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Some observations relating to natural factors influencing the incidence of insect pests.

By

V. TIRUMALA RAO B. Sc (Ag),

(Lecturer in Entomology, Agricultural College, Bapatla.)

Out of about seven lakhs of species of insects reported to be existing in the world with the identifications so far made only about 10,000 are known to be phytophagous (herbivorous) and of these it is only a small number of about 500 working out to a percentage of 5 that have been put under the category of major pests of some consequence to the agriculturists and horticulturists. From this we can easily infer that but for maintenance of 'balance-of-life' by the action and reaction of forces in nature many more would have menaced us by becoming pests. The physical and biological factors evidently create a strong environmental resistance round many other insects and do not allow them to become serious pests. The climate and cultural conditions forming the physical factors and food, natural enemies and competition with others forming the biological factors not only prevent many an insect from becoming a pest but even limit its distribution in case any insect is to become a pest with the breach secured in the environmental resistance keeping it at a particular balance in its association with the other animals in the world. Therefore we owe a good deal to the environmental resistance with its physical and biological factors for keeping many insects not only within bounds but also in limiting the zones of occurrences when any of them become pests. South India had recorded about 550 insects as occurring on economic plants and of these it was not even against 100 that artificial methods of control had to be resorted to. Even then it was not everywhere and at all times of the year that the pests proved to be of serious consequence. The occurrences of pests are limited to few areas and during certain seasons. These facts go to show that nature has helped and is helping not only the agriculturists and the horticulturists but also the economic Entomologist whose work would have become quite complex and unmanageable if every phytophagous insect becomes a pest.

The writer in the course of his work has had opportunities to make detailed observations on the incidence of insect pests in regions of widely divergent climatic conditions as for example, the Circars representing the hottest parts of the Madras Province on the one hand and the Nilgris in the south representing the cooler regions. This paper is a record of his observations, and is written with a view to invite attention to an important aspect of the insect control problem, namely, the influence of environmental factors in determining the nature and extent of pest incidence.

The factors that contribute towards natural control of insects are (1) climate (2) topography (3) agricultural practices and (4) natural enemies. Climate and the agricultural practices creating physical limitations for the development of insects constitute the physical factors in the environmental resistance whereas the natural enemies together with the agricultural practices regulating the food supply for pests constitute the 'Biological factors'. We have to consider to what extent these factors by themselves and in combination are influencing the incidence of insect pests.

Phyiscal factors.

Climate:— Climate is the result of combined action of all the physical factors of the environment like temperature, light, humidity, rain and air currents over a long period of time and is relatively stable for the same locality. Weather on the other hand is the result of combined action of all the physical factors of the environment at any time and it varies from hour to hour, day to day and week to week. For purposes of this note we are chiefly concerned with 'climate' as the permanent factor determining once for all whether an insect is to become a pest or not for a particular area. If any insect can become a pest then the 'weather' can determine when and under what weather conditions it can become a pest. It can now be seen that 'climate' determines the type of insects that are to exist in any given locality and when it varies between any two places the insect fauna also differs. This can be evident if we examine the insect fauna at different elevations in the hill regions of South India. In the Nilgiris along the Mettupalayam side the moist tropical region extends up to an elevation of 2,500 feet. It is marked by a limited season of moist weather with dry weather intervening. The Sub-tropical zone starting at the head of the tropical region extends up to an elevation of 6,000 feet. These elevations should not however be taken as defining the limits of the zones accurately. The Sub-tropical region is said to commence in the Himalayas at an elevation of 500 feet and for Nilgiris at 1,000 feet towards the Western Ghats side. We need not discuss about the tropical fauna in Entomology as it is too familiar with us. The Sub-tropical fauna is far more varied than the tropical. The number of species that can find food and can support existence in the extremely varied vegetation and moist equable climate of the former is far greater than those that have to face dry heat and limited vegetation of the latter. We find variety and number in Nymphalids, and Papilionid butterflies, Longhorned grasshoppers, Stick insects, Cicadas and wood boring *Coleoptera*. Grasshoppers and aquatic and scavenging beetles are however more abundant in plains than in the sub-tropical region. *Attacus atlas*, the atlas moth which is the largest amongst the Indian moths is found in hilly forests mainly in the Sub-tropical zone. The temperate zone presents a region of intense colds

and also frosts and it has a limited natural flora. Consequently the insect fauna of this region is not so rich and varied as that of the Sub-tropical regions.

If we take up the scrutiny of specific economic forms as occurring in definite zones we find that the following insect pests occur in all the three zones with the least consideration for the elevations in the Nilgiris and the differences they create in the climatic conditions. The wingless grasshopper (*Orthacris simulans*); the plant bug (*Bagrada picta*); the plant lice on rose (*Macrosiphum rosaeformis*); the cabbage aphis (*Myzus persicae*); the Red scale on rose (*Aspidiotus aurantii*); the Diamond back moth (*Plutella maculipennis*); the green scale of Coffee (*Lecanium viride*); the potato tuber moth (*Phthorimoea operculella*) amongst crop pests;

Sitophilus oryzae amongst granary pests, cockroaches, crickets, silver fish, book lice, house flies and fleas amongst household pests; hover fly (*Syrphus* sp), the giant water bug (*Belostoma indica*) the ground beetle *Anthia sexguttata*), lady bird beetles (*Rodolia roseipennis* and *Coccinella septempunctata*) amongst predators; *Apis dorsata*, *Apis indica* and *Apis florea* amongst productive insects also occur at all elevations.

The cutworms (*Euxoa segetum*, *Agrotis nigrum*) are not found in plains but are confined to Hills. The Cucurbit beetles (*Aulocophora spp*), the tobacco caterpillar (*Prodenia litura*), the red tree ant (*Oecophylla smaragdina*) amongst insect pests, ants, termites, bedbugs and mosquitoes amongst household pests the flour beetles, and moths amongst the stored products pests which are all serious in plains of South India are not at all felt in the temperate zones of the hills. It can now be seen what a wide range of pests we can have if the climatic conditions of different zones have not restricted the spread of different pests. Some are already bad enough with their adaptability to occur in any zone and if the others also are not bound by the climatic factors we would be having a long list of pests occurring at all the elevations and in all climates.

It is sufficiently known that insects do not flourish in places with diurnal variations but thrive best with a steady temperature. Coastal areas record narrow variations between the maximum and the minimum temperatures and high humidities and will consequently be helpful for insect development. Inland places with wider variations and low humidities necessarily discourage insect life that thrives best with a coastal climate. This aspect of insect problem was brought to light by the Department of Food of Government of India when they found that the central stocks of cereals in storage were preserved best when kept in interior places like Lahore. The Rice weevil, *Sitophilus oryza* is active only when the grain absorbs moisture from the humid atmosphere and increases the moisture content of the grain and this can happen in coastal areas and not in the interior dry tracts

Topography :— Next in importance to climate is the general topography of the tract acting as a physical factor and influencing the incidence of insect pests. The topography influences the climate of the place also but not to make any difference as far as our problem is concerned with the immediate neighbouring tracts. The soils however differ even between two adjacent areas and we have to see if they have anything to do with the occurrence of certain pests. It is well known that the Red Hairy Caterpillar (*Amsacta albistriga*) is a pest of groundnut and other crops confining itself to the light soil areas and not occurring in heavy soils. This is due to the fact that the insect which goes into the soil to a depth of 4 to 5" and even 9" at times as early as August or September has to remain in the soil as pupa till the break of next S. W. Monsoon i. e., for a total period of about ten months. The tunnel through which the caterpillar had entered the soil gets disturbed in the long interval that follows before it is able to emerge out as a moth. The spurs specially provided for the tibia help the moth in making out a tunnel for its escape and this can be done only in light soils but not in heavy soils where the clogging nature of the soils interferes with the tunnelling that has to be made for the escape of the moth. The Rice grasshopper (*Hieroglyphus banian*) is a serious pest of paddy in heavy soil areas in tracts that depend upon the break of S. W. Monsoon in June for growing of paddy. The pest tides over the off-season for paddy in its egg stage laid in bunds as early as the month of November but hatching out only in the next June with the break of S.W. Monsoon. The resting period for the eggs is however finished with the end of March and they can develop and hatch out subsequently if the required moisture is made available. In the case of light soils any rains occurring during the months of April and May can be readily absorbed to start the commencement of development of grass hopper eggs in the soil but unless there is the continuity of rains to complete the development of eggs they get desiccated while half way in development and are consequently disabled from hatching. Hence the summer rains occurring during the months of April and May act as a natural check for the grasshopper pest in light soil areas whereas with heavy soils a similar check is not available on account of the slow absorption of moisture by such soils during passing showers. The chilly root grub *Anomala* sp., is a definite pest in heavy soil areas and it may also be added that the rootgall eel worm though not an insect affects plants in light soil areas.

Agricultural Practices.

The agricultural practices influence the incidence of several pests to a considerable extent. Taking up the Paddy crop we find that the Paddy Grasshopper *Hieroglyphus banian* exists in a serious form in tracts where paddy is sown broadcast in heavy soils and where the nature of the cultivation is such that the field bunds are the least disturbed. The egg

masses kept in safe deposit by the pest in the field bunds for passing over the long off-season from the month of November to the next June, for a total period of nearly six months, can remain safe under such conditions whereas in places where paddy is transplanted the bunds are periodically trimmed and also remade now and then. These create a certain amount of natural check for the pest with the result that we do not find it as a serious pest in areas where the preparatory cultivation including the trimming of bunds for paddy is done early enough in the season.

In the delta areas where we have the practice of sowing the *saruva* (first crop paddy) nurseries even before the *dalwa* (second crop paddy) is harvested the paddy stem borer (*Schoenobius incertelus*) gets opportunities with the overlapping of crops to maintain itself to infest the next coming first crop of paddy with the protection the pest gets in the nurseries during the summer. In places abounding with wild paddies the pest gets similar opportunities and we find higher incidence of the pest in such tracts than elsewhere.

Paddy case worm (*Nymphula depunctalis*) is felt to be a regular serious pest in the upland areas of East Godavari District and in Vizagapatam District where the irrigation supplies are not of assured nature and the ryots have to sometimes allow water to stagnate in the paddy plots with the fear that any draining done to the plots may not secure fresh irrigation supplies. In the delta areas with copious supplies of irrigation water the ryot knows the benefits of frequent changes and it is very rarely we encounter the paddy case worm as a pest. In some of the delta tracts where the soils are rich and attain a rank growth with the possible early plantings the occurrence of Rice Hispa (*Hispa armigera*) is not considered by the ryots as harmful and some of them even take it as a blessing in disguise helping to minimise the topping, the crop is to get on account of rank growth in such soils. In other places varying with different degrees from these conditions there may be some loss differing with varying soil fertilities. In the Ramachandrapur area of East Godavari District where pillipesara *Phaseolus trilobus* is grown in small plots in paddy fields, rats have become a serious pest with the "Food Factor" helping them to breed throughout the year.

In parts of Vizagapatam District where sugarcane is planted towards the end of April so as to have the formation of main shoots after the break of South west monsoon the damage by the cane borer (*Argyria sticticraspis*) to young shoots is not felt. If however the crop is planted earlier and the main shoots come up during the dry summer months the sugarcane borer lays heavy toll and may even influence the final yields of the crop so affected. The cane fly (*Pyrilla perpusilla*) and the cane Aleurodids (*Aleurolobus barodensis*) are not felt as pests where the

sugarcane cultivation is so adjusted as to secure some off season between the planting of the new crop and the harvesting of the old crop and where rationing is not practised. It is also known to the cultivators that a cane crop grown near trees harbouring squirrels will attract their attention and sustain damage especially during the active breeding season of the rodent and to the possible extent such situations are avoided for cane growing. The stem borer beetle of plantain (*Cosmopolites sordidus*) is a serious pest under the old system of having perennial crops of plantain in the same land for several years. This pest has however receded to insignificance with the introduction of annual system of plantain cultivation where the crop is changed from place to place with each year and the suckers planted in the new field get sufficient root pruning before planting to dislodge any of the borers if they are found with the suckers. In the Vizagapatam District where chilly is cultivated as a garden crop from the month of October onwards after the root grubs (*Melolonthid*-beetle) get into a resting stage there is no trouble from the pest with the cultivation so nicely adjusting itself to come off after the pest disappears. It was also noted that the Red Hairy Caterpillar (*Amsacta albistriga*) established itself as a sort of indigenous pest on some of the mountain sides with *Canthium passiflorum* shrub (Tel: *Balusu*) as a host, but its presence is not felt by cultivators in the areas as they grow only ragi there and the crop is planted in August—September after the Red Hairy Caterpillars get into the soil for pupation to emerge as moths with the break of next S. W. Monsoon. It appears as though the cultivators have come to an understanding with the pest to allow it to have its way with the wild plants during the early part of the season in the year and have their crops in the later part when they get "all clear signal" with the pupation of the Amsacta caterpillars. In some places the annoyance of the Red tree ant (*Oecophylla smaragdina*) to gardening is sufficiently understood and it is not allowed to establish in the gardens by the burning down of their nests whenever they are found. In other areas where this precaution is not taken our visits to gardens are not at all pleasant and leave some unpleasant memories behind. Amongst the Agricultural practices the selection of resistant types like G. E. B. 24 against the paddy stem borer for Kollair tract in Kistna District and some canes against shoot borers in cane should be mentioned.

Natural enemies.

Not only do the climate, topography and the agricultural practices control the variety, size and distribution of insect population but the natural enemies of insects also especially their own tribe as predators and parasites influence the relative abundance of different insects at different times. An experienced Entomologist when called upon to deal with any pest would not be satisfied in examining the pest and its damage but would go a step further and examine it in relation to its biological

equilibirium and its different associates. If there is promise of early check by any of the biological agents he would necessarily defer the incurring of expenditure in taking up some chemical or other direct control and wait for the natural forces to help him. This aspect of pest control is applicable to the Paddy Leaf roller (*Cnaphalocrocis medinalis*) and the Paddy Gall Fly *Pachydiplosis oryzae*. In The Madras Agricultural Journal for December 1929 under the title 'Insect pests and their natural enemies in the Circars the author stated that, in the case of certain caterpillars found on paddy, such as *Psalis* and *Paranara* the parasites are so constantly found that it is generally difficult to rear the caterpillars of these two insects into adults and that is why they are never noted in a pest condition. To this day the statemet continues to hold good.

Summary and Conclusion.

The study of climatic factors influencing the occurrence of pests helps us a good deal in knowing the zonal distributions and spotting out such phytophagous insects as are likely to continue as pests. The topography can help us to know what kinds of pests can be encountered especially with the newly introduced crops. The agricultural practices give us a clue as to how we can possibly secure permanent relief from insect enemies wherever the local conditions permit. Amongst the different methods we have for control of pests Viz.. Agricultural, Mechanical, Insecticidal and Biological it is the agricultural methods that can fit in well with an Indian cultivator and secure for him a permanent relief from any pests. Methods requiring special sustained effect like chemical treatments require no ordinary struggle to become popular with an Indian agriculturist in spite of all their intrinsic worth. With a detailed knowledge of the local conditions and the pests that occur it would even be possible for us to chalk out the agricultural policy of a tract and put it on a firm ground so that it may not encounter any serious pests that can occur in the tract. As an instance I may add that when a construction of a reservoir for Sabari, one of the tributaries of the Godavari, was under consideration and when it was being designed to grow a short duration crop of paddy in the first season the Agricultural Department could point out that there would be considerable risk in proposing a short crop of paddy for the tract with frequent sporadic outbreaks of the climbing cut worm of paddy. *Cirphis albistigma* and the safest plan would be to have a long duration crop for such areas as it can be harvested during periods when the pest does not occur and evade it. In putting up the above notes to the readers it is my intention to show that the problem of control of pests has various aspects to be worked and to get at the fundamentals to base our recommendations on solid foundations that would stand the test of time.