Dr V. Narasimha Moorthy
(1 July 1903–30 August 1942)

Venkatanarasiah Narasimha Moorthy was born in Holalkere, Chitradurga district of Karnataka (old Mysore State) and entered Central College, Bangalore (Mysore University) in 1921 and graduated in science with Chemistry as a special subject in 1924. He joined the Mysore University Medical College in 1924 and graduated in Medicine in 1929. After finishing his House Job in Victoria Hospital, Bangalore, he joined the State Department of Health Service in October 1929. As health officer, he was posted to work in Chitradurga district.

He found that guinea worm disease was the most important problem in that district and was responsible for morbidity in a large population. It also interfered with the activities of the agricultural work force. He submitted a report outlining a scheme for the field as well as the laboratory. This work was read as a scientific paper before the Mysore Medical Association and later, because of its practical value, was published as a special bulletin for wider circulation.

During 1931–33, Dr Moorthy was deputed to Calcutta (Kolkata) by the Government of Mysore. He qualified for the Diploma in Public Health of the Calcutta University in 1932 and for the Diploma in Tropical Medicine of the School of Tropical Medicine, Calcutta in 1933. He continued his work on the guinea worm and extended his stay in Calcutta by one more year. In 1934, the Rockefeller Foundation sanctioned supplementary funds to those allotted by the Government of Mysore to enable him to pursue his work on guinea worm disease in Chitradurga district. He was awarded the fellowship by the International Health Division of the Rockefeller Foundation (1936–37) to pursue his work at the Johns Hopkins University, Baltimore, USA. He was awarded the Doctorate in Public Health from the Johns Hopkins University in 1938 for his thesis on ‘Epidemiological and life history studies of Dracunculus medinensis (Guinea Worm) in Chitradurga in erstwhile Mysore State’. In recognition of his work he was elected a member of Sigma Xi, a well known scientific organization of the USA and was permitted to wear a golden key—the insignia of the association. He was elected a member of the Delta Omega Society and of the American Society of Parasitologists and the Helminthological Society of Washington, USA.

For the first time in the world he succeeded in reproducing the disease in an experimental animal (dog). He was able to recognize and describe for the first time the male guinea worm. He discovered the two types of guinea worm larvae (A and B) and described the life cycle of the guinea worm in detail from his experimental studies on dogs. He observed that people using water from certain water resources which contained certain species of small fish of the family Barbus were free from guinea worm disease. After extensive studies he found that these fish were feeding on the infected cyclops and thus rendering the water safe. This important observation led to his paper on biological control of the disease in Chitradurga district. He successfully eradicated the disease in Chitradurga district in 1930 with limited resources and money.

Unfortunately, his brilliant career ended when he died at a young age of 39 years due to a sarcoma of the stomach.

AN EPIDEMIOLOGICAL AND EXPERIMENTAL STUDY OF DRACONTIASIS IN CHITALDRUG DISTRICT

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* From the Department of Health, Government of Mysore. Paper read at a meeting of the Mysore Medical Association.

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INTRODUCTION

The practical study of dracunculiasis, one of the oldest known and in some parts of India the most prevalent of tropical diseases has been singularly neglected. Although it is not a fatal disease or one which attracts much sympathy its incidence nevertheless is commonly the precursor of much suffering and physical incapacity. A very large percentage of the inhabitants in the infected areas is more or less completely incapacitated for 5 to 6 months and in some complicated cases even up to 8 months in the year. This can be easily seen when it is said that in Chitradurg district one has to import labourers from Malabar and other distant places for construction of draw-wells in some of the infected villages since local labour is so dear and so very difficult to obtain. Dr. J. V. Karve, Director of Health in Mysore, has stated in one of his reports on dracunculiasis in Chitradurg district that the economic loss to the district is nearly Rs. 40,000 a year. Modern methods of treatment are so very unsatisfactory and so often not available to the vast majority of the sufferers in the infected villages that it can only be from the application of prophylactic measures that the eradication of the disease, if possible, or even its diminution, is to be expected. In dracunculiasis a knowledge of the exact mode of entrance of the guinea-worm larvae into the human body and the exact role played by the intermediate host, the cyclops, forms the essential basis on which such measures may be framed. With this object in view an attempt has been made to study the various aspects of the disease in some of the infected villages in Chitradurg district, an endemic centre for dracunculiasis in Mysore State.

Experiments.—A good supply of cyclops, daphnia and diatomous, were collected from one of the infected step-wells in Chitradurg town, and they were isolated in separate glass dishes in a sample of the same step-well water from which they were collected. These specimens were microscopically examined and only such of them as had not already been infected with the larvae of Dracunculus medinensis, in nature, were selected and used for this experiment. To each of these dishes about one c.c.m of an emulsion containing live dracunculus larvae collected by one of the usual methods, was then added. During the first day of the experiment these crustaceans were examined under the microscope once an hour and subsequently once a day. A few of the specimens of cyclops, examined about an hour later, were found to have become infected with dracunculus larvae.

As a control, the different species of cyclops, daphnia and diatomous were isolated in the same step-well water in separate glass dishes without the larvae. The live dracunculus larvae were also isolated in different dishes containing step-well water, brackish draw-well water and distilled water. These specimens were examined every day and the following are the observations made during the above series of experiments:

1. Some of the infected cyclops were found to be alive for 62 days, i.e., for nearly 9 weeks after infection, provided they had been isolated in water from the same step-well as that from which they had been collected. But most of them died at the end of the 6th week (i.e., 42 days). In the control tube the non-infected cyclops were found to be alive for 108 days, provided they were isolated in the same step-well water, from which they were collected, and the water was changed once every 3 or 4 days.

2. The guinea-worm larva appears to undergo certain changes inside the body of the cyclops. The following are the most noticeable of them:
   (a) Increase in its size,
   (b) Differentiation of internal structure,
   (c) Casting off of its tail, and
   (d) Two ecdyses—the first between the 7th and 9th day and the second between 12th and 13th day.

3. The dracunculus larvae were found to be alive inside the body of the cyclops as long as the cyclops were alive, but their movements become comparatively sluggish after the second week of infection. In some of the cyclops that were found to be alive for nearly 62 days, the larvae were found to be lying absolutely quiet, when seen under the microscope. But they could be stirred into activity by transferring the infected cyclops into a solution of HCl of strength varying from 0.2 to 0.4 per cent., the strength of the acid used depending on the particular species of cyclops experimented with, as will be explained later.

4. Even when, as happened too often in the later stages of the experiment, the cyclops died, the larvae inside its body showed not inclination to leave the dead cyclops, as they do for instance when the cyclops are artificially killed by 0.2 per cent. HCl; and were on the contrary found lying dead in its interior.

5. As many as ten dracunculus larvae have been noticed in some of the infected cyclops. Leiper (1907) has observed that 'when more than half a dozen embryos gained access to the body cavity, the infection generally resulted in the death of the host'. I have however found a few of these heavily infected cyclops to be as active as the rest and their infection with so many dracunculus larvae does not seem to inconvenience them in any way. But they do not as a rule live for more than a fortnight at the most, unlike the others that are infected with one or two guinea-worm larvae and which live for nearly 62 days.

6. The guinea-worm larvae isolated in a sample of infected step-well water were found to be active for about 7 days, those isolated in distilled water only for about 28 hours. The dracunculus larvae appear to live longer in fresh water commonly used for drinking purposes.

7. Daphnia and diatomous were found to be alive for nearly five weeks (i.e., 35 days) when isolated in a sample of water from the infected step-well. However long they may be kept with guinea-worm larvae, they cannot be infected with these larvae.

8. In all the infection experiments of cyclops with guinea-worm larvae that have been conducted so far, it has been uniformly
noticed that the guinea-worm embryos are actually swallowed by the cyclops. The cyclops catches the larvae by means of its first pair of legs and with the help of its anterior and posterior pairs of antennae, pushes the larva gradually into its stomach through the mouth. Turkh (1912) has also demonstrated this fact by trying infection experiments with cyclops starved previously for at least 12 hours by isolating them in a sample of normal saline or distilled water, before trying the experiment. (Photomicrograph No. 1. Cyclops ingesting the guinea-worm larva.)

Clinical features of the disease.—The available clinical and experimental evidence is in favour of the view first suggested by Leiper (1906) that infection of man takes place through the drinking of water containing infected cyclops. The further chain of events intervening between the swallowing of infected cyclops by man and the appearance of the adult female worm in the subcutaneous tissue of the human body has not yet been fully worked out. For nearly 9 to 10 months after infection the patient does not usually exhibit any symptoms of the disease. At the end of this period, the fully impregnated female worm proceeds to bore her way through the tissues of the body and in nearly 75 to 80 per cent. of the cases she presents herself in some part of the lower extremities. I have seen the worm appearing on the trunk, scrotum, perineum, on the upper extremities and tongue (Appendix A). Cases where the worms have appeared on the head and in the eyelids have also been reported.

Just before the worm establishes connection with the surface of the body, it appears to inject certain toxic substances into the tissues below the dermis. Local inflammatory reaction produces serious exudation with blister formation. The absorption of the toxic substance into the circulation probably giving rise to a condition of protein shock, results in the early systemic clinical manifestations, such as urticaria, cyanosis, dyspnoea, vomiting, giddiness, fainting, diarrhoea and the like. The manner in which these helminthic products act is at present a matter ofsurmise. Hamilton Fairley (1924) considers this is probably anaphylactic in nature. These are the only recognizable symptoms of dracontiasis that appear after a period of nearly 10 to 11 months after infection; and I have invariably found that subcutaneous injection of 5 to 7 m. of adrenaline solution gives immediate relief to most of these symptoms. These symptoms last for a day or two if not treated with adrenaline injection, and later, the worm appears on the surface. For nearly 3 to 4 weeks afterwards it continues to discharge its young ones into water whenever it comes in contact with it. The head and anterior extremity of the worm can at this stage be drawn out by gently pulling it, and if the worm is completely extracted final healing of the lesion occurs. Not infrequently this happy result is prevented by the snapping of the worm during efforts at extraction, with consequent secondary infection by pyogenic organisms. The following are the complications that have been commonly noticed: acute abscess, cellulitis, arthritis, synovitis, epididymoorchitis, chronic ulcerations, fibrous ankylosis of joints and contraction of tendons. Occasionally a calcified guinea-worm has been found to cause inconvenience, but the great majority of complications and the sequelae of dracontiasis are attributable directly to bacterial invaders or indirectly to the prolonged immobilization of joints resulting from cellulitis, arthritis and synovitis associated with such infection.

More than 10 to 12 worms have been noticed in the same individual, appearing in different parts of the body either simultaneously (which rarely happens) or as is more commonly observed, at intervals of a week or a fortnight. The urticarial syndrome and other systemic disturbances are not so pronounced as they are when the worm appears for the first time. Attacks during previous seasons do not, however, seem to confer immunity to urticarial eruptions in subsequent years, but it is distinctly rare to find a history of more than one bout of urticaria during the same season. Perhaps as Hamilton Fairley (1924) thinks 'temporary desensitization to helminthic toxin supervenes on the urticarial syndrome'. When the guinea-worm fails to reach the surface, liberation of embryos into the subcutaneous tissues may give rise to subacute abscesses with gelatinous pus. Several such cases have been noticed by me. In five cases, I examined the pus aspirated from the abscess. It is of interest to note that this pus was found to contain a large number of eosinophile, polymorphonuclear and mononuclear leucocytes, along with a few dead and calcified guinea-worm embryos.

Natural infection with guinea-worm is known to occur in a number of different animals. These include dogs, horses, cattle, leopards, certain species of monkeys and a cobra. I have not however come across cases of infection among animals in any of the infected areas and the villagers also deny having seen their cattle infected with guinea-worm at any time. It may be as Turkh (1919) has pointed out in his notable case of guinea-worm infestation of a cobra, that the species of guinea-worm implicated in these animals is not *Dracontulus medinensis*.

Blood condition in dracontiasis.—Haematological data collected so far, show that general eosinophilia is a marked feature of this disease. Blood smears of patients suffering from different stages of the diseases, i.e., (1) in the stages of urticarial syndrome, (2) at the formation of the bleb, and (3) those taken before and after the extraction of the guinea-worm, were examined. The percentage of eosinophile cells in the blood appears to be at its maximum when the bleb is just forming. In one case blood examination was made during the urticarial syndrome. The percentage of eosinophiles was 6.8. About 3 days later when the bleb had fully formed the percentage of eosinophiles was 15.3. The low percentage of eosinophiles during the stage of urticarial syndrome has been suggested by Hamilton Fairley (1924) to be 'due to the migration of the eosinophile leucocytes into areas of urticarial syndrome in the subcutaneous tissues; and the subsequent rise is probably due to the increased manufacture of eosinophiles by the haemopoietic system under the stimulating action of the toxic substance elaborated by *D. medinensis*'.

In the same patient, an attempt was made to study the blood condition before and after the extraction of the worm. Unfortunately in an attempt to extract the worm in one sitting it snapped and hence blood examination could not be done in this case. This was however, done in another patient in whom the worm was seen coiled up under the skin. Since the worm was felt easily on the skin, an incision about ½ inches in length was made as far as the worm after anaesthetising the part by local infiltration with novocaine solution, the entire worm being thus extracted in this case. Blood smears taken before the extraction of the worm in this case showed the percentage of eosinophiles to be 18.6 and those taken 24 hours after extraction 15.2. The blood smears examined 3 days later showed the percentage of eosinophiles to be 3.3. Blood smears of fifteen other patients in whom the worm had not been completely extracted, were also examined. All of them showed general eosinophilia and the percentage of eosinophiles was found to vary from 8.8 to 20. But in six of those in whom the worm had been completely extracted, either by surgical interference or by the old winding method, the percentage of blood eosinophilia was only between 1.5 to 3. Secondary infection was found to be associated with a decrease in the proportion of eosinophiles and
Relative increase in the polymorphonuclear leucocytes. In the above seventeen cases, blood eosinophilia which might possibly be due to other intestinal helminthic infections was excluded by selecting only such patients as did not show the ova of any of the most common helminthic parasites such as hookworm, ascariis and oxyuris in their stools.

Examination of the fluid of the bleb:—this was studied in thirteen cases. On aspiration the fluid from the bleb was found to be composed of yellow serum containing live dracunculus larvae in an active condition. Microscopic examination showed the presence of mononuclear, polymorphonuclear and eosinophile leucocytes. As has been shown by Moorthy (1929) in the case of the vernal catarrh of the conjunctiva, this is one other condition where blood eosinophilia is associated with the presence of eosinophile leucocytes at the seat of inflammation. This general eosinophilia in this disease is perhaps the result of the stimulating action of the helminthic toxic elaborated by Dracunculus medinensis, on the haemopoetic system.

Epidemiological features of the disease.—During the course of the above investigation many interesting epidemiological features of the disease have been noticed, and with our present knowledge it is difficult to offer a satisfactory explanation for most of them. At the outset it is difficult to explain why there are only 70 guinea-worm infected villages in the whole of the Chitaldrug district though there are many other villages where the drinking water supply is derived mainly from step-wells that have been infected with cyclops. In one of the villages, Siramaranganahalli, in Davangere taluk, for instance, there are two step-wells, one of which is used by the caste people and the other exclusively by the Adikarnatakas. While nearly 20 to 30 per cent. of the former suffer from dracunculiasis every year, there has not been a single case of this disease among the Adikarnatakas for quite a number of years. In another village, Kundayada, which is situated only about two miles from this village, the exact reverse is the case, i.e., the Adikarnatakas suffer from the disease every year, while from the information given by the villagers most of the caste people appear to be free from the disease. It has also been noticed that in the same place and in some cases even in the same family, it is only a few who suffer from the disease every year, though all of them use the same infected step-well water. Detailed statistics collected in five infected villages (vide Appendix A) show that out of a total number of 544 houses the infection is practically confined to only 256 houses, dracunculiasis cases occurring only in these houses every year. Even in these, which the villagers call 'guinea-worm houses', out of about 925 people living in them, only about 256 suffer from the disease every year; though all the villagers derive their drinking water supply from a common, heavily infected step-well.

Unlike other diseases which sometimes confer immunity on patients when once they suffer from them, in dracunculiasis it is usually the individual who has suffered once from the disease that continues to suffer from it almost every year. Statistics collected in 40 guinea-worm infected villages in Chitaldrug district show that out of a total of 1,363 patients who suffered from dracunculiasis last year 1,144 of them had suffered from it in previous years also, and only 219 patients suffered from the disease for the first time. This gives the percentage of recurring old attacks to be nearly 83 and the fresh attacks last year as about 17 per cent. What it is that increases this susceptibility to infection in an individual who has suffered from the disease once before is a matter that requires careful investigation.

Effect of hydrochloric acid on infected cyclops.—Experiments conducted so far indicate that all the different infecting species of cyclops are not killed immediately by 0.2 per cent. hydrochloric acid, i.e., the percentage of hydrochloric acid that is present in the gastric juice of a normal healthy individual, and the strength of the acid needed to kill varies from 0.2 per cent. to 0.4 per cent. according as the particular cyclops experimented with belongs to one or the other species. Hydrochloric acid below 0.2 per cent. does not seem to kill any species of cyclops and in a few cases it was noticed that hydrochloric acid of strength beyond 1.0 per cent. kills the cyclops as well as the dracunculus larvae lying inside its body cavity. It has also been noticed that in a number of instances after the addition of hydrochloric acid of strengths varying from 0.2 to 0.6 per cent. the activated guinea-worm larvae do not always escape from the dead cyclops but remain actively moving inside the body cavity of the cyclops for a varying period of 1–4 hours and ultimately die inside the body of the cyclops after making several strenuous but futile attempts to make their way out through the hard exoskeleton of the cyclops. Out of 525 cyclops thus treated with hydrochloric acid of strengths varying from 0.2 to 0.6 per cent. in only 30 of them were the activated larvae seen to escape from the dead cyclops; while in all the rest of the cases though the guinea-worm larvae became very much activated after the addition of the acid, they did not escape from the cyclops. It has been further observed that with the gradual increase in the strength of the acid from 0.6 per cent. to 1.0 per cent. the activity of the larvae became very much diminished and at the end of a varying period of ½–1 hour the larvae were found dead inside the body of the cyclops. The problem is still under investigation and it is difficult to draw any definite conclusions from these observations. However, the results so far obtained are very interesting and serve to offer an explanation for some of the clinical features of the disease stated above. These experiments seem to show, as far as artificial experiments can indicate, that in certain constitutional conditions, such as hyperchlorhydria both the cyclops and the guinea-worm larvae are killed in the gastric juice, and in other conditions, such as hypochlorhydria or achylia gastrica, the strength of the acid in the gastric juice is not sufficient to kill the cyclops or activate the guinea-worm larvae inside its body cavity. Thus in either condition, the dracunculus larva has hardly any chance to develop into an adult worm and hence perhaps these individuals do not develop the disease. These experiments also suggest that in any place, there can be only a few individuals in whom the percentage of hydrochloric acid in the gastric juice is just sufficient to kill the cyclops and set free the activated guinea-worm larvae. Since the lethal dose of hydrochloric acid for cyclops varies with different species, it is likely that in a place where the step-well is infected with a species of cyclops like C. leukarti which is easily killed by 0.2 per cent. hydrochloric acid, i.e., the percentage of hydrochloric acid in the gastric juice of a normal healthy individual, the amount of guinea-worm infection is likely to be greater than in a place where the infecting species of cyclops requires more than 0.2 per cent. hydrochloric acid to kill them. In other words the amount of infection in any place appears to depend to a certain extent on the particular infecting species of cyclops present in the place. This therefore suggests the importance of making a detailed cyclops survey of the different guinea-worm infected areas before any serious epidemiological investigations on the disease are undertaken. These experiments also suggest that when constitutional conditions remain unaltered it is naturally the same individual who has suffered from the disease once, that continues to suffer from it every year. Mass infection, maturity of the cyclops and the
concentration of the hydrochloric acid in the gastric juice appear to be the factors that ensure successful infection in man, and alterations in any of these factors perhaps explain the variations in individual susceptibility.

Water analysis of the infected step-wells.—It has been noticed generally that in almost all the infected places the water in the step-well is so pleasant and nice that people persist in drinking this infected water in spite of providing them with a safer and a better source of drinking water like a draw-well or a bore-well. In one place, I was surprised to get a reply from an individual that the water in the step-well was so sweet and pleasant to drink that he preferred to drink this infected water and suffer from dracunculiasis once a year, rather than drink the brackish draw-well water which he considered a continuous misery. That people should take this extreme attitude indicates that the step-well water is really pleasant to drink. With a view to find out what it is that makes the water so sweet, a general chemical analysis of water from 12 infected step-wells was made in the Public Health Institute, Bangalore. It has been noticed that most of the samples of water examined were nearly alkaline to litmus and the pH value varied from 7.0 to 7.9. The pH value does not seem to have any definite relation to the degree of infection present in each of these guinea-worm infected areas. It has however been suggested by Davis (1931) that by the addition of alkali if the pH value of water is raised to about 10 then it has a definite lethal action on cyclops. The uniformly high values got for chlorine, free ammonia and albuminoid ammonia and oxygen absorbed in 2 hours show that these samples are heavily contaminated with organic and vegetable impurities. The presence of nitrates and nitrates in some samples suggests that the organic impurities are probably animal in origin. At this stage of the investigation it is, however, difficult to attribute the sweetness of the water definitely to any one of these impurities. As has already been stated, experiments show that the survival time of cyclops as well as that of the guinea-worm embryos is definitely shortened when they are isolated in brackish draw-well water. Therefore I think that a more detailed chemical analysis of these different samples of water might reveal the presence of certain substances naturally present in some which inhibit the growth of cyclops and guinea-worm larvae in them. Any such data collected will be of considerable importance since they may not only give a clue to the preventive measures that can be instituted, but incidentally may also serve to explain the prevalence of guinea-worm infection in only a few villages in the district, though there are any number of other villages which derive their drinking water supply from similar step-wells.

Biological control of dracunculiasis—(a possibility).—In this connection it is of interest to note that in one village Gannanaikanhalli in Chitaldrug district, about eight years ago there was a breach of the ditch situated close by and a large number of fish, most of them belonging to the genus Barbus, were accidentally introduced into this step-well. Before the accident happened there was not a single fish in the well and nearly 20 to 30 per cent. of the population of this village used to suffer from dracunculiasis almost every year, but since the introduction of these fish guinea-worm infection has become practically extinct in this village. The specimens of fish collected from this step-well were sent to the Indian Museum, Calcutta, where the following different species of Barbus were identified:—

1. Barbus saphore.
2. Barbus chola.

Taking the clue from the information given by the villagers, a few preliminary experiments were undertaken. The problem is still under investigation and from the observations that have been so far made, it has been noticed that one of the species of fish mentioned above—Barbus puckelli—feeds voraciously on cyclops. On account of the comparatively sluggish movements of the infected cyclops the fish appear to feed better on infected rather than on non-infected cyclops. When an emulsion of live guinea-worm larvae was put into a basin in which this species of fish had been isolated, and the intestinal contents of the fish were examined 12 hours later, it was found that this species of fish easily became infected with the guinea-worm larvae. Unlike the cyclops which are easily digested when they are taken in by the fish, the guinea-worm larvae were found to be alive and seen actively moving in the intestinal contents of this fish. At this stage of the investigation it is difficult to say whether similar infection of the fish with guinea-worm larvae takes place in nature. However, field observations made so far show that in heavily guinea-worm infected places, the step-well does not contain any fish. At present it is also difficult to estimate the value of this species of fish in the biological control of dracunculiasis.

Photomicrograph of guinea-worm larva found in the intestinal contents of fish—Barbus puckelli—(infected experimentally).

In one of the collections of cyclops the laboratory boy had brought a few mosquito larvae also. While conducting certain feeding experiments on this fish it was accidentally noticed that this species of fish—Barbus puckelli—feeds on mosquito larvae also voraciously, as do other mosquito larvicidal fish that have been described.

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The little work I could do on this problem was in no small measure due to the ready help and able guidance given by Dr. D. A. Turkud, Dr. J. V. Karve, Director of Health in Mysore, and Mr. L. N. Rao, Central College, Bangalore, and my grateful thanks are due to them. I must also thank Mr. D. D. Mukherjee of the Indian Museum for having kindly identified the different species of fish sent to him.

REFERENCES


A BIOLOGICAL METHOD FOR THE CONTROL OF DRACONTIASIS*

By V. N. MOORTHY, B.SC, M.B., B.S., D.P.H., D.T.M.
and
W. C. SWEET, M.D., Dr. P.H.

In two earlier articles (Moorthy, 1932 and 1932a) reference was made to the probable usefulness of certain species of fish in the control of dracontiasis, due to their habit of feeding on cyclops and guinea-worm embryos. This biological method has been in use in the Chitaldrug district of the Mysore State since 1931 and this report covers observations on its utility as a practical field measure for the control of guinea-worm disease.

A survey of the Chitaldrug district made in 1929 showed that

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*The work here reported was begun by the Mysore State Department of Health and continued with the support and under the auspices of the Department of Health, Government of Mysore, and the International Health Division of the Rockefeller Foundation.