Excerpt: Health Chem Corp
1979 Annual Report

An Emerging Technology

Very few people realize the extraordinary agricultural damage caused by insect pests. Enormous amounts of money and research are being dedicated to the world-wide struggle against these pests. It is not only possible for mankind to win this battle, it is essential that we do.

The importance of pest control is perhaps best illustrated by two highly significant facts: insect pests damage one-third of the nation's crops, or almost nine billion dollars worth each year, and, secondly, these insects have devoured about one-third of our food every year for more than thirty years.

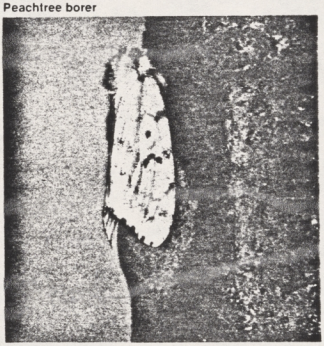
Farmers employ a billion pounds of pesticides annually with the inevitable endangerment to our environment. Through genetic change, there are now 400 species of insects and mites that have become resistant to pesticides, more than twice as many as in 1965. For these reasons, the interest in pheromones, which are not poisonous or toxic, has grown rapidly from the smallest farms to the highest levels of the United States Department of Agriculture.

The Hercon Division of our Herculite Products, Inc. has pioneered the development of controlled release pheromone products for a number of insects, and every one of these products is owned by Herculite and patented worldwide. Most of this technology was developed by Dr. Agis Kydonieus and his staff of scientists. Hercon technology is all in-house, and we believe we are well in advance of our nearest competitor in the world today.

The next few pages of this report are devoted to an illustrated description of Hercon's pheromone technology. It was derived from an interview with Dr. Kydonieus, Executive Vice President of Herculite.

Boll weevil *USDA*

Peachtree borer



Female gypsy moth laying egg mass *USDA*

Adult western pineshoot borer *Daterman, USDA*

Question: What are pheromones?

Kydonieus: Pheromones are natural chemicals that are released by insects to communicate with each other. For example, when a female insect is ready for mating, she releases a sex pheromone. The male can pick up the scent as far as a mile downwind and track it to find the female. There are trail, alarm, sex and aggregation pheromones. Sex and aggregation pheromones are used to suppress populations of destructive insects without toxic insecticides. The pheromones used in the various Hercon programs are synthetically produced but are identical to the natural chemical pheromones produced by insects.

Question: What are the commercial values of pheromones?

Kydonieus: At the manufacturers' level, over $3.5 billion worth of insecticides are sold annually. Insecticides used in cotton alone cost $800 million, and at the farmers' level, this amounts to over $1 billion. Even a small penetration of this market with Hercon pheromone products would create a very sizeable and profitable business.

Question: In what pheromone projects is Hercon now involved?

Kydonieus: They can be divided into three categories: field crop insects, fruit tree insects, and forest insects.

Question: What field crop insects?

Kydonieus: Hercon is working to suppress such field crop insects as the pink bollworm, cotton leafworm, boll weevil, corn earworm and the armyworm. Overseas, Hercon is working jointly with a major chemical company in Greece and Egypt to combat the cotton leafworm.

Question: And what fruit insects?

Kydonieus: Some of the projects with fruit tree insects involve the oriental fruit moth in peaches, codling moth in apples and pears, the navel orangeworm in almonds, the peachtree borer in Georgia and South Carolina, and the grape moth in Switzerland.

Question: What insects comprise the third category?

Kydonieus: Projects involving forest insects include the gypsy moth in the northeast; the spruce bark beetle (a major problem in Norway, Sweden and Germany); the western pineshoot borer and western spruce budworm in the U.S. northwest; and the southern pine beetle in the southeast. Other domestic projects worth mentioning are those concerning the Indian meal moth in warehouses and the Japanese beetle in ornamentals.

Question: Why is Hercon tops in its field?

Kydonieus: A major factor of Hercon's leadership in the pheromone area is our unique and patented controlled release dispensing system which consists of three polymeric layers. The inner layer is the pheromone reservoir. The outer layers control the release of the pheromone and protect it from degradation by oxidation, hydrolysis, and ultraviolet light. Hercon's major advantage over its competition is the flexibility of its dispensing system. We can control the size of the dispenser, the thickness and polymer type of the control layers, the reservoir type, and the concentration required to provide the desired pheromone protection and release rate.

Question: What is a dispenser and how does it work?

Kydonieus: Hercon dispensers can take a variety of forms including squares, ribbons, flakes or confetti. The squares, called Luretape™, are used for suppression of insect populations by mass trapping. This process involves the placement of several traps per acre with a pheromone dispenser serving as bait in each trap. If several traps are placed in a given area, enough insects are lured and caught in the traps so that insect population suppression takes place. The confetti and flakes, called Disrupt™, are used for pest suppression by the disruption of mating technique. This approach involves the large volume aerial application of 10,000 to 20,000 flakes per acre. The male insects perceive these flakes as females calling for mating, and, since they cannot locate a real female, they get confused and are unable to mate.

Question: Do you need government approval to sell pheromone products?

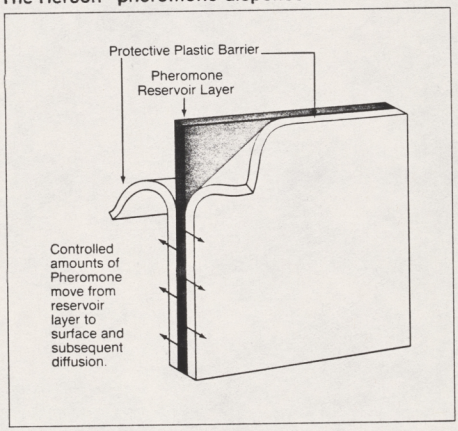
Kydonieus: Yes. Before we can sell any pheromone product, we must receive full registration from the Environmental Protection Agency. We have developed excellent relations with government regulatory agencies, and, under the direction of Dr. Alberto Quisumbing, we have received four out of the five full registrations granted so far by EPA for agricultural pheromone products. We also have six Experimental Use Permits from EPA for the western pine-shoot borer, spruce budworm, pink bollworm, and three for the tobacco budworm.

Question: What commercial pheromone products are currently available?

Kydonieus: Products developed through our experiments and targeted against the pink bollworm, gypsy moth, Japanese beetle, spruce bark beetle, western

Types of Hercon® controlled release dispensers; left to right: perforated rolls, ropes or strips, wafers, flakes, confetti.

The Hercon® pheromone dispenser



Pink bollworm within cotton bloom *Lingren, USDA*

Tobacco budworm moths mating *Lingren, USDA*

pineshoot borer and boll weevil will be marketed in 1980.

Question: Can you describe the pink bollworm product and its potential?

Kydonieus: The pink bollworm infests about 5 million acres of cotton in Arizona, California and Latin America, and probably another 5 to 10 million acres throughout the rest of the world. Last year Hercon sprayed by air approximately 3,000 acres with excellent results. The data were obtained by the USDA-Western Cotton Research Laboratory, Phoenix, Arizona, using twelve 40 acre fields treated with the gossyplure pheromone. Four untreated fields were used as controls. Although pheromone treated fields were sprayed with insecticides only once and the control fields three times, pink bollworm damage in the control fields was still three times higher than in the gossyplure treated fields.

Question: And the gypsy moth?

Kydonieus: The gypsy moth defoliates hardwood forests in the northeast United States. In 1979 we sprayed about 1,000 acres in Wisconsin, Maryland, Massachusetts, and New Jersey with Hercon flakes with disparlure, the gypsy moth pheromone. The Hercon product proved to be much more effective than a microcapsule formulation previously used as a standard.

We expect to sell substantial amounts of the disparlure product in 1980 and already have requests for quotations for about 20,000 acres for the coming season. We are working with state and federal agencies for expansion of our market potential in gypsy moth control.

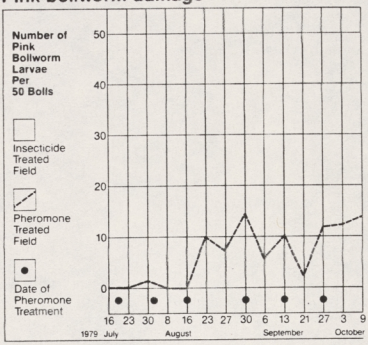
Question: Almost all of us know the Japanese beetle. How is it suppressed?

Kydonieus: The Japanese beetle is suppressed using the mass trapping approach. A trap baited with our japonilure pheromone dispenser is being marketed to the consumer through hardware and home and garden outlets. We have already received an order for over a million japonilure dispensers and expect to have additional orders before Spring 1980.

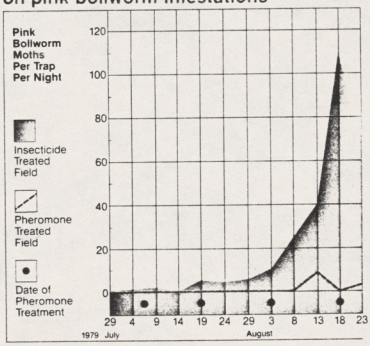
Question: What about the Scandinavian project against the spruce bark beetle?

Kydonieus: For the spruce bark beetle program in Norway and Sweden, over 600,000 Hercon dispensers were used as bait for mass trapping in 1979. The Norwegian government invested $20 million in this project and employed about 1% of its population for the placement of traps. Four and a half billion beetles were captured and it is believed that over three million acres of forests were saved. Because of

Pink bollworm damage

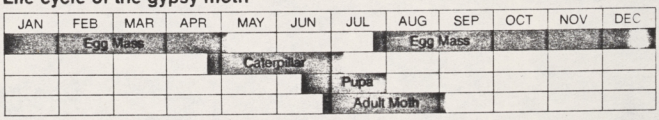


The effect of gossyplure on pink bollworm infestations



Japanese beetle damage USDA

Life cycle of the gypsy moth



Defoliation caused by gypsy moth

the overwhelming success of this project, Hercon is on its way to establishing a firm market in the area of spruce bark beetle control.

Question: And the California program against the western pineshoot borer?

Kydonieus: To combat the western pineshoot borer, the U.S. Forest Service treated over 1,000 acres in northern California with the Hercon pheromone formulation. Test results showed 99.6% mating disruption and 88% damage reduction. Similar work has already been started with a major processor of paper and forest products for a several thousand acre treatment for 1980.

Question: And what about the infamous boll weevil?

Kydonieus: Since the boll weevil pheromone, grandlure, is a sex as well as an aggregating pheromone, it serves as an excellent bait in mass trapping for boll weevil suppression. In tests conducted in the cotton belt from North Carolina to Mexico, the Hercon dispenser was shown to be the best of all formulations evaluated. This product has been used by pest management consultants for the last two years in the United States and South America.

Question: Are there other Hercon products now in the testing stage?

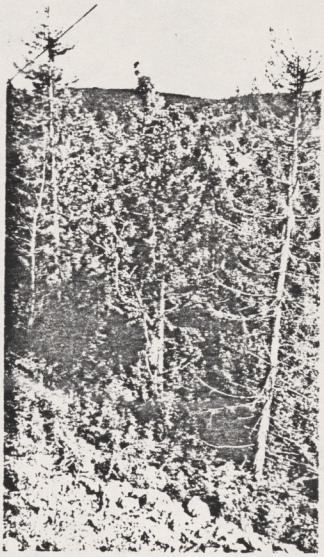
Kydonieus: Research in a high technology company like ours is the basis for its growth. In the pheromone area, our emphasis in 1980 will be against the tobacco budworm and corn earworm, spruce budworm, navel orangeworm, and peachtree borer.

Question: What type of pheromone is used against them?

Kydonieus: The pheromones of the tobacco budworm, corn earworm, spruce budworm and navel orangeworm are aldehydes. At this time the only commercially available formulation that can protect and release this type of pheromone is the Hercon multi-layered dispenser. Protection of the unstable aldehyde pheromone is essential because once oxidized, they lose their effectiveness.

Question: Can you describe these various insects?

Kydonieus: The tobacco budworm is the most damaging insect in the world, infesting cotton, corn, tobacco, lettuce, tomatoes and other crops. Hercon has three EPA experimental use permits under which we performed our field tests in 1979. Last year, test results on 2,000 acres in Arizona and California were very promising. However, because the natural



Trees devastated by spruce bark beetle

Damage caused by spruce bark beetle

Spruce bark beetle traps, Norway

Western spruce budworm

USDA

tobacco budworm infestations were unusually low, no conclusive experimental data could be obtained.

The spruce budworm infests over 100 million acres of forest in the United States and Canada and defoliates several million acres each year. In 1979, a 1,000 acres test performed by the U.S. Forest Service in a severely infested area (100,000 moths per acre) gave very promising results: 83% disruption of mating with a single pheromone application lasting for the complete season.

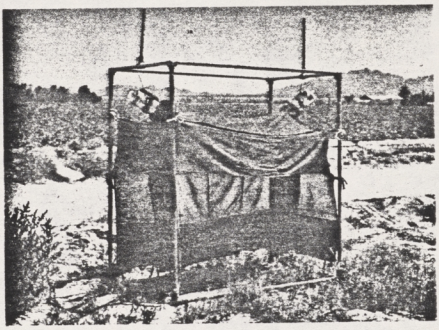
The naval orangeworm inflicted a $35 million damage to the almond industry of California in 1978. In tests conducted by USDA scientists in 1979, the Hercon "Luretape" was shown to be the only dispenser capable of protecting the naval orangeworm pheromone, an aldehyde, for over a month.

Question: What is the general response to pheromones?

Kydonieus: With the strong and increasing emphasis now being placed on ecological matters, it must be stressed that Hercon pheromone products are non-toxic and are in no way harmful to the environment. They are designed to be effective only against target insects and should continue to be popular with conservationists.

Western pineshoot borer — *Daterman, USDA*

Tobacco budworm moth trap



A large trap for insect monitoring

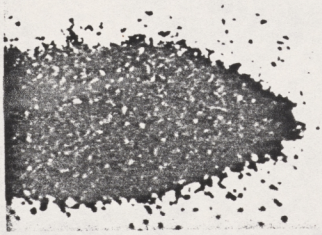
The boll weevil trap

Hercon Introduces Controlled Release Soil Insecticides

Another dramatic breakthrough in controlled release products for agricultural use. The Hercon Group has developed and patented granular dispensers for the controlled release of soil insecticides.

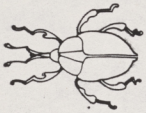
The minute sized dispensers offer several key advantages over conventionally applied soil insecticides. They extend the duration of the insecticide's effectiveness, decrease the amount of insecticide required for the particular application, are significantly less toxic to humans and animal life and reduce crop phytotoxicity.

Hercon is working with the U.S. Department of Agriculture as well as several large companies to develop end use products for combatting the fire ant, the corn root borer, the cabbage maggot, and other insects.



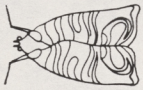
← new product lasts up to a month
→ 5 companies
Cyanamid
Union Carbide
Chem Agro
Sell Am. Group
O.M. Scott

Who's Who in Insect Pests



Boll weevil, *Anthonomus grandis:* No other insect has gained greater notoriety than the cotton boll weevil. Causes crop losses in the hundreds of millions of dollars throughout practically all the important cotton growing areas of the U.S. Ranges southward through Mexico and portions of Central America.

Bollworm (also known as corn earworm and tomato fruitworm), *Heliothis zea:* Caterpillar attacks cotton, corn, tomatoes, tobacco, beans, alfalfa and many garden plants. Worldwide distribution. In the U.S., its damage is most severe in the South.



Codling moth, *Laspeyresia pomonella:* Most persistent and destructive of all apple insect pests. Also attacks pears, quince and several other fruits. Can be found throughout the apple growing regions of the world.

Egyptian cotton leafworm, *Spodoptera litorallis:* Larva feeds on cotton in Egypt as well as sections of the Middle East and Asia.

Fall armyworm, *Spodoptera frugiperda:* Caterpillars usually crawl in great droves causing injury to field and vegetable crops. Larva attacks corn, sorghums, alfalfa, beans, peanuts, potatoes, turnips, spinach, tomatoes and cabbages, cotton and tobacco. A resident of the Gulf States as well as the southern portion of North America, Central and South America. Migrates northward as far as Montana, Michigan and New Hampshire.

Gypsy moth, *Lymantria dispar:* One of the most serious pests of evergreen, shade, fruit and woodland trees. Strips the foliage causing death of trees. Threatens the forests of the Northeastern U.S.

Imported fire ant, *Solenopsis invicta:* Imported from South America and first found in Alabama. Now infests several million acres in Texas, Arkansas, Louisiana, Mississippi, Georgia, Alabama, Florida, North and South Carolina. Considered a serious agricultural pest because it feeds on the tender stems of young plants just below the ground, causing damage to cabbages, collards, eggplants, potatoes and germinating seeds.

Indian meal moth, *Plodia interpunctella:* Infests stored products such as grains, meal, breakfast foods, soybeans, dried roots and herbs. The insect is of European origin but is now distributed generally throughout the U.S.

Japanese beetle, *Popillia japonica:* The adult beetles feed on the foliage and fruits of numerous plants including all deciduous fruits, shade trees, shrubs, corn, soybeans, garden flowers and vegetables. Originally imported into New Jersey from Japan. Now present in all states east of the Mississippi River except Florida and Wisconsin.

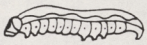
Navel orangeworm, *Amyelois transitella:* A major pest of almonds and walnuts. Found primarily in California.

Peachtree borer, *Synanthedon exitiosa:* Larva feeds on peach, cherry, plum, prune, nectarine and apricot trees as well as certain ornamental shrubs. Prevalent in all sections of the U.S. and Canada.

Pink bollworm, *Pectinophora gossypiella:* One of the world's most destructive insects. Uncontrolled it may cause up to 40% damage to cotton crops. Believed to have been imported from India. Discovered in Texas, it has spread through Oklahoma, New Mexico, Arkansas, Arizona and Louisiana. Also found in other cotton growing countries.

Spruce bark beetle, *Ips typographus:* Destroys spruce trees by attacking bark. A serious insect problem for Norway, Sweden and Germany.

Spruce budworm, *Choristoneura fumiferana:* High on list of major destructive insects. Attacks firs, spruces, larch, hemlock and pines over the coniferous forests of Northern U.S. and Southern Canada.



Tobacco budworm, *Heliothis virescens:* Another major insect pest. Relative of the bollworm. Attacks tobacco and cotton among other crops. Most injurious in the Gulf States.

Western pineshoot borer, *Eucosma sonomana:* Stunts the growth of seedlings of certain pine trees in Northwestern U.S. and Western Canada.

A Glossary of Commonly Used Terms

Aggregation Pheromone: A chemical which attracts insects and causes both sexes of the same species to concentrate in a particular area.

Air Permeation: See Disruption of Mating.

Aldehyde: A straight chain hydrocarbon that is highly volatile and easily decomposable.

Beneficial Insects: Certain insect species useful in the management of harmful or pest species.

Boll: The pod or capsule of a plant, such as cotton boll.

Control or Check Plot: Area receiving conventional insecticides for use in comparing with pheromone treated area to determine relative effectiveness.

Disparlure: The gypsy moth sex pheromone.

Disrupt™: A Hercon® controlled release pheromone dispenser formulation designed for aerial application and treatment of large areas. Also referred to as Hercon "flakes" or "confetti"; formerly called CHEK/MATE.

Disruption of Mating: A pheromone application designed to interfere with the ability of insects to locate members of the opposite sex, thus disrupting their mating and preventing an insect population increase.

EPA: Environmental Protection Agency.

EPA Registration: Approval issued by EPA which allows the sale and use of a pesticide product.

Experimental Use Permit (EUP): A permit issued by EPA allowing the use of a product in experiments to prove product effectiveness and to support proposed label claims.

Gossyplure: The pink bollworm sex pheromone.

Grandlure: The aggregation and sex pheromone emitted by male boll weevils.

Hydrolysis: A chemical process of decomposition by the addition of water.

Infestation: Any pests found in an area or place where they are not desirable.

Insecticide: A pesticide used to control or prevent damage caused by insects.

Integrated Pest Management (IPM): A system utilizing all compatible and suitable techniques and methods to maintain pest population below economic injury levels.

Japonilure: The Japanese beetle sex pheromone.

Larva: A stage early in insect development. The larva stage follows the egg and is before the pupa or resting stage. Other names: caterpillar, maggot, grub and "worm".

Luretape™: A Hercon controlled release pheromone dispenser designed for manual application. Used in the disruption of mating and/or as bait in mass trapping programs.

Mass Trapping: An application where the pheromone is used to lure responding insect pests into a trap for population suppression.

Metamorphosis: The series of changes through which an insect passes in its growth cycle from the egg through the larva and pupa to the adult.

Mimic: A substance chemically analogous to the pheromone or its components, which may be used to disrupt insect mating communication.

Mites: Any of a large number of tiny arachnids many of which live as parasites upon animals or plants.

Monitoring: Use of pheromone-baited traps to observe or determine the presence of certain insects and/or to measure the level of insect infestation.

Ornamentals: Plants or shrubs grown for their decorative effect.

Oxidation: The process of being combined with oxygen (air).

Pesticide: A chemical or other agent that will destroy a pest or protect something from a pest.

Pheromone: Chemicals emitted by an insect to induce a behavioral response by other members of its own species.

Phytotoxicity: Injury to plants caused by pesticides, chemicals or other agents.

Predator: Any animal or insect that attacks, feeds on and destroys other animals or insects. Predators are important in the food chain and some help to reduce pests which cause disease, damage or harm.

Pupa: The stage between the larval and the adult stages of insect metamorphosis.

Sex Attractant: See Sex Pheromone.

Sex Pheromone: A chemical released by an insect to attract another insect of the opposite sex of the same species for mating.

Toxicity: Levels used to explain "how poisonous" a pesticide is to a living organism.

Ultraviolet Degradation: Decomposition of a substance by ultraviolet light.

USDA: United States Department of Agriculture.

Virelure: The sex pheromone of the tobacco budworm.