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**ENTOMOLOGY
IN THE
SOVIET
UNION**

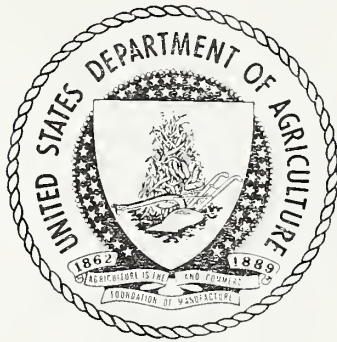
**REPORT OF A
TECHNICAL
STUDY GROUP**

Agricultural Research Service

UNITED STATES DEPARTMENT OF AGRICULTURE

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Foreword

An Agreement, concluded on January 27, 1958, between the Governments of the United States of America and the Union of Soviet Socialist Republics, provided for exchanges in the cultural, technical, and educational fields during 1958 and 1959. This Agreement is regarded as a significant first step in the improvement of mutual understanding between the peoples of the two countries.

Agriculture, which is essential to the national economies of the two countries, was specifically included in the Agreement as a field for exchange of specialists. The U.S. Department of Agriculture accordingly sent to the Soviet Union in 1958 six technical study groups of specialists in the following subjects: Agricultural Economics; Agricultural Crops; Soils and Water Use; Veterinary Science; Mechanization of Agriculture; and Cotton Growing and Plant Physiology. In 1959 three additional study groups were sent to the Soviet Union in the following fields: Biological Control of Pests; Animal Husbandry; and Forestry, Lumbering, and Millwork.

The Soviet Union in turn sent to the United States in 1958 six delegations of specialists in the following subjects: Farm Mechanization; Hydro-Engineering (Irrigation) and Reclamation; Animal Husbandry; Cotton Growing; Agricultural Construction and Electrification; and Veterinary Science. In 1959 three additional Soviet groups visited the United States, representing the following fields: Forestry, Lumbering, and Millwork; Mixed Feeds; and Horticulture.

Each U.S. exchange study group, on completion of its assignment, prepared a report for publication. Entomology in the Soviet Union is the report of the entomology exchange group and was prepared by Paul W. Oman, group leader, Lev F. Curl, and Herbert L. Haller, Agricultural Research Service, Washington, D.C.; Theodore B. Davich, Agricultural Research Service, College Station, Tex.; Halbert M. Harris, Iowa State University of Science and Technology, Ames, Iowa; Carl B. Huffaker, University of California, Berkeley, Calif.; and John V. Osmin, Purdue University, Lafayette, Ind.

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Washington, D.C.

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TRAVEL ROUTE

U. S. Delegation - Entomology

July - August 1959

U. S. S. R.



ENTOMOLOGY IN THE SOVIET UNION

Report of a Technical Study Group

The exchange delegation of six entomologists and one chemist visited the Soviet Union from July 10 to August 9, 1959.

We were met at the Moscow airport by William Horbaly, Attaché, and S. Washenko, Assistant Attaché, of the U.S. Embassy, Moscow; Professor I. Ya. Polyakov, of the All-Union Institute of Plant Protection,¹ Leningrad; and the following officials of the Ministry of Agriculture, Moscow:

A. F. Kharchenko, Assistant Director, Scientific and Technical Cooperation Department

V. V. Kosov, Director of the State Plant Protection Department

I. P. Lupashko-Stalskiy, Scientific and Technical Cooperation Department

Professor Polyakov, Dr. Horbaly, and Mr. Lupashko-Stalskiy accompanied the delegation throughout its travels in the Soviet Union. Mr. Lupashko-Stalskiy acted as interpreter for the delegation. The assistance of Dr. Horbaly, who is competent in the Russian language, as well as familiar with the customs of the country, was invaluable.

After a brief conversation at the airport during the necessary customs clearances, we proceeded to the Hotel Pekin, which became our headquarters while in Moscow.

On July 11 we met with G. A. Borkov, who is the Deputy Minister of Agriculture, Professor Polyakov, Mr. Kharchenko, Mr. Kosov, Mr. Lupashko-Stalskiy, and Dr. Horbaly to discuss an itinerary. We had expressed a desire to visit Baku, Azerbaijan, on the Caspian Sea, where we understood that work on biological control was underway, and Alma-Ata in southern Kazakh S.S.R., where we hoped to investigate the insect fauna of wild apples and wild pears. Neither of these places was included in our official itinerary,

¹ All-Union Academy of Agricultural Sciences im V. I. Lenin (VASKhNIL).

although a stop of approximately 8 hours was made at Alma-Ata, and discussions were held with officials of the Ministry of Agriculture, Kazakh S.S.R. In retrospect, it seems likely that our information regarding biological control studies at Baku was erroneous, and that Batumi, Georgian S.S.R., on the Black Sea was the locality intended. Batumi is an important center for biological control studies.

The Soviet officials showed some reluctance to attempt to include a visit to the New Lands in our itinerary, but a trip to western Siberia near Ak-molinsk, Kazakh S.S.R., was finally arranged. The initial plan was to make the eastern part of the trip first, but at our request the travel was rearranged to permit a return to Moscow on July 24 for the opening of the U.S. Exhibit at Sokolniki Park.

We were impressed by the unfailing courtesy of Soviet scientists and officials and usually by their genuine desire to be friendly. We were guests in their country, and "hospitality was rampant." In fact, our experiences nearly paralleled those of other delegations, because we sometimes found it difficult to accomplish our work because of the social activities arranged by those with whom we conferred.

We were invariably met by the responsible officials upon arrival at a new locality and bade farewell upon departure, regardless of the hour or circumstances.

Altogether the delegation traveled about 25,000 kilometers (15,500 miles) by airplane and approximately 3,000 kilometers (1,860 miles) by automobile (teste I. Ya. Polyakov (1959)²). We visited 22 scientific research institutes and experiment stations, 2 academies of agricultural sciences of the Republics, 1 training institute, and 9 col-

² Dates in parentheses refer to Literature Cited, p. 22.

lective, state, and training farms. Our route of travel is shown on the map (p. iv); details of our itinerary are given in the Appendix. We found the transportation equipment adequate and well managed; the jet planes Tu-104 and Tu-104A are impressive aircraft, and we were often amazed at how well Soviet automobiles stood up under the punishment they received in some of our travels over rather difficult roads. Russian pilots and drivers quite obviously know their equipment well, although we sometimes gained the impression that the automobile drivers were "attacking the road" with their vehicles.

With the exception of the trip from Leningrad to Moscow and the local travel in the vicinity of cities visited, all travel was by air. Russians are

definitely air-minded, and air travel is doing much to offset the lack of an adequate all-weather road net. From Moscow to Tbilisi we flew by jet; from Tbilisi to Sukhumi and from Sukhumi to Kiev, travel was by two-engine propeller-driven plane. The trip from Kiev to Moscow and from Moscow to Tashkent was by jet, as were the flights from Tashkent to Alma-Ata and from Sverdlovsk to Leningrad. Travel from Tashkent to Naman-gan and return and from Alma-Ata to Akmolinsk to Sverdlovsk was by two-engine propeller plane. Transportation from Akmolinsk to the New Lands was in a single-engine biplane of the type used for crop dusting. This aircraft carried 10 passengers, in bucket seats, in addition to the pilot and copilot.

Scope of Entomological Survey

The entomological delegation that visited the Soviet Union in 1959 was interested in assessing the level of research and the application of techniques to all phases of entomology. However, such an all-inclusive appraisal of entomology was not practicable, owing in part to the organization of entomological activities in the Soviet Union. Since the delegation was a part of the Agricultural Exchange Program, it concerned itself primarily with entomological problems of agricultural crops. There was very little contact with

forest entomology, although the control of certain forest pests was occasionally discussed. Typical forest regions were not visited.

Similarly, there was little direct contact with medical and veterinary entomology. Medical entomology comes under the jurisdiction of the Ministry of Health in the Soviet Union, and special arrangements were necessary in order to visit medical institutions. Veterinary entomology is mostly handled by veterinarians rather than by entomological personnel.

Organization of Entomological Activities

Except for the All-Union Entomological Society,³ there is no entomological organization as such in the Soviet Union. Entomology is usually one of several departments or laboratories in a plant protection institute or an academy of agricultural sciences. In general, entomology, along with other agricultural sciences, appears to be coordinated by the Ministry of Agriculture of the Soviet Union and by the Ministries of Agriculture of the independent Republics.

Technical phases of the agricultural sciences are directed by the All-Union Institute of Plant Protection, Leningrad. It is responsible for making broad recommendations to the Ministry of Agri-

culture, which in turn has the authority and responsibility for implementing whatever activities are desirable or consistent with Soviet Government policy. Technical phases of the agricultural sciences are coordinated by the All-Union Institute of Plant Protection with the plant protection institutes of the independent Republics.

Basic research in entomology is carried out by the Institute of Zoology, Academy of Sciences of the U.S.S.R., and the All-Union Institute of Plant Protection, Leningrad. Basic research also is conducted at various universities in the Soviet Union. The quality or quantity of such research cannot be assessed, since the itinerary did not include universities. The relationship between the All-Union Institute of Plant Protection and the Institute

³ Department of Biological Sciences, Academy of Sciences of the U.S.S.R.

of Zoology, Academy of Sciences, was described as one of cooperation on problems of common concern.

Activities of concern to both the Institute of Zoology and the All-Union Institute of Plant Protection are coordinated by zonal coordination meetings and the organization of "complex brigades" (=coordinating committees (?)) to study certain problems. These brigades may be made up of personnel from both Institutes. The All-Union Institute of Plant Protection holds annual conferences to develop the program of research in the Institute, its subordinate associated institutes, and their various experiment stations and laboratories. The program that is prepared is sent to the Academy of Agricultural Sciences of the U.S.S.R., which "approves" and sends it to the Ministry of Agriculture.

The nearest approach to a Unionwide entomological organization in the Soviet Union appears to be the All-Union Entomological Society, which has branches in the different Republics.

Entomological Training and Competence

The Soviet policy appears to be to train entomologists and other specialized personnel only as needed. Technical personnel are trained to fill a presumed need in the field of crop protection, veterinary science, public health, or some similar activity that may include entomology.

In Georgian S.S.R. training is carried on in the agricultural training institute and consists of a 5-year course, much of it concerned with practical application. After completing the basic course, research workers may take 3 years of postgraduate work, which is given at the Academy of Agricultural Sciences and at the university in Georgia. However, the number of postgraduate students in many specialties is determined by the presumed need for workers in a particular field. At the Moscow Agricultural Academy im K. A. Timiryazev, for example, there were currently 30 graduate students working in the broad field of plant protection; 5 of these were in entomology. Their areas of research were in the applied aspects of the science. The Institute of Plant Protection, Uzbek Academy of Agricultural Sciences, gives postgraduate courses for research workers and grants the degree of "Candidate of Science." Similarly, the Institute of Viticulture and Vini-

Certain of the independent Republics, either through the plant protection institute of the Republic or the academy of agricultural sciences, are responsible for coordinating plant-protection work and investigating agricultural problems on a regional basis. For example, the Institute of Plant Protection at Tashkent, Uzbek S.S.R., coordinates plant-protection work for all Soviet Central Asia, which includes in addition to Uzbek, the Republics of Kazakh, Kirghiz, Armenia, Azerbaijan, Turkmenia, and Tadzhik. Annual meetings are held with representatives from different regions of Soviet Central Asia. Work is carried out in collaboration with research institutes in some of the other Republics.

The Biological Laboratory of the Quarantine Service of Uzbek S.S.R. has regional responsibility for some phases of biological control methods. The All-Union Scientific Research Institute of Sugar Beets in the Ukraine near Kiev has branches in other parts of the Soviet Union.

culture im R. R. Shreder, Uzbek Academy of Agricultural Sciences, gives postgraduate work, as does the Kazakh Agricultural Institute.

The All-Union Institute of Plant Protection, Leningrad, in 1959 had on its staff 40 postgraduate students working on their dissertations. The staff of this Institute and the staffs of its subordinate associated institutes seem to constitute the faculty for most postgraduate work in agricultural sciences in the Soviet Union. The Institute of Zoology, Academy of Sciences of the U.S.S.R., has from 10 to 15 postgraduate students in entomology annually.

The agricultural workers in the Soviet Union are well informed on agricultural pest control, and research workers are invariably familiar with American literature relating to their particular field of interest. This is in marked contrast to the general level of knowledge American workers have of Soviet literature. The Soviet officials stated that the Bibliography of Agriculture (U.S. Dept. Agr.) includes only about half the papers published on entomology in the Soviet Union, and that literature coverage by the Review of Applied Entomology and Annual Review of Entomology

is inadequate. The policy of not including in the Bibliography of Agriculture references to articles received too late at the Department Library for publication undoubtedly accounts for part of the omissions; however, the criticism is nevertheless legitimate.

We saw little evidence of a central translating

service, which supplies scientific workers with translations of foreign-language articles. This activity apparently is accomplished in the various research organizations. It was stated that the All-Union Institute of Plant Protection had eight people whose major activity was translating technical literature from English to Russian.

Agricultural Entomology Activities

Forecasting

The forecasting and warning of the appearance of pests and diseases of crops is an important activity of the All-Union Institute of Plant Protection and its subordinate associated institutes. This work has been underway in the Soviet Union for about 30 years, and it is presently under the direction of I. Ya. Polyakov. Professor Polyakov (1958) has summarized the methods followed. A more elaborate account of forecasting procedures has been published by V. V. Kosov and I. Ya. Polyakov (1958).

In general, there are long-term and short-term forecasts. Long-term forecasts are concerned with the expected number and spread of pests and the extent of damage to be expected during one season or over a longer period of time. These forecasts are based on the number of hibernating pests and their physiological condition, particularly with respect to diapause, the presence and number of their natural enemies, and the agricultural practices in the region. These data for long-term forecasts are assembled by the members of the network of plant protection institutes, which extends throughout the Soviet Union.

In the case of *Eurygaster integriceps*, which hibernates in the adult stage, it has been established that its ability to survive the winter and its reproductive capacity in the following year depend on the reserve food accumulated during its transformation to the adult stage. If the reserve food is primarily fat, there is no true diapause and survival is poor. If the reserve food consists of both fat and protein, resistance to adverse climatic conditions and diseases is good and a high percentage of the population will survive.

In general, condition of the fat bodies is considered the best indicator of the physiological state of insects. Successful long-range forecasting has been applied to *Agrotis segetum*, *Heliothis*

armigera, and several other economically important agricultural pests.

Forecasting is also necessary in determining when not to use chemical control measures. With the brown-tail moth (*Nygmia phaeorrhoea*), small nests with high mortality of larvae are indicative of low population levels the following year, and spraying can be dispensed with for that period.

Coordination of Crop-Protection Activities

Forecasts are used as a basis for coordinating certain crop-protection activities, such as production and shipment of insecticides and agricultural equipment. The Ministry of Agriculture of each Republic has all data relating to that Republic and may have additional information from other Republics as well. The Ministry of Agriculture of the Soviet Union is responsible for overall decisions regarding production and distribution of materials.

If a difference of opinion exists as to the relative effectiveness of different control methods, the All-Union Institute of Plant Protection may arrange for an economic comparison to be made. When general methods for the control of crop pests are agreed upon, the local district or Republic authorities promulgate regulations regarding the methods to be used. Methods decided upon are followed areawide.

If available equipment for airplane application of insecticides is not adequate, the responsible crop-protection officials may contract with the Civil Aeronautics Division of Aeroflot for additional aircraft as needed. Those who evaluate conditions include technical personnel on the staff of regional officials and may also involve well-trained personnel on each state or collective farm, particularly the larger units.

All possible or practicable control methods are used in dealing with agricultural pests. The

rather sparing use of chemical insecticides appears to be part of a carefully planned approach to the total problem, and the impact of chemicals on all elements of a biological system is considered. General policies have been outlined by I. M. Polyakov (1958).

Agrotechnical Methods

In the Soviet Union considerable attention is directed to the use of cultural methods to protect crops from pest attack. These are commonly referred to as agrotechnical methods. Usually they are dependent for their success on a rather thorough knowledge of the bionomics of a pest or a complex of pests, and they may also require coordination with forecasting procedures.

Several pests are routinely subject to these control methods. Late planting of grain crops to control frit fly (*Oscinella frit*) infestations and other grain pests, such as the grain cutworm *Hadena anceps*, is used in the same manner in which observance of "fly-free" dates in North America serves to control hessian fly (*Phytophaga destructor*) populations. Disking and deep plowing are also standard and widely followed practices that are said to be helpful in controlling a variety of pests. Plowing immediately after harvest is essential for control of *Hadena anceps*.

Two-stage harvesting of wheat is used to control *Eurygaster integriceps*, *Aelia acuminata* (both hemipterous), and thrips on grain. This method includes cutting and windrowing wheat when the grain reaches the wax stage and leaving it in the field for some time before threshing. The feeding period of these pests is thus restricted. With thrips it may be merely a matter of preference for high-moisture content that makes this method effective, but with *Eurygaster* and *Aelia* the critical factor is fat storage. In these insects the transformation from the nymphal stage to the adult coincides with the wax stage of wheat. Fat bodies of the type necessary for successful hibernation are formed during the 10-day period following transformation to the adult stage, and wheat in the wax stage is a necessary food for this purpose. Deprived of suitable food during the critical period, these pests are unable to diapause, and they succumb to low temperatures and generally adverse weather conditions during the winter.

Two-stage harvesting also tends to deplete cutworm populations, since cutworms may accu-

mulate in windrowed wheat and some are mechanically destroyed. Dobrovolskiy (1958) has described agrotechnical methods for wireworm control.

A hardwood forest pest, *Cerambyx cerdo*, is successfully controlled by the pattern of forest harvest. This pest has a 3-year life cycle, is sunlight associated in its habits, and attacks only living trees, although physiologically weakened trees are preferred. It rarely attacks any trees other than oaks. Under old methods of harvesting, trees were felled in alternate strips through a forested area, with the result that along the margins of the felled strips high beetle populations developed. Under a revised method of harvesting, adjacent strips are cut in successive years, so that beetle populations at the edge of previously harvested strips do not mature to adults. This method has almost completely eradicated the pest.

Biological Control Methods

Like agrotechnical methods, biological methods for the control of agricultural pests are widely used. Techniques employed include the introduction of parasites and predators from other areas, acclimatization of beneficial species to ecological conditions of some areas where they are needed, integration of chemical, agrotechnical, and biological methods, mass propagation of beneficial insects for periodic field release or recolonization, supplying supplemental food sources, and the use of pathogens. Telenga (1958) has reviewed the biological methods used against crop and forest pests in the Soviet Union.

In Georgia the scale *Ceroplastes japonica* is a pest of many fodder crops and a variety of other plants; it has about 90 host species. A *Scutellista* was introduced into Georgia from Albania in 1958 and is doing well against the scale on all hosts. As of 1959 this hymenopterous parasite had been used only in the Sukhumi area. The vedalia (*Rodolia cardinalis*) was introduced into Georgia to combat the cottony-cushion scale (*Icerya purchasi*) in 1932, but it is recolonized each spring, since it does not tolerate winter conditions in that area. Another coccinellid beetle, *Cryptolaemus*, is also used against the cottony-cushion scale in Georgia, as is *Lindorus*. It was reported that a cold-hardy strain of *Lindorus* had been developed at Batumi.

In the Ukraine and elsewhere parasitic wasps

of the genus *Trichogramma* are used against three important lepidopterous pests, as well as against some of less importance. *Trichogramma* is widely used against the cutworm *Agrotis segetum* and less extensively against *Mamestra* (= *Barathra*) *brassicae* and *Pyrausta nubilalis*. It is said that 68 percent of *Agrotis* eggs and between 90 and 100 percent of *Mamestra* eggs are parasitized.

The Biological Control Laboratory at Belaya Tserkov, Ukrainian S.S.R., coordinates the work of *Trichogramma* production, which is accomplished in the laboratory with eggs of grain moths (*Sitotroga*) as hosts, and distributes both *Trichogramma* and *Sitotroga* to subordinate laboratories and collective farms, where parasites are produced in the desired numbers each season. This laboratory also trains technicians from the collective farms. Production of parasites on the farms is carried out only during the growing season. Release rates of parasites against different pests were given as follows:

Pest	Parasites (thousands) per hectare ¹
<i>Agrotis</i> -----	15-20
<i>Mamestra</i> -----	30-50
<i>Pyrausta</i> -----	30-50

¹ 1 hectare = 2.471 acres.

Cost of parasite production was given as from 2 to 8 rubles⁴ per hectare. Releases are made at from 10 to 15 sites per hectare. One release is made when the host begins egg laying. Two releases were found to be no better than one. The extent of biological control practice in the Ukraine can be estimated by the Soviet statement that 300,000 hectares were treated with *Trichogramma* in 1957 to control the three pests listed above.

Three species of *Trichogramma* are used in the Soviet Union, and each is said to be represented by biological strains or races. It was emphasized that for successful control the strain used must be adapted to the environmental conditions in which the pest species occurs.

Agrotechnical methods are sometimes used to enhance biological control measures. For example, the scale *Pulvinaria floccifera* on tea plants prefers the shade of dense foliage, but a coccinellid predator, *Hyperaspis campestris*, used against the scale, prefers more light. Tea plants are accordingly pruned to let in light and to induce the coccinellid to feed on the scale; from 50- to 90-percent reduction of populations results. This particular

biological control operation also involves the interareal movement of *Hyperaspis* from the trees *Taxus baccata* and *Ilex colchica* to tea plants. When so transferred, beetles are released in scale-infested tea at the rate of 1,000 at 5 to 10 sites per hectare.

The Comstock mealybug (*Pseudococcus comstocki*) was found in Uzbekistan in 1939. It quickly adapted to conditions there, has three generations annually, and became widely distributed on about 300 cultivated and wild hosts. In 1945 the parasite wasp *Pseudaphycus malinus* was introduced from Virginia to Uzbekistan and, together with agrotechnical methods, now controls this scale.

It was reported that at Batumi, Georgian S.S.R., chemical and biological control methods had been used successfully against a complex of citrus pests. A predator, *Lindorus*, is used to control the cottony-cushion scale. It is released early in the season, for example in April when chemical insecticides are not used. In July when chemical treatments are necessary for mites, either schradan or polysulfides may be used. The former is not harmful to *Lindorus*, but the polysulfides are, and if used, recolonization of *Lindorus* becomes necessary. *Rodolia* and *Cryptolaemus* are also used.

The combined use of chemical insecticides and pathogens to control the sugar-beet weevil *Bothynoderes punctiventris*, codling moth (*Carpocapsa pomonella*), brown-tail moth, and other pests was said to be effective. The method, as described for *Bothynoderes*, requires sublethal dosages of BHC or DDT applied to the soil with mineral fertilizers. The chemical insecticides modify the blood of the weevils and make them more susceptible to pathogens. The pathogens—chiefly *Beauveria bassiana* and *Metarrhizum*—are applied as seed treatment. Against the codling moth, this method of control consisted in using a low dosage of DDT, not toxic to the fungi, which was mixed with a suspension of fungi and sprayed on the tree trunks. Surviving moths were said to have considerably decreased egg-laying capacity.

Creating environmental conditions suitable for natural enemies of insect pests is much emphasized. Intercropping is widely practiced, and except for the wheat-growing areas in western Siberia, all areas visited had a considerable variety of crop plants growing in close proximity. Sometimes plants, which are attractive to parasites, are

⁴ 1 ruble = 10 cents.

grown specifically to attract beneficial insects. Interplanting of corn with pumpkins is said to attract parasites of the European corn borer (*Pyrausta nubilalis*) to the fields. The extent to which these measures have been evaluated is not known, but the work is thought to be in the trial stages.

For the mass production of predators and parasites in the laboratory, suitable scale hosts are propagated on melon, pumpkin, or yucca in the same manner as in the United States.

All biological control materials from outside the Soviet Union are processed through the Central Quarantine Laboratory, Moscow, from which they are transmitted to laboratories in the Republics.

Chemical Control Methods

Although much emphasis is placed on agrotechnical and biological control of insect pests, chemical control is widely used in the Soviet Union. The insecticidal chemicals are limited in number and variety as compared with those available in other countries. The principal chemical insecticides are chlorinated hydrocarbons and organic phosphorus compounds.

DDT and BHC are the most widely used of the chlorinated hydrocarbons. BHC is designated "gexachloran" or "hexachlorocyclohexan" in the Soviet Union. The product designated lindane there probably contains about 86 percent of gamma isomer of BHC. Aldrin and heptachlor seem to be in limited use, especially as seed treatments in combination with fungicides. Chlor-dane, endrin, dieldrin, and toxaphene have been experimentally studied, but they are apparently not widely used in control operations.

There is considerable interest in the organic phosphorus compounds, especially as systemic insecticides. Parathion (thiophos) and demeton (mercaptophos) were frequently mentioned, and methyl parathion (methyl thiophos) is apparently used on a large scale. Malathion (carbophos) is being investigated. Two new organic phosphorus compounds—K-20-35 ($(\text{CH}_3\text{O})_2\text{PONHCOOCH}_3$) and avenin ($(\text{CH}_3\text{O})_2\text{PONHCOOC}_3\text{H}_7(\text{iso})$)—synthesized by A. V. Kirsanov, were stated to be rather effective and to be specific for the sugar-beet weevil *Bothynoderes punctiventris*. These compounds are also reputed to have low mammalian toxicity.

Other insecticides mentioned rather frequently

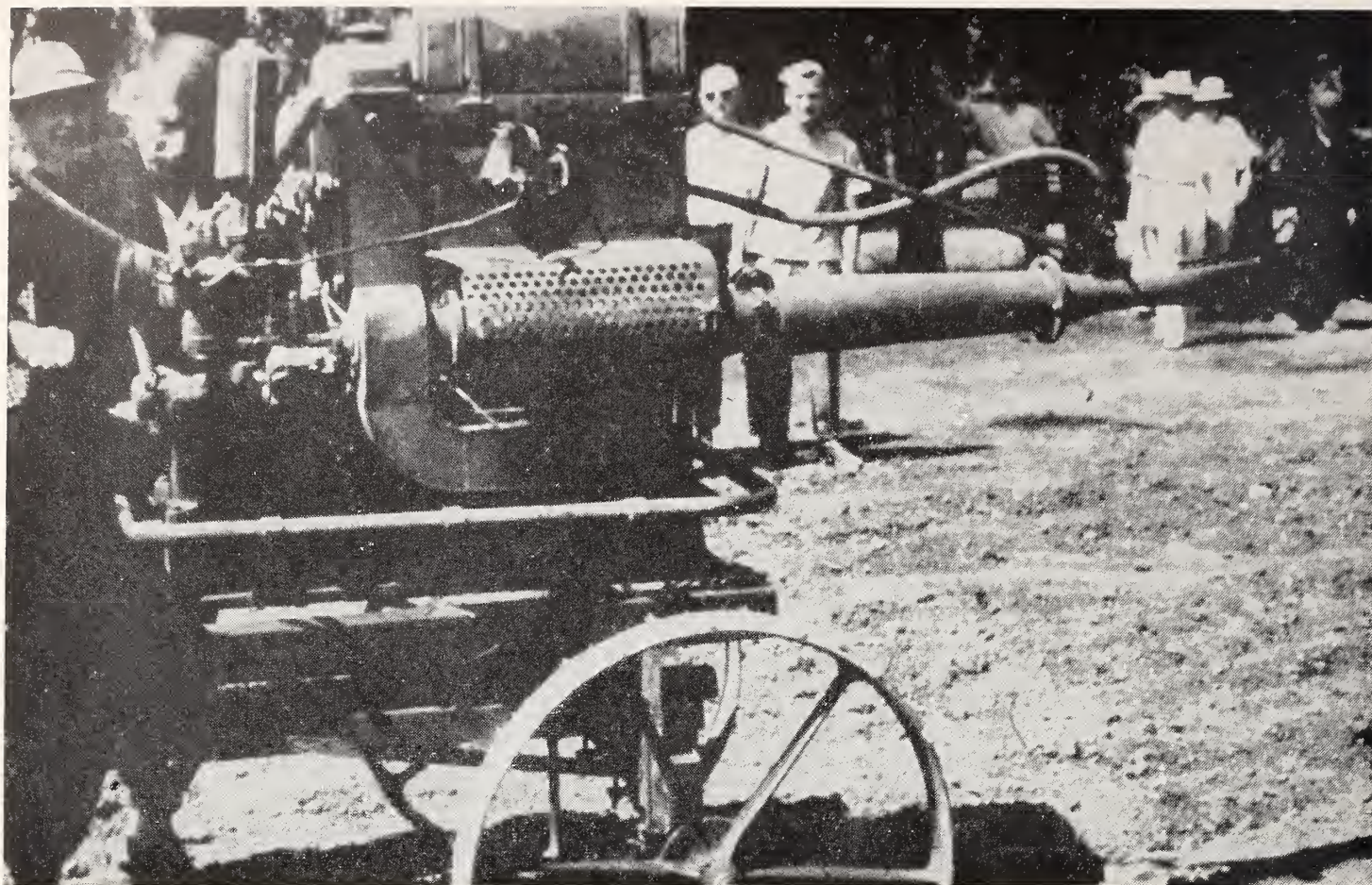
were ovex (p-chlorophenyl p-chlorobenzenesulfonate), designated "estersulfonate" in the Soviet Union, and the ammonium salt of 2,4-dinitrophenol. The former is used for spider mite control, and the latter, along with certain mineral oils, is used as a dormant spray. Sevin (1-naphthyl N-methylcarbamate) has been investigated experimentally and is recognized as an effective insecticide, but some concern was expressed about its use, because some related carbamates, such as N-isopropyl phenyl carbamate, have been found to be carcinogenic.

The scientific studies in the Soviet Union on the preparation, properties, formulation, and application of chemical insecticides are carried out in the All-Union Institute of Plant Protection, Leningrad, at the Scientific Research Institute of Fertilizers and Insectofungicides im Ya. V. Samoylov, Moscow, and in several of the plant protection institutes throughout the Republics. The Scientific Research Institute for Fertilizers and Insectofungicides, Moscow, not only conducts a wide range of studies on insecticides but also works closely with manufacturers in the large-scale production of pesticides. It also works closely with institutions studying the pharmacology and toxicology of pesticides. Prof. N. N. Melnikov, the institute director, stated that an important consideration as to whether a new pesticide would be introduced into agriculture is its toxicity to warm-blooded animals. Emphasis is placed on products low in mammalian toxicity. Pharmacology of new pesticides is reviewed by a commission, and final determination on their use is made by the Ministry of Health, which also sets tolerances.

Studies are also carried out on the effect of chemical insecticides on plant growth, the mode of action of insecticides on insects, and the development of insect resistance to insecticides. For some of these studies, radioactive-tagged insecticides are used. No indication of the source of these chemicals was given.

Thermal aerosols appear to be used rather commonly in the Soviet Union, although liquefied gas aerosols are virtually unknown. Aerosols for orchards have from 6 to 8 percent of DDT in oil. DDT is normally used in a dust or in a wettable-powder spray.

Soviet entomologists are rather conscious of the potential hazards of residues resulting from application of chemical insecticides and of the develop-



PN-1101

FIGURE 1.—Thermal aerosol generator at Kiev.

ment of insect resistance to chemicals. Studies on insecticide residues appear to have been undertaken relatively recently. Residues of lindane in the soil are determined by dechlorination to benzene, which is nitrated to form dinitrobenzene; on treatment of the dinitrobenzene with methyl ethyl ketone in strong alkali, a violet color is produced. This method was developed in the pesticide chemicals laboratories of the U.S. Department of Agriculture.

The method being studied to determine the gamma isomer of BHC is based on polarography. It was first studied about 10 years ago in the United States. Heptachlor residues are determined by chromatography followed by organic chlorine determinations. Phosphorus residues are determined by the usual method for this determination. In laboratories in the Ukraine spectrophotometric equipment was not yet available.

It was stated that residue determinations are based on samples taken 3, 6, and 10 days after insecticide application.

Equipment for applying chemical insecticides is not highly specialized but appears to be effective

as used. The Soviet Union as compared with the United States has less mechanization and uses more thermally generated aerosols and little, if any, gas pressure-generated aerosols. In the thermally generated aerosols observed the venturi principle was applied, and an oil-burning heat generator and turbine air blast were used. The fog discharge was directed reasonably well with an adjustable deflector plate at the discharge orifice (fig. 1). A considerable variety of equipment for insecticide and herbicide application was on exhibition at Moscow, but that observed in actual use for formulation and application was usually of an older vintage.

Thermally generated aerosols were used to treat about 24,000 hectares of land for cutworm control in 1958 in the Akmolinsk Agricultural District, which comprises about 4,180,000 hectares of sown land. On one state farm visited, 4,000 out of 24,000 hectares of arable land were treated in 1958 with DDT aerosols to control *Hadena anceps*.

Airplanes are widely used for insecticide application. The ones we saw in use for this purpose



FIGURE 2.—Spray boom of airplane used for spraying cotton in Uzbekistan.

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were single-engine biplanes with four-blade propellers and wing lengths (top wing to body of fuselage) of about 30 feet (fig. 2). The spray was distributed by 34 nozzles evenly spaced on

each wing. The spray pattern appeared excellent at a flight height of 10 to 15 feet above the plants. The crew consisted of pilot, copilot, and groundman.

Quarantine Operations

In the Soviet Union the term "quarantine" has a broader connotation than in the United States; it implies control operations as well as regulatory procedures. The status of quarantine methods in the Soviet Union has been reviewed by Churayev (1958) and Kosov (1958).

Quarantines on the movement of plant materials into the Soviet Union or from region to region within the country are well planned and rigidly enforced. Regulations are based on a good knowledge of the pests against which quarantines are directed, and effective methods for their enforce-

ment have been developed. For example, all cottonseed coming into the Soviet Union is subject to examination, largely to prevent entry of the pink bollworm (*Pectinophora gossypiella*). Samples of the seed are X-rayed for detection of infestation. Methyl bromide fumigation is widely used, and HCN and ethylene dibromide are also employed.

The Colorado potato beetle (*Leptinotarsa decemlineata*) is a quarantine objective. It occurs in the western Ukraine, and foci of infestation are quarantined as found and usually eradicated.

Medical and Veterinary Entomology

Little information was obtained on the applied phases of medical entomology, for this work is normally carried out by laboratories under the Ministry of Health. Apparently little work in veterinary entomology is underway.

In Moscow three institutes concerned with medical or veterinary entomology were visited. One was the All-Union Institute of Veterinary Entomology, of which A. A. Polyakov is director. The Laboratory of Entomology and Insect Extermination there is headed by K. P. Andreyev. Although the general atmosphere was cordial, little positive information was obtained. Research with animal systemic insecticides and with tracer-detection techniques was reportedly being undertaken. C-14-tagged BHC was being used for studies on the fate of insecticides in animals. Organic phosphorus compounds were said to be superior to DDT for house fly (*Musca domestica*) control.

At the Institute of Medical Parasitology and Tropical Medicine in Prof. E. I. Martsinovskiy, the principal studies pertained to malaria. It is anticipated that malaria will be eradicated from the Soviet Union by 1960 or 1961. There are but a few small foci of malaria remaining, and control measures emphasize detection of cases, sanitation in the vicinity of known cases, and treatment of the disease. Much emphasis is placed on social prophylaxis, i.e., separation of the host and the vector. A drug, quinocide, related to primaquine, was mentioned as being used for prophylaxis.

Sand fly-transmitted diseases, such as kala azar and visceral and cutaneous leishmaniasis, also are being eradicated. Research on tickborne encephalitis is underway.

The Martsinovskiy institute is also concerned with the synthesis of chemicals of a medically preventive nature, including both repellents and

materials for internal medication. Prof. M. D. Mashkovskiy of the institute staff talked at some length and very interestingly on the mode of action of these chemicals. He discussed the principles of physiological imitation, and said that chemically related compounds should not be expected to give the same or even similar physiological end results, although some imitation may occur. The third institute concerned with medical problems that we visited in Moscow was the Moscow Institute of Vaccines and Sera in I. I. Mechnikov. So far as we were able to determine, no entomological studies are underway there. It was stated that the institute has two divisions. One is concerned with basic research on the epidemiology of infections, microbiology and immunity, and virology and the other with the production of bacterial preparations for prophylactic treatment. There was said to be no work underway on the epidemiology of arthropodborne diseases. Studies on whooping cough and theoretical studies on the immunity of pox and rabies are made. Success in the development and use of a concoction that immunized against a broad spectrum of dysentery-causing organisms was reported.

Basic studies on arthropods of medical and veterinary importance are carried out by the Institute of Zoology, Academy of Sciences of the U.S.S.R. Although this work is centered at Leningrad, subordinate associated institutes elsewhere carry on similar studies. All the basic work in systematics, ecology, zoogeography, and biology is coordinated by the Institute of Zoology. The accomplishments of the Institute in this field are widely recognized, for example the work of Ye. N. Pavlovskiy, I. A. Rubtsov, A. S. Monchadskiy, and A. A. Stakelberg, all of whom are well known for their studies of medically important arthropods.

Apiculture and Sericulture

In some parts of the Soviet Union both apiculture and sericulture are important agricultural activities. Apiaries were frequently noted in Georgia and Uzbekistan. At the Collective Farm Leningrad in Namangan, Uzbek S.S.R., there were 300 bee hives. This farm is occupied by

approximately 2,200 families and comprises 4,000 hectares of land. The annual production of silk-worm cocoons in Uzbekistan was reported to be approximately 14,300 tons.

There was little evidence of research underway in either apiculture or sericulture in the areas

visited, and these activities were seldom included in the organizational schemes of agricultural institutes. In the Georgian Academy of Agricultural Sciences apiculture and sericulture are included in the Animal Husbandry and Veterinary Science Branch. In the mountainous Caucasian area be-

tween Sukhumi and Lake Ritsa in Georgian S.S.R. hundreds of apiaries were observed. This is the productive area for the Caucasian race of the honey bee. Movement of hives by automobile was noted.

Basic Studies

Basic research is carried on and coordinated by both the All-Union Institute of Plant Protection and the Institute of Zoology, Academy of Sciences of the U.S.S.R. Both are located in Leningrad, but they have numerous subordinate associated institutes in different regions of the Soviet Union. In general, the functions of the All-Union Institute of Plant Protection are concerned with the biology and ecology of plant pests, diseases of interzonal significance, and development of methods of forecasting and of pest control. The Institute of Zoology is concerned with studies in systematics, ecology, biology, and zoogeography relating to the insect fauna in general rather than to pest species. The following areas of investigation illustrate more precisely the division of responsibility between these two influential organizations.

Entomological studies of the All-Union Institute of Plant Protection include pests of shelterbelts, population dynamics, changes in biocoenoses due to the use of insecticides, toxicology, mode of action of insecticides, appearance of pests as a result of cultural practices, forecasting of pest outbreaks, histology, pathology, methods of using radioactive substances, and methods of using microorganisms, parasites, and predators to control pests.

Leading scientists of the All-Union Institute of Plant Protection were as follows:

Director—I. M. Polyakov

Deputy Director—Ye. M. Shumakov

Head, Laboratory of Forecasting—I. Ya. Polyakov

Head, Laboratory for Pests of Shelter Belts—V. N. Stark

Head, Laboratory of Insecticides—P. V. Sazanov

Head, Laboratory for Pests of Grain Crops—T. G. Grigor'yeva

Head, Laboratory of Biomethods—V. A. Shepetilnikova

Head, Laboratory of Microbiomethods—N. S. Fedorinchik

Entomological studies of the Institute of Zoology are concerned with systematics, biology, ecol-

ogy, experimental work in evolution and the nature of species, and zoogeography, including faunal studies of the Soviet Union and neighboring countries and in recent years of China.

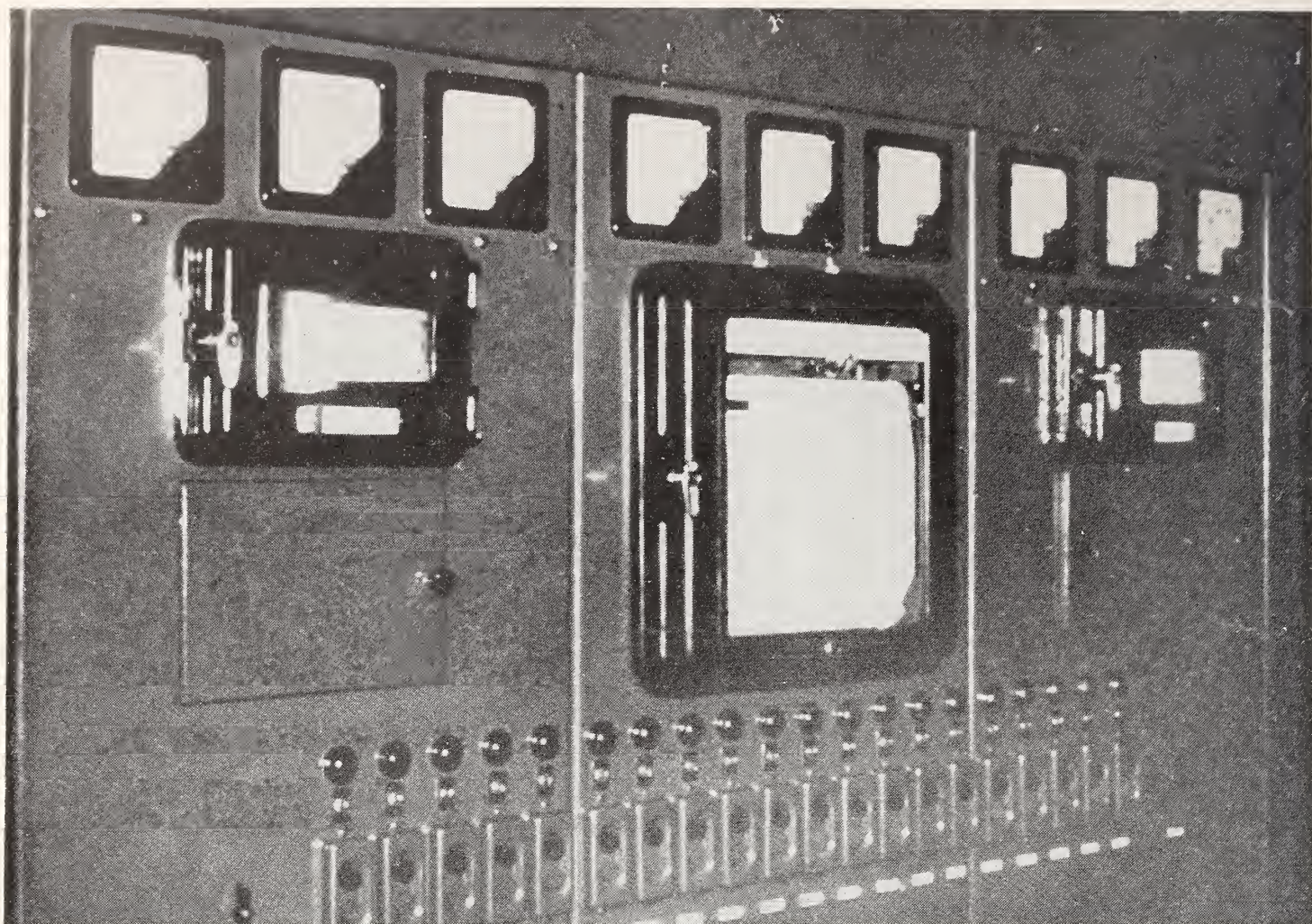
Insect Physiology and Toxicology

One of the most important research establishments in the Soviet Union for insect physiology and toxicology is the All-Union Institute of Plant Protection, Leningrad. Several laboratories in the Institute are concerned with these two subjects, both in the sense of what we normally think of as "laboratory" and in field investigations. Physiology includes ecological studies in the field. Toxicology includes what we would normally classify as primary screening, secondary evaluation, field testing of candidate insecticides, and application methods.

New chemicals synthesized elsewhere are screened for insecticidal activity. Secondary evaluations, in the field, and some primary screening are conducted on *Tetranychus*, *Pseudococcus*, *Heliothis armigera*, and a cutworm. Mammalian toxicity and insecticidal evaluations are conducted simultaneously. Mammalian toxicity tests are made at one or more of 22 medical institutes.

The Insecticide Laboratory works extensively on organic phosphorus compounds. In December 1955 the Kazan Branch of the Academy of Sciences of the U.S.S.R. held a conference on the chemistry and use of organic phosphorus compounds. The results of this conference were published by Arbuzov (1957). A second conference was to be held in November 1959, at which the synthesis of organic phosphorus compounds and their application in medicine and agriculture would be further discussed.

Soviet scientists are doing a great deal of ecological research on many insects in the field, especially work on nutrition, temperature, photoperiod, and the effect of these factors on diapause,



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FIGURE 3.—Phytotron, or bioclimatic cabinet, in the Biophysics Laboratory at Leningrad.

hibernation, and survival potential. This information is being used to develop an accurate and efficient insect-forecasting system.

The Physiology Laboratory at the All-Union Institute of Plant Protection was well equipped and staffed. Workers were interested in the use and effect of insecticides in such problem areas as residues, phytotoxicity, germination effects after seed treatment, and stimulatory effects on plant growth.

The Biophysics Laboratory is concerned with new methods or techniques in insect control, measurement of environmental factors by electrical methods, and physical factors associated with entomological research that possibly could be used for control or detection, such as X-rays, ultrasonics, light, and gamma rays.

This laboratory also utilizes radioisotope-labeled compounds in mode-of-action and residue studies. Insofar as we were able to determine, the Biophysics Laboratory is responsible for the construction of controlled environment cabinets,

such as the phytotron we saw (fig. 3). Only one was in operation, but a second was under construction. This phytotron had an internal capacity of about 530 cubic feet and was approximately 10 feet long, 7½ feet wide, and 7 feet high. It was stated that daily or weekly temperature, humidity, and light fluctuations could be simulated as desired.

The insect nutrition research at the Institute is under the immediate supervision of a nutritionist-biochemist, N. M. Edel'man. She is studying the nutritional requirements of three species—*Gelechia malvella*, which is related to the pink bollworm, *Heliothis armigera*, and the gypsy moth (*Porthetria dispar*). These are all laboratory studies, which utilize "purified" diets. Dr. Edel'man's basic diets are modifications of the casein diet developed by Erma S. Vanderzant at College Station, Tex., for the pink bollworm. This diet is based on casein as the amino acid source. Dr. Edel'man has added, for *G. malvella* rearing, the amino acids arginine, valine, lysine,

cystein, and glycine. She modified the vitamin solution so that it contains only B₁, B₂, B₆, B₁₂, and choline. *G. malvella* is reared from egg to adult without changing the diet. The diet is changed every 2 days when rearing *H. armigera* because of microbial contamination from the feces. Eggs are sterilized in 2-percent sodium hydroxide prior to implanting in the diet. All studies on nutritional requirements are conducted under aseptic procedures. *G. malvella* and *H. armigera* have been reared for several generations on artificial diets. Good growth and development of the gypsy moth, up to the pupal stage, have been obtained. As of our visit in August 1959, Dr. Edel'man had not succeeded in obtaining gypsy moth pupae or adults on any artificial diet. She is attempting to devise chemically defined diets for these three insects.

No need was seen nor apparently was there any desire to rear insects en masse. Research on anti-metabolites in the nutritional studies appeared not to have been considered. This seemed odd, because one of the stated aims is the development of chemically defined diets.

The laboratory in which this work was being done was neat. It was occupied by Dr. Edel'man and three technicians. Lack of adequate space and sufficient equipment appeared to be a real handicap so far as rapid data turnout was concerned. The research in this laboratory was all basic. The pursuit of fundamental research was repeatedly emphasized.

The Institute of Plant Protection, Georgian Academy of Agricultural Sciences, was studying the nature of insect toxins. Isotopes of sulfur and phosphorus were used to study insecticide residues, especially the penetration of parathion and other organic compounds into grapes and other fruit and DDT into apples. Work was underway in conjunction with a physics institute to develop a method of killing silkworm pupae with gamma rays. It was claimed that an 8-percent increase in silk production was obtained with this method instead of the old hot-water dip method.

In one of the entomology laboratories in the Ukrainian Institute of Plant Protection, Ukrainian Academy of Agricultural Sciences, studies were being made on insect survival, reproduction on various cereal crops in relation to soil fertility, crop variety, temperature, and growth stage of food. Winter survival was estimated by some of

these factors and by the fat content of the insects, as determined by fat extraction from specimens brought in from the field. This same laboratory had dropped the study of insect amino acids (no reason given), but was studying insect carbohydrates and vitamins. Field and laboratory studies were being conducted on nutritional requirements, but not on purified or defined diets. About 8,000 specimens of *Agrotis segetum*, a cutworm, were brought into the laboratory for studies on the effect of sublethal insecticide dosages on fertility.

At this same laboratory carefully controlled dosage-mortality determinations were being made on many new insecticides. Factors considered included sex differences, temperature effects, and types of solvents. *Bothynoderes* and *Eurygaster* were the principal test insects. Extensive tests were also being conducted in insect physiology. These included pathological changes within the insects, cell respiration, carbohydrate metabolism, and the relationship of age to toxic susceptibility.

The research at the Laboratory of Chemical Toxicology, Institute of Plant Protection, Uzbek Academy of Agricultural Sciences, is considered to be basic in nature. The toxicity of chemicals and formulations used against insect pests in Uzbek S.S.R. is determined there. In 1958 limited synthesis of new compounds was begun. Compounds are first screened in the laboratory and then in small field-plot tests. This screening was reported to take from 2 to 3 years before a compound was ready for large-scale field use. Systemics are said to be ready for field use much sooner.

The Laboratory of Physiology and Biochemistry at the same institute is concerned with mode-of-action studies with herbicides and insecticides, the latter especially in relation to absorption by and effects on plants, persistence of toxicity, carry-over into seed, and effect on animals feeding on treated plants. The metabolism of systemics was not being studied at this laboratory—only toxicity measurements via horse-serum cholinesterase assay and insect bioassay.

Most, if not all, of the academies of agricultural sciences in the Soviet Union have laboratories where toxicology of insecticides and, usually, application methods are studied. Work is carried out in collaboration with laboratories of the Min-

istry of Health, nutrition institutes, and institutes of labor hygiene on residues, their toxic effect on mammals, and toxicity to personnel concerned with application.

Considerable emphasis is placed on the relationship between the physiological condition and the ability to diapause and to resist pathogen attacks. Winter survival of several important pest species and the reproductive capacity of surviving individuals are said to be closely correlated with the fat and other reserves accumulated before hibernation. The physiological condition is also said to affect egg survival in locusts. Locust egg pods, usually covered with water, are not injured, and embryological development proceeds normally if the diapausing germ forms. The diapausing egg shows the germ with the amnion and second coat separated. When diapause is complete, these two layers are joined. Inundation before the diapausing germ is formed causes death of the egg.

Histological studies of the fat bodies and of blood are routinely carried out to supply data for forecasting.

Insect Systematics

The Institute of Zoology, Academy of Sciences of the U.S.S.R., is well known for its extensive and significant contributions to systematic entomology. These are for the most part set forth in a series of publications of the Academy, such as that dealing with the fauna of the U.S.S.R., identification guides, scientific papers of the Institute of Zoology, parasitological studies, and a series dealing with publications of the All-Union Entomological Society. The last publication is sponsored jointly by this society and the All-Union Institute of Plant Protection.

The Institute is under the directorship of Academician Ye. N. Pavlovskiy, who has worked principally in parasitology, including blood-sucking Diptera. Assistant directors are Prof. B. E. Bychowsky (parasitology) and Prof. N. S. Borkhsenius (coccidology). Entomological investigations are carried on in both the Department of Invertebrates and the Department of Parasitology. Their organization and staff in August 1959 were as follows:

DEPARTMENT OF INVERTEBRATES (Including Entomology):

The head—corresponding member of the Academy of Sciences of the U.S.S.R.—Prof. V. V. Popov D. Sc.

LABORATORY OF HIGH INSECTS:

The head—corresponding member of the Academy of Sciences of the U.S.S.R.—Prof. V. V. Popov D. Sc.

SECTION OF COLEOPTERA:

Prof. L. V. Arnoldi D. Sc.....	Coleoptera, Curculionidae
Prof. M. Ye. Ter Minasyan D. Sc....	Coleoptera, Curculionidae, Attelabidae
O. L. Keyzhanovsky D. Sc.....	Coleoptera, Carabidae
G. A. Zinovyev.....	Coleoptera, Ipidae
Ye. L. Guryeva.....	Coleoptera, Elateridae
G. S. Medvedev.....	Coleoptera, Tenebrionidae

SECTION OF LEPIDOPTERA:

A. S. Danilevskiy D. Sc.....	Lepidoptera, Ecology of Insects
A. K. Zagulyayev D. Sc.....	Ecology of Insects, Lepidoptera, Tineidae
V. I. Kuznetsov D. Sc.....	Lepidoptera, Tortricidae
M. I. Falkovich.....	Lepidoptera, Tortricidae

SECTION OF HYMENOPTERA:

Corresponding member of the Academy of Sciences of the U.S.S.R.—Prof.

V. V. Popov D. Sc.....	General Entomology, Hymenoptera, Apoidea
M. N. Nikolskaya D. Sc.....	Hymenoptera, Chalcidoidea
A. A. Ponomareva.....	Hymenoptera, Apoidea
V. A. Tryapitsyn D. Sc.....	Hymenoptera, Chalcidoidea (Encyrtidae)
V. I. Tobias D. Sc.....	Hymenoptera, Braconidae

SECTION OF NEUROPTERA AND OTHERS:

Prof. S. G. Lepneva D. Sc.....	Trichoptera, Aquatic Insects
L. A. Zhiltsova D. Sc.....	Plecoptera
N. N. Derbeneva.....	Thysanoptera

LABORATORY OF LOW INSECTS:

The head—Prof. A. A. Stakelberg D. Sc.

SECTION OF DIPTERA:

Prof. A. A. Stakelberg D. Sc.....	General Entomology, Diptera
I. A. Rubtsov D. Sc.....	Diptera: Simuliidae: Insects—Entomophagous

K. Ya. Grunin D. Sc.....	Diptera: Oestridae, Hypodermatidae, Gastrophilidae
E. P. Narchuk D. Sc.....	Diptera, Chloropidae
V. F. Zaytsev.....	Diptera, Bombyliidae
SECTION OF HETEROPTERA:	
Prof. A. N. Kirichenko D. Sc.....	Hemiptera
G. Kh. Shaposhnikova D. Sc.....	Aphidoidea
M. M. Loginova D. Sc.....	Psylloidea
I. M. Kerzhner.....	Hemiptera
A. F. Yemelyanov.....	Auchenorrhyncha
SECTION OF ORTHOPTERA:	
Corresponding member of the Academy of Sciences of the U.S.S.R.—	
Prof. G. Ya. Bey Biyenko D. Sc...	Orthoptera, Dermaptera, Blattoidea, General and Agricultural Entomology
L. L. Mishchenko D. Sc.....	Orthoptera, Mantoidea
I. A. Tshetyrkina D. Sc.....	Orthoptera
SECTION OF COCCOIDEA:	
Prof. N. S. Borkhsenius D. Sc.....	Coccoidea
T. N. Bushchik D. Sc.....	Coccoidea
LABORATORY OF EXPERIMENTAL ENTOMOLOGY AND THEORETICAL GROUNDS OF BIOMETHODS:	
The head—Prof. D. M. Shteynberg D. Sc_ Scoliidae, Embryology of Insects	
A. B. Getsova.....	Ecology of Insects
Ye. S. Sugonyayev.....	Taxonomy and Ecology of Encyrtidae
G. A. Pantyukhov.....	Frost-Resistant Ability of Insects
G. G. Sheldeshova.....	Ecology of Tortricidae
V. A. Zaslavskiy.....	Coleoptera, Curculionidae
V. N. Tanasiychuk.....	Diptera, Chamaemyidae
DEPARTMENT OF PARASITOLOGY:	
The head—Prof. A. S. Monchadskiy D. Sc.... Entomology—Diptera, Culicidae	
LABORATORY OF BLOOD-SUCKING INSECTS AND ACARINA:	
The head—Prof. A. S. Monchadskiy D. Sc_ Taxonomy of Acarina	
V. I. Volgin.....	Tyroglyphoidea
V. G. Shevchenko.....	Phytophagous Mites
L. G. Sitnikova.....	Oribatei
B. Krasinskaya.....	Uropodidae
Ye. V. Kozlova.....	Gamasoidea
N. G. Bzegetova.....	Gamasoidea
G. V. Serdyukova.....	Ixodoidea
Yu. S. Balashov.....	Ixodoidea
N. A. Filippova.....	Ixodoidea
LABORATORY OF PARASITIC WORMS:	
The head—Prof. B. Ye. Bykhovskiy D. Sc_ Parasitology, Monogenoidea	
LABORATORY OF ICHTHYOLOGY:	
The head—corresponding member of the Academy of Sciences of the U.S.S.R.—	
Prof. A. N. Svetovidov D. Sc.....	Taxonomy of Fish
LABORATORY OF EMBRYOLOGY:	
The head—Academician I. I. Shmalgauzen_ Morphology and Embryology of Vertebrates	
LABORATORY OF PROTOZOLOGY:	
The head—Prof. A. A. Strelkov D. Sc.... Protozoology	

The entomological collections, comprising about 14 million specimens, are housed in the Institute of Zoology. As with collections in most similar institutions, space is a critical factor. The collections are well curated, although in some groups related materials have not been integrated to form a single collection that would be efficient for reference purposes.

It was stated by staff members at both the Institute of Zoology and the All-Union Institute

of Plant Protection that insufficient attention had been paid to systematic work in the past, and it was implied that this activity would be expanded.

Field expeditions to various parts of the Soviet Union are an integral part of the work of the Institute of Zoology. These may be made by staff members of the Institute of Zoology, Leningrad, or of the associated subordinate institutes and laboratories. Also, taxonomic studies on problems directly related to investigations of an ap-

plied nature may be carried on at agricultural installations in the various Republics. For example, at the Biological Laboratory of the Quarantine Service of Uzbek S.S.R., I. V. Roganov was studying the taxonomy of the Aphelinidae, a group of parasitic wasps of considerable economic

importance in the biological control of crop pests. Work in insect systematics is also carried on at universities, such as the Moscow State University in M. V. Lomonosov.

Stakelberg (1957) has reviewed developments in insect systematics in the Soviet Union.

Major Insect Pests and Methods of Control

The problems resulting from insect attacks on agricultural crops seemed to be generally well understood and efficiently handled. Although Soviet entomologists and agricultural officials spoke freely about their pest problems, we saw little evidence of severe insect damage in 1959 in the areas visited. This applied to crops observed incidental to travel by automobile, as well as those inspected during visits to farm areas and experimental plantings.

Locusts

The desert locust (*Schistocerca gregaria*) invaded the Soviet Union in the region adjacent to Iran and Afghanistan in 1928 and 1929. It has been of considerable concern to Soviet entomologists since that time. Studies of the problem have been carried out by Soviet entomologists both within the Soviet Union and in the permanent breeding grounds. These studies were summarized by Shcherbinovskiy (1958).

Other species of locusts are important pests in the arid and semiarid southern areas of the Soviet Union. In Uzbekistan over 150,000 hectares of land were treated for locust control in 1958.

Pests of Subtropical Fruit and Tea

Citrus in Georgia is grown largely on rather steep slopes, where air drainage prevents winter killing. The only plantings seen where winter killing was severe were in flat areas adjacent to the Black Sea. These areas were about at the limit of winter temperatures that citrus will tolerate. "Creeping" lemons have been developed to permit ready coverage for winter protection.

The principal pests of citrus in Georgia are such scale insects as *Pulvinaria*, *Ceroplastes japonica*, cottony-cushion scale, and the citrophilus mealybug (*Pseudococcus gahani*). These are mostly controlled by the coccinellid predators *Rodolia cardinalis*, *Cryptolaemus montrouzieri*,

and *Lindorus lophanthae*. For treatment of material passing through quarantine, HCN or methyl bromide is customarily used, although nursery cuttings and young plants may be dipped into solutions of organic phosphorus materials.

Tea pests in Georgia are also principally scales. The black citrus aphid (*Toxoptera aurantii*), which attacks tea, is not difficult to control in commercial plantings, because it prefers the upper new growth, which is regularly picked. *Pulvinaria floccifera* appeared to be the most important pest, but it can be controlled by coccinellids. Where the tea moth (*Parametriotes theae*) occurs, there appears to be a greater need to use insecticides. Strict quarantine measures are enforced to prevent movement of tea pests from old tea-growing areas to new areas.

Pests of Deciduous Fruit

In the Soviet Union as in the United States the codling moth is the major pest of apples and pears. It is widely distributed and occurs in all apple-growing areas of the Soviet Union except the far eastern section. It has from one generation per year in the northern latitudes to three or more per year in the southern regions. A comprehensive report on this pest was made by Vasil'yev (1958).

DDT is the principal insecticide used against the codling moth, but the number of applications is limited to not more than three per year in Uzbekistan, and the rate of application is low because of the low residue tolerance permitted (1 mg. per kilogram of fruit). Alternative control measures are being explored, such as using bands around tree trunks to trap overwintering stages, spraying trunks and lower branches with weak dosages of DDT and pathogenic fungi, and using egg parasites (*Trichogramma*). A fungicide, probably bordeaux mixture, is frequently included in the DDT spray.

In Georgia certain varieties of apple trees are attacked by the larvae of the moth *Synanthedon myopiformis*. This pest bores under the bark of the trunk and larger branches and may cause the death of the tree or a major part of it.

In the Ukraine, in addition to the codling moth, leafhoppers (*Typhlocyba*), apple suckers (*Psylla mali*), leaf rollers (probably more than one species), and aphids were observed, but not in damaging numbers. It was reported that the gypsy moth and occasionally other Lepidoptera were sometimes fruit pests. Mites were also troublesome. The woolly apple aphid (*Eriosoma lanigerum*) is present in Georgia, the Ukraine, and other areas, but it is well controlled by the parasite *Aphelinus mali*.

A cherry maggot, *Rhagoletis cerasi*, is an important pest of both sweet and sour cherries in Georgia. Early varieties of fruit are less susceptible than late-maturing varieties. Dusting with DDT and treatment of soil under trees with a soil insecticide are customary control procedures.

Grapes are an important economic crop in many areas of the southern Soviet Union, and everywhere appear to be relatively free of damaging

insect pests. For example at Tashkent, Uzbek S.S.R., there were 650 varieties of grapes at the Institute of Viticulture and Viniculture im R. R. Shreder, Uzbek Academy of Agricultural Sciences, but there was no evidence either of insect damage or of excessive use of insecticides to protect the crop. Leaf rollers, bud mites, and red spiders are said to be occasionally troublesome, but not difficult to control.

Figs, pomegranates, peaches, apricots, and plums are also grown in Uzbekistan without serious insect-control problems.

Pests of Sugar Beets

Sugar beets are the only source of sugar in the Soviet Union, except sugar cane, which is grown in small amounts for rum. Pests that attack sugar beets receive serious attention. About 90 percent of this crop is grown in the Ukraine. Research on this crop and its pests is coordinated by the All-Union Scientific Research Institute of Sugar Beets at Kiev, Ukrainian S.S.R. This institute has branches in other parts of the Soviet Union.

The chief pests in the regions where sugar beets are grown are as follows:

<i>Bothynoderes</i> spp., mostly <i>punctiventris</i> , <i>Aphis fabae</i>	Ukraine
<i>Gnorimoschema ocellatella</i>	Northern Caucasus
<i>Chaetocnema coneinna</i> , <i>C. tibialis</i> , and <i>C. breviscula</i>	Siberia, Baltic Sea to Pacific Ocean
<i>Agrotis segetum</i>	Soviet Central Asia, in irrigated land

Forecasting is helpful in the control of sugar beet pests, in that it permits the production and distribution of insecticides to localities where needed, and other planning. However, forecasts of impending outbreaks are not used as a basis for reduction or elimination of beet production in areas of anticipated trouble.

Control of *Bothynoderes* is chiefly with chemicals, or a combination of chemicals and pathogens as described under Biological Control Methods. DDT, BHC, or toxaphene may be used against this weevil, or chlordane, heptachlor, or aldrin in combination with phosphate fertilizers, followed by one of the first three insecticides mentioned. Granulated formulations are just beginning to be used. The organic phosphorus compounds K-20-35 and avenin have been used experimentally and are said to be highly effective against the sugar beet weevil.

Against flea beetles (*Chaetocnema* spp.), the customary control measures include eliminating weeds in the vicinity of beetfields with 2,4-D.

DDT is also used on weedy areas to destroy the beetles before they enter beetfields.

Control of *Gnorimoschema* is largely agrotechnical and includes removing tops of beets at harvest and plowing them under with a moldboard plow to a depth of 25-27 cm. (10-10½ inches) to kill the moths. Aphids on sugar beets are controlled with anabasine sulfate and with organic phosphorus compounds used as systemics. Damage by *Agrotis segetum* can often be avoided by early planting. DDT is used and also *Trichogramma*, which are released at the rate of 10,000 to 20,000 per hectare, as described under Biological Control Methods.

A comprehensive treatise on pests of sugar beets was published by the All-Union Scientific Research Institute of Sugar Beets (1959).

Pests of Vegetable Crops

Relatively little attention appears to be directed toward insect pests of vegetable crops except potatoes. This may be because vegetable crops are

of less importance to the total economy of the Soviet Union than the major grain crops and sugar beets. Also consumer acceptance standards have not yet required damage-free produce.

The Colorado potato beetle was found in the Ukraine for the first time in 1949. Since then small infestations have been frequently discovered and eradicated. Prior to 1959, when more than 100 infestations were found in the Ukraine, this pest had not been particularly damaging. The central government has supplied funds for the treatment of areas adjacent to infested foreign countries, a quarantine policy in effect with respect to specified agricultural pests.

The Colorado potato beetle is eradicated with DDT. Soviet entomologists have studied this species closely and are rather familiar with research developments relating to it. For example, it was stated that in Germany two spray applications were used against the beetle—the first a light application of DDT, the second a muscardine fungus. The DDT does not kill, but the larvae pupate earlier, and pupal mortality is 90 to 95 percent. This method is used against both generations of beetles.

Pests of Grain Crops

Grain crops, particularly wheat, are subject to attack by many serious pests. Although these species differ from region to region, they fall roughly into the following categories: Sucking insects such as bugs and thrips, cutworms, frit flies, wireworms and false wireworms, and flea beetles.

Eurygaster integriceps is apparently the most destructive of the sucking insects, although *E. maura* and *E. austriacus* are also wheat pests. Of these, *E. integriceps* causes approximately 98 percent of the damage in the steppe area of the Ukraine. It occurs chiefly in the vicinity of forests or shelter belts. There appears to be no correlation between *Eurygaster* outbreaks and weather conditions.

In Kazakhstan another grain bug, *Aelia acuminata*, is a pest comparable to *Eurygaster* in the more western grain areas. A grain thrips (*Haplothrips* sp.) is also an important pest in Kazakhstan.

Agrotechnical methods, particularly two-stage harvesting, are used to control these sucking insects that attack grain, although insecticides may also be employed. Insecticide treatment of grain

for small larvae of *Hadena* sometimes gives good control of grain bugs.

The grain cutworm *Hadena anceps* occurs in both the Ukraine and in the New Lands of western Siberia. Since the eggs are laid precisely on the "fruit set," a tight wheat head discourages oviposition. The newly hatched larvae live first inside the kernel and later continue to feed on the developing kernels while living on the grain head. *Hadena* hibernates as a fully grown larva and emerges early in the spring to feed on early spring growth and scattered grain. Dusting at this time with DDT or BHC gives good control. Dusting may also be done to control small larvae on grain heads. Agrotechnical methods are preferred. Those used against *Hadena* are fall plowing, preferably immediately after harvest, and late sowing of spring wheat. Late sowing cannot always be practiced owing to the short seasons in western Siberia. Also some control of *Hadena* results from two-stage harvesting, as the larvae tend to congregate in windrows of grain and are mechanically destroyed during threshing. DDT applied in a thermally generated aerosol may also be used for grain cutworm control.

About 25 species of wireworms (*Selatosomus* spp., *Agriotes* spp., *Melanotus* spp., and others) and 12 species of false wireworms (*Pedinus femoralis* and others) are troublesome over wide areas of the Soviet Union, but especially in the New Lands. Various agrotechnical methods used for control include timing of cultivation, weed control, crop control, crop rotation, and bait crops that can later be destroyed. Control with BHC and poison barriers is also employed. Tillage practices that permit carabid predators to feed on the wireworms are also recommended. As in the United States, the problem is exceedingly complex. Work on wireworm control has been reviewed by Dobrovol'skiy (1958).

Frit flies or "Swedish flies" are sometimes troublesome in the New Lands in Kazakhstan. Larvae of the flea beetles *Phyllotreta vittata* damage seedling wheat by feeding on the roots.

Pests of Stored Grain

The granary weevil (*Sitophilus granarius*) and grain mites (Acarina) are important grain-storage pests. Control measures include cleaning storage areas and treating empty houses with thermal aerosols.

Pests of Corn

The principal pests of corn in the western and southern Soviet Union are the European corn borer and wireworms. Frit flies may at times cause damage, as well as flea beetles (*Chaetocnema* spp.). Wireworms are the principal pests of corn in the New Lands of western Siberia. Control measures for these pests are almost entirely agrotechnical and biological. This topic has been reviewed by Kalashnikov and Shapiro (1958).

In Georgia and other southern areas where ear corn is grown the Angoumois grain moth (*Sitotroga cerealella*) attacks the kernels in the field at the milk stage. One or two generations may occur. To counteract this infestation, some areas are experimenting with concentric planting. At the center of the planting is a building stored with corn. This food source serves as a gradient attractant for egg-laying moths. The result is said to be 80-percent infestation of growing corn within a radius of 100 meters,⁵ but only 1- to 2-percent infestation at 500 meters.

Pests of Alfalfa

Alfalfa is unquestionably an important economic crop in the Ukraine and particularly in the irrigated areas of the southern Soviet Union. The principal pests are *Phytonomus variabilis*, *Sitona cylindricollis*, *Adelphocoris lineolatus*, *Bruchophagus gibbus*, *Aphis laburni*, and *Therioaphis ononidis*. There was no indication that control measures other than agrotechnical and biological were being used.

Pests of Cotton

Most of the cotton in the Soviet Union is grown in Uzbekistan. Of the 2,513,000 hectares of irrigated land in this Republic, about 52 percent is in cotton. The climate is favorable for pests and disease development. The most important pests of cotton include—

Tetranychus telarius—damages cotton every year from the seedling stage to the first frost

Thrips tabaci—extensively damages cotton from the seedling to the flowering stage

Aphis gossypii—worst aphid pest because of lint damage due to its exudate

A. laburni—important pest only on seedlings

Agrotis segetum—a cutworm pest of seedlings

Heliothis armigera—attacks primarily the squares

Caradrina—a noctuid

Some of the pests of lesser economic importance include *Laphygma exigua*, *Acrythosiphon gossypii*, and *Pectinophora* (= *Pexicopia* (?)) *malvella*. The pink bollworm and the boll weevil (*Anthonomus grandis*) have never been found in cotton in the Soviet Union.

Insecticide control measures against the aphid-mite-thrips complex are practiced on about 1,200,000 hectares annually, including repeat treatments. The annual infestation by species of this complex occurs on approximately 360,000 hectares. Prior to 1957 sulfur, nicotine, and anabasine were used for control. Demeton and schradan are now used. One or two preemergence applications of either systemic may be made to mulberry trees and weeds adjoining cottonfields. In the absence of mulberry trees around field edges mite infestations are not too severe. Schradan is first applied to mulberry trees just before the buds open and then after the leaves are picked for silkworm feeding. The first application to cotton is made at the seedling stage, or up until the first week in June (April 20 is the end of the planting season); it is considered a preventative. A second application usually is made in July. One-fourth kilogram⁶ per hectare is used for the preventive application and up to 1 kilogram for the second application. It was said that mite infestations on cotton in June if allowed to go untreated would cause yield losses of 50 to 60 percent. For July and August the losses would be 25 to 30 percent and 2 to 5 percent, respectively. Studies of insecticide resistance in mites have recently been undertaken.

In 1956, about 1,560,000 hectares of cotton were treated with insecticides, of which 65 percent was by tractor, 15.5 percent by airplane, and the balance by horse-drawn and hand equipment. In 1957, 54.6 percent of the 1,700,000 hectares treated was by tractor and 25.6 percent by airplane. Of 2,200,000 hectares treated in 1958, 45 percent was by airplane and 40 percent by tractor. During 1959 it was expected that 75 percent of the cotton acreage would be treated by airplane. Uzbekistan, which has approximately 65 percent of the cotton acreage in the Soviet Union, had 155 planes, mostly biplanes, in operation as sprayers and dusters. Most insecticides are applied in sprays because of the widespread and severe mite problem.

⁵ 1 meter=39.37 inches.

⁶ 1 kilogram=2.2 pounds.

The spray volumes are approximately 45 liters⁷ per acre by airplane and 250 by ground machine. Swath width ranges from 20 to 25 meters and the payload averages about 1,500 kilograms.

Systemic insecticide formulations were usually 30-percent emulsifiable concentrates, but a 60-percent formulation was under test. Phorate has been tried as a seed treatment, but because poor stands resulted the method was discarded. Approximately 350,000 hectares were treated with systemic insecticides by airplane in 1958, and it was expected that 1,400,000 hectares would be treated in 1959.

Agrotis segetum causes widespread seedling damage and is difficult to control. About 1,250,000 hectares are infested each year. BHC for seed treatment is recommended. Aldrin is being tested. *Trichogramma* was unsuccessful, apparently because of climatic conditions.

Heliothis armigera has two to three generations per year. *Caradrina* populations fluctuate from year to year. This pest caused widespread damage in 1956 and 1959. Both are controlled with DDT. It is applied in a 10-percent dust or in a wettable-powder spray. Two and sometimes three applications are made beginning in mid-July. The dosage ranges from 0.8 to 1.6 kilograms of toxicant per hectare. Aldrin and heptachlor are being tested against these two pests.

Crop rotations also are considered necessary for pest control. Two of the rotations are 1 year of corn, 2 years of alfalfa, and 5 years of cotton or 1 year of corn, 3 years of alfalfa, and 6 years of cotton.

Examination of 100 plants in one of the fields visited in late July revealed three live aphids, three mummified aphids, one coccinellid adult, one coccinellid larva, four coccinellid eggs, and one ant lion adult. The cotton was squaring profusely in a lush condition and at about 20-percent bloom. In two other fields the aphid infestation averaged approximately 25 per leaf. Preparations were being made to apply demeton to both fields that evening.

Pests of Forests

No true forest areas were visited. However, certain problems in forest entomology were outlined during discussions at Kiev and Leningrad.

In the Ukraine, primary pests of forested areas are the defoliators *Porthetria dispar*, *Euproctis chrysorrhoea*, *Dendrolimus pini*, and *Malacosoma*. They are mainly destructive in previously cultivated land not planted with pines. Studies are made on the effects of forestry practices on these pests and the impact of these pests on broad-leaved forests. The planted forests usually have different types of soils and different plant complexes from the natural forests. They also differ in the absence of the ant *Formica rufa*, an important natural enemy of numerous defoliating caterpillars. In particular, caterpillars of *Malacosoma* and *Dendrolimus* have higher survival rates in planted forests.

Biological trends are considered in control measures for the gypsy moth. If more than 50 percent of the eggs and larvae show parasitization or predation, insecticide spraying is not done. *Dermestes lardarius* is said to be an important predator of the eggs of the gypsy moth. Birds and the mice *Apodemus* and *Clethrionomys* also suppress gypsy moth outbreaks, as do silvicultural practices. When insecticides are used, DDT is applied by airplane at the approximate rate of 1 kilogram per hectare, or approximately 1 pound per acre.

The larvae of *Dendrolimus pini* hibernate in the upper layer of forest litter. In addition to biological control methods and airplane spraying of foliage, trees may be encircled with a band 1 cm. wide of BHC or DDT to prevent the caterpillars from returning to the forest canopy. A similar method of spraying the basal 30 cm. of the trunk with 10-percent DDT or 4-percent BHC is used to control *Aradus cinnamomeus*, a bug that damages trees 10 to 12 years old by sucking sap from the phloem.

Secondary forest pests in the Ukraine are *Cerambyx cerdo*, *Melolontha vulgaris*, *M. hippocastani*, and *Polyphyllo fullo*. The control measures used against *C. cerdo* are outlined under Agrotechnical Methods. The remaining species, all scarab beetle pests of seedlings, are controlled by applying at planting time 2 to 3 kilograms of 12-percent BHC dust per hectare. This treatment increases planting costs by about 10 percent.

Khromzov (1958) and Telenga (1958) have reviewed methods used to control forest pests in the Soviet Union.

⁷ 1 liter=1.0567 liquid quarts.

Pests of Animals and Man

The limited information we were able to obtain about pest species that attack animals and man confirms the experiences reported by the U.S. delegation concerned with veterinary science. Relatively little serious or well-organized research seems to be underway on such problems, and knowledge or application of knowledge for the control of pests of animals and man lags far behind work in crop protection. Considering the current emphasis on increased production of meat in the Soviet Union, this is a rather surprising situation. In part it appears to result from the division of responsibility between the Ministries of Agriculture and Health and from failure to place with the Ministry of Agriculture those functions that are primarily related to agricultural activities.

House flies were abundant and very annoying at most localities visited in Uzbekistan and Kazakhstan. Even though their abundance results largely from agricultural activities, responsibility for fly control rests with the Ministry of Health. We saw no evidence that fly control was being attempted, and flies generally were regarded as an inconvenience to be tolerated.

In Uzbekistan, where livestock production is an important part of the economy, ticks occur in the lowland area and are responsible for piroplasmiasis in cattle, horses, and sheep. Nose bots of sheep (*Oestrus ovis*) are common, as are stomach bots of horses (*Gasterophilus*) and *Hypoderma* bots of cattle. Horse flies (Tabanidae of many species) are reported to be common in lowland areas.

Black flies (Simuliidae) are reported to be abundant in mountain areas of Kazakhstan in June, but they are pests of humans more than of livestock. Developments with respect to problems of medical importance are outlined under Medical and Veterinary Entomology.

Control methods for pests of veterinary importance are discussed in the U.S. Department of Agriculture (1959) report on Veterinary Science in the Soviet Union. Developments in medical entomology in the Soviet Union were summarized by Pavlovskiy and Gutsevich (1957). Their report, which was translated, reproduced, and distributed by the World Health Organization, contains an extensive bibliography.

Household Insects and Termites

Because the delegation was operating in agricultural channels, it was impossible to observe in detail any household insects. Although cockroaches were reported to be troublesome to American personnel in Moscow, we did not see any, except a few of the Oriental species in Georgia. Sodium fluoride was used in one hotel, but BHC seemed to be the most common insecticide used around garbage and trash areas in Moscow and southern cities.

In Sukhumi, Georgian S.S.R., we were informed that in 1956 many homes had been treated for bed bugs (*Cimex lectularius*) by the mass use of HCN applied to blocks of houses at one time. Bed bug control is carried out by local teams under the direction of the Ministry of Health in each Republic.

Termites as a structural hazard are so negligible as to be practically unknown.

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Appendix

The itinerary of the entomological delegation in the Soviet Union from July 10 to August 9, 1959, was as follows:

Date	City	Place visited
July 10	Moscow	Ministry of Agriculture.
11	do	American Embassy.
12	do	{ Kremlin. Permanent exhibition of Soviet accomplishments.
13	do	{ Moscow Agricultural Academy im K. A. Timiryazev. Ministry of Agriculture. All-Union Institute of Veterinary Entomology.
14	do	{ Institute of Medical Parasitology and Tropical Medicine im Martsinovsky. Mechnikov Institute.
15	Moscow to Tbilisi	
16	Tbilisi	Ministry of Agriculture.
17	Gori	{ Champagne plant. Stalin Collective Farm. Brethi Collective Farm.
18	Sukhumi	{ Laboratory for Inspection and Plant Quarantine. Experimental farm of All-Union Institute of Tea and Subtropical Crops. Plant breeding station. Iliyeh State Farm for Citrus Production.
19	do	{ Training farm of agricultural institute. Lake Ritsa.
20	Sukhumi to Kiev	
21	Kiev	{ Ukrainian Institute of Plant Protection, Ukrainian Academy of Agricultural Sciences. Ukraine agricultural exhibition.
22	do	{ Ukrainian horticultural institute im Chaban. All-Union Scientific Research Institute of Sugar Beets.
23	Belaya Tserkov	{ Belotserkovskaya Plant Breeding Station. Biological Control Laboratory. Chkalov Collective Farm.
24	{ Kiev to Moscow Moscow	{ American Embassy. American exhibition.
25	Moscow	Campus of Moscow State University im M. V. Lomonosov.
26	Moscow to Tashkent	
27	Tashkent	{ Ministry of Agriculture. Biological Laboratory of the Quarantine Service of Uzbek S.S.R.
28	do	{ Akkavak Experimental Station of the All-Union Institute of Cotton Research. Institute of Viticulture and Viniculture im R. R. Shreder, Uzbek Academy of Agricultural Sciences.
29	Namangan	Collective Farm Leningrad.
30	do	Kzyl-Ravat State Farm.
31	Tashkent to Alma-Ata	Officials of Ministry of Agriculture, Kazakh S.S.R.
Aug. 1	Akmolinsk and the New Lands.	Dvurechniy State Farm.
2	do	{ Svobodniy State Farm. Chorman agricultural research institute.

Date	City	Place visited
Aug. 3	Akmolinsk to Leningrad	
4	Leningrad	All-Union Institute of Plant Protection.
5	do	{ Institute of Zoology, Academy of Sciences of the U.S.S.R. { All-Union Institute of Plant Protection.
6	do	{ Institute of Zoology, Academy of Sciences of the U.S.S.R. { All-Union Institute of Plant Protection.
7	Leningrad to Moscow	
8	Moscow	Ministry of Agriculture.
8	Moscow	Do.

