editor, Mr. Kunhi Raman Menon, has often declared him his right hand.

He was highly respected wherever he was known. Possessed of a large fund of humour and ready wit, he was a brilliant conversationalist and was known amongst his colleagues as "Mark Twain" of the Legislative Council. That he was elected by the jenmies and landholders of Malabar and South Canara to represent their interests in the local Legislative Council is sufficient proof that he had the confidence of his constituents, especially if it is remembered that Rajah Vasudeva Rajah of Kollengode who had already sat with distinction for 2 terms in the Council was his rival competitor for the seat. The late Hon'ble Mr. Nayanar was one of the first Vice-Presidents of the Union and presided at its first General meeting. He was an Honorary visitor to the College and one of the first Benefactors of the Union.

We offer our heartfelt condolence to his son, Mr. M. A. Kandeth, Professor of History in the Presidency College, to his cousin Mr. Krishnan Nayanar and all the members of his family.

The late Mr. S. Raghunatha Rao.

We have to express our heartfelt condolence with the widow and children of the late Mr. Raghunatha Rao who went on furlough about 18 months ago. He was another Saidapet first class graduate and one of the Agricultural Inspectors entertained by Mr. Benson. He was Farm Manager, First grade, at Nandyal when he took furlough and was one of the first members of the Students' Union. A quiet-going man, of a somewhat reserved nature, he did his work conscientiously and we are sorry that he did not live to enjoy his pension.

The late Mr. K. S. Narayana Aiyar.

Yet another Saidapet College Student whose early death we deplore is the late Mr. K. S. Narayana Aiyar who was Agricultural Instructor in the Training school at Kurnool and latterly at Villupuram. He had gone to conduct the oral and practical Government Technical Examinations in Agriculture and Elementary Botany at Sivakodu in Godavery District and succumbed to a sudden attack of Cholera. He was a keen teacher of Nature Study and was a successful school-gardener. He leaves behind him his widow, two sons and a daughter to whom we extend our sympathy.

* The Problems of an Economic Entomologist.

To even the literate layman an Entomologist is but one of the army of the new-fangled —Zoologist and Geologist, Bacteriologist and Physiologist, Mycologist and Pathologist, Psychologist and Ethnologist — that have all of a sudden burst on the fossilised civilisation of an old-world India. He may be even tempted to think that the word "Entomology" is really a misspelt form of Etymology —a dear old friend of his, whom he has shaken hands with at the very entrance into the regions of English grammar. It is not, therefore, surprising if the average Indian ryot, who is generally ignorant of English and whose outlook is usually limited to a few miles around his native village, neither has any ideas as to what an Entomologist may be nor can understand his ways. The Entomologist is an enigma to him, with his net and tubes and pill boxes, hunting after butterflies and beetles, grasshoppers and caterpillars. To him the type of a respectable officer, beneath, of course, the grade of the all-powerful Collector Saheb,—is

* Paper read at the last Agricultural Conference by Mr. Y. Ramachandra Rao, M. A., Assistant to Government Entomologist.

the Tahsildar, Subadar or Amildar, the Sheristadar or the Police Inspector. He can understand an Overseer, a Stone Inspector (Land Records Inspector), a plague Inspector or even a cattle doctor, but a puchi wala! he is above his comprehension! Can such an officer be? Is it possible that the Government can be so feather-brained as to employ one whose sole business is to catch insects? He smiles and he wonders.

Who then is the Entomologist and what is his work? Described in brief, he is essentially a lover of nature and a keen observer of the ways of her creatures. His supreme pleasure lies in probing into the secrets of nature. A net in his hand, a satchel full of collecting materials on his shoulder and perhaps a small kodak in his pocket, he walks on and on, wandering about as one demented—intent on observation and collection—knowing neither hunger nor fatigue. Now he is after a splendid swallow-tail butterfly—rushing through a thorny jungle or down a steep incline, running as if his very life depended on the capture of that much-valued specimen for his cabinet. Or he may sit hours together at a spot, watching a wasp capturing spiders or grasshoppers or caterpillars and storing them in its nest, or following the manifold activities of ants—which embody the highest form of intelligence or instinct among insects and whose social organisation outrivals that of man in certain respects. Perhaps he may be seen half-buried in mud in marshy corners of jungles, engaged in collecting rare insects, or following the life history of perhaps some noxious insect whose breeding habits may have been unknown till then.

His collecting work over, he gathers together his spoil, takes them home and carefully prepares them for his beautiful cabinets—containing undoubtedly a magnificent array of rare and lovely forms—which he now and again goes over and gloats upon, as a miser would on his hard-saved gold.

Here then is a picture of an ideal Entomologist—unfettered by any responsible work. In most cases, a private man working at the subject as a hobby, he is as free as air and, being his own master, can go where he lists and collect what he likes. His pursuits are all—embracing and

are not shackled by considerations of the economic interest of the insect.

Far different is the position of an Economic Entomologist who has certain definite duties to perform. Instead of being a hobby, his is a serious work on which important interests depend. He is not free to hunt after butterflies or ransack forests for rare beetles, except perhaps on rare occasions. His avowed business is to apply his knowledge of the habits and lifehistories of insects to every day life and thus make himself useful to the public. His work does not necessarily lie in dense forests, perhaps untrodden by human foot-steps, but in tracts densely populated—city or country alike—where man's handiwork is most in evidence.

Here comes the question as to how the Entomologist—or in other words the scientist who makes a special study of insects—has anything to do with the public and as to how the latter is interested in him. Insects—which, in brief, may be defined as small joint-legged animals with three pairs of legs and in general two pairs of wings also—are the dominant group among the terrestrial fauna of the world, or expressed in more intelligible language, are far more abundant than any other group of animals inhabiting the land—both in the number of individuals and in the number of species, and probably in fact may outnumber all the rest of the terrestrial animals put together. As such, they also form the major part of those that injuriously affect man and his interests. They may attack his crops and destroy them utterly as illustrated by locusts and grasshoppers, or attack his stored grain, meat or clothing, and thus affect him *indirectly*, or *directly* by biting him and sucking his blood and, in a good many cases, at the same time communicating various diseases from man to man. His work thus falls into two main divisions (1) *agricultural*, where he has to devise measures for ridding the crops of pests; and (2) *pathological*, where he has to investigate into the life history of insects carrying disease and think out measures for keeping the increase of such insects in check.

The vast importance of the pathological side of his work will be apparent to you when some of the many diseases borne by insects are

recounted. Foremost comes *Malaria*,--the great scourge of India from which very few persons remain free and which is the ultimate cause of a large percentage of mortality. This has been definitely established to be carried by certain species of Anopheles mosquitoes. Next come *Elephantiasis* iu its manifold disgusting forms—carried from man to man by the Culex mosquito: Typhoid fever, Pthisis or Consumption, Cholera and Dysentery and what not, spread broadcast by no less a personage than the familiar innocent-looking little housefly; and the dread bubonic plague spread by the rat flea.

As regards the agricultural side, with which this Conference is more directly concerned, it is a fact that may not be very generally known that there is scarcely any crop which is free from insect attack of some sort. There are a good many pests in Southern India capable of causing even total loss under favourable circumstances. Foremost among these is the Deccan grasshopper, an insect pest, for the last ten years responsible for a large amount of annual loss to the poor ryots of the dry land areas in Bellary and Kurnool. There is next the hairy caterpillar which infests red soil areas in many parts of the Presidency. The paddy stem-borer causes yearly a loss of at least 10% in most paddy growing areas. The rice bug does immense damage to paddy in some tracts, especially parts of South Canara. A caterpillar that appears at times in immense numbers all at once in certain years in Malabar, Chingleput & other districts may altogether wipe out the paddy crop. There is the green bug of coffee which was the cause of the once flourishing coffee cultivation being entirely abandoned in Ceylon, and is now in the process of causing very much the same catastrophe to that industry in South India. Besides these and certain others not mentioned here, which are of major importance, there are others which, ordinarily of minor rank, may suddenly assume a very destructive form in certain years.

What does the Economic Entomologist do to combat these inimical hordes? His first move is to see that he knows all about these pests — their modes of living and their food, their behaviour under various circumstances and their lifehistory.

The lifehistory, by the bye, of an insect is an important point about which the Entomologist must have a full knowledge, for an insect is not, as in man and the cow, the horse and the dog, born as it is (except in rare cases), but has to pass through a series of definite stages. The parent insect almost invariably lays eggs, from which, as in certain sub-groups of insects, young ones more or less similar to the adult ones except in their small size and their wingless state—are hatched: and these gradually grow into the mature insects. Or as in the other sub-groups, the egg hatches into a worm-like form—caterpillar, grub or maggot—which feeds until it is full grown, when it passes into an inactive resting stage—the pupa. During this period, the organs of the adult gradually develop, and when the change is complete, the winged adult emerges, The Entomologist has thus to find for each insect how and when exactly these stages are passed through.

Having thus studied its lifehistory and known all about it, he should be able readily to put his finger on the weak or vulnerable points in the life of the insect. Supposing, for instance, that the eggs were readily seen and laid in large masses, they could easily be handpicked or scraped out; or in case the pupae occurred in large numbers in the soil in certain definite localities, they could be advised to be dug open and collected or to be ploughed up.

In suggesting remedial measures one has to use the greatest circumspection. It is essential that, if the remedies proposed are to be practical, they ought to pass through the severe test of common sense. They should be efficient and at the same time cheap, simple and at the same time suited to local conditions. It will of course be obvious, that it is an extremely difficult task to devise measures satisfying all the above conditions. What may be effective may in many cases be neither cheap nor simple. Cheapness bought at the sacrifice of efficiency is like gathering up the chaff leaving the grain behind. It must be clearly borne in mind that a panacea for all sorts of pests and diseases—although very desirable—is altogether a myth. Neither the wand of the magician nor the legerdemain of the juggler are of any avail against insects. The Entomologist has to plod on in an honest, straight-

forward way, study the insect pests and advise measures that would seem suited to the special nature of the infestation.

Entomology has been not inaptly described as a bundle of methods; and methods there are innumerable and of every sort. As most of these methods are dealt with in any good text-book of Entomology I shall not go into detail.

(1) The first measure recommended is *general cleanliness*—based on the principle "Prevention is better than cure"—a precept that is more often followed in the breach than in the observance. Pests almost always pass their resting stages in neglected corners of field bunds, at the base of bushes or in the stubbles left on the ground. If clean cultivation were resorted to, many of the pests could be nipped in the bud.

(2) Again most of the pests appear on crops in but small numbers at the outset, and are not then noticed. As insects are capable of laying a very large number of eggs—at times more than a thousand—, the pest increases enormously in the succeeding generation and causes immense damage to the crop. If the ryot had been vigilant and destroyed as many of the first generation as possible, much of the damage could have been prevented.

(3) The above methods are of a preventive nature. In order to deal with an attack directly, he has first to consider the nature of the insect causing damage. Insects have either (1) biting mouth parts wherewith they gnaw the leaves or stem or attack other insects or (2) have sharp sucking apparatus wherewith they pierce plant or animal tissues and suck up plant-sap or blood. Where insects having biting mouthparts are concerned, the plants affected may be treated with some form of arsenical poison—either dusted as powder or sprayed mixed with water. The insect, as it feeds, also takes in the poison and dies.

(4) With insects with sucking mouthparts, such poisons are no good, as they cannot reach the plant sap which alone the insects feed on. Here, when small delicate insects such as plant-lice and scale insects are concerned, a contact poison may be used—usually an

emulsion of kerosine in soap and water and in some cases preparations containing resin. These contact poisons reach the breathing tubes of such insects and by closing them up suffocate them.

(5) In the case of larger and actively flying sucking insects and also of grasshoppers, neither stomach nor contact poisons may be any good. In such cases mechanical methods, such as collection by hand, or with handnets—may have to be resorted to. In wide-spread attacks of grasshoppers large nets of cloth have been found useful. They are carried by 2 men who run with them over the crop to be protected, when the hoppers or bugs which jump in or fly may be caught and destroyed.

(6) Many insects have a great attraction for light, which is sometimes made use of by setting light-traps in fields. The insects that come to the light fall into a pan of water and kerosine and are drowned.

(7) Most insects have a very keen sense of smell as may be exemplified by ants ferretting out sugar wherever it may be stored in houses. However it is only certain odours that are attractive to certain insects which do not respond to others. This property has been in a few cases taken advantage of for combating certain pests, but this method, though full of promise, is yet one wherein a good deal of more work is yet needed before it can become really practicable.

(8) *Natural Enemies.* Most insects have certain insect—enemies which can subsist only by feeding on these particular species, so that, when present in large numbers, they serve to check the extraordinary increase of these pests and keep them within certain bounds. Had it not been for these natural enemies, — which are the friends of the agriculturist — the whole world would have been overrun by insects and cultivation would have been impossible. In spite of the beneficial nature of these natural enemies, and their apparent usefulness in the hands of the Economic Entomologist, a study of their behaviour in nature shows that they cannot be relied upon on the whole. They increase only after the pest has reached its zenith of development

and when the actual damage has been done; and again they are themselves prevented from increasing by their own enemies, the hyperparasites. Except in the case of certain imported insects in America, natural enemies have not been very much utilised in practical Entomology.

The above are only a few of the ways by which the Economic Entomologist combats insect pests, for his methods are legion. Yet, in spite of his numerous methods, I must confess, he often shares the fate of the Jackal in the story, which in spite of the innumerable ways of eluding the enemy it had boasted of, could not escape when pursued by hunting hounds, whereas the cat with his only but ready method climbed up a tree safe out of their reach. It is often so difficult to decide as to the proper method in particular cases.

Now I trust I have been able to let you have a peep into the work and the methods of an Economic Entomologist. As part and parcel of the Agricultural Department his real goal is to aid the cultivator in his own way and enable him to "grow two blades of grass where one grew before." In this work he has innumerable difficulties to overcome and various problems to solve.

Firstly his information is not yet complete and his methods are not yet perfect. There are some pests which continue to defy all honest attempts at working out their lifehistory and certain others whose behaviour at certain periods—as for example where they hide during the dry summer months—has as yet been an unsolved mystery. In certain instances, even when every bit of the life of the insect has been known, not even a single vulnerable point is noticeable so that in these cases remedies are impossible.

In certain classes of insects—as for instance, the stemborers—remedies are extremely difficult to carry out. Where large trees are concerned the burrows might be searched out and treated with Carbon bisulphide or Chloroform and Carbolic, but where bulk crops such as cholam and sugarcane are concerned similar treatment is impossible.

There are some pests which appear all at once in such enormous numbers and, after destroying crops wholesale, disappear so quickly, that, unless ready and immediate action is taken at the very outset, it is hopeless to save the crops. In such cases where the utmost urgency is wanted, reports have been received—thanks to the red-tape of the public offices—months after they had disappeared.

It is a well-known fact that theory and practice do not always go hand in hand together but may sometimes be almost antagonistic to each other. In Entomology, as in other matters, when carrying out measures practically, one has to adjust oneself to the special conditions, often in ways at variance with the generally accepted theories of the same. In leaflets or in similar publications dealing with remedial measures, it is impossible to give any but very general measures as may be expected to suit ordinary cirumstances, but unless these measures are altered a bit to suit the special conditions of a locality, failure may result, in lieu of success.

In this connection I shall take the opportunity of pointing out the mistaken impression some people have about what an Enconomic Entomologist ought to be able to do. They expect that he should have ready at his fingers' ends remedies for every sort of insect attack, fancied or real. In case he tells them that he cannot suggest any till he studies the insect's lifehistory or confesses—after a detailed investigation—that he cannot suggest any remedies for a pest of a particular sort, they think that he has been remiss in his duties and make rather unkind remarks about him and about scientists in general. They do not understand that there are things impossible in this world and that there are limits beyond which even the utmost ingenuity of a genius cannot go. It is certain that, for certain pests, no practicable remedies can ever be devised and, if only such people be so reasonable as to put themselves in the position of the Entomologist and view from his standpoint, they would spare him such remarks.

Conceding now that he has studied the pest in question and has been successful in his experiment as to their control, his next problem

is how to bring it to the notice of the ryot and how best to convince him of the efficacy of his methods and make him adopt them.

1. The success or failure of the methods suggested will be determined by their degree of efficiency. When a pest is really destructive and the ryot keenly feels the loss sustained by him year by year, he will eagerly adopt any really good methods. The efficacy of the measures must, of course, be demonstrated actually in his fields and, if he sees for himself the good results obtained, you may be quite sure he takes to them. If, on the other hand, the remedies are only partially effective or involve personal trouble or expense out of proportion to the results obtained, he will never go in for them. My humble experiences with the Deccan grasshopper work in Bellary corroborate the above statements. *Bagging*, which was then the only feasible and cheap method that could be recommended, was demonstrated in various centres to the ryots, but was not eagerly taken up in any place in spite of much persuasion and a free distribution of sample bags, as they found that, though it did good work on the whole, it was only at the sacrifice of immense personal trouble; for, in order to be a success, each field had to be bagged more than six times before the crops had grown tall and in the teeth of the mostly beastly and howling winds imaginable.

2. Secondly, *cheapness* is even as great a factor as efficacy. The present conditions of the Indian ryot are very peculiar and distressing. The land is held both by monied proprietors and small ryots, but, practically speaking, the small ryot is the real man that tills the soil—either cultivating his own area or acting as the tenant of his neighbour, who, in many cases, is an absentee landlord. Owing to the property being divided equally between the sons of the same father, the holdings tend to become smaller and in some cases have become ridiculously small. The poor owner is himself generally in the clutches of the money-lender, often a rich neighbour who eventually confiscates the land for the money lent—the interest for which doubles and quadruples the principal in no time. Under these circumstances, the huge power spraying machines, the steam ploughs or the

fumigation tents used in the United States of America—where, with the large stretches of fertile land possessed by the farmers, conditions are entirely different— are out of place in India. Again much of the land in India is dry and rainfed and subject to the caprices of a fickle monsoon, so that, as was the case last year in Bellary, the ryots may spend both money and energy towards protecting their crops from pests but in vain, as the crops may utterly fail with the failure of the rains. It is therefore quite obvious that cheapness ought to be one of the essential features of the remedies suggested.

In the case of garden lands, especially where valuable fruits are cultivated, where the ryot is assured of a steady supply of water and where he practises intensive cultivation, the ryot may very advantageously adopt modern Entomological methods, for instance, by keeping a small spraying machine and spraying the crops in time when any pest is noticed. Even though the advantages of the methods may be evident, ryots do not in many cases take to them, simply because they are innovations—they look strange. Their fathers knew them not—nor their grandfathers nor their great grandfathers—and yet they thrived—why should not they? This line of thought is due to their natural conservatism which may be partly broken down by demonstrations and partly by educating them in up-to-date methods. Matters will have been a great deal smoothened for future workers if the present young generation get a sound education in such methods.

3. Thirdly. In the case of widespread pests of a serious nature, there is one factor in the absence of which the Economic Entomologist is helpless, however efficient his methods may be. I speak of the presence of co-operation among ryots. For instance, one of the chief arguments advanced against bagging or indeed any other method, was that unless all the ryots in an area unanimously adopted these methods, the pest might easily pass from an untreated to a treated field, and mar all the trouble taken by the careful ryot. The argument was of course well-founded. The only means at the hands of the worker in the field was persuasion and that was what was resorted to

but usually without much effect, for in a village, which is a microcosm in itself, people of all shades of character and all grades of understanding are found and are therefore very difficult to be convinced alike. In many cases there was sufficient cause to believe that more work could have been done, if means of coercion were at hand—just as salutary to the ryots as a rod to an unruly child,—but such a procedure is quite alien to the spirit of the Agricultural Department whose aim is to gain the confidence and the esteem of the ryots on far gentler lines.

If co-operation is really brought about among villagers, a great help will have been given to the Entomologist, for he will then have only to suggest measures to the people, who will, of their own accord and according to a private understanding, arrange matters among themselves and facilitate his work. Again costly apparatus such as spraying machines can be bought and kept in a central place and hired out when necessary. Such co-operative centres will also serve as bureaus of information on matters Entomological as well as agricultural.

The above are some of the problems that at present beset the work of the Economic Entomologist and he has plenty of work to do in attempting to solve them to a satisfactory conclusion. As it is, the Entomological section might not have accomplished much or made itself felt as indispensible as it ought. To an indulgent audience the reasons may not be difficult to find. The section is quite young and comparatively recently set on its legs. We are yet in the beginning of serious work. The lifehistories of many of the South Indian pests are but partially known and have yet to be fully worked out. Experiments without end have yet to be made, regarding economic and efficient insecticides, good cultural methods and light traps,—more has yet to be known of local conditions which, as is well-known, vary from place to place. More experience has yet to be gathered not only as to the treatment of pests but also in dealings with the ryot.

But better times seem to be dawning. During the past few years a change—not at all indecisive—has been coming over economic

conditions in India. Living has been perceptibly growing dearer and dearer, a change though quite undesired for by the employee, yet conducive to the growing prosperity of the ryot. The money value of produce and, consequently of land, has risen by leaps and bounds and the ryot is profiting by it. The greater money value of grain will of course enable him to grow richer and encourage him to invest more money in manure, and adopt better and more intensive methods of cultivation. Thus there seems to be in future more scope for the Entomologist who need not very much fear whether his methods may not be taken up on the score of not being cheap enough.

Thanks to the energies of the co-operative section, more societies are being opened and when the present tender bud of co-operation blossoms up into the ideal aimed at, the Entomologist will be as busy as the proverbial bee utilising all the benefits conferred by it.

With a steady aim at the goal, with sincere and unremitting work and with better economic conditions dawning, gentlemen, I believe the Economic Entomologist will in a few years have developed into a most useful member of the Agricultural Department.

Notes.

His Excellency Lord Pentland, Governor of Madras, was able to spare a day out of his busy programme on the West coast last month, to inspect the Taliparamba Agricultural Station. The Director of Agriculture and Mr. Govinda Kidavu, Farm manager, showed him over the place. It was here that the late Hon'ble Raman Nayanar's hill tribes and tenants entertained His Excellency with their dancing.