The plant is a twining shrub. The young branches are nearly smooth except for a few scattered emergences. Old branches are thick, about an inch across and are characterised by a fissured condition of the rind. Leaves are about 1″—1½″ across, opposite, leathery, almost round or ovate, with usually a round tip and six pairs of arched veins. Flowers small, in axillary penduncled cymes ; calyx deeply penta—fid ; corolla rotate, lobes five, valvate, white, villous within ; stamens at the base of the corolla ; ovary of two, many ovuled carpels ; fruit of two thick lanceolate, short follicular mericarps ; seeds ovate, ridged, tipped with a white coma. Fruits in pairs each 2½″ long and 0·7″ in diameter at base and tapering above. Roots are brittle, 3′—4′ long and attain diameter of even ¾″--1″. The core is woody enclosed in a thick fleshy coat. It is this fleshy coat that is used for pickling. The flavour is very similar to that of *Hemidesmus indicus, R. Br.* (Country Sarsaparilla ; Tamil : *Nannari*).

Market. It is available for sale in the Pollachi shandy (Coimbatore District) throughout the year. From Pollachi it is exported to Calicut, Palghat, Udumalpet and Coimbatore. At Coimbatore it is available in fairly large quantities at about 1 to 2 annas per pound.

Method of pickling. The roots are thoroughly washed and the central woody core is removed by splitting and discarded. The fleshy portion is then cut into small cubes of ⅛″ and is mixed thoroughly with pounded chillies and salt. The whole stuff is soaked in lime juice (*Citrus acida, linn.*) and preserved in porcelain jars. In this condition it can keep well for over a year. The quantity required for daily use is taken and a little buttermilk is added before use.

AGRICULTURAL ZOOLOGY

With special reference to S. India.

By T. V. RAMAKRISHNA AYYAR, B.A., Ph. D.,
Retd. Govt. Entomologist, Madras.

Lecture No 2.* **Agricultural Entomology.**

In my last lecture I gave you some idea of the economic importance of the different animal groups from the lowest organisms (Rotozoa) to the highest evolved group of animals (Mammals), especially from an agricultural point of view. I shall deal now with the different aspects of the Arthropoda in their relation to the S. Indian farmer, with the help of diagrams and slides, which in a subject like this, will be far more effective and telling than a torrent of the most carefully selected adjectives. I may state at the very beginning that the animals included in this big sub-kingdom of animals (Arthropoda)

* Lecture No. 1 appeared in the March issue of this journal and was delivered under the auspices of the University of Madras—Maharajah of Travancore Curzon lectures on Agriculture. The lecture was illustrated with lantern slides.

play a far more important role in the economy of man than most others and from the point of view of harm they cause to the farmer and layman, this group surpasses in importance every other animal community in the world.

The most important features of the Arthropoda consist in their bodies being made up of a series of ring like divisions or segments arranged one behind the other like the segmented worms, and their paired limbs which vary in number, being made up of different pieces or joints—hence their name (*Arthropoda*=with jointed legs). This great group includes the subdivisions shown below.

Important characters of the chief Arthropod classes.

Class.	Antenna or feeler.	Legs.	Body divisions.	Eyes.	Remarks.
1. *Onychophora* (only *Peripatus*).	One pair.	Many pairs of unjointed legs.	No clear divisions.	Two simple eyes.	Aberrant lowly organised group with characters connecting segmented worms and Arthropoda. Possess both nephridia and trachael vessels.
2. *Crustacea* (crabs, prawns, wood lice, etc.)	Two pairs.	Many or at least five pairs.	Two—(Cephalothorax and abdomen.)	Compound (often stalked).	Mostly aquatic forms with gills.
3. *Arachnida* (scorpions, spiders, mites and ticks).	No Antenna	Four pairs only.	Two—(Cephalothorax and abdomen) or no divisions.	Simple eyes.	Land forms with lung like structures for breathing. Chiefly carnivorous, some plant feeding.
4. *Myriapoda* (centipedes and millipedes).	One pair.	Numerous one or two pairs to each segment.	Two—(head and the lung trunk).	Simple eyes or clusters of simple eyes.	Worm like long forms. Land animals.
5. *Insecta* (Insects).	One pair.	Only three pairs (hence called *Hexapoda*)	Three distinct regions—(head, thorax and abdomen).	Compound eyes and very often simple eyes also.	Wings present in many air breathers. Found chiefly on land though some are aquatic.

From an Agricultural point of view the *Crustacea* are of little importance excepting for some crabs pests. Fresh water crabs of different species (*Paratelphusa*, *Potamon*, *Varuna* etc.) give some trouble in paddy fields, especially in some of the delta areas. These attack young rice plants and cause severe damage during certain seasons, destroying over 50% of the seedlings which are cut at ground level and removed to the crab holes where they are chewed. The next group—

Myriapoda—is also of little importance in that direction. Occasionally species of Millipedes (*Julus* etc.) have been found to attack ripening groundnut pods under the soil; the creatures feed on the seeds and leave the pods empty. The group *Arachnida*, however, plays a more important economic role than the two groups noted above; there are numerous species of arachnida which are known as pests of cultivated plants and as parasites on cattle and man. The plant pests include the well known mites often called as *red spiders*, *spider mites*, *gall mites* etc. In S. India we find different species attacking specially cereals, cotton, ganja, citrus and tea; these include the genera *Paratetranychus*, *Tetranychus* and *Eriophyes*. Parasitic arachnida include cattle, dog and poultry ticks (*Psoroptes*, *Argas*, *Rhipi-cephalus*, *Hyalomma*), and the skin mites affecting man (*Sarcoptes*, *Demodex*, *Peduculoides*, *Tyroglyphus* etc) causing complaints known as '*Acariasis*'. Spiders as a group are generally insectivorous and prove helpful in trapping various flying insects like moths, flies, mosquitoes etc. in their webs. Occasionally we come across spiders the webs of which are thick and cover some plants so badly that the growth of the latter is often checked.

We now come to the consideration of the group of *Insects* and their relations to man,—especially the farmer and stock breeder. Hardly any naturalist who knows anything of insects and their ways will doubt the fact that, in the keen struggle for existence going on incessantly in nature among the various animals living on the surface of the globe, no other animals have gained such remarkable success as the members of the insect world. This may be attributed among others to such important factors as their remarkable numerical strength, their peculiar life histories, their extraordinary powers of multiplication and their wonderful adaptations to put up a strong fight and survive the struggle for life. Among the various living beings inhabiting this world of ours, no other group of animals, except perhaps the fishes, can approach the insect community either in numerical strength or in the wealth and variety of species. The number of known living species of animals has been roughly estimated at about 900,000 and of this number over 60 % or about 625,000 are found to be insects. To give an idea of the comparative size of this group among the various divisions of the animal kingdom, we may take this illustration (slide shown). If we take the entire distance between the finger tips of our outstretched right and left arms across our chest to represent the size of the whole animal kingdom, then the size of all the other groups put together will not extend beyond the elbow of one arm from its finger tip, while the size of the insect group would occupy a distance stretching from the elbow of one arm across the chest and the two shoulders right up to the tip of the middle finger of the other arm. In size however, insects are comparatively small and this varies from one-seventy-fifth of an inch to six or seven

inches in length. The apparent defect in the size of insects, as compared with that of other animals, is more than made up by their remarkable numerical strength as has been shown above. As regards the distribution of insects, it may be stated that they are found all over the world; in land and water, on trees and shrubs, on other animals in households and under the soil. Knipe has described the position very nicely regarding the strength and distribution of these creatures in the following verses:—

> And what of insects, present everywhere,
> Through sea and land and flitting in the air?
> Why, half the matter charged with light on land
> These little creatures, countless, must command
> See how in orders, legions filled, they rise,
> Living alone, and in communities;
> From mites so small as scarce to meet the eye,
> To ant and bee, and gorgeous butterfly.

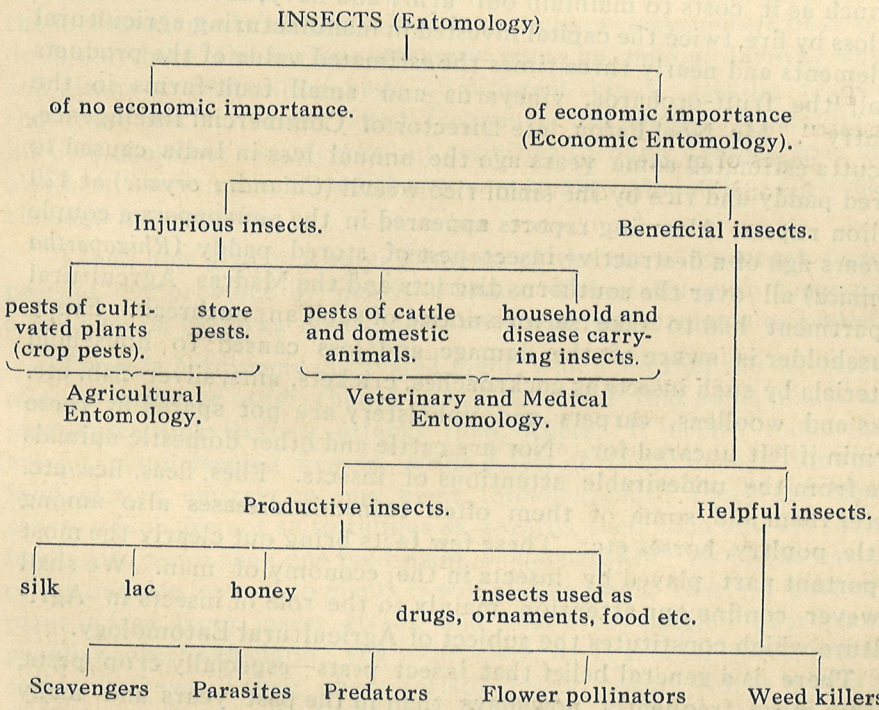
To give even a very vague idea of the remarkable adaptations possessed by insects to carry on successfully their vital activities will occupy pages of matter; so numerous, varied and extraordinary are these. Astonishing are the various adaptations for securing food, the structural provisions for offence and defence, the wonderful arrangements for communication between each other and the innumerable adjustments for sexual relations and propagation of the species. Such wonderful phenomena as parasitism and social life, the various adaptations in structure, mimicry, maternal instinct, and host of other features in their behaviour which Thompson aptly calls "*shifts for a living*" are factors very remarkable and often unique in the world of insects. One of the most remarkable phenomena in the whole animal kingdom is the peculiarity found in the life history of many insects. Unlike as in the higher animals and many other lower animals there is a phenomenon known as "*Metamorphosis*" among insects a series of striking and remarkable changes undergone by an insect as it passes from its childhood to its adult stage. The passage of a common butterfly from the tiny egg to the worm-like caterpillar or grub, into apparently lifeless objects the chrysalis or pupa, and the final transformation into the beautiful winged butterfly, all these striking changes, known together as Metamorphosis constitute a phenomenon which even many of our educated men are not aware of, though Shakespeare put it so nicely in the lines:

> "There is a differency between a grub and a butterfly.
> Yet your butterfly was a grub."

Most insects give rise to numerous offspring, which in their turn produce further generations in a very short period of time compared to higher animals and thus increase in numbers rapidly. These two advantages of greater fecundity and shorter life cycle play a very

important part in maintaining the remarkable numerical strength of many insects. According to Hodge "a pair of flies beginning operations in April, might be progenitors, if all were to live, of 191,010,000,000,000,000,000 flies by August, and allowing 1/8 cubic inch to a fly, this number would cover the earth 47 feet deep". But, fortunately nature keeps up an even balance in the world without allowing any one creature to multiply extraordinarily and become a nuisance.

With these necessarily brief remarks on the general features of insects I would take you to the different aspects in which insects affect human interest and especially the agriculturalist. From the point of view of a layman and farmer, insects may be conveniently grouped as below under three main groups according to their behaviour towards man and his belongings.



From the above classification we find that under 'Economic Entomology' we can include Agricultural entomology, Veterinary and Medical entomology, apiculture, sericulture and lac culture. Agricultural entomology deals mainly with pests, their bionomics, and the methods which the farmer can adopt to check pests and utilise the help of other animals to control injurious insects. Now what is the part played by insects in relation to man and to our agriculture? The answer to this question is effectively supplied by the farmer in the fields, the kitchen gardener, and the provision dealer in stores and mills. For, these are the individuals who suffer from the depradations

of various insects which destroy a good portion of their produce from the fields and their stored stocks and thereby affect their finances. During certain years cultivated crops are entirely wiped out by hordes of locusts, caterpillars or bugs, and heavy loss is sustained by the farmers. Though in our country we have no clear ideas or statistics as to the extent of losses sustained in this way, the extent of loss caused by insects has been accurately assessed in the United States of America. 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 300 million dollars". According to Slingerland "The yearly losses from insect ravages in our country (the U. S. A,) 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". Mr. Noel Paton, late Director of Commercial Intelligence, Calcutta estimated some years ago the annual loss in India caused to stored paddy and rice by the small rice weevil (*Calandra oryzae*) at 120 million rupees. Alarming reports appeared in the newspapers a couple of years ago of a destructive insect pest of stored paddy (*Rhizopertha dominica*) all over the southern districts and the Madras Agrcultural Department had to take serious notice of such an outbreak. Every householder is aware of the damage and loss caused to household materials by such insects as cockroaches, crickets, ants, silver fish, etc. Silks and woollens, carpets and upholstery are not spared by these vermin if left uncared for. Nor are cattle and other domestic animals free from the undesirable attentions of insects. Flies, fleas, lice etc. pester them and some of them often transmit diseases also among cattle, poultry, horses etc. These few facts bring out clearly the most important part played by insects in the economy of man. We shall however confine our attention mainly to the role of insects in Agriculture which constitutes the subject of Agricultural Entomology.

There is a general belief that insect pests—especially crop pests, appear more frequently nowadays than in the past years and many an old farmer has asserted to me that during the palmy early years of his life they had very few and only occasional outbreaks of pests to contend with. We have to admit the truth of this statement to a great extent; for, as civilisation advances and man begins to control nature in various ways, the "Balance of life in Nature", which keeps up a sort of balance among the various living beings in the world under ordinary conditions, is frequently upset and as a result we often hear of pest outbreaks.

A. Chief factors maintaining the Balance of Life are

1. Food 2. Climate 3. Enemies.

even from the external indications of the damage done, which the particular kind of pest is. Nor will he find it difficult in course of time to foresee as to the season or seasons when he might expect particular pests of different crops. In this way, experienced farmers of each different tract will be in a position to prepare what may be called insect pest calendars suited to the area and thus be not only well prepared to meet insect pests when they appear, but even be fit to prevent their appearance by methods adopted sufficiently early. In the same way, cultivators of special crops also come to know by experience as to the particular stage or stages in the growth of his crop when they can expect a particular kind of pest.

Apart from the specific pests of each particular crop there are a few categories of insects which infest many plants and cause the same kind of damage. These include, plant lice (*Aphidae*), scales, and mealybugs (*Coccidae*), locusts and grasshoppers (*Acridiidae*) leaf caterpillars of sorts, borers of different kinds (including beetles, caterpillars and flies), surface insects and underground insects of different kinds. I shall now explain to you some of the slides illustrating the more important of the general features of insects as briefly touched upon by me at the beginning, and some of the more injurious insect pests of agricultural importance found in our province, with the nature and extent of damage.

Within the past thirty years a good deal of spade work has been done in S. India in the matter of recognising our important insect pests and gathering preliminary data regarding their life histories, habits, and their relation to different crops, as may be seen from the numerous published papers on the subject. The real work however, of relieving the farmer and the cattle breeder from the losses caused by insect pests has only just started. This work which can only be carried out after much pioneering studies, is of a very important nature and is sure to tax the knowledge, ingenuity and resources of agricultural entomologists. For in the words of Curtis "The first step towards vanquishing the enemy is to ascertain correctly its habits, the next to be certain of its appearance, as not to mistake one party for the other and a third and no less important object is to be well acquainted with our friends and allies". Unless one gets some correct and definite ideas as to the real nature of the damage done, the remedies we may suggest may often prove worse than the diseases themselves. The utilisation of such knowledge and the devising of control methods should not merely be of an empirical nature; for Entomology is something more than squirting or dusting aresenicals or emulsions on the tails of insects—this is scarcely Entomology at all any more than horse shoeing is animal husbandry. The success of the Agricultural Entomologist depends a good deal on his proper up-to-date knowledge of the subject and sufficient practical experience

parasite, is found to have its own natural enemy and, the latter in turn another as the doggerel runs.

" Those fleas that do us bite
Have other fleas that bite them
And those in turn have other fleas
And so *ad infinitum* "

Under the circumstances though biological control when feasible, is the most economic of all measures, the success or otherwise of each case will depend a good deal on the nature of the natural enemies, their number, their inter-relations and their efficiency in keeping the pest under check. In any case this method will have to be supplemented by other pest control measures indicated above; in this connection I might draw your attention to one or two weed pests where biological control has shown very remarkable promise of success. The most familiar example is the wonderful work of the *Cochineal* insect in eradicating prickly pear, one of our worst weeds, and another is the Lantana bug *Orthezia*, which, though not so marvellous in effect as the Cochineal, is capable of checking the wild spread of the lantana weed in some of our hill districts.

It will be unfair to the group of insects if, before finishing this theme, I do not at least make a passing reference to the brighter side of insect activities and show that, after all, we cannot condemn all insects as a whole and that there are insects which are extremely useful to man in several ways such as silk, lac and honey producers, flower pollinators, others that yield drugs, etc., and some others which are even used by man as food.

Gentlemen, I have tried in my own way to give you some ideas of Agricultural Entomology with special reference to South India and it is evident from all I have said and shown so far, how very important a subject Economic Zoology is. Professor Wilson of the U. S. A. Biological Survey has beautifully summarised the value of Economic Zoology in its relation to human affairs in the following words:—" 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 beneficent 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 ."

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Though as I said once before a considerable amount of valuable spade work has been done in the field of Agricultural Entomology till now, a good deal remains yet to be done in the shape of bringing the fruits of the knowledge gained in that line and contributing its own share to the material prosperity of the country. In my opinion, apart from continuing the studies on the lines hitherto followed, viz., the recognition, collection, identification and life history studies and the usual treatment of pests, it is highly desirable that intensive studies and investigations should be pursued on the ecology of insect pests; in the words of Elton: "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 civilization 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". I would also emphasise the need for investigations in Agricultural Meteorology with special reference to the incidence of pests—a line of research which is full of promise in helping us to foretell the outbreak of pests and be on our guard. Nor need I emphasise the need for co-operation that is essential between the entomological worker, the plant breeder, the bio-chemist and the agriculturist in all the allied investigations and operations which have for their final aim the prosperity of agriculture in our country. I can only conclude this theme by repeating the following words of Professor Maskew in this connection—"The most important, the most vital thing in all the world is to get something to eat. If all of us here present, or mankind in general, were positively unable to obtain anything to eat for the space of one week, the affairs of this world—commercial or otherwise, would soon become of no more consequence than duckweed upon the surface of a pond. Without something to eat there would be no coal mined, no steel forged, no freight cars rolling. Agriculture in its broadest sense is the source of something to eat, and hence the original source of all subsequent action. Applied agriculture in practically all lands now recognizes that the greatest source of loss to cultivated crops can be traced to the depredations of insect pests and plant diseases".

I have finally to thank our president Mr. Broadfoot who has, besides honoring me by presiding over my lectures, helped me in every way with facilities for delivering my lectures at the Agricultural College, Coimbatore. I have also to thank Dr. Mulyil, Messrs G. V. Narayana, Suryanarayana and Naganatha Ayyar of the Institute for general help in making arrangements to project the lantern slides and diagrams during the lectures.

[*Note*:—The lecture was illustrated with numerous diagrams and lantern slides.]