https://doi.org/10.29321/MAJ.10.A04916

INSECT PHOTOTROPISM AND ITS ECONOMIC IMPORTANCE IN INDIA

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Introduction. Studies on the behaviour of organisms, and especially on that of Insects, have formed the theme of many eminent zoologists in the past and yet there exist numerous points in the different aspects of the subject which offer avenues for further investigations. The study of insect tropisms is one of these, and though a good deal of work has been done by eminent workers like, Loeb, Wheeler, Morgan and Jennings in the west, the study of the complex tropic reactions of insects in the Indian region has received hardly any serious attention so far. This paper is the result of some preliminary studies recently started to study the aspect of one of the various insect responses, viz., '*Phototropism*' with special reference to South Indian insects, and indicate in what way it has an economic bearing on Agricultural Entomology.

To an agriculturist the study of entomology is solely a utilitarian one, particularly with an aim to control his crop pests. Next to a knowledge of the life-history of the insect pests, the study of their behaviour, their adaptations and response to environments, and external stimuli forms one of the main lines of work for finding ways and means of control on scientific and economic lines.

Tropisms. The behaviour of insects in different ways may be attributed to three different sources—instinct, intelligence and tropisms; while the two former are generally the result of some internal stimuli, tropic reactions are generally the result of environmental influences. Some of the external factors such as atmospheric temperature, humidity, light, certain chemical substances, etc, often direct the activities of some insects, and the responses of the latter to such external stimuli are usually known as Tropisms. All these phenomena "are responses of the protoplasm to definite stimuli and are almost as inevitable as the response of a needle to a magnet." Of these *Chaemotropism* the different responses to stimuli from chemical substances, which in the words of Wheeler "are among the most potent factors in the lives of Insects", and *Phototropism* the response to stimuli from light, have offered very useful lines of research and have contributed factors for extensive application in pest control. Some of the other tropisms known are, Hydrotropism and Anemotropism the responses to water and winds.

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* Paper presented at the Agricultural Section of the Indian Science Congress, Bombay, in January 1934.

Phototropism. It is a familiar phenomenon, especially just before and soon after first summer rains, to find thousands of insects dashing to our lights and often hovering around them in clouds; this is particularly so, around bright gas or electric lights in highways and railway stations. Enthusiastic insect collectors taking advantage of this habit, frequently adopt attracting insects by lights, just in the same way as some entomologists collect insects by what is called 'sugaring' baiting with some chemical mixed with syrup. It will, however, be found by experience that it is not all insects that exhibit this tropic attraction to come towards lights. Those that have this striking character are known to be positively phototropic and others which have a marked tendency to shun and move away from the source of light are said to be negatively phototropic. There are various factors influencing these strongly opposite and varying grades of phototropism; the direction of rays of light, the color of the light rays, and their intensity, varying metabolic conditions and even other tropisms have been noted to come into play in such phenomena, and some of these therefore account for such striking habits of familiar insects like moths and butterflies, the former nocturnal and often phototropic, the latter diurnal and generally heliotropic (attracted and influenced by sunlight). Among these which display a strikingly positive response to lights are the cockchafer beetles of different kinds, winged ants, winged white ants (termites), crickets and long-horned grasshoppers, leaf-hoppers of different kinds (especially Jassids), some aquatic bugs especially the giant electric-light bug, *Belostoma* (the largest bug known which comes to light in numbers in steamers and boats in some rivers), and moths and beetles of different kinds. Among those which generally avoid lights may be mentioned the day-flying butterflies, cutworm moths, the bed bug, thysanoptera and some beetles.

Phototropism among Insects in S. India. Though the experience during the past decade or more has given the writers some idea of the kinds of insects that exhibit photographic reactions in different parts of S. India no organised attempts were made till recently to make a special study of our phototropic insects. About two years ago when the senior author planned some intensive work on the bionomics of one of our common pests—the paddy stem-borer *schoenobius incertellus* which exhibits positive phototropism, it occurred to him that experiments with light traps throughout the year would, in addition to adding to our data regarding the chief insect concerned, help us in gathering a good deal of information regarding other phototropic insects. With this hope, light traps were kept in Coimbatore Central Farm right through the year from 1931 and the results have not belied our hopes. The following is a rough statement of the important representatives of the different orders of Coimbatore insects so far

noted, showing positive phototropism. Among moths, the most important are some of the crambine pyralids like the paddy stem-borer (*Schoenobius incertellus*) and other borers like *Chilo*, *Diatroea Ancylolomia*, etc., the groundnut surul (*Stomopteryx*), the ragi white borer (*Saluria inficita*), the hairy caterpillar moths (*Amsacta*, *Estigmene*, and the sunnhemp moth (*Utetheisa*), the agaristid (*Aegocera*) a very common phototropic insect, some psychids, limacodids and hawk-moths. Of the coleoptera, among the common ones trapped were, the chafers of different kinds including dung rollers, scarabaeids, Ruteline, etc., stray dynastids, numerous green and blue blister beetles, staphylinids, glow-worm beetles, the longicorn beetle *Dorysthenis*, the leaf-like tenebrionid *Cossyphus* and stray tiger beetles, ground beetles and weevils. During certain years, the beettle *Dorysthenis* comes to light in swarms during October—November rains in Coimbatore. The hymenoptera include chiefly winged ants (including *Dorylus*) and occasionally some parasitic wasps and the honey bee. Among diptera, gall flies, some syrphids, stray tabanids and chironomids are the ones usually found. Among orthoptera trapped are crickets of numerous kinds (the mole cricket *Gryllotalpa* being very common), locustidae, some cockroaches and some of the tettigidae and surface grasshoppers. Winged termites, ephimerids, stray dragon flies and ant-lions and occasionally the chrysopa form the neuroptera. Among the Rhynchota, are the jassids of different kinds, some fulgorids and the pentatomids-chiefly the green plant bug *Nezara* and the black *Cydnus*. In addition to these, several insects of minor importance are frequently seen trapped. The number and frequency of the catches of these insects give us an idea as to their seasonal occurrence and emergence periods; it is needless to add that such data collected for fairly long periods will contribute to our knowledge of the local phototropic fauna. Detailed records on these catches are being made with the idea of utilising them in other ways.

Economic Importance of Phototropism in Insects. Apart from the academic and purely biological interest created by a study of insect phototropism, there is the economic aspect of the matter, which gives one some ideas as to how far the agriculturist can take advantage of the phototropic responses exhibited by some insects which have some economic importance. Especially in the control of some moth or other borers, the light trap forms one of the useful means of destroying large numbers of insects. The method of trapping such insect pests with lights of various kinds has been in vogue in other countries. Lawson (6) records that 126 species and varieties of leaf-hoppers were collected and an average of 1000 insects were captured in 70 nights. In Japan, light trap has proved one of the most efficient means of control against the rice borer *Chilo simplex*, Buk (9) A cotton boll-worm (*Diparopsis castanea*, *Hmpn.*) in Nyassaland (8) is reported to

be freely captured in a 200 candle power acetylene light which is described as effective over a square of about 10 acres. In the Punjab (7) the cane borers such as *Diatroea auricilia*, Dudg., *Chilo*, *Scirpophaga*, and *Emmalocera* have been recorded in large numbers at light. It is also reported from the Punjab (7) that light traps have proved very effective against the hairy caterpillar (*Amsacta*) and some 300,000 are recorded in light catches in one season from two districts.

In S. India, the phototropic reaction of some important insect pests attracted the attention of entomological workers many years ago. As early as 1906, when the senior author had opportunities of studying two of the pests of groundnut in S. Arcot area, viz., the hairy caterpillar and the *surul poochi*, it was found that both these creatures had very strong attraction for lights. Similarly the phototropic response and other observations made by him on the paddy stem borer (*Schoenobius incertellus*) in 1907 when the earliest investigations were started on that insect in S. India have been recorded in his note on South Indian Insects in 1921 (1) In the same note may also be found his record of the phototropic hairy caterpillar moth (*Asura conferta*) which is a nasty domestic pest, all along the submontane tracts of the West Coast during the post-monsoon months. Similarly another phototropic moth (*Ancylolomia chrysographella*) was first noted by him as a pest on paddy in 1908 (2) The attraction to light of most of our cockchafer beetles, some of which are pests both as larvae and adults is very well known. During the summer of 1915, when the senior author was investigating the white grub pest of cinchona seedlings in the Nilgiris, species of *Serica* and *Helotrichia* were found attracted to light in thousands. The cockchafer beetles attacking grape-vines, roses and sundry other garden plants are also attracted to lights. Among our other insects of economic importance showing this habit are the ragi white borer moth *Saluria inficita* first noted as pest in 1908 in the Coimbatore farm, the blue and green blister beetles often found on flower heads of millets; the injurious paddy jassids of which the green spotted one (*Nephotettix*) and the white species (*Tettigoniella*) are the commonest in S. India, are often caught at light traps in shoals. Gall-flies of which the paddy Cecidomyid (*Pachydiplosis*) is the chief, are also trapped at lights in numbers. Thus it will be found that we have some insects of economic importance for which the setting up of light traps may be tried as one of the practical measures of control.

Light Trap Mechanism. While it is found that lights like bonfires of rubbish heaps, torches and other naked lights do attract phototropic insects, for a regular study of insects, thus trapped it is necessary to have a contrivance which, while attracting insects, would help in collecting them without being burnt or destroyed. There are numerous such traps known and used by workers in different parts of the world. An insect light trap in its simplest form is

a light suspended over the middle of a tray containing water mixed with a few drops of kerosene spread as a thin film on the surface. All insects attracted by the light dash against it, drop into the oiled water below and get killed. Such a simple trap suits quite well the purpose of the farmer, but scientists who make a special study of the species obtained, make use of more powerful lights and arrangements to catch, kill and preserve the specimens without damaging them. Most commonly electric lights or acetylene lights are employed and instead of a tray of water a funnel with a killing bottle at bottom is attached to receive the insects dry. Such mechanisms could be made in many ways by maintaining the underlying principle of the apparatus. A good hurricane lantern will serve the ordinary purposes of a light trap. If, however, it becomes an economic proposition to use brighter lights a high power gas lamp will be found to trap more insects. Further investigations have to be made to get some data as to the kind of light, the area a light would command and other factors in this direction.

Light trap with special reference to paddy stem borer. A few remarks may be added with regard to the trials so far made with light traps for the paddy stem borer (*Schoenobius incertellus*) in some of our rice areas. Recent observations on the light trap catches have made it abundantly clear that the paddy stem borer is by far the more easily attracted and the more numerous of the many forms captured. The catches of moths of this borer during the different parts of the year at Coimbatore, Pattambi, Maruteru and Aduthurai were as follows:

	Total	
Coimbatore	4013	(3362 females ; 651 males) in 83 nights December 1932 to March 1933.
Pattambi	5341	(2806 g. females ; 369 males 2176 s. females) in 29 nights. June 1933 to August 1933.
Maruteru	16427	(9090 g. females ; 5038 males 1299 s. females) in 106 nights from September 1932 to February 7th, 1933.
Aduthurai	5090	(in 15 days—November 32 to February 1933—Maximum 879 on 6—1—1933.

(The writers are indebted to the Farm Superintendents at Pattambi and Maruteru for helping them in making light trap trials and giving figures of the catches.)

From the preliminary observations so far made it has been found that (1) at every fresh brood the insect comes to light in very large numbers (2) that at the peak of emergence it is highly phototropic and comes to light at all hours of the night even in moonlit nights, (3) the percentage of gravid females is always greater than the spent ones, (4) the proportion of females to males varies in different localities and at the same locality during seasons and (5) during the paddy season the insect makes its first appearance in the trap during transplantation.

Conclusion. In applying phototropism to practical entomology the study of the meteorological conditions affecting insect activity has also to be followed since changes in the atmosphere induce increased or decreased phototropic activity among insects. It has been observed that on a windy moonlight night very few insects are caught, so also during nights of heavy rain and storm, whereas in warm still dark nights the insect catches are abundant both in variety and number. For termites, which are recorded in large numbers on certain nights at lights, rain followed by sunny weather and warmth appear to be very favourable conditions. In the matter of the application of the light trap method as control against any insect, investigations have to be made on numerous factors such as the relation between the crop and the broods, the conditions of weather favourable for emergence of the broods, the relative percentage of the pest population attracted to light, the percentage of gravid female coming to light, the attractive capacity of the different kinds and colors of lights, the maximum distance from which the insect comes towards a particular light and numerous allied points. It is the intention of the writers to carry on detailed investigations on these and many other points which may, not only help us to effectively deal with this important pest of paddy, but might give us numerous facts and data for use against similar phototropic insects in the future.

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