openly discouraged and before doing so suitable substitute measures should be found out.

The important uses the sheep is put into at the present time are for the production of wool, for the purposes of mutton, for the manuring of fields, for skins and lastly also very questionably for the produbtion of milk. It should be the aim and desire of every worker in this line to increase the yield of all these products and at the same time improve the quality.

N. L. NARAYAN,
Jaipur State, Jaipur. *Sheep & Wool Improvement Officer.*

Chronic Luxation of Patella.

Sir,

I have gone through the articles of Mr. M. Ramakrishna Pillai, and Mr. Md. Rahim-Ud-Din in the *Indian Veterinary Journal* Vol. XXI, No. 1 and of Mr. K. Venkataraman in Vol. XXIII No. 5 regarding Chronic Luxation of Patella. I fully agree that treatment with Liq. Iodine Mit gives successful result with one or two injections at reasonable interval, but I do not agree with Messrs. Pillai and Venkataraman regarding the confirmation as an etiological factor.

They say that when young animals are put to heavy work for the first time this affection usually occurs probably due to the undue strain brought about by heavy work on the tendon in mature ligaments of the femero-patellar articulation but in my experience in the State and Deogarh Model Dairy Farm I have seen this affection occurring in both male and female animals without their being put to work. In this farm, there are two cows which have got luxation of patella. Observations for the last several years have shown that cases of Luxation of Patella are confined to the offsprings of these two cows which get the complaint sooner or later, though there are other 100 heads of cows along with them with some care, management and ration. Generally the complaint is noticed between 1½ years to 3 years.

And this, irrespective of their being put to any work. Further, the heifers and cows are not given any work and yet they get the complaint Therefore the statement of Pillai and Venkataraman cannot be substantiated. Cases of Luxation of Patella occur both in working and non-working animals. Under these circumstances the etiology of Luxation of Patella is still unknown and require investigation.

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The Indian Dairy Science Association

Sir,

An Association called "Indian Dairy Science Association" was formed about two months back at Bangalore and a provisional executive committee was appointed. A meeting of this committee was held at New Delhi on the 16th December with Sardar Bahadur Sir Datar Singh, Vice-Chairman, Indian Council of Agricultural Ressarch, in the chair. It was decided to open the membership of the Association to all persons engaged in teaching, research and advisory work in dairying persons holding technical positions in the field of dairying. The Association has received the support of leading dairy scientists and the Association's aim is to publish a journal devoted to dairy science in all the branches in course of time. The need for such a journal devoted exclusively to this subject has been universally felt.

The work of enrolling Foundation Members is proceeding briskly and in such a short time of its foundation the Association has on its roll over fifty members. A good response is expected from the past members of the Indian Dairy Research Institute, Bangalore, Agricultural Institute, Allahabad and other qualified persons who have been anxious to bring into being a voluntary association of dairy scientists. Amongst its objects the Association aims at the advancement of dairy science in all aspects by the dissemination and application of knowledge, providing opportunities for the exchange of knowledge and ideas through discussion and other means, collaboration with other institutions engaged in activities relating to advancement of dairy science, and encouragement of scientific enquiry into problems arising in the dairy industry. For the present the headquarters of the Association is located at the Indian Dairy Research Institute, Bangalore, and those desirous of joining the Association should communicate with the Joint Secretary of the Association.

Indian Dairy Research Institute
Hosur Road, Bangalore.
Dec. 22, 1947

H. LAXMINARAYANA
Hon. Joint Secretary.