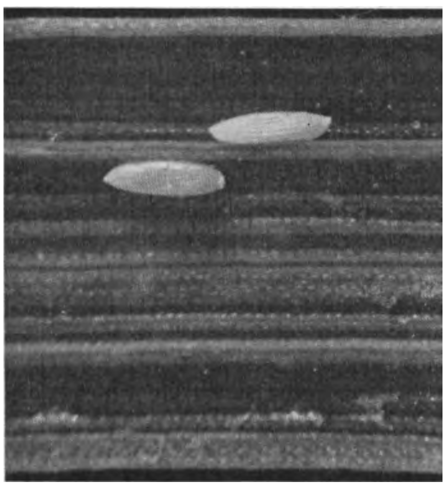
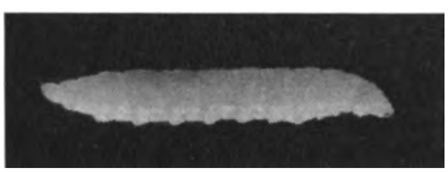
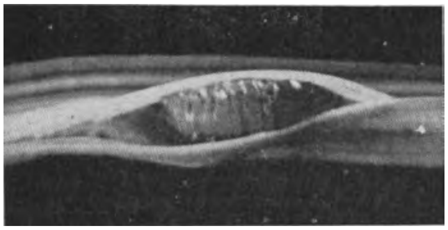
Adult male of the rice leaf miner.



Eggs of the rice leaf miner.



Maggot of the rice leaf miner.



Puparium—resting stage—of rice leaf miner inside rice leaf.

Rice Leaf Miner

severe attack controlled by water management, insecticide application

W. H. Lange, Jr., K. H. Ingebretsen, and L. L. Davis

The 1953 outbreak of the rice leaf miner, *Hydrellia griseola* var. *scapularis* Loew, is the worst reported in California since 1922.

An estimated 10% to 20% of the crop was destroyed by the pest at a probable loss of about $16,000,000. In addition, $1,200,000 were expended for insecticide control of the insect.

Growers near Maxwell, Colusa County, first reported the presence of the maggots inside the rice leaves on May 26, 1953. On May 28 the first experimental plots using four different insecticides were applied by airplane, and on May 29 commercial applications were started. In a few days over 20,000 acres were sprayed. In rapid order the insect was found in practically all of the rice growing areas of California, the damage ranging from none to severe. It is estimated that about 200,000 of the 382,000 acres of California's rice acreage have been treated with insecticides for the control of this pest.

The Rice Leaf Miner

The rice leaf miner belongs to the family Ephydridae which are essentially water-loving flies. The elongate, ribbed, white eggs are about 1/40″ long and are laid singly on the leaf blades. Flies prefer leaves lying prone on the water for oviposition sites and from one to 15 eggs may be laid on the same blade. The eggs hatch in about four days into small maggots which almost immediately start mining inside the leaves. The maggots feed on the green cells causing the leaf blades to turn transparent leaving only the leaf epidermis. The leaves subsequently shrivel and lie prostrate on the surface of the water. Maggots may also mine the leaf sheaths. The maggots enlarge their mines as they grow larger and often two may feed together inside the leaf blades. The maggots reach a length of about 1/8″ when mature, and pupate to brown, capsular puparia inside the leaves. The puparia are usually attached by the posterior end to the leaf tissue and are 1/8″ long. A single maggot can mine about 2″ of leaf blade and ordinarily three to four maggots per leaf can cause complete destruction of chlorophyll. The exact length of time of the larval and pupal stages have not been determined, but the usual length of time from laying of the egg to emergence of the adult is estimated at from 15–24 days. The adult flies emerging from the puparia are grayish in color and when alive have a distinct metallic greenish sheen. They range in size from 1/7″ to 1/10″, the females being slightly larger than the males. The adults prefer to rest upon the leaf blades, particularly those lying on the surface of the water. Adults have been kept alive in the laboratory for two weeks and feed readily upon a 10% sucrose solution.

On May 26 when the infestations were first found at Maxwell there was some evidence that this was the second generation of the fly reaching maturity at this time. Due to the longevity of the fly a two-week overlap in generations would be expected. The first generation of the fly could have been completed on wild grasses prior to the emergence of rice in the fields. The second generation attacked early planted fields in the Maxwell area—those fields planted between April 15 and 25. The third generation started toward the last of May and eggs were laid during the first two weeks of June. The overlapping of the generations made it possible to obtain all stages of the insect from any particular rice field except newly emerged rice. The insect apparently is not able to lay eggs under water, although there is some evidence that the larvae and pupae can tolerate some degree of submergence, obtaining their oxygen from plant tissues.

Control

Control of the leaf miner was achieved by a combination of water management and the application of dieldrin or heptachlor. It was apparent in most fields that more severe damage was experienced in the deep water areas of any checks, as weak plants were susceptible to decay or were not strong enough to force their way to the surface.

A satisfactory program consisted of lowering the water in the field to about 2″, spraying with dieldrin or heptachlor at the rate of 1/2 pound of actual chemical per acre in 10 gallons of water applied by airplane, and leaving the water low for approximately 48 hours. The water is then brought up and the checks blocked off so no water is spilled from the fields for two weeks, to protect fish,

Undamaged rice field due to proper water management.

domestic animals, and wildlife from the effects of dieldrin and heptachlor.

The immediate effect of lowering the water forced the flies into the places in the checks where water still was deepest, and seemed to bring about a high mortality of young larvae emerging from the eggs. The first effect of the chemical applications was a kill of adults in the fields. In addition, the chemicals caused many maggots to leave their mines. Within 24 hours following treatment an effect was noticed on larvae remaining in the mines, and usually by 48–96 hours 99% to 100% of the larvae were dead. Larvae emerging from the eggs were killed before they started to mine in the leaves, and some larvae inside the eggs were killed just prior to hatching. The final effect at six days following treatment was practically perfect control.

The combined effect of the water management and spraying resulted in an immediate benefit to the plants, and 10 to 17 days following treatment new green growth began to appear. After 17 days following a dieldrin application at Maxwell one or two new eggs could be found, and water beetles began to reappear in the checks. With heptachlor, adults, eggs and water beetles were found in about 10 days following treatment. The chemical treatments seemed to kill some newly formed pupae, but most adults were able to emerge and were killed by the residual chemical on the leaves.

Later tests in Yolo County have shown that both dieldrin and heptachlor at four ounces of actual chemical per acre applied in the same manner as the commercial applications can give almost perfect control, although the initial control is not as great as that obtained with the higher concentrations.

Reasons for Outbreak

The 1953 outbreak of the leaf miner may be associated with cool temperatures during May. The slow and weak growth of the plants due to cool temperatures made them more susceptible to insect injury. The insect is widely distributed throughout the northern parts of the United States and probably feeds on numerous grasses. In California rice fields it selects water grass, brome grass, wild oats, nut grass, joint grass, cattail, arrowhead, water plantain and probably many other plants. Conditions must have been favorable for its buildup on these plants prior to the emergence of rice from the water. The pest has been found in Kern County where rice has never been grown before. In certain of the fields high water also encouraged the development of the insect and lowering the water was not put into effect soon enough to be of much value. The occurrence of two natural internal parasites to date would indicate that natural enemies might also play a part in keeping down attacks in some years.

Future Outbreaks

It is believed that a combination of factors such as brought about the 1953 outbreak would not ordinarily be expected during most years, and this is borne out by the 30-year lapse between severe attacks. Growers of rice feel that the insect has been present every year, but that the plants were able to outgrow the effects of the damage due to better growing conditions. An outbreak in the Biggs area in 1951, for example, was remedied when the weather became warmer. There is no evidence to show that the application of DDT to rice fields could result in lowering of the parasite population, but this possibility should be investigated. In future seasons it is thought that if water can be managed to the extent that the plants are kept upright the insect will not ordinarily be able to severely injure the plants. Most of the injured fields during 1953 were those where water was kept high, and where the land was not too fertile and the plants were growing very slowly.

Losses during 1953 will not result so much from complete loss of the rice, but from a delay in harvest, partial killing of stand with probable yield reduction, and an increase in weeds in certain areas due to lowering or completely draining the fields. The final estimate of damage can only be made when the 1953 crop is harvested.

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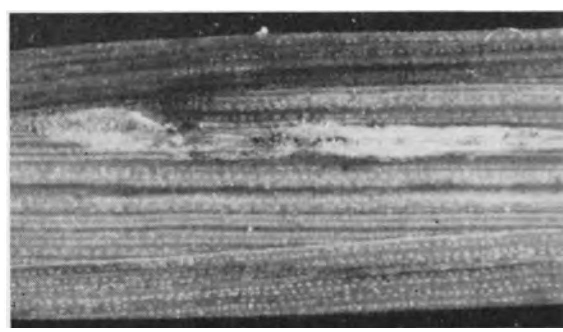
The success of this project was due to full cooperation of a number of individuals representing private, county, state, and government organizations.

Damage of the rice leaf miner. *Left,* light attack to 15 plants growing in high part of a check. *Right,* severe shredding of leaves to 15 plants growing in an adjacent part of the same field.



Above: Start of a mine of the rice leaf miner showing young maggot inside leaf. *Below:* Collapse of young rice plants in the field showing damage of the leaf miner.