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Cooperative Economic Insect Report

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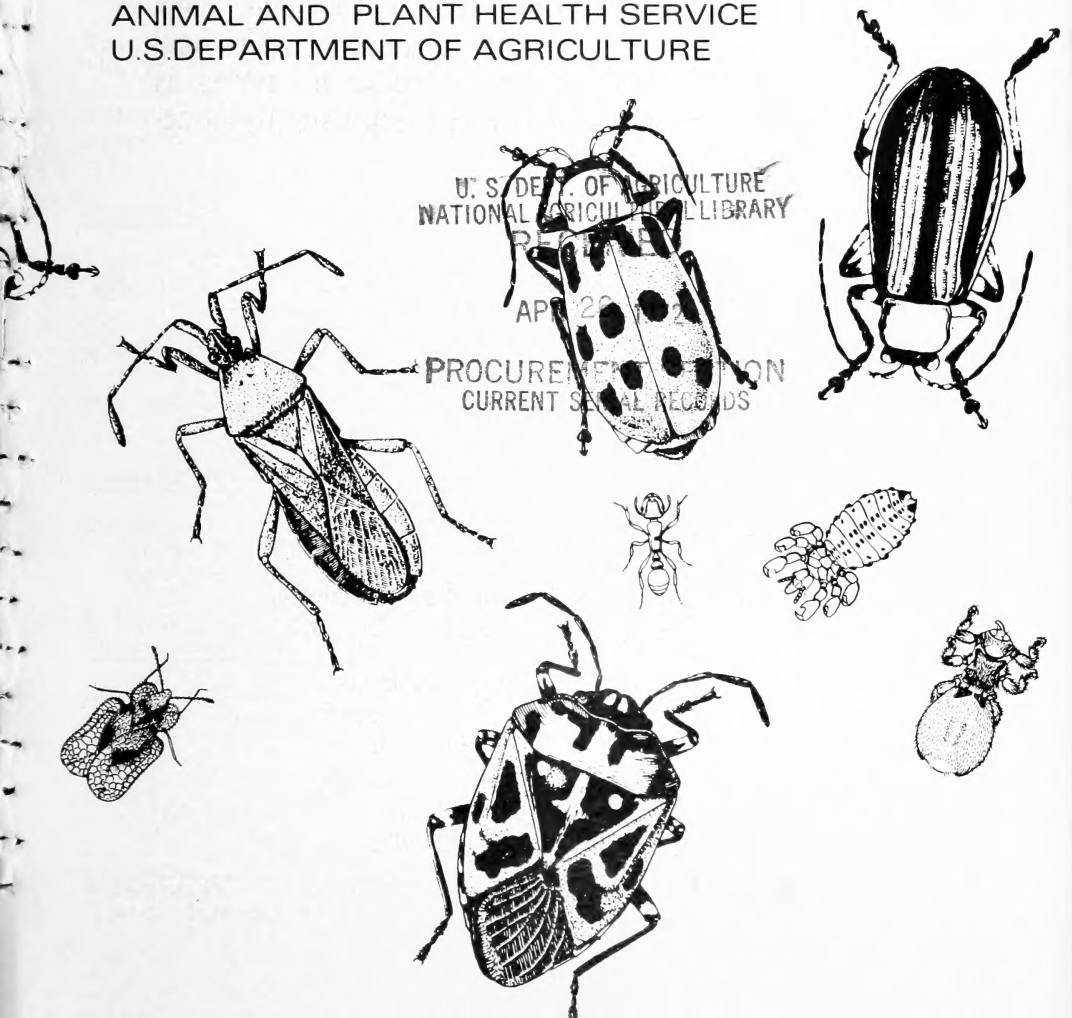

ANIMAL AND PLANT HEALTH SERVICE
PLANT PROTECTION AND QUARANTINE PROGRAMS
ECONOMIC INSECT SURVEY AND DETECTION STAFF

The Cooperative Economic Insect Report is issued weekly as a service to American Agriculture. Its contents are compiled from information supplied by cooperating State, Federal, and industrial entomologists and other agricultural workers. In releasing this material the Service serves as a clearing house and does not assume responsibility for accuracy of the material.

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COOPERATIVE ECONOMIC INSECT REPORT

HIGHLIGHTS

Current Conditions

GREENBUG continues to damage small grain in Oklahoma. Economic on oats in east-central Arkansas. (p. 189).

ALFALFA WEEVIL continues to damage alfalfa in Oklahoma. Controls applied in all areas of Arkansas and planned in Missouri. (p. 190).

PEPPER WEEVIL serious on peppers in limited area of Florida. (p. 191).

Total number of SCREWWORM cases in the U.S. increased from 22 the previous period to 71 this period. (p. 192).

WHITEFRINGED BEETLE larvae damaged tomato plants in southern Alabama. (p. 194).

Detection

- A PHYTOSEIID MITE reported from Florida for first time. This is a new United States record. Little known of biology of this species. (p. 193).

A WEEVIL reported from Maine for a new State record. (p. 192).

For new county records see page 194.

Special Reports

Summary of Insect Conditions in the United States - 1971.
Forest Insect Highlights (pp. 195-198).
Contributors (pp. 198-199).

A Review of Literature on the Pheromone of the Boll Weevil, Anthonomus grandis Boheman (pp. 200-207).

European Chafer Quarantines. Map. Centerfold.

Reports in this issue are for week ending March 31 unless otherwise indicated.

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NATIONAL WEATHER SERVICE'S 30-DAY OUTLOOK APRIL 1972

The National Weather Service's 30-day outlook for April is for temperatures to average below seasonal normals across the Nation except for near normal in the Northeast and along the south Atlantic coast and near to above normal over California, portions of the central and southern Plateau, and the Rio Grande Valley. Precipitation is expected to exceed normal from central and southern portions of the Mississippi Valley to the middle and south Atlantic coast and also along the north Pacific coast. Subnormal totals are indicated for the Southwest as well as for the north Atlantic coast States.

Weather forecast given here is based on the official 30-day "Resume and Outlook" published twice a month by the National Weather Service. You can subscribe through the Superintendent of Documents, Washington, D.C. 20250. Price $5.00 a year.

WEATHER OF THE WEEK ENDING APRIL 3

Reprinted from weekly Weather and Crop Bulletin supplied by environmental Data Service, NOAA.

PRECIPITATION: A severe late winter storm brought a variety of disagreeable weather to mid-America in the first half of the week. Heavy snow fell over the northern Great Plains and Montana to the Great Lakes. Light snow fell in the Northern and Central Rocky Mountains, intermittent snow glazed highways from the Great Lakes to New England. Gusty winds, blowing snow and drifting snow, snarled automobile traffic, delayed air travel, and closed schools. Eleven inches of snow fell in 12 hours Wednesday, at Moline, Illinois, 9 inches accumulated in Madison, Wisconsin, and 5 to 8 inches covered the Chicago, Illinois, area. Ten inches

Weather of the week continued on page 208.

SPECIAL INSECTS OF REGIONAL SIGNIFICANCE

ARMY CUTWORM (Euxoa auxiliaris) - COLORADO - Larval counts per linear foot of small grain: 1-4 in Adams County; 2 in Arapahoe County; 1-2 in Elbert County; 3 in Lincoln County; and 6 in Washington County. (Marquardt). OKLAHOMA - Pupation started in alfalfa in Pontotoc County. (Okla. Coop. Sur.).

ARMYWORM (Pseudaletia unipuncta) - ARKANSAS - Moths reported in area east of Little Rock, Pulaski County. (Boyer).

BEET LEAFHOPPER (Circulifer tenellus) - CALIFORNIA - Treatment underway. Spring population moderate throughout most of San Joaquin Valley. Strong winds drying host vegetation. This will cause some natural mortality but will also cause dissemination of adults to croplands earlier than anticipated. (Cal. Coop. Rpt.).

CORN EARWORM (Heliothis zea) - ARIZONA - This species and CABBAGE LOOPER (Trichoplusia ni) required controls on lettuce at Yuma, Yuma County. (Ariz. Coop. Sur.).

GREENBUG (Schizaphis graminum) - OKLAHOMA - Light to heavy on wheat in Wagoner County. Ranged 50-100 per sweep in Pottawatomie County. Moderate in Kingfisher County. Ranged 25-75 per linear foot in wheat and oats in Sequoyah and Le Flore Counties with some damage in spring oats. Ranged 20-40 per linear foot in Kay County. Numbers reduced by predators and parasites in Major County. Greenbug ranged 1-5 per linear foot in McCurtain and Choctaw Counties and light in Dewey and Roger Mills Counties. (Okla. Coop. Sur.). ARKANSAS - Some concern mainly in east-central area small grains. Economic in about 15 percent of oat-fields east of Little Rock. Two fields treated in Lee and Monroe Counties. In most cases, Macrosiphum avenae (English grain aphid) associated with greenbug. Greenbug increased slightly in north-west areas, no economic infestations observed or reported. (Boyer).

SPOTTED ALFALFA APHID (Therioaphis maculata) - ARIZONA - Counts of 253 per 100 sweeps of alfalfa in Maricopa County. (Ariz. Coop. Sur.). NEW MEXICO - Light on alfalfa in Chaves and Eddy Counties. (Mathews). OKLAHOMA - Ranged 25-150 per square foot in alfalfa in Major County. (Okla. Coop. Sur.).

CORN, SORGHUM, SUGARCANE

SOUTHWESTERN CORN BORER (Diatraea grandiosella) - OKLAHOMA - Overwintering larvae in 20 percent of cornstalks in Muskogee County field and 10 percent of stalks in Okmulgee County field. (Okla. Coop. Sur.).

SMALL GRAINS

APHIDS - MISSISSIPPI - Mixed populations of Rhopalosiphum fitchii (apple grain aphid) and R. padi heavy on oats in Panola County; also Schizaphis graminum (greenbug) light in this population. Some parasitism. R. padi heavy on small grain in Issaquena County. About 95 percent of population parasitzied by a braconid. (Robinson). OKLAHOMA - R. padi ranged 2-10 per linear foot in oats and wheat in McCurtain, Choctaw, Le Flore, Sequoyah, and Payne Counties. (Okla. Coop. Sur.).

BROWN WHEAT MITE (Petrobia latens) - SOUTH DAKOTA - Reported as new county record for Haakon County. (Jones). OKLAHOMA - Heavy in field of barley in Roger Mills County; light and scattered in other areas. Ranged 0-20 per linear foot in wheat in Major County. (Okla. Coop. Sur.). NEVADA - No increase from previous period on winter wheat in Lovelock area, Pershing County, due to cold, damp weather. (Stitt).

WINTER GRAIN MITE (Penthaleus major) - OKLAHOMA - Moderate in wheat in Lincoln and Kingfisher Counties. (Okla. Coop. Sur.).

HESSIAN FLY (Mayetiola destructor) - KANSAS - During period November 1971 to March 1972, wheat samples checked to determine population densities of overwintering pupae (flaxseed). Significant damage noted to wheat where 35+ percent plants infested. Average percent infested plants by district: Northeast 5, east-central 2, southeast 0.6, north-central 8.7, central 6, south-central 7.5, northwest trace, west-central 55, and southwest 7. (Bell).

TURF, PASTURES, RANGELAND

WESTERN TENT CATERPILLAR (Malacosoma californicum) - OREGON - First instar larvae on bitterbrush at Mt. Vernon, Grant County. (Penrose).

FORAGE LEGUMES

ALFALFA WEEVIL (Hypera postica) - COLORADO - Adults laying eggs past 4 weeks in Western Slope area; alfalfa 1-2 inches tall. Mostly light to moderate in alfalfa checked. (Bulla). OKLAHOMA - Continues heavy in northeast, east-central, southeast, central, south-central, and southwest areas. Larval counts of 200-300 per square foot common. As much as 90-95 percent of foliage destroyed in many untreated fields. Many fields treated and some treated twice. Pupae common in southern half of State and adults emerging. Eggs found in Lincoln County. Numbers increasing in north-central, northwest, and west-central areas with counts of 10-60 larvae per square foot in several counties. Most reported damage moderate. Controls underway in these areas. (Okla. Coop. Sur.).

ARKANSAS - H. postica controls general statewide. Egg hatch continues. Larvae ranged 800-900 per 100 sweeps in untreated field in Washington County. Larvae in this field last period ranged 300-400 per 100 sweeps. (Boyer). MISSOURI - Egg count in southern half of State ranged 143-1,010 per square foot. Larvae in fields checked, controls planned. (Munson). KENTUCKY - Averaged 7.5 second instar larvae and 164 eggs per square foot in central areas. (Gregory). ALABAMA - Mixed larval populations of this species and LESSER CLOVER LEAF WEEVIL (H. nigrirostris) and CLOVER LEAF WEEVIL (H. punctata) feeding on crimson and burclover in south and central areas. Heaviest feeding on burclover. (Barwood et al.).

EGYPTIAN ALFALFA WEEVIL (Hypera brunneipennis) - ARIZONA - Larvae 62 per 100 sweeps of alfalfa in Maricopa County and adults 52 in Yuma County. (Ariz. Coop. Sur.).

PEA APHID (Acyrthosiphon pisum) - NEVADA - Averaged 300 per sweep in Moapa Valley, Clark County, alfalfa hay fields. (Hoff, Zoller). ARIZONA - Counts of 1,214 per 100 sweeps in Yuma County alfalfa. (Ariz. Coop. Sur.). NEW MEXICO - Light, ranged 10-40 per 25 sweeps

in alfalfa in Eddy, Chaves, and Dona Ana Counties. (Mathews, Riddle). OKLAHOMA - Continues in alfalfa in all areas of State except panhandle. Infestations light to moderate in many areas, counts of 300-500 per square foot reported from few counties in northwest, northeast, and south-central areas. (Okla. Coop. Sur.). ARKANSAS - Continues to increase in legumes. Infestations non-economic; some counts ranged 500-1,000 per 100 sweeps. (Boyer).

ALFALFA CATERPILLAR (Colias eurytheme) - ARIZONA - Larvae 8 per 100 sweeps in Maricopa County alfalfa, and 20 in Yuma County. (Ariz. Coop. Sur.). NEW MEXICO - Light in most alfalfa in Chaves and Eddy Counties. (Mathews).

ALFALFA LOOPER (Autographa californica) - OREGON - Single moth recovered from light trap in Marion County and moth observed in Polk County, first of season. (Westcott, Long).

SUGAR BEETS

BEET ARMYWORM (Spodoptera exigua) - ARIZONA - Larvae infested 30 percent of crowns in Yuma County field. (Ariz. Coop. Sur.).

POTATOES, TOMATOES, PEPPERS

PEPPER WEEVIL (Anthonomus eugenii) - FLORIDA - Serious problem in parts of Palm Beach and Broward Counties. Larvae and adults infested fruits of most of sweet and hot peppers on two farms west of Delray Beach, Palm Beach County; infested about 25 percent of bell peppers on farm in middle Palm Beach County. Infestations thin out northward in Palm Beach County; 2 farms near Palm Beach and Martin County line negative; however, one farm with 2 percent infestation. Farm west of Deerfield Beach, Broward County, near 100 percent of hot peppers infested. (Genung). Apparently this "hot spot" area in Palm Beach and Broward Counties is of recent vintage because this is first record of pepper weevil in State since 1945. At that time records confined to Tampa Bay area. (Woodruff, Mead).

GREEN PEACH APHID (Myzus persicae) - FLORIDA - More prevalent than in 1971 on tomatoes in Homestead area, Dade County. (Wolfenbarger).

COLE CROPS

CABBAGE LOOPER (Trichoplusia ni) - NEW MEXICO - Controls applied on young lettuce in Dona Ana County. (N.M. Coop. Rpt.).

CUCURBITS

MELON APHID (Aphis gossypii) - ARIZONA - This species and Tetranychus sp. (a spider mite) required treatment in cantaloup at Yuma, Yuma County. (Ariz. Coop. Sur.).

DECIDUOUS FRUITS AND NUTS

GREEN PEACH APHID (Myzus persicae) - COLORADO - Eggs 95 percent hatched by March 10 on Western Slope area peaches. Egg and nymph counts moderate in orchards sampled. Nymphs 6-8 per 100 fruit buds

March 20. Most dormant and delayed dormant sprays applied and peaches in fullbloom by March 24 in Mesa County. Earliest peach bloom date since 1930. (Bulla).

ROSY APPLE APHID (Dysaphis plantaginea) - COLORADO - Hatch near complete March 31 in Western Slope orchards. (Bulla).

TWOSPOTTED SPIDER MITE (Tetranychus urticae) - COLORADO - Noted on trunk and lower twigs in apple orchards March 17 in Western Slope area. (Bulla).

ORNAMENTALS

SPRUCE SPIDER MITE (Oligonychus ununguis) - ARIZONA - Heavy on arborvitae and Italian cypress in Salt River Valley. Webbing noticeable and many trees discolored. Similar to 1968 infestations in Maricopa County. (Ariz. Coop. Sur.).

FOREST AND SHADE TREES

NANTUCKET PINE TIP MOTH (Rhyacionia frustrana) - OKLAHOMA - Overwintering generation emergence complete and adults on young pines in Latimer County. (Okla. Coop. Sur.).

EASTERN TENT CATERPILLAR (Malacosoma americanum) - SOUTH CAROLINA - Webs 2 per tree on wild cherry in Sumter, Richland, Lexington, Calhoun, Dorchester, and Colleton Counties. First of season. (King). NORTH CAROLINA - Webbing noted in Wake, Columbus, Bladen, and Brunswick Counties. (Hunt). MARYLAND - First larvae of season on wild cherry in Montgomery and Prince Georges Counties. (U. Md., Ent. Dept.).

ELM LEAF BEETLE (Pyrrhalta luteola) - IOWA - Collected in Plymouth County, for a new county record. (Iowa Ins. Sur.).

A WEEVIL (Phyllobius oblongus) - MAINE - Specimens reported at Hampden, Penobscot County, by R. Cyr on June 17, 1971. Adults feeding on newly planted Norway maple. Determined by R.E. Warner. This is a new State record. (Gall).

A MARAGRODID SCALE (Kuwania quercus) - CALIFORNIA - Specimens collected from oak at Napa, Napa County for a new county record. This scale collected for first record outside Asian Continent in 1965 at Monticello Dam in Yolo County. (Cal. Coop. Rpt.).

MAN AND ANIMALS

SCREWWORM (Cochliomyia hominivorax) - Total of 71 cases reported in U.S. March 26 to April 1 as follows: TEXAS: Dimmit 1, Duval 2, Frio 1, Hidalgo 7, Jim Hogg 3, Kenedy 2, La Salle 2, Live Oak 4, Maverick 1, Medina 2, Real 1, Starr 5, Webb 10, Willacy 2, Zapata 5, Zavala 1, Goliad 1, Gonzales 1, Jim Wells 1, Karnes 1, De Witt 3, Kendall 1, Kleberg 2, McCulloch 1, Refugio 3, San Patricio 1, Victoria 1. ARIZONA: Cochise 5, Santa Cruz 1. Total of 259 laboratory-confirmed cases reported in portion of Barrier Zone in Republic of Mexico as follows: Sonora 109, Chihuahua 37, Coahuila 27, Nuevo Leon 35, Tamaulipas 51. Total of 56 cases reported in Mexico south of Barrier Zone. Barrier Zone is area where eradication operation underway to prevent establishment of self-sustaining population in U.S. Sterile screwworm flies released: Texas 67,172,000; Arizona 6,480,000; Mexico 35,912,000. (Anim. Health).

HORN FLY (Haematobia irritans) - OKLAHOMA - Ranged 25-500 per head on cattle in Major County and 250-400 per head in Payne County. Light in Craig and McCurtain Counties. (Okla. Coop. Sur.).

MOSQUITOES - MINNESOTA - First egg hatch noted March 24, larvae too small to identify; up to 25 per dip noted at several sites in Ramsey County area. (Minn. Pest Rpt.).

STORED PRODUCTS

A SCARAB (Strigoderma arboricola) - NORTH CAROLINA - Less than 5 percent grub damage in sweet potato packing sheds. Potatoes damaged in Sampson, Johnston, and Wilson Counties. (Hunt).

BENEFICIAL INSECTS

LADY BEETLES - KANSAS - Surveys of bunch grass March 7-17 showed overwintering Hippodamia convergens (convergent lady beetle) adults to range from 0 to 273 per square foot (4 samples per county). Coleomegilla maculata adults ranged 0-29 per square foot during same survey. (Bell). OKLAHOMA - All stages of H. convergens common in wheat and alfalfa in most areas. Ranged up to 60 per linear foot in wheat in Major County and up to 100 per sweep in wheat in Pottawatomie County. Helping to control greenbugs in these areas. H. convergens heaviest in untreated alfalfa in south-central area; ranged up to 200 per 10 sweeps. Adults of Coleomegilla maculata in alfalfa in Hughes County and on pine trees in Latimer County. (Okla. Coop. Sur.).

A BRACONID (Lysiphlebus testaceipes) - OKLAHOMA - Parasitized 60 percent of greenbugs in several wheatfields in Major County, caused considerable reduction in numbers. Also reducing greenbug populations in Payne County. (Okla. Coop. Sur.).

AN EULOPHID WASP (Tetrastichus incertus) - OKLAHOMA - Released about 125 adults of this alfalfa weevil parasite in infested alfalfa in Stephens County. (Okla. Coop. Sur.).

AN EULOPHID WASP (Aprostocetus diplosidis) - ALABAMA - Specimens collected in grain sorghum field in Macon County during September 1971 by H.F. McQueen. Determined by B.D. Burks. This is a new State record. (McQueen).

A PHYTOSEIID MITE (Ricoseius loxocheles) - FLORIDA - Adult found on seagrape (Coccoloba uvifera) at Miami, Dade County, by F.J. McHenry on January 18, 1972. This is a new United States record. This is the third time species collected anywhere. Previous reports from Puerto Rico and Brazil. Little known of biology of this species. (Mead, Denmark).

FEDERAL AND STATE PLANT PROTECTION PROGRAMS

CARIBBEAN FRUIT FLY (Anastrepha suspensa) - FLORIDA - Specimens collected in 50 percent of traps in Sarasota area, Sarasota County. (McFarlin, Mead). Heaviest count 291 in single trap March 14-23. (Mead).

GRASSHOPPER - OKLAHOMA - Melanoplus sp. and Ageneotettix deorum hatched on rangeland in Comanche County March 20. These species and Cordillacris crenulata ranged up to 1 per square yard in rangeland in Jefferson County March 22. (Okla. Coop. Sur.).

PINK BOLLWORM (Pectinophora gossypiella) - TEXAS - Collected 3 moths in blacklight trap in McLennan County. (Cowan).

WHITEFRINGED BEETLES (Graphognathus spp.) - ALABAMA - Larvae destroyed 50 percent of tomato plants in 3-acre commercial planting in Houston County. Remainder plowed up and treated and will replant. (Smith et al.). Larvae heavy and damaging at 3 additional sites in same area. (Wilson, Curtis).

WOOLLY WHITEFLY (Aleurothrixus floccosus) - CALIFORNIA - Light in about 40 properties in 10-block-area at Ocean Beach, San Diego County. (Cal. Coop. Rpt.).

HAWAII INSECT REPORT

Corn - CORN PLANTHOPPER (Peregrinus maidis) trace (less than 2 nymphs or adults per plant) in 2.5 acres of sweet corn seedlings at Waimanalo, Oahu. Adults of Cyrtorhinus lividipennis (a predacious mirid bug) trace to light. (Kawamura).

General Vegetables - Adults of a GREENHOUSE WHITEFLY (Trialeurodes vaporariorum) light, eggs and nymphs moderate in one acre of snap beans at Waimanalo, Oahu; all stages light in 5,000 square feet of sweet pepper seedlings. SWEETPOTATO LEAFMINER (Bedellia orchilella) larval mines trace in two separate, one-half acre planting of sweet potato at Waimanalo, Oahu. (Kawamura).

Fruits and Nuts - PALM MEALYBUG (Palmicultor palmarum) heavy on about 15 percent of young coconut trees at Keehi Lagoon Park, Oahu, on new unfurled fronds. Larvae and adults of lady beetles (Azya luteipes and Cryptolaemus montrouzieri) light amid infestation. COCONUT SCALE (Aspidiotus destructor) spotty, colonies on lower leaves in most commercial plantings of papaya at Waimanalo, Oahu; light on about 50 coconut trees at Keehi Lagoon Park. (Kawamura).

Ornamentals - A TERMITE (Incisitermes immigrans) moderate on structural garage lumber at Hilo, Hawaii. I. immigrans most commonly found in drought-affected woody shrubs in drier sections of islands. (Kobayashi).

DETECTION

New United States Record - A PHYTOSEIID MITE (Ricoseius loxocheles) - FLORIDA - Dade County. (p. 193).

New State Record - A WEEVIL (Phyllobius oblongus) - MAINE - Penobscot County. (p. 192).

New County Records - BROWN WHEAT MITE (Petrobia latens) - SOUTH DAKOTA - Haakon (p. 190). ELM LEAF BEETLE (Pyrrhalta luteola) - IOWA - Plymouth (p. 192). A MARAGRODID SCALE (Kuwania quercus)- CALIFORNIA - Napa (p. 192).

SUMMARY OF INSECT CONDITIONS IN THE UNITED STATES - 1971
(Continued from page 180)

FOREST INSECT HIGHLIGHTS 1/

Situation in the Western States

BARK BEETLES continued to dominate the forest insect situation in the Western States. Several new outbreaks and many existing ones caused severe timber losses.

In ALASKA, the overall forest insect situation improved in 1971. Epidemic SPRUCE BEETLE (Dendroctonus rufipennis) populations persisted but tree mortality caused by this pest decreased. WESTERN BLACKHEADED BUDWORM (Acleris gloverana) populations remained at endemic level for the sixth consecutive year.

BARK BEETLES continued to be the most destructive group of forest insects in OREGON and WASHINGTON. Severe outbreaks of MOUNTAIN PINE BEETLE (D. ponderosae), DOUGLAS FIR BEETLE (D. pseudotsugae), and FIR ENGRAVERS (Scolytus spp.) occurred throughout the region. Losses resulting from outbreaks of FIR ENGRAVER (S. ventralis) were much less in 1971 but were still considered serious. Defoliator activity increased substantially with widespread damage occurring in hemlock, true fir, and Douglas-fir stands. Populations of WESTERN SPRUCE BUDWORM (Choristoneura occidentalis) and WESTERN BLACKHEADED BUDWORM are increasing. Another important defoliator, the LARCH CASEBEARER (Coleophora laricella) continued to spread throughout the Pacific Northwest.

In CALIFORNIA, rapidly expanding DOUGLAS FIR TUSSOCK MOTH (Hemerocampa pseudotsugata) populations were the major concern in in 1971. New infestations were discovered at seven locations from Shasta County to Fresno County. Increased activity by the LODGEPOLE NEEDLEMINER (Coleotechnites milleri) occurred on the Yosemite National Park. BARK BEETLE activity remained at a low level in most areas. Many of the air pollution affected trees in San Bernardino County were infested by bark beetles.

Populations of several species of destructive forest insects increased in the Northern Rockies during 1971. WESTERN SPRUCE BUDWORM defoliated 4.1 million acres in western Montana and northern Idaho and continued to spread northward in Montana. Increased activity occurred on portions of the Gallatin and Helena National Forests and the Yellowstone National Park. The LARCH CASEBEARER has now spread to all of the western larch type in the Region. Severe infestation of MOUNTAIN PINE BEETLE continued on the Kaniksu and Flathead National Forests in Montana and increased DOUGLAS FIR BEETLE population occurred in Idaho. Populations of SPRUCE BEETLE and FIR BEETLE continued to decline.

1/ The following summary is the highlights section of the "Forest Insect Conditions in the United States - 1971" which was compiled and published by the Forest Service, U.S. Department of Agriculture. Copies of the complete annual summary are available upon request from the Regional Forester or Area Director in your area. Addresses of the regional offices may be found on page 198 in this issue of the CEIR.

The forests in the intermountain States were plagued by a variety of insects in 1971. As usual BARK BEETLES, particularly the MOUNTAIN PINE BEETLE, caused more timber damage than any other group of insects. Although overall mountain beetle activity was at the lowest level in several years, a large volume of lodgepole and ponderosa pine trees were killed. The most severe outbreak was on the Targhee National Forest in Idaho. Population of DOUGLAS FIR BEETLE in southern Idaho were beginning to subside after remaining at epidemic levels during the last 2 years. The area infested by WESTERN SPRUCE BUDWORM increased on the Payette and Boise National Forests, but decreased on the Bridger National Forest. Natural factors were responsible for reducing DOUGLAS FIR TUSSOCK MOTH populations in southern Idaho.

In the Central Rocky Mountains, the most troublesome forest insects were MOUNTAIN PINE BEETLE and SPRUCE BEETLE. Most SPRUCE BEETLE infestations appear to be stable or decreasing but windthrown trees resulting from several windstorms in the fall of 1971 may trigger increased spruce beetle activity in 1972. MOUNTAIN PINE BEETLE populations continue to cause severe mortality in South Dakota, Colorado, and Wyoming. Losses in the Black Hills caused by this pest were estimated at 21 million board feet in 1971. The WESTERN SPRUCE BUDWORM outbreak on the San Isabel National Forest increased from 32,000 acres in 1970 to 113,000 acres in 1971.

In the Southwestern States, epidemic SPRUCE BEETLE populations were reduced by abnormally low temperatures. ROUNDHEADED PINE BEETLE (Dendroctonus adjunctus) activity remained at epidemic levels on the Lincoln National Forest and Mescalero and Apache Indian Reservation in New Mexico. Defoliator activity increased in the Southwest during 1971. WESTERN SPRUCE BUDWORM and WESTERN TENT CATERPILLAR (Malacosoma californicum) were the most important defoliators.

Situation in the Southern and Southeastern States

The SOUTHERN PINE BEETLE (Dendroctonus frontalis) continues to be the principal forest insect in the South and Southeast. During the summer of 1971, populations increased rapidly to epidemic levels over widespread areas of the region. Timber losses were very severe on the Francis Marion National Forest in South Carolina, where the infestation level was the highest it has been in 9 years. An outbreak on a 25,000-acre area of the Great Smoky Mountains National Park reached an infestation level of 1,000 infested trees per thousand acres of host type. Other SOUTHERN PINE BEETLE outbreaks occurred in Virginia, North Carolina, South Carolina, Tennessee, Georgia, Alabama, Mississippi, Louisiana, and Texas. Populations of ENGRAVER BEETLES (Ips spp.) were generally lower in 1971 than in 1970, however, increased activity did occur in Texas and Florida. The most important forest insect defoliators in 1971 were the VARIABLE OAKLEAF CATERPILLAR (Heterocampa manteo), FOREST TENT CATERPILLAR (Malacosoma disstria) and several pine feeding SAWFLIES. The GYPSY MOTH (Porthetria dispar) was trapped at locations in Virginia, North Carolina, and South Carolina. One small infestation was discovered in Pensacola, Florida, and promptly treated.

Situation in the Lake and Central States and the Northeast

Defoliators continued to dominate the forest insect situation in the Eastern Region. More than eight million acres of hardwood forests were defoliated by the major hardwood insect defoliators

in 1971. The impact of this defoliation was especially severe in intensively managed hardwood forest and urban areas. The most important defoliators were GYPSY MOTH, a REDHUMPED OAKWORM (Symmerista canicosta), VARIABLE OAKLEAF CATERPILLAR, SADDLED PROMINENT (Heterocampa guttivitta), and a complex of LEAFROLLERS. Another 4.5 million acres of coniferous forest were defoliated by increasing populations of SPRUCE BUDWORM (Choristoneura fumiferana) The SOUTHERN PINE BEETLE outbreak on the Delmarva Pennisula in Delaware and Maryland continued to cause serious pine mortality. Other important forest insects in 1971 were various SAWFLIES, BALSAM WOOLLY APHID (Adelges piceae), SARATOGA SPITTLEBUG (Aphrophora saratogensis), and PINE ROOT COLLAR WEEVIL (Hylobius radicis).

Suppression Activities

Forest insect suppression programs were conducted throughout the United States and emphasized suppression measures that have minimal impact on the environment but will accomplish control objectives. Cultural practices, use of natural enemies and applying nonpersistant pesticides are but a few of the measures recommended in 1971 to reduce forest insect and disease caused losses.

Bark beetles were a major target of control in the Western States. The most significant control decision was to terminate the large-scale project for suppressing mountain pine beetle populations on the Targhee National Forest in Idaho and Wyoming. Although this virulent outbreak continues to increase in severity, suppression was considered unfeasible for various reasons. Elsewhere in the West, silvicultural measures, removal of infested trees, piling and burning and limited chemical control were used to combat bark beetles. Other bark beetles requiring suppression in the West were Douglas fir beetle, western pine beetle, spruce beetle, roundheaded pine beetle and various engravers. In the South and Southeast, forest managers relied almost entirely on non-chemical measures for suppressing the southern pine beetle. Removal of infested trees and piling and burning were the primary suppression measures used in Alabama, Louisiana, Mississippi, North Carolina, Tennessee, Texas, and Virginia. Several large-scale control projects were directed against defoliators in the Eastern Region during 1971. A total of 372,000 acres were aerially sprayed with carbaryl for gypsy moth suppression. Infestation of forest tent caterpillar and oak leaf rollers also required chemical suppression. Oak wilt and white pine blister rust were two disease problems that required control efforts in the eastern region.

A number of field test and pilot projects were conducted to evaluate promising methods for controlling important forest pest. In California, continuing studies to determine the effectiveness of synthetic attractants for suppression of western pine beetle showed promising results in 1971.

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COOPERATING WITH AFFECTED STATE

COUNTIES ENTIRELY COLORED ARE COMPLETELY REGULATED
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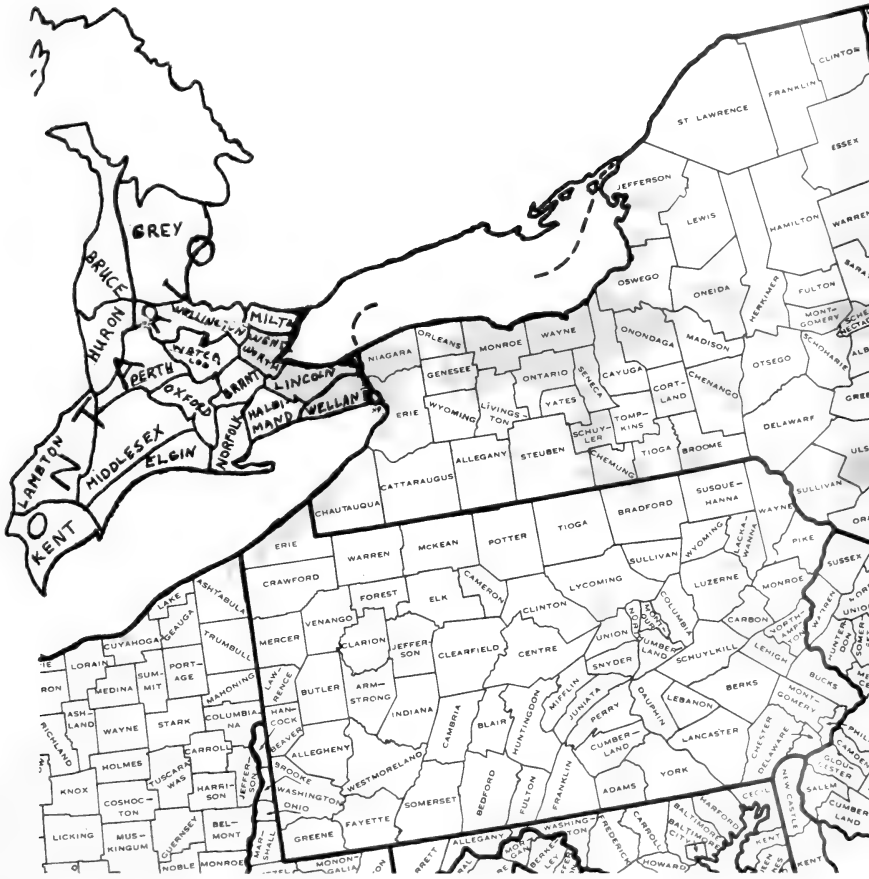

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GENERALLY INFESTED AREA — STATE, FEDERAL, AND CANADIAN REGULATIONS (ERADICATION TREATMENTS NOT IN PROGRESS OR PLANNED)

STATE REGULATIONS ONLY (ERADICATION TREATMENTS APPLIED OR IN PROGRESS)

ERADICATED — REGULATIONS REMOVED

RESTRICTIONS ARE IMPOSED ON MOVEMENT OF REGULATED ARTICLES FROM A REGULATED AREA AS FOLLOWS

1. RED INTO OR THROUGH WHITE OR BLUE
2. BLUE INTO ANY OTHER AREA WHEN REQUIRED BY APPROPRIATE STATE QUARANTINE OR BY AN AUTHORIZED INSPECTOR

IN THE UNITED STATES, CONSULT YOUR STATE OR FEDERAL PLANT PROTECTION INSPECTOR OR YOUR COUNTY AGENT AND, IN CANADA, YOUR NEAREST PLANT PROTECTION DIVISION OFFICE FOR ASSISTANCE REGARDING AREAS UNDER REGULATION AND REQUIREMENTS FOR MOVING REGULATED ARTICLES.

THE FOLLOWING REGULATED ARTICLES MOVED FROM GENERALLY INFESTED AREAS (RED) REQUIRE A CERTIFICATE OR PERMIT YEAR-'ROUND EXCEPT AS INDICATED:*

1. Soil, compost, decomposed manure, humus, muck, and peat, separately or with other things.
   Soil samples shipped to approved laboratories do not require attachment of certificate or permit.**
   Compost, decomposed manure, humus, and peat are exempt*** if dehydrated, ground, pulverized, or compressed.

2. Plants with roots, **except** soil-free aquatic plants, moss, and Lycopodium (clubmoss or ground-pine or running pine).

3. Grass sod.

4. Plant crowns and roots for propagation.

5. True bulbs, corms, rhizomes, and tubers of ornamental plants when freshly harvested or uncured.
   True bulbs, corms, rhizomes and tubers (other than clumps or dahlia tubers) of ornamental plants are exempt*** if free of soil.

6. Used mechanized soil-moving equipment.
   Used mechanized soil-moving equipment is exempt*** if cleaned and repainted.

7. Any other products, articles, or means of conveyance of any character whatsoever, not covered by the above, when it is determined by an inspector that they present a hazard of spread of the European chafer and the person in possession thereof has been so notified.

THE FOLLOWING REGULATED ARTICLES MOVED FROM STATE REGULATED AREAS (BLUE) REQUIRE A CERTIFICATE OR PERMIT YEAR-'ROUND EXCEPT AS INDICATED:*

1. Bulk soil.

2. Used mechanized soil-moving equipment.
   Used mechanized soil-moving equipment is exempt*** if cleaned and repainted.

3. Any other products, articles, or means of conveyance of any character whatsoever, not covered by the above, when it is determined by an inspector that they present a hazard of spread of the European chafer and the person in possession thereof has been so notified.

* See "Restrictions Imposed on Movement of Regulated Articles" on the reverse side.

** Information as to approved laboratories may be obtained from an inspector.

*** Exempt if not exposed to infestation after cleaning or other prescribed handling.

(clubmoss or ground-pine or running pine).

3. Grass sod.

4. Plant crowns and roots for propagation.

5. True bulbs, corms, rhizomes, and tubers of harvested or uncured.
True bulbs, corms, rhizomes and tubers (ot bers) of ornamental plants are exempt*** if

6. Used mechanized soil-moving equipment.
Used mechanized soil-moving equipment is painted.

7. Any other products, articles, or means of whatsoever, not covered by the above, whe spector that they present a hazard of sprea the person in possession thereof has been so

THE FOLLOWING REGULATED ARTICLES MC LATED AREAS (BLUE) REQUIRE A CERTIF 'ROUND EXCEPT AS INDICATED:*

1. Bulk soil.

2. Used mechanized soil-moving equipment.
Used mechanized soil-moving equipment is painted.

3. Any other products, articles, or means of whatsoever, not covered by the above, when i that they present a hazard of spread of person in possession thereof has been so n

* See "Restrictions Imposed on Movement of I reverse side.

** Information as to approved laboratories may b

*** Exempt if not exposed to infestation after cle dling.

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A Review of Literature on the Pheromone of the Boll Weevil, Anthonomus grandis Boheman (Coleoptera: Curculionidae)

D. D. Hardee1/

Since its introduction into the United States about 1892 (Hunter and Hinds 1905), the boll weevil, Anthonomus grandis Boheman, has been the most costly insect in the history of American agriculture and is often termed the "$10 billion insect" (Dunn 1964). Losses in cotton production due to the boll weevil are estimated to average $200 to 300 million annually; to prevent even greater losses, growers spend an estimated $70 million each year (Knipling 1964) for its control. It is estimated (Rainwater 1962) that about one-third of all insecticides used for agricultural purposes are applied for control of the boll weevil. The extensive use of insecticides for control of boll weevils not only may cause a serious problem of environmental pollution but often causes a drastic reduction of natural biological agents that otherwise would hold other agricultural pests in check. The adverse effect on natural insect parasites and predators often leads to an increase in subsequent populations of such insects as the tobacco budworm and the bollworm. This, in turn, may result in increased crop losses and increased intensive use of insecticides to protect the cotton crop.

Attempts to solve the problem resulted in considerable research in the past decade directed toward the development of ways to eliminate the boll weevil from all infested cotton growing areas in the United States. An area of research that has shown a great deal of promise in manipulation of populations of the boll weevil has been the use of pheromones (Karlson and Lüscher 1959). General reviews of literature on the boll weevil are available (Dunn 1964, Mitlin and Mitlin 1968). This review, however, is concerned only with literature relating to the pheromone of the boll weevil.

In the earliest record of sexual attraction in the boll weevil, Hunter and Hinds (1905) concluded that females were not attractive to males and that ". . . instead of seeking widely for the females, the males are content to wait for them to come their way." It was not until 1962 that Cross and co-workers (Cross and Mitchell 1966, confirmed by Keller et al. 1964) showed conclusively that the male boll weevil produces a wind-borne sex attractant (pheromone) that is attractive to females.

Once a laboratory bioassay procedure was developed (Hardee et al. 1967a), female attraction to males was confirmed, and subsequent research in the laboratory (Hardee et al. 1967b, Bartlett et al. 1968) showed that (1) males sterilized with apholate or gamma radiation were equally as attractive as untreated males when both were fed cotton squares (flower buds) as food; (2) peak sexual activity of both males and females occurred when weevils were 4 to 6 days old; (3) females responded to a single male, but response was significantly greater to 5, 10, or 25

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males; (4) virgin males were twice as attractive and virgin females were 3 times as responsive as mated males or females; and (5) comparisons between laboratory-reared and native weevils indicated food to be of greater importance than culture in determining female response.

Additional diet studies in the laboratory and field in 1966-69 (Hardee 1970c) showed that: (1) Males fed cotton squares, bolls, and blooms were considerably more attractive than males fed terminals, cotyledons and leaves; (2) pheromone production by males was reduced by about 50 percent one hour and over 90 percent twenty-four hours after food was removed; (3) males survived well and produced pheromone in laboratory bioassays on a variety of foods (50-70 percent as much as on cotton squares) such as apples, bananas, okra, peaches, and string beans, but the most favorable diet was cotton squares; and (4) overwintered male boll weevils survived longer without food than laboratory-reared males, but both needed some food before pheromone production began. In field tests, however, Cross et al. (unpublished data) were not able to show response to male boll weevils fed on any diet except cotton. The results indicated that a constant supply of adequate food, preferably cotton squares or small cotton bolls, is essential to continued production of a high level of pheromone by males.

The effectiveness of males or extracts of males in different kinds of traps in capturing virgin, released females (Cross et al. 1967, 1969, Hardee et al. 1969a) was evaluated in 1965-66 in several field studies in Mississippi, Florida, and Mexico. It was concluded from these studies that a wing-type trap coated with an adhesive was the most effective trap for boll weevils. Hardee et al. (1969a) concluded from these field tests that: (1) Males in close proximity to females were no more attractive to females than isolated males; (2) females responded to males as many as 3 times and from distances of as much as 250 feet; and (3) the high percentage of females captured in traps baited with males in the absence of competing males, and the low percentage captured with males in traps in an infested plot containing large numbers of competing males suggest that the sex pheromone might have a major role in suppressing boll weevils in areas where populations are extremely low; for example, in the spring after an effective fall diapause-control program has substantially reduced the number of overwintering boll weevils. They also substantiated results from previous tests in showing that: (1) Laboratory-reared males were as attractive and females were as responsive as native weevils if they had access to cotton squares (flower buds) as food; (2) isolated males were more attractive than grouped males; (3) males in close proximity to females were no more attractive to females than isolated males; (4) the lack of response of recently mated females emphasized the need to capture females in traps before they mate with free, competing males; and (5) sterilization of males with apholate or irradiation did not significantly decrease their attractiveness compared with untreated males.

In 1967 Cross and Hardee (1968) demonstrated for the first time, Bradley et al. (1968) confirmed, and Hardee et al. (1969b) showed in detail that the male pheromone is not only a sex pheromone for females but also acts as an aggregating pheromone for both sexes, primarily in the spring and fall, and to a lesser degree in midseason. In 1968, Hardee et al. (1970a) confirmed the aggregating characteristic of the pheromone and studied in the field the influence of diet on production of the aggregating pheromone.

The potential of the pheromone in survey, control, and eradication procedures was studied in detail in west Texas in 1968 and 1969 and in Mississippi in 1969 (Hardee 1969c, Hardee et al. 1970b, 1971a, Lloyd et al. 1972a). Conclusions from these studies were that (1) live male boll weevils in traps afforded 60-80 percent suppression of boll weevils in the spring following an effective reproduction-diapause control program in the previous fall; and (2) 1 or 2 traps per acre were more effective than 4 or 8 traps per acre in suppressing boll weevils.

Since 1967 males in traps have been used extensively: (1) In survey and ecological studies (Bottrell et al. 1970, Walker and Bottrell 1970, Roach et al. 1971b, Mitchell et al. 1972); (2) in demonstrating that boll weevils will disperse up to 45 miles in search of cotton or other boll weevils (Davich et al. 1970, Ridgway et al. 1971); (3) in showing that treatment of male boll weevils with the chemosterilant, busulfan, does not reduce pheromone production (Klassen and Earle 1970); (4) in obtaining a positive correlation between the number of over-wintering weevils captured and the number observed in the field (Roach et al. 1971), and; (5) in determining that a metal wing trap (about 4 X 6 inch wings X 9 inch base) painted daylight fluorescent yellow over a white undercoat, coated with an adhesive, containing live male boll weevils or synthetic pheromone, and placed around a cotton field adjacent to overwintering sites at distances of 1-3 feet above ground was the most effective trapping procedure (Hardee et al. 1972b).

Following the isolation (Tumlinson et al. 1968), identification, and synthesis (Tumlinson et al. 1969, 1971, Zurfluh et al. 1970) of the 4 components of grandlure, the name assigned to the pheromone of the male boll weevil (Hardee et al. 1971b), a great deal of effort was made to study in the laboratory factors that influence activity of grandlure, to develop a gas chromatographic procedure that would permit analysis of the four components with a single injection, and to develop a slow-release formulation of grandlure that would remain competitive with square-fed males in traps for at least one week. Hardee et al. (1971b) determined that: (1) Inert firebrick was an effective carrier to use in laboratory bioassays; (2) grandlure was attractive to females at dosages as low as 5×10^{-6} mg but was most attractive at 2.5 to 50 mg ; and (3) addition of a cotton plant attractant to grandlure markedly increased its attractiveness. Bull et al. (1971) devised a gas chromatographic procedure that detected accurately as low as 20 mg of each of the 4 components of grandlure in a single injection. McKibben et al. (1971) developed a polyethylene glycol tablet formulation of grandlure that showed no decrease in activity after aging 128 hours under simulated field conditions. Hardee et al. (1972a) reported that a formulation of grandlure containing glycerol, water, polyethylene glycol, and methanol impregnated on a cigarette filter wick was more than 80 percent competitive as an attractant for 7 days with caged, live males, fed cotton squares once or twice per week. They also showed that grandlure attracted boll weevils in sex ratios similar to live males, indicating that it evokes the aggregating response from both sexes as do live males. Subsequent to the development of this formulation, Moody et al. (1972) and McKibben (1972) developed devices for dispensing grandlure automatically to cigarette filters. In the 1971 growing season grandlure in this formulation was used with great success by 28 investigators representing 8 agencies in 7 states across the

Cotton Belt (Hardee, unpublished data).

In 1970 Cross et al. (1971) reported improved designs of the standard wing trap constructed of cardboard, painted daylight fluorescent yellow, coated with an adhesive, and baited with grandlure or square-fed males. Subsequently, Leggett and Cross (1971) developed a non-sticky trap ("Leggett" trap) which captures boll weevils alive and is more effective than the wing trap when baited with grandlure or males. Lloyd et al. (1972b) showed the potential effectiveness of males and grandlure in conjunction with the systemic insecticide,aldicarb, in a modified trapping system for suppressing low density populations of overwintered boll weevils.

From their theoretical calculations on the effects of pheromones used for insect control, Knipling and McGuire (1966) concluded that under the right set of conditions, pheromones offer a great potential in insect suppression. Studies during the past 7 years have shown that the potential for such use of the pheromone of the boll weevil is great, and grandlure will undoubtedly play a major role in the future in survey, management, suppression, and hopefully eradication of the boll weevil.

References Cited

Bartlett, A. C., P. A. Hooker, and D. D. Hardee. 1968. Behavior of irradiated boll weevils. I. Feeding, attraction, mating and mortality. J. Econ. Entomol. 61(6): 1677-80.

Bottrell, D. G., R. E. Reeves, L. K. Almand, D. D. Hardee, and W. H. Cross. 1970. Studies of boll weevil populations and their movement in the High and Rolling Plains of Texas using male-baited traps, 1968. Texas Agric. Exp. Sta. Misc. Publ. 948, 8 p.

Bradley, J. R., Jr., D. F. Clower, and J. B. Graves. 1968. Field studies of sex attraction in the boll weevil. J. Econ. Entomol. 61(5): 1457-8.

Bull, D. L., R. A. Stoker, D. D. Hardee, and R. C. Gueldner. 1971. Gas chromatographic determination of the components of the synthetic boll weevil sex pheromone (grandlure). J. Agric. Food Chem. 19(1): 202-3.

Cross, W. H. and H. C. Mitchell. 1966. Mating behavior of the female boll weevil. J. Econ. Entomol. 59(6): 1503-7.

Cross, W. H., D. D. Hardee, and F. Nichols. 1967. Punch cards in attraction and population studies of boll weevils. Ibid. 60(5): 1484-5.

Cross, W. H. and D. D. Hardee. 1968. Traps for survey of overwintered boll weevil populations. Coop. Econ. Ins. Rpt. 18(20): 430.

Cross, W. H., D. D. Hardee, F. Nichols, H. C. Mitchell, E. B. Mitchell, P. M. Huddleston, and J. G. Tumlinson. 1969. Attraction of female boll weevils to traps baited with males or extracts of males. J. Econ. Entomol. 62(1):154-61.

Cross, W. H., J. E. Leggett, and D. D. Hardee. 1971. Improved traps for capturing boll weevils. USDA Coop. Econ. Ins. Rpt. 21(21): 367-8.

Davich, T. B., D. D. Hardee, and J. Alcala M. 1970. Long-range dispersal of boll weevils determined with wing traps baited with males. J. Econ. Entomol. 63(5): 1706-8.

Dunn, H. A. 1964. Cotton boll weevil, Anthonomus grandis Boheman: Abstracts of research publications, 1943-1960. USDA Misc. Publ. 985, 194 p.

Hardee, D. D., E. B. Mitchell, and P. M. Huddleson. 1967a. Procedure for bioassaying the sex attractant of the boll weevil. J. Econ. Entomol. 60(1):169-71.

Hardee, D. D., E. B. Mitchell, and P. M. Huddleston. 1967b. Laboratory studies of sex attraction in the boll weevil. Ibid. 60(5): 1221-4

Hardee, D. D., W. H. Cross, E. B. Mitchell, P. M. Huddleston, H. C. Mitchell, M. E. Merkl, and T. B. Davich. 1969a. Biological factors influencing responses of the female boll weevil to the male sex pheromone in field and large cage tests. Ibid. 62(1): 161-5.

Hardee, D. D., W. H. Cross, and E. B. Mitchell. 1969b. Male boll weevils are more attractive than cotton plants to boll weevils. Ibid. 62(1): 165-9.

Hardee, D. D. 1969c. Pheromones - their potential use in eradicating the boll weevil. Proc. 1st Annu. Texas Conf. on Insect, Plant Disease, Weed, and Brush Control. p. 214.

Hardee, D. D., T. C. Cleveland, J. W. Davis, and W. H. Cross. 1970a. Attraction of boll weevils to cotton plants and to males fed on 3 diets. J. Econ. Entomol. 63(3) 990-1.

Hardee, D. D., W. H. Cross, P. M. Huddleston, and T. B. Davich. 1970b. Survey and control of the boll weevil in west Texas with traps baited with males. Ibid. 63(4): 1041-8.

Hardee, D. D. 1970c. Pheromone production by male boll weevils as affected by food and host factors. Contrib. Boyce Thompson Inst. 24(13): 315-22.

Hardee, D. D., O. H. Lindig, and T. B. Davich. 1971a. Suppression of populations of boll weevils over a large area in west Texas with pheromone traps in 1969. J. Econ. Entomol. 64(4): 928-33.

Hardee, D. D., N. M. Wilson, E. B. Mitchell, and P. M. Huddleston. 1971b. Factors affecting activity of grandlure, the pheromone of the boll weevil, in laboratory bioassays. Ibid. (In Press).

Hardee, D. D., G. H. McKibben, R. C. Gueldner, E. B. Mitchell, J. H. Tumlinson, and W. H. Cross. 1972a. Boll weevils in nature respond to grandlure, a synthetic pheromone. Ibid. (In Press).

Hardee, D. D., W. H. Cross, E. B. Mitchell, P. M. Huddleston, and H. C. Mitchell. 1972b. Effect of size, location, and distance from ground level of traps baited with males on capture of boll weevils. Env. Entomology. (In Press).

Hunter, W. D. and W. E. Hinds. 1905. The Mexican cotton boll weevil. USDA Bur. Entomol. Bull. 51, 181 p.

Karlson, P. and M. Luscher. 1959. Pheromones, a new term for a class of biologically active substances. Nature 183: 55-6.

Keller, J. C., E. B. Mitchell, G. McKibben, and T. B. Davich. 1964. A sex attractant for female boll weevils from males. J. Econ. Entomol. 57(4): 609-10.

Klassen, W. and N. W. Earle. 1970. Permanent sterility induced in boll weevils with busulfan without reducing production of pheromone. Ibid. 63(4): 1195-8.

Knipling, E. F. 1964. The potential role of the sterility method for insect population control with special reference to combining this method with conventional methods. USDA ARS-33-98, 54 p.

Knipling E. F. and J. U. McGuire. 1966. Population models to test theoretical effects of sex attractants used for insect control. USDA Agr. Inf. Bull. 308, 20 p.

Leggett, J. E. and W. H. Cross. 1971. A new trap for capturing boll weevils. USDA Coop. Econ. Ins. Rpt. 21(45-48): 773-4.

Lloyd, E. P., M. E. Merkl, F. C. Tingle, W. P. Scott, D. D. Hardee, and T. B. Davich. 1972a. A large-scale field evaluation of reproduction-diapause control and male-baited traps for boll weevil control in Monroe County, Mississippi. J. Econ. Entomol. (In Press).

Lloyd, E. P., W. P. Scott, K. K. Shcaunak, F. C. Tingle, and T. B. Davich. 1972b. A modified trapping system for suppressing low density populations of overwintered boll weevils. Ibid. (In Press).

McKibben, G. H., D. D. Hardee, T. B. Davich, R. C. Gueldner, and P. A. Hedin. 1971. Slow-release formulations of grandlure, the synthetic pheromone of the boll weevil. Ibid. 64(1): 317-9.

McKibben, G. H. 1972. An automatic device for dispensing grandlure. Ibid. (In Press).

Mitchell, E. B., D. D. Hardee, W. H. Cross, P. M. Huddleston, and H. C. Mitchell. 1972. Influence of rainfall, sex ratio, and physiological condition of boll weevils on their response to pheromone traps. Ibid. (In Press).

Mitlin, L. L. and N. Mitlin. 1968. Boll weevil, Anthonomus grandis Boh.: Abstracts of research publications, 1961-5. USDA Misc. Publ. 1092, 32 p.

Moody, D. S., J. R. White, and D. G. Bottrell. 1971. A machine for automatic dispensing of a synthetic boll weevil pheromone. Ibid. (In Press).

Rainwater, C. F. 1962. Where we stand on boll weevil control and research. In Proc. Boll Weevil Research Symposium, State College, Mississippi. March 21, 1962. USDA pp. 10-19.

Ridgway, R. L., L. A. Bariola, and D. D. Hardee. 1971. Seasonal movement of boll weevils near the High Plains of Texas. J. Econ. Entomol. 64(1): 14-9.

Roach, S. H., L. Ray, H. M. Taft, and A. R. Hopkins. 1971a. Wing traps baited with male boll weevils for determing spring emergence of overwintered weevils and subsequent infestations in cotton. Ibid. 64(1): 107-10.

Roach, S. H., L. Ray, A. R. Hopkins, and H. M. Taft. 1971b. Comparison of attraction of wing traps and cotton trap plots baited with male boll weevils for overwintered weevils. Annals Entomol. Soc. Amer. 64(2): 530-1.

Tumlinson, J. H., D. D. Hardee, J. P. Minyard, A. C. Thompson, R. T. Gast, and P. A. Hedin. 1968. Boll weevil sex attractant: isolation studies. J. Econ. Entomol. 61(2): 470-4.

Tumlinson, J. H., D. D. Hardee, R. C. Gueldner, A. C. Thompson, P. A. Hedin, and J. P. Minyard. 1969. Sex pheromones produced by male boll weevils: isolation, identification and synthesis. Science 166: 1010-12.

Tumlinson, J. H., R. C. Gueldner, D. D. Hardee, A. C. Thompson, P. A. Hedin, and J. P. Minyard. 1970. The boll weevil sex attractant, pp. 41-59. In M. Beroza (ed.) Chemical Controlling Insect Behavior. Academic Press, New York, 170 p.

Tumlinson, J. H., R. C. Gueldner, D. D. Hardee, A. C. Thompson, P. A. Hedin and J. P. Minyard. 1971. Identification and synthesis for the four compounds comprising the boll weevil sex attractant. J. Org. Chem. 36(18): 2616-21.

Walker, J. K. and D. G. Bottrell. 1970. Infestations of boll weevils in isolated plots in Texas, 1960-69. J. Econ. Entomol. 63(5): 1646-50.

Zurfluh, R. L., L. L. Dunham, V. L. Spain, and J. B. Siddall. 1970. Synthetic studies on insect hormones. IX. Stereoselective total synthesis of a racemic boll weevil pheromone. J. Amer. Chem. Soc. 92: 425-7.

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Weather of the week continued from page 188.

fell at Rockford, Illinois. Rain and drizzle fell on the warm side of the storm Monday, followed by showers, thunderstorms, strong winds, hail, and a few tornadoes Tuesday, Wednesday and Thursday. Showers fairly well covered the area from Kansas to the Ohio River Valley and southward to the Gulf of Mexico. Hail, approaching the size of baseballs, fell in spots in Arkansas and Louisiana. High winds blew down a house, trees, and a power line 6 miles south of Eldorado, Arkansas Tuesday afternoon. A late evening tornado occurred at Clinton, Arkansas. In western Tennessee, high winds destroyed a tractor shed and uprooted trees. The storm center moved across the Great Lakes to Ontario Thursday, but a new storm developed over the Gulf of Mexico and moved across the Florida Peninsula headed northward along the coast. It spilled several inches of rain over the northern part of Florida, parts of Georgia, and the Carolinas. Hail fell in spots and up to 8 inches of snow fell in the mountains and western North Carolina. As the storm moved northeastward, it caused considerable cloudiness and light rain from North Carolina to New England. A weekend storm brought snow flurries to the northern and central Great Plains with rain farther south. Blustery winds accompanying snow made conditions hazardous for your livestock. Rain fell late in the week along the northern Pacific coast with snow in the Cascades and northern Rocky Mountains. Much of the Southwest received no rain or only light, widely scattered sprinkles and needed rain badly.

TEMPERATURE: Cold northerly winds kept temperatures below freezing Monday afternoon from the Continental Divide to western Wisconsin. Warm moist air covered the southern Great Plains. Little Rock, Arkansas, registered 84 degrees Monday afternoon, Nashville, Tennessee, recorded 76 degrees Tuesday, and the mercury at Pikeville, Kentucky, reached 75 degrees Wednesday when lower Michigan was still near the freezing mark. The North Central States continued cold because of northerly winds and deep snow. Snow remained on the ground because of cold weather. Cold air spread southward as the week advanced. Birmingham, Alabama, and Atlanta, Georgia, registered 30 degrees Sunday morning. Spots in the Rocky Mountains recorded subzero weather on one or two days. The mercury at Leadville, Colorado, plunged to 9 degrees below zero Thursday morning. Temperatures ranged mostly in the 70's and 80's across the Southland except Tuesday; they reached the 90's in the lower Rio Grande Valley. McAllen, Texas, registered 100 degrees Tuesday. Temperatures averaged below normal over most of the Nation. Parts of the central Great Plains averaged 6 to 10 degrees colder than normal. Above normal weekly mean temperatures occurred along the western gulf coast, over most of the Florida Peninsula, northern New England and from Los Angeles to San Diego, California.

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