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minnesota science

UNIVERSITY OF MINNESOTA
AGRICULTURAL EXPERIMENT STATION

interview with the DIRECTOR

Research on agricultural marketing became a major enterprise within the USDA and among state agricultural experiment stations when Congress passed the Agricultural Marketing Act in 1946. This act gave specific direction and provided federal funds to carry out research designed to improve the opportunities for using agricultural commodities. However, since the Marketing Act was passed, the definition and direction of marketing research has changed. In 1946, marketing was simply regarded as the events that occurred to raw agricultural products as they moved from the farm gate to the consumer. Over the years, though, consumer concern for better quality food products enlarged the scope of marketing research. Research directed toward improving an agricultural product before it leaves the farm is now regarded as part of marketing research. Plant breeding research, for example, that improves the protein content and milling qualities of wheat qualifies as a marketing project.

Since many people misunderstand or feel more marketing research should be done, we asked Dr. William F. Hueg, Jr., Director of the Minnesota Agricultural Experiment Station, to explain the present program.

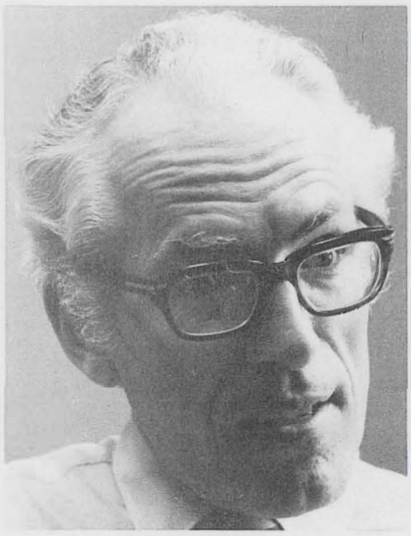
EDITOR: Dr. Hueg, what portion of the Station budget is earmarked for marketing research?
HUEG: The Marketing Act of 1946 stipulates that 20 percent of the Hatch Act funds from the federal government must be spent on marketing research. This fiscal year, the state legislature provided $157,784 for marketing projects. The total budget for marketing research amounts to $465,387 or about 5 percent of the station's total operating budget.

EDITOR: Why is marketing research sometimes criticized?
HUEG: I think the major reason for this is that recommendations from marketing studies are too often not followed. Most marketing research ends up in some type of change--either in Congress or state legislatures and in corporations. Some legislative bodies ignore or turn their backs on research recommendations, such as those studies that have shown some artificiality in dairy marketing orders. By the time legislation has been passed, the recommendations are so modified in new laws that it is hard to recognize the original findings.

EDITOR: How does marketing research affect product quality?
HUEG: It provides background information for decision-makers, such as those in the Minnesota Department of Agriculture. It enables them to establish regulations that insure high quality products. This, in turn, helps Minnesota products to remain competitive within the state, national, and world market structure.

EDITOR: Should more marketing research be conducted?
HUEG: It's not a question of more research being conducted. It is the emphasis and direction of the original Marketing Act that should be modified to better accommodate present conditions. Also, I think marketing research should be done on a broader, regional basis, rather than by single states. We need to look at and recognize the full scope of the marketing scheme as we know it in the entire United States today.

"Most marketing research ends up in some type of change--either in Congress or state legislatures . . . Some legislative bodies ignore or turn their backs on research recommendations."



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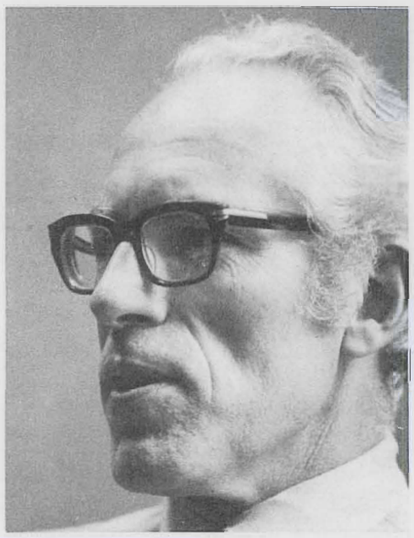

"Marketing research provides background information for decision-makers who establish regulations that insure high quality products. This helps Minnesota products to remain competitive in the marketplace."

minnesota science

Cover photo: Don Breneman

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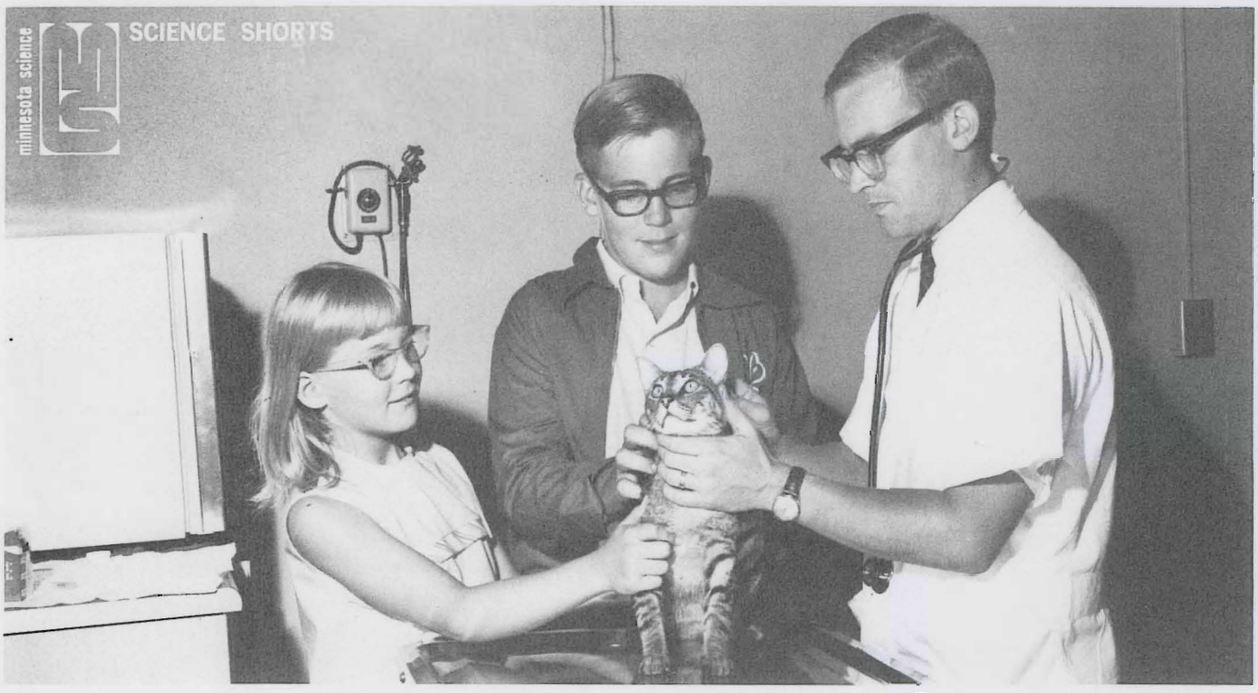
HAYES SCHOLARSHIP FUND ESTABLISHED

Dr. Herbert K. Hayes, regarded as one of the world's leading crop scientists during the first half of this century, died September 9, 1972, in St. Paul at the age of 88. Dr. Hayes' early research greatly contributed to the development of procedures that are the basis for modern plant breeding. His major research efforts included development of Minhybrid corn varieties; Thatcher wheat; Andrew, Bonda, Mindo, and Minhafer oats; Emerald rye; and Park Kentucky bluegrass.

Despite his outstanding achievements in crops research, Dr. Hayes perhaps is best remembered for his classroom and laboratory work with students. His interest, enthusiasm, and constructive criticism attracted students from home and abroad, and established an international reputation for the University's Department of Agronomy and Plant Genetics. Many of Dr. Hayes' former students are leading scientists in their native countries. Eleven of them have received the highest honor the University bestows on alumni, the Outstanding Achievement Award.

A graduate student scholarship fund has been established in Dr. Hayes' memory. Those who wish to contribute may send their donations to the Hayes Scholarship Fund, Department of Agronomy and Plant Genetics, University of Minnesota, St. Paul, Minnesota 55101.



TOXOPLASMOSIS: Disease of Man and Cats

A parasitic infection that in rare cases can produce severe birth defects in humans has been linked to a similar infection in cats. The disease, toxoplasmosis, can be contracted by eating raw or undercooked meat containing the disease organisms. Another possible source of infection is contact with infected cats, which excrete fertilized eggs containing the parasite in their feces.

Discovery that the two diseases (toxoplasmosis in humans and coccidiosis in cats) are caused by different forms of the same organism came as a revelation to researchers. "It was a unique discovery," according to Dr. James A. Libby, veterinary hygienist at the University. "Some parasitologists didn't buy it at first." Both diseases had long been known, but were not thought to be related.

Most toxoplasmosis infections are so mild that they are never diagnosed. The symptoms—a slight fever, a 'washed-out' feeling, and swollen lymph glands—are much like those of flu or infectious mononucleosis. Libby says it can be mistaken for those diseases. It is rare for toxoplasmosis to have serious effects, but a few victims have suffered heart attacks, blindness, brain damage or harm to other parts of the central nervous system.

Greatest danger of the disease results when it is contracted by a woman during the last 5 or 6 months of pregnancy. Like German measles, toxoplasmosis can cause severe birth defects, including blindness and brain damage. Stillbirths and some miscarriages have been attributed to toxoplasmosis.

Estimates vary as to the incidence of prenatal (occurring before birth) toxoplasmosis infection among newborn babies. As many as one baby in every 1,000 may be congenitally infected. Another estimate puts the incidence at one in 4,000 babies.

Only about half the cases of congenital toxoplasmosis produce physical abnormalities. Many of those infected before birth carry the parasite in their bodies all their lives without effect. In some cases, however, the cysts encasing the parasites rupture. The parasites then invade and destroy body cells. The brain, spinal cord, and eyes are particularly susceptible to invasion.

No successful cure has been devised for toxoplasmosis, although there are drugs that help control the disease if it is discovered in time. To prevent infection from raw or undercooked meat, the National Livestock and Meat Board recommends that all meat be heated to at least 140 degrees F. throughout to kill toxoplasma organisms. This is the "rare" reading on meat thermometers, so pregnant women who are fond of rare meat need not give it up. However, they are advised to order all meats well-done when eating out.

Pregnant women should be especially careful in their contacts with cats. Since the parasite-containing eggs passed in cat feces become infective in 2 to 4 days, litterboxes should be changed every day by someone other than the expectant mother. Cats not already infected with the parasite can be kept free of the disease by feeding them only well-cooked meat or commercially processed cat food. Cats should be kept from contact with other animals that might be infected.

"Anyone who has questions about the disease or about his cat should contact the local veterinarian," Libby says.

There is a test to determine whether or not a person or animal may at some time have had toxoplasmosis and thus carries antibodies against further infection. Immunity of previously infected cats is not long-lasting, however. After a period of time they may become reinfected. Blood tests have shown that 20 to 30 percent of the people in the U.S. have toxoplasma antibodies in their blood.

CONTROLLED FIRES MAY RESTORE PARK FORESTS

Foresters are once again using controlled forest fires in Itasca State Park in an attempt to return fire to its age-old ecological role in the park and to regenerate pine forests there. Earlier this year some 30 acres were burned and seeded in the park. Another burn of 200 acres is planned for next spring or summer in the northwest corner of the park.

Funds for the controlled fires come from the Minnesota Conservation Resources Commission, a legislative commission. Department of Natural Resources personnel under district forester Vernon Miller conduct the burnings with advice from Experiment Station foresters.

It is hoped that the 200-acre burn planned for next year will induce natural regeneration of jack pine. Jack pine cones that contain seeds seldom open without the hot temperatures from forest fires, says University forester Henry Hanson. Fires also help pine regeneration by preparing an ash-mineral seedbed and by reducing brush competition.

Since forest fires have all but been eliminated in northern Minnesota, few pine seedlings survive to replace the once magnificent northern pine forests. If fire is not soon restored to its ecological role in northern Minnesota, and if young pine are not planted, desirable pine forests will continue to decline while acreage of less desirable brush and trees increase, Hansen says.

The University forester estimates that within 25 years, almost 6,000 acres of red pine in Itasca Park will be reduced by nearly half. And most of the Park's 847 acres of white pine will be completely eliminated if young pine growth is not regenerated to replace it.

After next year's burn at Itasca State Park, foresters will analyze the fire's effect on water quality of streams and lakes. They will also check the influence of fire on cycling of plant nutrients in the forest soil system.

The old "Smokey the Bear" fire control policy of eliminating forest fires is changing in parks, but that policy is not likely to change drastically in federal and state-owned forests, Hansen says. In parks, controlled burning might prove to be useful to preserve forests in their "natural" state. Before the white man arrived, this natural state included periodic exposure to massive forest fires. However, using controlled burning on a large scale in federal and state forests would probably prove too hazardous and costly in tree loss, the forester says.

Controlled forest fires are also planned for St. Croix State Park this fall or next summer. One burn will be 80 acres and another 100 acres. The purpose there is to convert aspen forests to red pine types.

WHEY PROTEIN STUDY ALSO POLLUTION CURB

The fabled "Little Miss Muffet" may have eaten her curds and whey with no trouble, but many people have never eaten whey—a sour, salty substance.

Minnesota's cheese industry produces about 800,000 tons of whey annually as a by-product of processing. Whey has been dried and fed to animals and used in the production of food, candy, and pharmaceutical products. But it has also been dumped into streams and lakes where it becomes a troublesome pollutant.

Flushing whey down the drain presents problems that even the most sophisticated sewage treatment systems have difficulty handling. Plant engineers must "shift gears" to accommodate the ebb and flow of whey from cheese processing plants. Since whey doesn't separate easily from waste water, it requires more treatment than other sewage.

Cheese processors and food scientists have recognized for some time that whey was too valuable to be merely dumped. Minnesota's 1.6 billion pounds of whey contain about 8 million pounds of protein and 80 million pounds of lactose. The protein and lactose have an estimated value of over $20 million, says Experiment Station food scientist Charles V. Morr.

Food scientists are intrigued by the possibilities for using whey protein in modern fabricated food items, such as beverages, baked foods, and whipped toppings. First, however, researchers must perfect the processes for recovering protein from whey. Then it can serve a nutritional and functional use in formulated foods. Whey protein would not only provide nutritional enrichment but also bind ingredients together, for instance, in meat substitutes made from soybeans.

Morr and food scientist Stan Richert are attempting to modify whey protein concentrates to make them more functional in food uses. Morr says results are "extremely promising." By altering the acidity and chemical composition of the whey solution under controlled heat, they have greatly improved the whipping properties of whey protein concentrates. As a result, whey protein concentrates compare quite favorably with egg white proteins and casein as a whipped topping.

For more than a year, Morr's research group has investigated functional properties of whey protein concentrates prepared at the University, from major food companies, and other university and government research units.

SEMIDWARF BARLEY LOOKS PROMISING

Semidwarf barley varieties will eventually be commonplace, according to Experiment Station agronomist Donald Rasmusson, who heads experimental work at the University. "We're at the stage where our best semidrawf barley varieties yield about the same as standard varieties such as Larker. In one trial at Crookston last year, one semidwarf variety out-yielded Larker that was lodged—94 bushels per acre compared to 72 bushels for Larker.

"However, malting quality of the short varieties is not adequate, so the first semidwarf varieties released could be grown for feed grain," he says.

Semidwarf barley varieties offer greater dependability because the shorter straw length is less susceptible to lodging. Semidwarf straw length is about 30 inches compared to 38 inches for standard varieties. "Less lodging will mean fewer disease losses and consequently higher yield potential," Rasmusson says.

However, Rasmusson and other plant scientists eventually hope to develop semidwarf varieties that have an inherent yield advantage beyond that obtained due to less lodging. This is the case with semidwarf wheat varieties now being grown in the Red River Valley.

About 100 semidwarf barley varieties have been tested for yield at the Experiment Station's Crookston branch this year. The first semidwarfs came from Norway 15 years ago, but were susceptible to disease, and were late maturing and low yielding," Rasmusson says. "In the last few years we've had a breakthrough with the plant breeding program and are optimistic about the long-range future of semidwarf barley varieties."

THE VENGEFUL WOLF

An Accurate Image?

STEVEN A. CARON
undergraduate
wildlife management and technical communication

We reached the old wolf in time to watch a fierce green fire dying in her eyes. I realized then, and have known ever since, that there was something new to me in those eyes—something known only to her and the mountain. I was young then and full of trigger itch; I thought that because fewer wolves meant more deer, that no wolves would mean hunters' paradise. But after seeing the green fire die, I sensed that neither the wolf nor the mountain agreed with such a view.

Aldo Leopold
A Sand County Almanac

Five gray silhouettes quietly slide through a stand of spruce ringing the frozen shoreline. Single file, the animals step into a freshly made snow trail. A barrel-chested male wolf follows a hot scent, its thick, red-tinged fur barely visible in the failing light. The gray she-wolf remains 20 yards back, followed by three young pups. They are eager to push on faster, but control their impatience.

Abruptly, the male stiffens and stops, then slowly raises his head. Less than a hundred yards away, two deer pick at clumps of snow-covered brush. The familiar scent excites the five wolves, but they move with caution, their eyes fixed on their prey. Creeping forward, they close to within fifty yards. Then the young buck senses danger. He quickly turns his head to stare in the wolves' direction. The old buck, standing behind his younger companion, cautiously raises his head to gaze at the wolves.

Neither party makes a move in this waiting game. Suddenly, the young buck breaks away and bolts into the trees. Almost in unison, the adult wolves pursue him. The three pups go after the old buck whose escape is slowed by a slight limp.

The young buck quickly outdistances his shorter legged foes. Realizing the chase is hopeless, the adult wolves head back to find their pups. Out on the snow-covered ice, the pups hold the old buck at bay. The adults rush to their aid. When the old buck sees this greater threat, he runs in panic. But the wolves weaken the old buck by slashing his

Hardly the ferocious, bloodthirsty creature it is fabled to be, the wolf (Canis lupus) has been a handy scapegoat for declining deer numbers in Minnesota. Wildlife researchers, however, say there are more likely explanations for fewer deer. They point to the reduction of habitat for deer and a series of four or five very severe winters in recent years as reasons for reduced deer numbers.

flanks and legs and abdomen, preventing his escape.

Watching this scene in a nearby cabin are two men. They grab their rifles and coats and run out the door, loading as they go. Oblivious to everything except the wounded buck, the wolves quickly pull down their prey. Several shots crack through the cool air, scattering the pack. Lungshot, the female writhes in the snow. Two pups scurry away in pain, carrying slugs in their thighs. The male retreats to the protection of the trees, stops, and stares back in bewilderment at his dying mate. His animal mind cannot understand why the humans have reacted so violently. He only knows his hunger. Killing animals is the way he survives.

The two men walk back to the comfort of their cabin. Less wolves mean more deer. Predators, they believe, serve no purpose and should be killed on sight.

* * *

This fictitious episode illustrates the attitude many people harbor against wolves. But wildlife researchers have gathered considerable evidence that predators, such as the wolf, have a definite purpose in nature. Their role or "niche" in the wilderness is to keep populations of large plant-eating animals, such as deer, healthy and in balance with their food supply. Findings show that wolves have what researchers call a "sanitation effect" on deer. Wolves successfully kill "cull" animals (the very young, the old, and diseased or crippled) to a greater degree than healthy animals in their prime.

Some wildlife biologists contend that wolves, on the whole, don't compete for the same animals that deer hunters seek. Also, Minnesota's wolf population is generally confined to extreme wilderness areas, such as the Boundary Waters Canoe area—areas usually too remote for hunters to reach. The exception to this rule is a portion of Lake Superior's North Shore where a population of wolves exists within the bounds of a human populated area.

Interest in the unusual situation along the North Shore led to a research project proposed by Albert Erickson, former curator of mammals at the University's Museum of Natural History. The Big Game Club of Minneapolis funded the study.

TRACKING THE WOLF

Graduate student Vic Van Ballenberghe (pronounced Ball-N-Burg) began an intensive, three-year study within a 1,000 square-mile area in the summer of 1969. He trapped 110 wolves during the study, radio-tagging 40 to monitor their movements from an airplane and from the ground using signal detection equipment. Radio signals enabled Van Ballenberghe to track the animals and gather information on the number of wolf packs in the area, the number of wolves in each pack, the sex and age composition of packs, and their summer and winter hunting ranges.

Van Ballenberghe located 11 separate wolf packs in 720 square miles of the area studied. This population is more dense than any previously reported in North America. Five of the packs occupy ranges along 29 miles of Lake Superior's shore. Ranges extend inland 10 to 15 miles. The other six wolf packs occupy areas bordering these ranges.

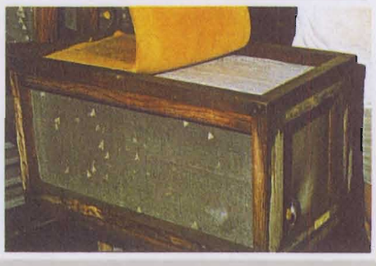
Van Ballenberghe discovered that wolves along Lake Superior range over a larger area in summer than in winter. This is the reverse of wolves' seasonal movements in Minnesota's interior.

The most influential factor governing the size of the wolf's range is the availability of food. Wolves with ranges near Lake Superior move shorter distances in winter because deer gather or "yard" along the shore when snow becomes deep. Researchers found that deer are concentrated in a 50-to 60-mile strip extending about one mile

(Continued on page 15)

Researcher Vic Van Ballenberghe weighs one of the wolves he trapped in northern Minnesota. The tranquillized animal was later released so Van Ballenberghe could trace his movements. Note the white antenna protruding from the radio signaling device mounted on the wolf's collar.

EUROPEAN CORN BORER: An International Pest



Canada

United States

Left. Research assistants collect moths from corn fields at St. Paul. Several rows were enclosed with screening to capture moths.

Above. Moths were transferred to smaller cages where they laid their eggs on waxed paper. Moistened foam rubber covers the waxed paper.

Below. Eggs laid on sheets of wax paper were then cut out by a special machine. Each circle contains an egg mass.

H. C. CHIANG
professor
Department of Entomology, Fisheries and Wildlife

MARK B. WINDELS
research assistant
Department of Entomology, Fisheries and Wildlife

The European corn borer, as its name implies, originated in Europe. About 1910 it was accidently brought into the U.S. and reached Minnesota about 1943. Today, it is a major pest of corn in large areas of our nation.

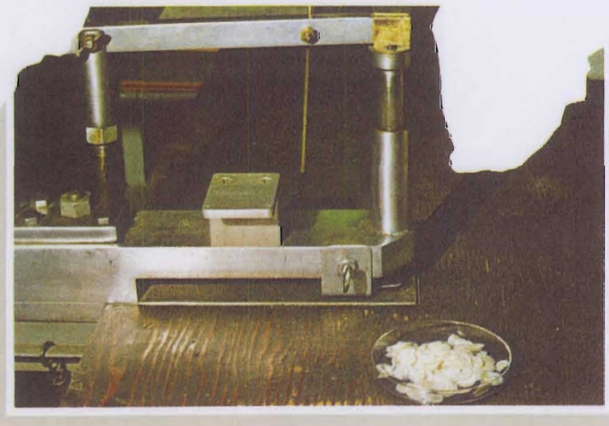
The Minnesota Experiment Station initiated a study in 1948 to examine the biology of the corn borer under local conditions. Research was designed to devise ways to control the insect with minimum dosages of insecticides. Our trials determined the need for and the proper timing of insecticide application to lessen the impact of chemicals on the environment. Breeding corn varieties for resistance and tolerance to the insect was given equal emphasis. Corn varieties planted by farmers in recent years are 5-15 percent more resistant to corn borer than varieties used a decade ago.

Corn borer research on a regional and national scale began in 1953, with Minnesota, Iowa, Kansas, Missouri, and Ohio cooperating. An important objective was to establish the pattern of population fluctuations from year to year and in different geographical locations. Our study showed that population fluctuations did not follow a cyclic pattern as some scientists thought. We found that population peaks did not move in a predictable direction across the region. Rather, the population in each state was affected by local weather conditions, farming practices, and corn varieties.

Since 1963, we have investigated the extent of biological differences among borer populations nationwide. We have studied corn borer larvae from egg sources as far north as Quebec, Canada, as far south as Alabama, and east to Maryland, and west to Nebraska. We found that three distinct types of corn borers exist: northern, central, and southern (or coastal). The borers differ in the number of generations per year (a response to light and temperature differences), the speed with which each type develops, and the extent of damage they do to host plants. Since 1971, another regional project has explored the possibility of manipulating the borer's genetic differences as a management procedure to reduce injury to plants.

Each of the ten countries is studying the survival rate of corn borer populations on 40 different varieties of corn.

Wax discs containing corn borer eggs are taken to field plots to be implanted in the soil. This insures plots are uniformly infested with borers.



INTERNATIONAL RESEARCH

European and Asian scientists were very aware of work by Minnesota and the regional group on the corn borer. During the 13th International Congress of Entomology held in Moscow, Russia, August 1968, researchers working on this insect from Hungary, Poland, Rumania, USSR, USA, and Yugoslavia met informally. Ground work was laid for an international cooperative project to study the response of the borer to corn varieties of different geographic origins. Professor H. C. Chiang of Minnesota was elected coordinator, and a timetable was set up to contact other interested entomologists and finalize a work outline. These aims were accomplished by January 1969, and scientists from Austria, Canada, France, and Spain joined the international team.

The research team agreed to study the survival rate of corn borer populations on a set of corn inbreds at 10 different geographic locations, and to determine the responses of host plants to local borer infestation. Each country selected four native corn inbreds, ranging from very resistant to very susceptible to corn borer infestation. Seeds were exchanged among the 10 countries, and both native and exotic inbreds were grown and observed. Certain characteristics of the plants were recorded. A uniform population of corn borer was produced by artificially infesting test plots. Survival of the insects and the damage to plants were checked.

We expect that the research will add to our understanding of how the corn borer adapts to varied environments in different areas of the world. It will also throw light on the evolutionary relationships among populations in different geographic areas. It is also possible that a corn inbred shown to be susceptible in one country may become more resistant in another area because of environmental differences. Thus the exchange of exotic inbreds may reveal some useful varieties previously overlooked.

U.S. RESEARCH HIGHLIGHTS

The Southern Experiment Station at Waseca was the U.S. study site.* The Waseca Station is where most previous Minnesota work on the corn borer, including regional projects, has been conducted. The four U.S. corn inbreds used were C1 31 A, Oh 43, WF 9, and M 14. The first two are generally rated as resistant and the others are susceptible varieties. Major responses observed were (1) number of borers per plant 30 days after infestation, (2) number of tunnels per plant, (3) leaf injury (4) plant height reduction due to borer infestation, and (5) overall plant damage. Each of the 40 inbreds was ranked, with the number one assigned to varieties with the greatest resistance to borers (lowest number of borers per plant and lowest number of tunnels per plant), and/or least affected by the infestation (lowest leaf injury, least reduction in plant height, and lowest overall plant damage.) A ranking of 40 was assigned to inbreds most susceptible to the borer and/or most affected by infestation.

The ranking of the four U.S. inbreds is given in the data table. The average rankings observed in all countries are given in parentheses for comparison. Generally, the rating of C1 31A and Oh 43 as more resistant inbreds than WF 9 and M 14 was confirmed in most responses. However, there were some exceptions. In 1969, overall plant damage and reduction in plant height were unexpectedly

* Cooperation of staff at Southern Experiment Station, Waseca, especially Dr. William Lueschen and Martin Gehring, was appreciated.

Al Mushi and co-author Mark Windels examine an ear of corn from a borer-infested plot. Most corn borer research has been conducted at the Waseca branch station.

high for Oh 43 and low for WF 9. In 1970, the number of borers was unusually high for C1 31A and Oh 43 and low for M 14. Note that these variances disappeared in the 10-country averages. Thus, local environmental conditions may cause a variance in the responses of an inbred. But the average response over different geographic areas is more representative of genetic characteristics. This confirms initial expectations that testing host plants in wider areas would provide an opportunity to identify useful varieties.

Several exotic corn inbreds had low borer survival and tunnel counts. They included F574, F562 (France), LP 1289, LP 1433 (Spain), YU-ZP-K107 (Yugoslavia), and Ky27TB (USSR). These inbreds could contribute to the effort to breed borer-resistant varieties in the U.S.

In other studies conducted at Waseca, we determined the capacity of moths to reproduce young from larvae grown on different inbreds, and the chemical resistance factor of inbreds. Russian scientists are also studying the moths, and Dr. A. J. Klun of the USDA Corn Borer Research Laboratory at Ankeny, Iowa, is cooperating with Minnesota on the chemical resistance study.

FUTURE DEVELOPMENT

Work in 1973 and 1974 will involve testing crosses of native and exotic inbreds made in 1972 to incorporate borer resistance and early maturity. Faster maturing varieties are particularly important to corn culture in eastern Europe.

As the international project has gained momentum, it has attracted the attention of other countries. Bulgaria contributed one line in 1972 that has been planted for observation in all 10 countries. Czechoslovakia has expressed interest in cooperating and will be represented at this year's conference.

International programs take many forms. In some, U.S. scientists pass on knowledge to people in other countries through such organizations as the Peace Corps and the Agency for International Development (AID). In others, U.S. scientists learn about other countries from biological, geological, and sociological expeditions. Equally important are programs in which U.S. scientists work as peers with scientists from other countries toward a common goal, such as the I.G.Y. (International Geophysical Year), and IBP (International Biological Programs). The European corn borer project might be considered an IBP on an informal basis. In fact, this project has been effective because it was initiated and carried out by individuals with a personal interest. Besides scientific results, through this project participants have developed mutual respect, good will, and fellowship, and are learning to work together on an international scale.

As the U.S. and other world powers move into an era of new international understanding and cooperation, it appears especially appropriate that the worldwide research team will hold its 1974 meeting in Minnesota, which has played a sustained and significant role in corn borer research.

Rankings of four U.S. inbreds among 40 inbreds from 10 countries, in five responses to corn borer infestation

U.S. varieties	C1 31A	Oh 43	WF 9	M 14
	1969 results			
No. borers per plant	3 (1)*	12 (7)	31 (29)	33 (40)
No. tunnels per plant	1 (1)	3 (5)	28 (31)	38 (40)
Leaf injury	7 (8)	7 (4)	40 (39)	32 (38)
Overall plant damage	1 (2)	27 (26)	1 (21)	35 (34)
Reduction in plant height	3 (13)	34 (14)	7 (31)	25 (34)
	1970 results			
No. borers per plant	35 (1)	38 (18)	34 (36)	13 (31)
No. tunnels per plant	7 (1)	10 (5)	28 (21)	34 (38)
Leaf injury	6 (7)	5 (22)	36 (40)	27 (30)
Overall plant damage	22 (1)	16 (15)	25 (21)	16 (33)
Reduction in plant height	10 (30)	2 (7)	28 (27)	27 (40)

* Figures in parentheses are rankings on the basis of average responses observed in all countries. A ranking of one represents most resistance to corn borer attack.

The ban on DES in feed could be followed by restrictions on the use of other antibiotics, warns animal scientist Les Hanson. He urges producers to read the label and follow directions to the letter.

DRUG RESIDUES

Misuse Can Lead to More Bans

L. E. HANSON
professor
Department of Animal Science

"MEAT HORMONES CAN AFFECT YOUR DAUGHTER" was the eye-catching headline on an article in a recent issue of a magazine that promotes "organic farming" and "natural vitamins." The article declared that "Hormones that increase animal weight faster are profitable but produce inferior meat—and cancer as a by-product." Alongside the headline was a picture of a pretty young girl, perhaps 14 years old, perched on a rail fence, looking at some cattle lazily grazing in the background.

The article appeared on the heels of a government announcement that residues of diethylstilbestrol (DES) had been found in the livers of a few beef cattle. The story failed to mention that DES is not found in beef muscle, because the residue remains only in the animal's liver. Residue levels found in the beef cattle ranged from 5 to 10 parts per billion (ppb). The article neglected to mention that DES has long been used to treat various problems in humans, at dosage rates of 1 milligram per day or more. The article didn't point out that when liver contains 10 ppb, a person would have to eat 220 pounds of liver *per day* to get 1 milligram.

Omissions from the article are really irrelevant, however, because the law requires that there be *no residue*. In late July, the Food and Drug Administration (FDA) ordered an end to DES production by August 4, 1972. They did permit the use of premixes on hand, but no feeding of the drug will be permitted after January 1, 1973. In announcing the ban, FDA personnel observed that "the continued use of meat from animals fed DES, of feed already containing and of premixes already manufactured does not present a health hazard. Approval is being withdrawn not because there is a proof of danger from DES but because at this time the new USDA study shows a lack of clear and convincing evidence that the requirements of the law are fully satisfied" (*Feedstuffs*, August 7, 1972).

WITHDRAWAL TIMES

There are specific instructions and regulations for all feed additives (drugs) used in modern animal production. Most antibiotics do not have prescribed withdrawal times when they are fed at low levels because they leave no residue. Some, as we shall see later, do have withdrawal times when fed at very high levels or in combination with sulfonamides. Exact withdrawal times prior to slaughtering treated animals are specifically stated for each drug that has this restriction on its use. Withdrawal periods are based on the length of time required for the treated animal to excrete drug residues. Similarly, "withdrawal times" have been determined for drugs given by injection. Following injection, an animal must be held for a specified number of days before it is slaughtered for food.

Despite these specific instructions, in 1970 the USDA meat inspection service condemned 98 cattle carcasses. Thirty-eight cattle were condemned for sulfonamides, 49 for antibiotics, 7 for mercury and 4 for chlorinated hydrocarbon pesticides. USDA also condemned 100 swine carcasses: 81 for sulfonamides, 13 for arsenicals, 2 for antibiotics, and 4 for mercury. Some chickens were condemned for arsenicals, some turkeys for antibiotics, and more than 4 million pounds of turkeys because of pesticide residues. While these condemnations are serious, they represent only about 0.5 percent of those animals sampled. In April 1971, USDA reported that 76 of 4,043 livestock carcasses (1.8%) tested had residues exceeding legal tolerances as did 0.14 percent of the poultry sampled. These findings and the unfavorable publicity associated with them threaten the future use of feed additives.

ADDITIVES—VALUABLE ALLY

There is a tendency among all of us to take feed additives for granted. We forget how valuable they are in maintaining herd health and high production levels. Malcolm Reid, University of Georgia professor of parasitology (Georgia ranks no. 2 in broiler production), says, "The shift from a three-times-a-year Sunday dinner treat to the most economical source of meat available every day of the week has come about because of four technical improvements, one of which has been coccidiostat development." The other three key developments, according to Reid, are

advances in genetics, advances in nutrition, and development of mass production methods. Mass production is possible only because effective coccidiostats (drugs that combat coccidiosis, a protozoan disease) were developed. Table 1 shows coccidiostats developed since 1948.

Histomoniasis or "blackhead" in turkeys, like coccidiosis, is a disease caused by protozoa. Drugs listed in table 2 were developed to combat this disease and have greatly aided turkey producers.

One of the first studies to demonstrate the value of an antibiotic in diets of unthrifty pigs was carried out by a University of Florida research team (table 3). They conducted 12 tests in which levels of chlortetracycline ranging from 24 to 167 grams of drug per ton of feed were fed. Untreated control pigs gained 0.72 lb. per day and required 4.1 lb. feed per pound of gain. Those fed the antibiotics made average gains of 1.39 lb., but required only 2.9 lb. feed per pound of gain.

My first experience with an antibiotic was in 1950 (table 4). Test results demonstrate better than words the value of prophylactic (disease-preventive) use of an antibiotic. Pigs used in the test were well developed and thrifty looking at the start. About one week after tests began, all pigs were vaccinated for hog cholera by the serum live-virus technique. Two weeks later most of the pigs not receiving the antibiotic were scouring. This continued for the duration of the test. Those fed the antibiotic did not scour. After the test was completed, all pigs that were scouring were placed on a diet containing the antibiotic and they promptly recovered. The protein-vitamin-mineral (PVM) supplement used and the method of feeding, free-choice or complete mixed diet, had only minor effects on daily gain and feed/gain ratio. The low level of chlortetracycline was the major factor in the test.

Table 5 illustrates the value and usefulness of water-soluble antibiotics for baby pigs. In 1950, the Olahoma Experiment Station published a study on "baby pig disease." The study described symptoms of the mysterious disease and its dismal outcome: 75 percent of the pigs died. Their findings indicated the disease was not due to toxic milk, as other researchers had suggested. They had no suggestions for combating the disease.

I had previously encountered this disease at the University of Nebraska. My experience was similar to that of the Oklahoma researchers: most pigs in affected litters died. In 1955, we had the same problem in our St. Paul Campus herd. Fortunately, we had on hand "Aureomycin" soluble powder (ASP), "Terramycin" soluble powder (TSP), and a soluble mixture of streptomycin-sulfaquinoxaline. We prepared water solutions of these drugs to treat all litters of sick pigs. Most were dosed individually by mouth, but they also had free access to medicated water. Our pig loss was only 5 percent (table 5). We have since had similar experiences from time to time and have found several injectable antibiotics useful as well.

In a recent review, Dr. Hays of Kentucky collected research data published since 1960 on the use of a penicillin-streptomycin mixture. The data are summarized in table 6 and are arranged on the basis of the daily gain of the control pigs from the poorest to the best gains. These data support earlier findings that the size of the response to antibiotics in feed is inversely proportional to the health of the pigs. When pigs were very unthrifty and growing slowly (0.2-0.4 lb. per day) there was a very significant (22 percent) increase in rate of gain and an 8.2 percent reduction in feed/gain due to the antibiotic fed. On the other hand, when pigs were quite thrifty and gaining at a rate of 1.6 lb. per day, the antibiotic increased rate of gain only 3.8 percent and feed/gain 1.8 percent.

The fact that the gain response obtained varies according to the "enteric health" of the pig is not really understood by many producers and others. They expect the same response in each test. In tests with germ-free animals at the Lobund Institute, University of Notre Dame, research-

Table 1. Early coccidiostats used in feeds, Reid

Chemical or common name	Trade name	First used
sulfaquinoxaline	SQ, Sulquin	1948
nitrofurazone	NFZ	1948
nitrophenide	Megasul	1949
roxarsone	3 Nitro, Ren-O-Sal	1951
sulfanitran + roxarsone	Nitrosal	1953
aresenosobenzene	Arzene	1953
2-4 diamino-5-(p-chlorophenyl)-6-ethylpyrimidine + sulfaquinoxaline	Whitsyn-10	1955
nitrofurazone + furazolidone	Bifuran	1956
bithionol + methiotriazamine	Trithiadol	1957
furazolidone	nfl80	1957
glycarbylamide	GlyCamide	1958
amprolium	Amprol	1960
chlortetracycline	Aureomycin (potentiated)	1960
Currently used in feed formulation		
butynorate + sulfanitran + dinsed + roxarsone	Polystat 3	1954
nicarbazin	Nicarb	1955
nitromide + sulfanitran + roxarsone	Nicarb	1955
zoalene	Zoamix	1960
amprolium + ethopabate	Amprol-plus	1963
nihydrazone	Ni-dra-fur	1963
aklomide	Aklomix, Novastat, Aclan	1965
buquinolate	Bonaid	1967
clopidol	Coyden	1969
deccoquinate	Deccox	1970
monesin sodium	Coban	1971
nequinate	Statyl	1971

Table 2. Drugs for treatment or prevention of histomoniasis, Reid, 1969

Common or chemical name	Trade name	Year approved
2-amino-5-nitrothiazole	Enheptin, Sol-Hep, Nox-Hep-100, Amnizol, Histosep-S, Blackhep-S	1950
4 nitrophenylarsonic acid	Histostat	1951
2-acetylamino-5-nitrothiazole	Cyzine, Enheptin-A	1954
furazolidone	nfl80	1953
p-ureidobenzenearsonic acid (carbarsone)	Histocarb, Carb-O-Sep	1956
nithiazide	Hepzide	1958
dimetridazole	Emtryl, Emtrymix	1964

Table 3. Effect of APF† on rate of gain and on efficiency of feed utilization by pigs fed corn-peanut meat diets, Florida

Test no.	Days fed*	Calculated antibiotic g/ton of feed†	Initial wt. of pigs	Av. daily gain, lb.		Feed/100 lb. gain	
				Control	APF	Control	APF
1	42	83.6	33	1.14	1.44	559	345
2	35	167.2	18	0.29	0.73	425	334
3	37	167.2	27	0.62	1.42	369	228
4	42	167.2	20	0.52	1.44	429	239
5	42	61.2	19	0.79	1.21	285	269
6	40	61.2	19	0.75	1.25	285	261
7	37	28.0	35	0.77‡	1.36	429	276
8	54	28.0	35	0.75‡	1.46	468	281
9	62	28.0	36	1.01‡	1.67	325	305
10	37	14.0	22	0.47	1.19	393	268
11	59	24.0	48	0.79	1.72	446	307
12	87	24.0	48	0.70	1.74	507	322
		Average	30	0.72	1.39	410	286

* Number of days pigs fed; 4 to 5 pigs/treatment/test.
† Five batches of APF supplement fed; each batch assayed for chlortetracycline and vitamin B_{12}. Prior to its identification, vitamin B_{12} was referred to as animal protein factor (APF)
‡ B_{12} included in basal diets for these tests, but not for tests 1-6 and 10-12.

ers showed that there was no response from feeding antibiotics. This contrasts sharply with my experience with a swine herd infected with bloody dysentery. A combination of antibiotic and arsenic in the feed reduced the feed/grain ratio from 21 to 3.5, a six-fold improvement.

HUMAN HEALTH CONCERNS

We now have 18 years of experience with DES, 22 years with antibiotics, and 24 years with coccidiostats. Billions of pigs, calves, and poultry have been fed diets containing one or more of these drugs. Not one documented

Table 4. Effect of chlortetracycline (CTC) supplement on pigs fed mixed diets or by the free-choice method

Treatment*	Av. daily gain, lb.	Feed/gain, lb.
Trial 1 (70 days-free-choice fed)+		
PVM supplement 1	0.39	4.9
" " 1+ CTC supp.	1.23	3.1
" " 2	0.54	4.0
" " 2+ CTC supp.	1.16	3.1
Trial 2 (84 days - Mixed, complete diet)†		
PVM supplement 1	0.64	4.2
" " 1+ CTC supp.	1.30	3.3
" " 2	0.61	4.0
" " 2+ CTC supp.	1.12	3.2

* CTC supp.—Lederle's APF supplement No. 5 (1950); PVM supplement 1 contained tankage, soybean meal, distillers' solubles, alfalfa meal (dehy) and salt; PVM supplement 2 contained tankage, soybean meal, alfalfa meal (dehy) and salt.
† Pigs in Trial 1 were fed corn and the PVM supplements, free-choice, with 1.0 lb. CTC supplement added per 100 lb. of PVM supplement. Pigs in Trial 2 were fed corn and the PVM supplements in a complete mixed diet with CTC supplement added at the rate of 0.25 lb/100 lb of complete ration.

Table 5. Baby pig disease (diarrhea, vomiting, emaciation, dehydration, rough hair, coma, and death)

Oklahoma, 1948	
No. litters	16
No. live pigs	104
No. pigs died	78
Pigs died, %	75

Age at death	number
1-15 days	44
6-10 days	16
11-15 days	10

Minnesota, 1955	
No. litters	22
No. live pigs	227
No. sick litters	18
No. sick pigs	178

Treatments	No. pigs
ASP*	58
TSP†	10
S-SQ‡	110
No. pigs died	9
Pigs died, %	5

* ASP is Aureomycin soluble powder
† TSP is Terramycin soluble powder
‡ S-SQ is streptomycin-sulfaquinoxaline, 1:1 mixture

Table 6. Relationship between growth rate of control pigs and pigs fed penicillin-streptomycin

Av. daily gain of controls, lb.	No. of comparisons	Improvement over controls	
		Gain, %	Feed/gain, %
0.2-0.4	2	22.0	8.2
0.4-0.6	3	27.0	4.5
0.6-0.8	4	20.4	5.6
0.8-1.0	7	16.1	11.1
1.0-1.2	9	12.3	6.4
1.2-1.4	9	9.4	1.9
1.4-1.6	20	5.6	4.7
1.6	7	3.8	1.8
Total	61	10.7	5.1

Data summarized from Ag. Exp. Station reports since 1950, Hays.

case of harm to humans from the consumption of meat or eggs from these animals has been recorded. Despite this record, though, the practice of using medicated feeds is under attack by various public interest groups and individuals. Some attack from ignorance and fear, some for selfish reasons, and some believe that the widespread use of drugs in feed, specifically some antibiotics, poses a potential threat to man's health.

The two major human health concerns are the presence of drug residues in the tissues of meat animals and milk, and the development of antibiotic resistance in bacteria that are pathogenic in man. The concern over antibiotic resistance is occasioned by the fact that animals are treated with antibiotics which are also valuable in human medicine. The fear is that drugs such as chlortetracycline, oxytetracycline, streptomycin, penicillin, and others will develop vast reservoirs of bacteria resistant to the drug used. Concern is expressed that the resistance factor could be transferred from resistant bacteria in animals to the bacteria in man and thus reduce the effectiveness of the antibiotic when used for clinical treatment. Experience of the past 22 years does **not** support the idea that cross contamination from animals to man with resistant bacteria will become a problem in maintaining human health.

The question of drug residues in animal tissue is raised due to the hypersensitivity of some persons in our population. There is no published evidence that the occasional presence of drug residue in meat has caused any problem for persons eating the meat. However, reports of residues being found in meat usually result in negative publicity for the livestock industry. Furthermore, there is no reason why drug residues should appear in meat if the user reads the label on the feed tag and follows instructions given for its use.

Table 7. Drug withdrawal periods for food producing animals*

Parenterals: (Injectables)	
Dihydrostreptomycin	30 days
Oxytetracycline	18 days
Tylosin—cattle	8 days
—swine	4 days
Penicillin	5 days
Erythromycin—cattle	14 days
—swine	7 days
Lincomycin—swine only	48 hours
Sulfonamides—also orally	10 days unless otherwise declared
Neomycin	Not cleared for food-producing animals
Chloramphenicol	
Feed additives:	
Swine—	
Aureo SP-250	7 days
Tylan—Sulfa	5 days
Arsenicals	5 days
Cattle—	
Aureo S-700	7 days
Diethylstilbestrol (Use in feed terminates Dec. 31, 1972)	7 days
Melengestrol Acetate (MGA)	48 hours
Chlortetracycline—over 350 mg/head/day	48 hours

Always read and observe label directions.
Lists such as this are subject to change and are seldom complete. Warning statements other than withdrawal periods may be required. For more complete information consult your supplier.

* (The above list was obtained from the Minneapolis district office of Food and Drug Administration. Correct as of August 14, 1972.)

WITHDRAWAL PERIODS

Manufacturers of the various antibiotics have determined for each drug they make, the time required to clear all residues, if any, from tissues of the animal to which it is fed. Based on these data and its own studies, the FDA has defined the maximum permissible level of each antibiotic for prophylactic use (to "promote growth") in each species. Similarly, they have defined permissible levels of each drug when drugs are used in combinations of two or more. At these defined levels, there either are no residues or the residues are within established tolerance levels for the antibiotics used singly and in approved combinations. Thus, no drug withdrawal period is necessary prior to slaughter of the animal for food. No antibiotic or other drug may be fed (legally) if it has not been approved for such use and its limits of use defined by the FDA.

Each of the antibiotics approved for use in swine feeds has been fed at levels two to ten times higher than the approved level to measure the effect of high levels on tissue residues. For most antibiotics there is a wide margin between the approved level and the level that leaves a residue in the tissues, if there is no withdrawal period.

Sulfonamides have not been approved for prophylactic use in swine rations, except in combination with antibiotics. These combinations include chlortetracycline and penicillin with sulfamethazine, and chlortetracycline and penicillin with sulfathiazole (this is a new combination). Both combinations require 7-day withdrawal periods. A combination of tylosin and sulfamethazine has a 5-day withdrawal requirement. Whenever arsenicals are used singly or in combinations with antibiotics, a 5-day withdrawal period is required before the animal can be slaughtered for food.

Required withdrawal periods for drugs approved for feed use as well as those administered by injection are summarized in table 7.

When drugs are injected there is a withdrawal period for each of them ranging from 4 days for tylosin to 30 days for dihydrostreptomycin. This is necessary because in most instances injected drugs are at much higher levels than those offered in the feed. For this reason it is especially important that label instructions on dosage be followed when injectable drugs are used and that treated animals *not be marketed* until the required "withdrawal period" has been observed.

RESIDUES—INEXCUSABLE

Occurrence of antibiotic and other drug residues in tissues of animals raised for food is unnecessary and inexcusable. Residues occur primarily because; 1) there is therapeutic misuse of drugs, due to failure to follow dosage instructions and required withdrawal times before the treated animal is slaughtered, 2) failure to follow withdrawal instructions when arsenicals or high levels of sulfonamides are fed. There are no residues when prophylactic levels of antibiotics are fed. READ THE LABEL AND FOLLOW THE INSTRUCTIONS!

Radio-tagged wolves were tracked to their den sites. Droppings gathered there were analyzed to determine the wolves' diets. Deer was the primary food item, but moose, beaver, and fruit were important summer food items if available.

WOLF RESEARCH

(Continued from page 7)

inland. They occupy southeast-facing slopes, which are protected from heavy snows and where spring comes earlier. Some places harbor as many as 100 deer per square mile.

Humans also exert a strong influence on the size of the wolf's hunting range. They provide wolves two excellent sources of food along the lake: garbage dumps and deer carcasses—the result of collision with cars. Wolves visit the dumps, feeding on discarded fat, entrails, and other refuse. Approximately 160 deer are killed by cars each year. Many deer are left to die in ditches and edges of woods. Wolves frequently scavenge the abandoned carcasses. With food close at hand, the wolf's hunting is easier and its movement reduced.

FOOD HABITS OF THE WOLF

David Byman, another graduate student, studied the wolf's food habits and preferences during summer and winter. The researchers radio-tagged wolf pups they trapped and then followed them to their home sites. Byman gathered droppings at the sites and analyzed them to determine the wolves' diets. He found that besides deer (the primary food item) and moose (a secondary item), beaver and fruit were important summer food items in areas where available. These discoveries support the contention wolf experts have held: wolves are opportunists, eating whatever they can to satisfy their nutritional needs.

Every wolf trapped by the researchers had its blood sampled and analyzed to determine nutritional levels. These levels were then compared to those of zoo wolves and domestic dogs. The North Shore wolves were on a lower nutritional plane than the comparison animals, which might reflect the effects of the area's dense wolf population in the presence of a dwindling deer herd.

ATTITUDES TOWARD THE WOLF

The high density of wolves close to several North Shore communities has led to a high number of encounters between wolves and people. This situation has created an unfavorable climate of opinion toward the wolf. People often see wolves prowling garbage dumps, feeding on road kills, or actually walking on roadways. Tracks are commonly seen, sometimes as close as 15 feet from homes. Wolf kills are often discovered, some within 100 yards of houses.

These human encounters with wolves have given the wolf notoriety as a killer. Many people shoot, trap, or run over wolves whenever the opportunity arises. This anger or emotion is intensified if the person is a deer hunter. The wolf serves as a handy scapegoat for declining deer numbers.

Wildlife biologists, however, point to other, more likely explanations for low deer numbers in recent years. "We question," says Van Ballenberghe, "whether the wolf is a limiting factor on the deer population. Certainly deer, moose, and other wild animals are killed by wolves. But I suspect that the reduction of habitat for the deer, combined with a series of four or five very severe winters experienced in the northern part of Minnesota in recent years has had far more effect than wolf predation in reducing deer numbers."

He notes that when this area "was heavily logged 30 or 40 years ago, great sections of brush and secondary growth sprang up. That was to the benefit of the deer herd. But since then, most of those areas have once again become stands of timber, and the understory necessary for the deer has largely disappeared."

Wolf research findings further indicate that wolves experience a very low hunting success rate.

Considering the evidence wildlife biologists have gathered, it is surprising that attitudes toward the wolf remain unfavorable. People seem unaware of the ways in which nature keeps things in balance. In northeastern Minnesota the wolf keeps deer numbers in balance with their food supply. Millions of years of evolution have insured that the wolf will not exterminate its prey and that the deer will not overpopulate and destroy its food supply in the presence of wolves. So the overworked stereotype of the vengeful wolf, fangs bared and eyes gleaming evilly as he springs toward his innocent prey, remains a durable, but hardly accurate image.

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AUTHORS OF ARTICLES

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