https://doi.org/10.29321/MAJ.10.A01482

Farming will never be a success unless the farmer had more voice in the disposal of his produce—P. Morrel.

The

Madras Agricultural Journal

(ORGAN OF THE M. A. S. UNION)

Vol. XVIII] SEPTEMBER 1930 [No. 9

THE RÔLE OF THE ZOOLOGIST IN THE FIELD OF APPLIED BIOLOGY*.

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The subject I have selected for this evening's discourse is already known to you and I dare say most of you have a copy of a rough abstract of my paper. My idea in selecting this theme is to present a very brief survey of the more important lines of work in which the Zoologist has contributed so far to the progress of Applied Biology and indicate what his future functions might be; as a student of Zoology myself, and this being our inaugural gathering I thought such a subject may not be inappropriate on this occasion and not stale, at least, to those among us who are not Zoologists and to whom such a paper on the general economic aspects of a sister science may appeal. Though the study of Zoology was in existence as early as the fourth or the fifth century B. C. the progress of this science was greatly influenced by various world movements. From the decline of the Greek Civilisation on through the Roman and early Christian epochs—which may be called the 'Dark Ages' for the natural sciences, very little progress was made not only in Zoology but in the allied sciences as well. In the 16th Century a revival began, when bold natural philosophers like Vesalius, Bacon and Harvey broke away from the bonds of political and ecclesiastical authority and asserted their views and the results of their observations. Since then zoological studies made rapid progress and in the succeeding centuries remarkable researches and revolutionary discoveries were made by such eminent and well known scientists as Linnaeus, Cuvier, Von Baeer, Lamarck, Darwin and Wallace—to mention only a few of the galaxy of

* Inaugural address to the Association of Economic Biologists, Coimbatore (20th June 1930).

brilliant naturalists. It must be stated, however, that until about the middle of the last century zoological studies were pursued more with the idea of discovering and elucidating scientific truths than with the object of utilising the knowledge so gained towards the everyday needs and practical affairs of man ; in other words very little attention was paid to the applied aspects of the science as compared with the purely academic and philosophical sides of it. But the rapid march of civilisation, the general increase in the earth's population, the growing rivalry among the more advanced nations in the exploitation of the rich tropical regions, the frequent wars in that connection and the consequent economic needs of human communities all over the world —all these have compelled man to look for the applied aspects of the different sciences for his future needs. Thus, within the past sixty or seventy years the study of economic zoology has been making rapid strides, and this is also due a great deal to the progress of Agriculture which began to loom large in the public eye. Within a comparatively short period of time so much work has been done in Zoology that special branches of studies have developed in modern days such as Protozoology, Helminthology, Parasitology, Economic Entomology, Pisciculture, and Economic ornithology. The subject of my discourse can be conveniently dealt with in one of two ways, one method is to consider the work of the economic zoologist in the different groups of animals in their natural order, while the other is to treat of the economic importance of the various animals connected with the different human departments or activities, such as animals concerned in food and clothing, those connected with diseases, those connected with various industries and so forth. I am taking up the former method and in doing so I shall very briefly and rapidly review the work done by the zoologist in the more important economic aspects of the different groups of animals and wherever possible indicate future lines of work ; anything like doing full justice to the importance or magnitude of the subject is far beyond the possibilities of a short paper like this and with the time I can reasonably expect to take to-day. I have a few slides and diagrams to illustrate some of the statements in my paper and I believe that in subjects like this a diagram is more effective and telling than a torrent of the most carefully selected adjectives.

Starting from the lower rungs of the Animal Kingdom we have the *Protozoa* or unicellular organisms. It will be seen that in no group of animals has work of such remarkable nature and magnitude been done in such a comparatively short period of time as in this group, and the branch of Protozoology has advanced by leaps and bounds and has almost outbeaten all other branches of biological study in its economic importance. The wonderful researches in the aetiology of malaria, yellow fever and sleeping sickness, the study of the causative organisms and their life histories in different hosts —these alone of the many other studies connected with Protozoa will be sufficient to indicate some of the outstanding triumphs of modern scientific investigations. Other studies worth noting are the researches in connection with the organisms causing Pebrine in silkworms, Kala Azaar in man, Surra in horses and Texas in cattle fever. Most of the protozoan investigations relate to medical and veterinary branches and the application of such knowledge in the alleviation of pain and the treatment of some of the deadly diseases to which man and beast are subject to. The love and devotion to science of many of the medical zoologists who have carried on investigations, often under very trying and risky situations, can only be compared to their marvellous achievements in the field of Science, and humanity should ever be grateful to these

eminent workers. Pebrine is the earliest known of Protozoan maladies and this disease was on the point of completely ruining the silk industry of France, when Louis Pasteur saved the same by his studies of the Pebrine organism and his method of microscopic selection of seeds. Recent researches in rabies have made it easy for medical men to diagnose as to whether a suspected dog is rabid or not by an examination of its brain cells for 'Negri' bodies and then decide as to whether a bitten patient needs the pasteur treatment or not. In the following table are enumerated some of the important protozoan organisms with their pathogenic characters to show the importance and magnitude of the work done.

Name of organism	Disease it is connected with	Remarks
Nosema bombycis.	Pebrine.	In silk worms.
Entamoeba histolytica.	Dysentery.	In man in tropical and semitropical regions (by fly).
Negri bodies in brain.	Hydrophobia.	In dogs and man.
Trypanosoma gambiense.	Sleeping sickness of man.	Africa, carried by Tsetse fly.
Plasmodium spp.	Malaria.	All over tropics (by Mosquito).
T. evansi.	Surra in horse.	N. India (by stable fly).
T. brucei.	Cattle nagana.	Africa (by Tsetse fly).
Piroplasma bigemina.	Cattle fever.	Tick (*Boophilus annulatus*) Texas (first protozoan disease carried by arthropods).
Leishmania donovoni.	Kala azaar.	Asia (Bug).
Leptospira icteroides.	Yellow fever.	Central America (mosquito).
Spironema sp.	Relapsing fever.	Asia (Lice).
Treponema pallidum.	Syphilis.	Widely distributed.

Before leaving protozoa it may be interesting to make a passing reference to the recent researches in soil protozoa and their effect on field crops. Russell and Hutchinson have propounded a theory to the effect that many soil protozoa are injurious to the growth of plants and that a partial sterilization of the soil yields better crops; this new theory is likely to lead into interesting avenues of investigation.

Leaving the unicellular animals we come to the lowest of multicellular forms, the group *Porifera* or sponges. It is probably not known to many that sponges are of animal origin and that they have any economic importance. The bath sponge or sponge of commerce used for toilet and other purposes is the fibrous skeleton (called spongin) of a colony of sponge organisms; this skeleton is rough when dry and smooth and flexible when wet. The studies on these creatures have shown that they can be artificially cultivated from cuttings in shallow seas; and at present sponge farming on a large scale is carried on in parts of the Florida coast and the Mediterranean.

From sponges we come to the next economically important group the '*Worms*' which constitute a very important division both from the purely scientific and the economic points of view. As in the case of protozoa the studies on worms have been chiefly confined to those forms having a pathogenic importance and a special branch of zoology called Helminthology has been erected to include such and allied studies. Most important of such worms are the Flukes, tape worms, and the round worms including among others the human eel-worm, the pin-worm, the filiariasis worm, the guinea-worm, and the notorious hook-worm. As in Malaria and yellow fever it has

been found that some of these worms during their life pass through alternate hosts. A knowledge of the relationship between the liver fluke (the cause of liver rot in sheep) and the garden snail, the human tape-worm and the ox, the guinea-worm and the water-flea, and the filarial worm and the house mosquito—all these have considerably helped us in devising various ways and means in the control of such disease carrying worms. Considerable amount of work has been done in recent years on the hook-worm *(Ancylostoma)* in the different parts of the world and it has been found that it is one of the worst maladies affecting man in the tropics, and that combined with malaria it has affected very appreciably the health of the labouring classes and racial stamina in the tropics. The Rockfeller health board is doing remarkable work of a philanthropic nature in this direction in different parts of the world.

Apart from these forms affecting the health of man there is a small group of worms called Eelworms, very minute forms with a wide distribution all over the world and affecting cultivated crops of different kinds; they live inside roots and rootlets and cause root nodules and often kill the plants. In this country we have eel worms attacking tea, pepper, betel vine, and a number of garden plants; it is probably known to many of you that the 'Ufra' disease of paddy is caused by an Eel worm. The studies on earthworms and their beneficial effects on the soil are too well known to deserve any special remark here. The Leech which is occasionally used as a blood-sucker by surgeons is a great nuisance in the hill plantations and causes great deal of bleeding among coolies working barelegged. Not much is known of the bionomics of these forest forms, and these deserve attention.

The group *Mollusca* including shelled animals is of economic importance in different ways and zoological work on them has helped man considerably. Studies on the breeding and seasonal habits of different kinds of oysters, mussels and snails have enabled such industries as oyster and shell fish farming, Pearl fisheries and mother of Pearl industry to develop on a commercial scale. There are regular oyster breeding farms in the west, especially in America where oysters are extensively used as an article of food. Snails are a delicacy in France and in some of the restaurants of Paris I was shown costly dishes made of snails called *Escargot* in French. Around Paris there exist snail farms called 'Snaileries' where special studies are made of the breeding and other habits of these creatures and number of them reared for the city markets. The importance of the Pearl oyster *(Margaritifera)* is well known to us all. The formation of pearl inside the shell of an oyster is the secretion of pearly substance by the creature around a foreign body which irritates its soft body; it is believed that this foreign body may be a grain of sand, a calcareous particle, or even the larva of a parasitic worm. The industry thrives generally in the Persian Gulf, in the Gulf of Mannar and other places. Recently in Japan Prof. Mitsukuri has very successfully produced pearls by the introduction of foreign particles inside the bodies of oysters and this method of producing what is called 'cultural pearls' as different from 'natural pearls' or 'artificial pearls' has recently been attracting great attention among those interested in Pearl fisheries. Allied to this are the minor industries, such as collection of shells and cowries of sorts and the mother of pearl industry connected with the manufacture of buttons, combs and other fancy articles.

We now come to the big sub-kingdom *Arthropoda* which includes the groups *Crustacea* (Crabs, prawns, etc.) *Arachnida* (Scorpions, spiders, ticks, mites, etc.) *Myriapoda* (centipedes and millipedes) and the division of *Insects*. The first three groups include fewer forms and are not of such

economic importance as the insects. Considerable amount of work has been done on insects both from the purely scientific and economic aspects, and the branch of Economic Entomology has come into great prominence nowadays, especially due to the rapid progress of scientific Agriculture. One important point which the economic entomologist has to note in the study of insects is the phenomenon of metamorphosis—passing through a series of different stages in the life history; the different stages are in most cases so different in structure and habits that the layman and even some educated men would refuse to believe that the leaf-eating caterpillar crawling over the plant is the young one of the gaudy butterfly hovering in the air; this aspect necessitates a more thorough study of the insects of economic importance.

It is needless to state that insects affect human interests in various ways both for good and evil more than any other or all the other groups of animals put together. To have a rough idea of the loss caused by insect pests to cultivated plants I might quote the statement of two well known American authorities. According to Webster 'It costs the American farmer more to feed his insect foes than it does to educate his children; the estimated damage done by insects comes annually to 400 million dollars while the common schools and higher educational institutions cost together only about 300 million dollars.' According to Slingerland 'the yearly losses from insect ravages aggregate nearly twice as much as it costs to maintain our army and navy, more than twice the loss by fire, twice the capital invested in manufacturing agricultural implements, and nearly three times the estimated value of the products of all the fruit orchards, vineyards and small fruit farms in the country'. A vast collection of literature has accumulated around this subject of Economic Entomology, and so I can do nothing more than give a glimpse of this subject in this short paper, one with a more comprehensive theme. Some of the farmers' pests which have gained international notoriety are the locusts, termites, scale insects, fruit flies and caterpillars of sorts. The depredations of termites are serious all over the tropics and to have an idea of their ravages we may quote Drummonds' words during his African experiences, *viz.* 'If a man lay down to sleep with a wooden leg, it would be a heap of dust the next morning'. I daresay many of you must have seen the termite queen. If there are any who have not had an introduction to Her Majesty I have got some specimens here. We have at present the locust problem engaging the attention of the authorities in North India, and the menace of fruit flies is always before us though the dreaded Mediterranean form (*Ceratitis*) has not come into our midst. The notorious Fluted Scale (*Icerya*) has gained admission and it remains to be seen what more is in store for the future. In addition to these crop pests are the pests of cattle and domestic animals, the household insects, and those affecting man himself. Some of these latter have been referred to in connection with Protozoan diseases. Almost every one among us, scientist or no scientist, is aware of the extent and seriousness of the harm caused to public health by the common and apparently innocent looking housefly; such dreadful diseases like cholera, typhoid, dysentery, pneumonia are easily transmitted by this insect wherever opportunities offer themselves, and we cannot sufficiently warn householders to be on the guard against this most dangerous insect.

Many of us in Coimbatore know by actual experience the part played by rats in the spread of bubonic plague; it is now well known as a result of studies that the rat flea—an active little insect living on the rat, is the transmitting agent of the disease germ from rat to man. Nor are cattle and

domestic animals free from the attention of noxious arthropods. Numerous ticks, mites and flies not only seriously affect their general condition, but often kill them in numbers. The life history of the Horse Bot is one out of the many interesting investigations not only to give us an idea of the wonderful adaptations in the animal world, but also the great value of zoological observations. The bot fly attacking the horse attaches its eggs singly on the hairs in the regions near the fore legs of the horse. When the egg is about to hatch or has just hatched the horse feels some slight irritation and licks up the maggot which on that account finds its way into the horse's stomach through the alimentary tract where it remains for some months and then passes to the soil with the faeces. If the eggs are laid beyond the reach of the horse's tongue and if the horse does not lick up the maggot, there is no hope for it but to die. The scabies in sheep, the red mange in dogs, the itch and kopra sores of man are all arthropod diseases and considerable amount of work has been done in this line both by pure zoologists and veterinary men in studying the habits of the responsible arthropod organisms and contriving control methods.

As though to compensate for all these losses, we have another set of arthropods which are on the other hand useful to man in different ways; this aspect of their beneficial activities is often overlooked because it is not so very obvious as compared with the depredations of injurious forms. Sericulture, Bee-keeping, and Lac culture form the most important industries related to the respective beneficial forms—the silkworm, honey bees and the lac insect. In addition to these which may be called as productive insects there are others which help man in such acts as fighting both his plant and animal pests, as parasites, predators, etc., serving as articles of food, drug or ornaments, or in the pollination of flowers useful to him. An interesting example of the latter is furnished by the Smyrna fig the proper fruiting of which is absolutely dependent on the fertilizing wasp 'Blastophaga' for which one must have Capri figs in which the insects breed. The process is called 'Caprification,' and without this process the Smyrna fig industry does not thrive. I think it is time that I now leave this group of animals lest I unnecessarily wax eloquent on insects having become a little more familiar with them during the past two decades.

We now come to higher animals. Almost every one of them has some economic importance or other, and a good deal is well known to most of us; so, I shall just skip over the groups just touching on such points which, in my opinion, may be of interest and may not be too well known to all of us.

The studies in *Fishes* relating to the recognition of edible and poisonous forms, the breeding, spawning and migrating habits and the methods of artificial propagation, preservation and canning—have all within the past few decades helped to build up various famous and flourishing fisheries industries in almost all countries. The discovery of some kinds of fish as mosquito destroyers and their employment in mosquito-ridden regions may also be mentioned in connection with the economic importance of fishes. Some of us would naturally doubt as to whether such creatures as frogs and toads have any mission or economic importance in this world. As a typical animal for experimental purposes and dissection in science institutions the frog has been found very handy and it is practically the 'martyr' for zoological studies. It is perhaps known that the frog is used as an article of food in many western countries and I have had occasion to see them being sold alive for food purposes in the markets of California. Regular frog farming is carried on in different places and there

is said to exist in Ontario a farm in operation for the past 25 years, producing every year 7,000 living frogs, in addition to 500 lbs. of dressed frogs' leg which is regarded as a special delicacy; zoologists are employed by these farms to investigate into the life history, breeding season and habits of different frogs so as to keep the industry flourishing. All of us are familiar with the tadpole stage of the frog and it has been found by frog farmers that the tadpole does not change into the tailless frog unless the edge of the natural or artificial pond has a sloping side, and in its absence remains as a tadpole for months together. Another interesting and important problem with which these frog farmers who have to keep thousands of frogs alive all through the year is said to be that of feeding them; for, the frog does not eat anything that is not moving though the tadpole in the water eats anything. I have referred to this apparently unimportant fact just to give an example of how small points in zoological studies often become important economic problems. Toads are not generally eaten but are very useful as insect destroyers as may be found by their presence in numbers around electric lights in the streets which attract numerous small insects. Kirkland in his account of his observations on the American toad says that the toads food is about 88 per cent insects and 16 per cent of these are cut worms and counting these cutworms alone he has estimated the annual saving to the farmer by each toad as 20 dollars or nearly Rs 60. During a pest of army worms he found in toad's stomach 55 worms; as such, as an insect destroyer the toad has few superiors.

A study of lizards and snakes has generally enabled us to recognise which of them are harmless and which dangerous or poisonous. It has been found that among lizards of which there are hundreds of species the American 'Heloderma' is the solitary example of a poisonous form. As to snakes the most important of our poisonous forms are the Cobra, Russell's Viper, Bungarus and the Pit Viper. A great deal of work has been done both by Ophiologists and medical men in the study of snakes of different kinds, the poison apparatus of the different forms, the nature of the poison, the treatment of snake bites, the preparation of anti venom sera and all these have received considerable attention in modern days, and men like Col. Wall have helped the layman a good deal in this direction and deserve our grateful thanks for such work.

The economic importance of birds in various ways and the work of zoologists in that direction have developed the branch of Ornithology. Many birds are used as food both as egg, and adult, many are useful as insectivorous and helpful to man and there are a few valued for their plumage. The African Ostrich, the largest of living birds, sometimes reaching eight feet in length is reared in ostrich farms in South Africa chiefly for its beautiful white plumage. The flesh of it is not much eaten but the egg is relished and is said to contain as much food as two dozen hens' eggs. At the same time there are some like the sparrow, crow, and some graminivorous and frugivorous birds which do us harm. The study of the food, breeding and migrating habits of birds—especially of those affecting man's interests has brought economic ornithology to an important position among applied sciences.

We now come to the highest group of animals the *Mammals*, which includes among others many of the oldest companions of man like the cow, the sheep, the horse, cat, dog, rat, etc. etc. There is hardly any necessity for me to dwell on such well known and ancient aspects of mammalogy as sheep breeding, stock raising, animal Husbandry etc. etc. The rats, jackals,

squirrels, and monkeys are some of the mammals which cause often serious damage to our crops and other belongings, and attention is nowadays being paid to study the habits of these pests and vermin and to control them. The injury caused to man and his belongings by such wild animals as tigers, leopards, board, elephants etc. are also too familiar and shikars and naturalists have helped us considerably in adding to our knowledge of the habits of these animals—especially the pages of the Journal of The Bombay Natural History Society abounds in information on such topics connected with Indian forms and these will be very useful to us in many ways. I would, however, invite your attention a little to one or two interesting aspects of mammalogy with which I believe some of us are not quite familiar. I refer to the economic importance of the aquatic forms like whales, seals and the fur bearing groups of mammals like foxes, sable, otter, skunk etc. The economic importance of whales consists in the demand for a few important whale products *viz.* whale oil, whale bone, spermaceti and ambergris. Whale oil is got by boiling the thick fatty layer just below the naked body surface, 12 to 18 inches thick in some cases, and fetching about 30 tons of oil from each whale. This has been used for various purposes, chiefly candle making. Whale bone which is found in toothless whales, is a structure composed of a series of fringed plates attached to the upper jaw and this helps the creature in feeding by straining all the small animals from the water which enters its mouth. These were in use largely for ladies' (crinoline) dresses till recently but at present there is not so much demand for it. Spermaceti is a wax like solid obtained with the oil, especially from within the skull of some whales; this is also used in the manufacture of candles. Ambergris is a light solid often found inside the intestine of the sperm whale. It is a very costly stuff and lumps have been obtained worth about Rs 30,000; it is used for medicinal purposes and chiefly in the manufacture of perfumes. The flesh of whales is made into guano as with fish. Whale fishing is a very old industry and until a few decades ago whaling was carried on extensively and indiscriminately so much that some of the species of whales became almost extinct. Nowadays men engaged in this industry have found out that whaling should be restricted not only in the interests of the industry but in the interest of the conservation of the different species of whales which were almost nearing extinction. Some measures adopted in different areas comprise the annual licensing of whaling steamers, prohibition of whaling in some waters and protection of gravid females and cows accompanied by calves. In this way in the interests of zoological science as well, measures to conserve these leviathans of the ocean from becoming extinct have been gradually adopted. Similar is the story regarding the aquatic carnivora, popularly known as seals, but which include the sea lions, the walrus and the true seals. Like the whales these are adapted for an aquatic life though they have not become modified to such an extent as in the whales. Seals are hunted for their skin or pelt and for their oil. Sealing was carried on indiscriminately and seals were ruthlessly slaughtered and consequently the number of animals began to decrease considerably and the sea elephant was almost extinguished. At the suggestion of some American naturalists pressure was brought on Government and an international treaty was agreed to in 1911 whereby measures to conserve these animals were adopted. The fur bearing mammals are chiefly of the Weasel and fox family and distributed in the north temperate and polar regions. Russia, Greenland and Canada being the chief centres for the fur industry. Fur industry is a very old industry since furs were important objects of barter between civilised and savage communities. Recent investigations on the

habits of the various fur bearing forms have helped not only to place this industry on a solid foundation but to conserve many of the fur bearing animals from becoming extinct.

Gentlemen, I have now finished my very rapid survey of the economic aspects of the different groups of animals. I feel that in doing so I have chiefly dwelt only on the economic aspects of the different groups and the work done so far by the zoologist and that it was not possible for me to dwell satisfactorily on the future rôle of the zoologist, especially on such important subjects as principles of pest control, Biological methods of pest control, legislation for animal conservation especially for birds and wild beasts of sorts, and such interesting matters. Before I finish I beg to be allowed to make just a reference or two to certain other aspects of the zoologist's work which have proved of great material and moral value to mankind. The investigations on such important phenomena as Parasitism, Social life and the various adaptations in structure and habits as mimicry, protective structure, maternal instinct and a host of other characters which Thomson aptly calls 'shifts for a living' have taught many lessons to us which often influence our worldly affairs. To take only one or two examples out of the many—a knowledge of the social or family life among animals especially, such forms as ants and bees have helped us to understand such things as co-operation division of labour, union, team work and so on; similarly from parasitism in animals we have learnt how in its wake follow dependence on another and the loss of individuality and degeneration. Apart from these which might help man in his behaviour etc., the accumulated knowledge of animals in their various aspects have given plenty of material for man to understand or at least get a partial insight into such phenomena as Variation and Heredity and the principles of Genetics, Eugenics etc. The earlier but none the less remarkable and classical works of naturalists like Darwin, Wallace, Mendel and Weissman have been considerably augmented by modern zoologists and botanists in different ways. In the branch of experimental zoology which has considerably developed in connection with these studies, most remarkable and wonderful work has been done by eminent scientists like Morgan, Castle, Newman, Wilson and many others, in solving some of the most wonderful problems in Biology. The Classical work on the Pomace fly (Drosophila) by Prof. Morgan of Columbia and the results so far achieved in that connection will alone stand as one of the most wonderful and remarkable accomplishments in Biological science, since it led to the discovery of the Chromosome theory of heredity. Such accomplishments in co-operation with the work of Botanist's on similar lines have revolutionised plant and animal breeding and made Applied Biology a science of vital importance to humanity. I cannot do better than sum up the value of the Zoologist in his relation to human activities by quoting the words of Mr. Wilson the Chief of the U. S. A. Biological Survey some years ago.

"In its relation to public welfare economic zoology is of the most vital and far reaching importance. Animal life from its lowest organisms, among which lurk some of our deadliest foes as well as beneficient friends, to the highest vertebrates, touches and affects our lives and welfare in innumerable ways. It must be studied in all its phases as never before to guard against previously unsuspected or little known diseases of man and domestic animals as well as to develop the wealth and ever increasing variety of products from which we obtain food, medicines, clothing, dyes, ornaments and an endless number of useful articles. No man can be considered well informed who has not a considerable knowledge of economic zoology in its more direct relationship to human life, while to the scientific investigator the subject has the charm of endless variety and service to mankind."

While I yield to none in my appreciation of the importance of applied zoological work, I must be allowed to point out that there is a deplorable tendency in some quarters to belittle the value of work in pure or systematic zoology on the score that such work may not be of immediate economic importance; such an attitude on the part of one who professes to be a scientist cannot be sufficiently deprecated; for, no zoological work of an applied nature can progress on correct lines without the sure foundation of preliminary studies in pure zoology and systematics. I would invite the attention of such short-sighted men to the words of the eminent scientist Prof. Pearl—'It is the systematist who has furnished the bricks with which the whole structure of biological knowledge has been reared, without his labours the facts of organic evolution could scarcely have been perceived and it is he who to-day really sets the basic problems for the geneticist and the student of experimental biologist.'

In my opinion the most important lines in which biological work might be carried on to be of great help to the economic zoologist are intensive life history and systematic work and the study of animals from an ecological point of view—an aspect of zoology in which very little work has been done in India.

'Animal ecology is a branch of zoology which is perhaps more able to offer immediate practical help to mankind than any of the others and in the present rather parlous state of Civilisation it would seem particularly important to include it in the training of young zoologists. It is the real foundation for applied Biology. The tropical entomologist, mycologist or weedkiller will only be fulfilling his functions properly if he is first and foremost an Ecologist' (Elton).

In conclusion I would add that while in these days there is need for specialisation on the part of different biological workers each in his own branch, a general knowledge on the part of each of the specialists of what others are engaged in will be of great advantage to all; since, nowadays, there arise numerous biological problems which call for co-operation and team work.

Gentlemen, I have now finished with my apparently imperfect and unconnected thoughts. I am afraid, my paper might have been to some a rather tedious infliction; if it were so I am indeed very sorry, but if I have succeeded in creating in my hearers some interest in some of the many problems I touched upon I shall be amply repaid and feel that I have not wasted your valuable time.