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RESEARCH SERVES COLORADO

EIGHTIETH ANNUAL REPORT • COLORADO STATE UNIVERSITY • 1966-67

**Annual Report
1966-67**

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RESEARCH SERVES COLORADO

EIGHTIETH ANNUAL REPORT

COLORADO STATE UNIVERSITY

1966-67

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Honorable John A. Love
Governor of Colorado
Denver, Colorado

Dear Sir:

In compliance with the Act of Congress entitled "An Act to Establish Agricultural Experiment Stations," approved March 2, 1887, and with Acts supplementary thereto, I hereby present Colorado State University's Eightieth Annual Report. This report encompasses research activities of the Colorado Agricultural Experiment Station and of other major divisions of Colorado State University for the fiscal year 1966-67.

Respectfully,

A handwritten signature in dark ink, appearing to read "Rue Jensen". The signature is fluid and cursive, with the first name "Rue" being more prominent and the last name "Jensen" following in a similar style.

Rue Jensen,
Vice President for Research
Colorado State University
and
Director, Colorado Agricultural
Experiment Station



Research and the University

All men alive today owe a debt of gratitude to Sir Isaac Newton, Louis Pasteur, and Dr. Jonas Salk. These men represent a relatively small group of creative individuals known as researchers—men and women who are never satisfied with what they know but are constantly asking—why, why, why?

It is in keeping with this tradition of restless searching, of constant probing and inquiry into new questions that arise from the answers to the old, that researchers at Colorado State University bend their efforts. They hope, as do we, that practical results eventually will follow from the answers they reach—that further knowledge about the life and habits of an insect will help reduce the shortage of food in the world. But immediate application of new knowledge is not necessary; it is helpful simply to know more about the insect, to understand more about the world.

Colorado State University, dedicated as it is to the furtherance of man's understanding of himself and his world, is the logical home of research. Here members of the community of seekers may gather, work together, and share their understanding and intuitions. Here they may pass these insights along to those in a younger generation, and collaborate with them in developing the tools to extend the frontier of man's knowledge one more step.

W.E. Morgan

William E. Morgan
President
Colorado State University

To Find an Answer

The researcher places little importance on immediate practical results of his studies. He is concerned with learning, not with doing. It is inevitable, however, that increased learning by some leads to more efficient doing by the rest of us. We all benefit more or less directly from the studies of the few.

Colorado State University is eager to pass along to the people of Colorado the practical as well as theoretical results of its research. Soon it may be possible for the housewife to buy better meat because of genetic improvement of meat producing animals. New information is being acquired about the management of surface and ground water, a precious commodity of the country and the world. Further study of pre-Civil War free states may help us understand de facto segregation in the North and how to educate against it. New strains of feed grains will help us meet the needs of underfed populations.

It is accomplishments such as these, and others reported in these pages, that have made a better world for us, and presumably will make a better world yet for our children and grandchildren. Without research, not only would we never reach the answers to our problems, we might never recognize those which are really important.



Rue Jensen,
Vice-President for Research
Colorado State University



Colorado State University Research Foundation

In 1941 a group of faculty organized the CSU Research Foundation to help administer sponsored research contracts and grants. The Foundation was established primarily to handle patent matters resulting from inventions developed by the CSU faculty.

During the early years few projects existed and only an occasional contract or grant required administration outside the scope of the Agricultural Experiment Station. By 1957, however, it was necessary to assemble a staff to administer the increasing numbers of contracts and grants.

Starting with approximately \$400,000 in contract and grant expenditures in 1957, research projects administered by the Foundation grew rapidly, and in fiscal 1966-1967 the total expenditures exceeded \$9,000,000.

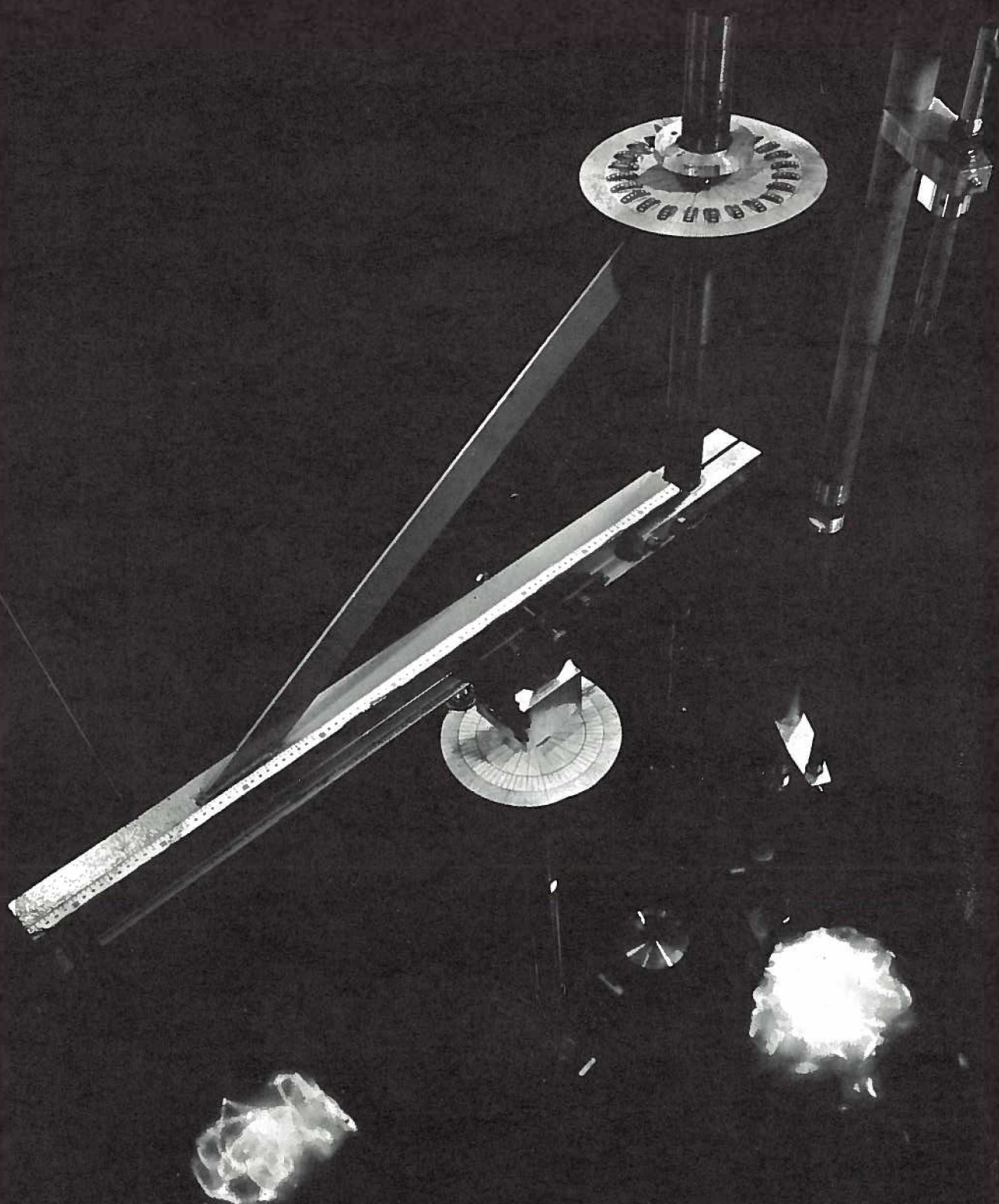
At the close of fiscal 1966-67, contracts and grants in force amounted to some \$21,300,000, a figure that promises to rise somewhat next year.

The Research Foundation serves the faculty member by providing the fiscal management of research contracts and grants, relieving him of mundane management problems so he can devote his full attention to the project he is working on. Although the Foundation is a separate composite organization, it operates solely as the administrative arm of the University for research contracts and grants. It does not undertake research work in its own name or for its own account.

Since research and teaching go hand in hand, Colorado State University accepts only those research projects which can be conducted conveniently within the framework of the existing academic organization and which will further the educational program. Projects of a purely commercial nature or those which are not compatible with the academic program are not accepted.

So successful has this program been to date that a large percentage of all graduate students presently enrolled in the University are supported in some way by the research program.

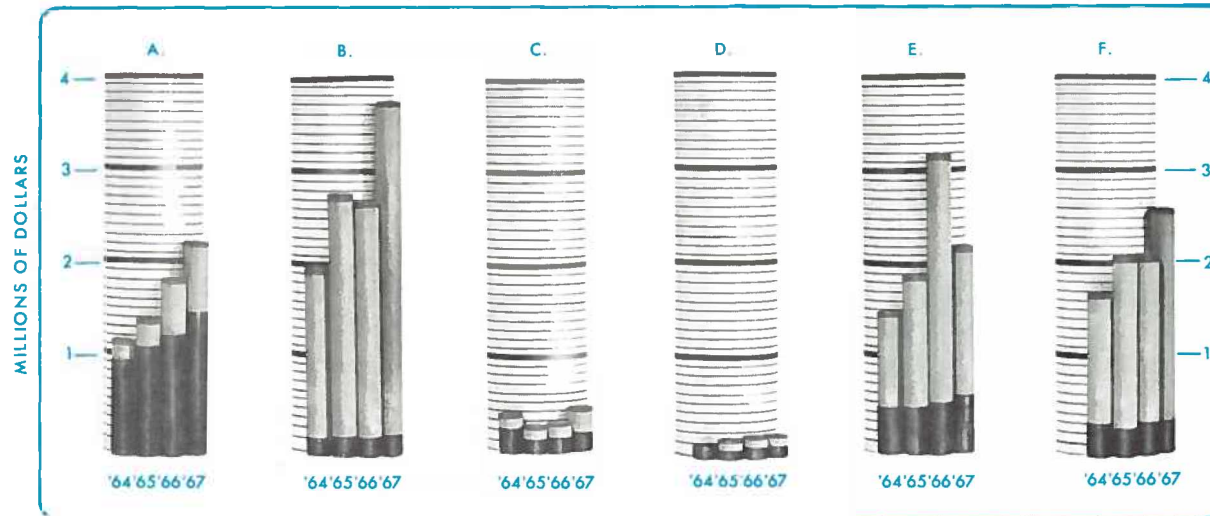
The expenditures by the Research Foundation in conjunction with contracts and grants encompass over 500 projects. Included are the international programs administered by the University such as the veterinary college in Kenya, a co-operative project with the University of Peshawar, Pakistan, management of the Asian Institute of Technology in Bangkok, and AID programs for rural development in Nigeria and Brazil.



Sophisticated electronic devices and a tank of water lead to new discoveries in acoustics.

GROWTH OF RESEARCH

RESEARCH FUNDS EXPENDED BY COLLEGE 1964-1967



A. COLLEGE OF AGRICULTURE

D. COLLEGE OF HOME ECONOMICS

B. COLLEGE OF ENGINEERING

E. COLLEGE OF VETERINARY MEDICINE AND BIOMEDICAL SCIENCES

C. COLLEGE OF FORESTRY AND NATURAL RESOURCES

F. COLLEGE OF ARTS AND SCIENCES



FINANCIAL STATEMENT

COLORADO STATE UNIVERSITY EXPERIMENT STATION - FISCAL YEAR 1966-67

	Hatch	RRF	McIntire-Stennis	Specific Research	State Approp.	Vibrio	Research	Sole	Grants	State Contract	ARS	Total
Carryover			\$21,761.58			\$7,239.12	(\$8,251.10)	\$ 20,647.24	\$21,824.69		(\$27,474.14)	\$ 35,747.39
Receipts 1966-67	489,242.00	273,726.00	53,479.00	11,200.00	1,709,522.00	190.00	341,616.03	297,728.49	50,925.23	8,200.00	103,256.41	3,338,085.16
Total	\$489,242.00	\$273,726.00	\$75,240.58	\$11,200.00	\$1,709,522.00	\$7,429.12	\$333,364.93	\$318,375.73	\$72,749.92	\$8,200.00	\$ 75,782.27	\$3,374,832.55
Disbursements:												
Personal Services Administrative	22,808.50				20,159.77							42,968.27
Personal Services	369,330.14	201,305.50	36,279.51	3,596.20	861,263.18		5,004.94	29,274.69	31,522.54	3,991.06	41,963.03	1,583,530.79
Labor	25,606.63	7,308.71	4,338.25	1,399.71	109,131.74		57,137.89	27,681.01	6,541.76	288.83	65,149.44	304,583.97
Travel	5,725.91	11,896.31	3,530.31		31,851.20		11,351.98	2,921.78	4,231.26	265.52	2,728.11	74,502.38
Equipment	19,335.38	18,970.01	10,763.51	817.85	51,315.85		22,925.63	21,532.48	1,566.04		2,488.03	149,714.78
Lands & Structures								20,900.00				20,900.00
Personal Benefits					77,968.78		63.92	1,551.04	1,071.25	133.25	1,313.13	82,101.37
Supplies and Materials	31,703.26	24,328.66	2,859.89	2,557.19	145,316.08		161,898.16	153,416.19	11,840.61	21.98	12,797.33	546,739.35
All Other	14,732.18	9,915.81	2,960.32		126,316.41		69,179.72	42,069.81	6,418.63	3.00	10,873.75	281,969.63
Plant M&O					286,158.00							286,158.00
Total Disbursements	\$489,242.00	\$273,725.00	\$60,231.79	\$8,370.95	\$1,709,481.01		\$327,562.24	\$299,347.00	\$63,192.09	\$4,703.64	\$137,312.82	\$3,373,168.54
Balance 6/30/67		1.00	15,008.79	2,829.05	40.99	7,429.12	5,802.69	19,028.73	9,557.83	3,496.36	(61,530.55)	1,664.01
Sum of Disbursements and Balance	\$489,242.00	\$273,726.00	\$75,240.58	\$11,200.00	\$1,709,522.00	\$7,429.12	\$333,364.93	\$318,375.73	\$72,729.92	\$8,200.00	\$ 75,782.27	\$3,374,832.55

COLORADO STATE UNIVERSITY

STATEMENT OF EXPENDITURES FOR RESEARCH - FISCAL YEAR 1966-67

College	Total	CSU Research Foundation	Experiment Station	Faculty Improvement Committee	Facilities Development
Agriculture	2,258,227.36	724,676.61	1,529,530.00	2,558.00	1,462.75
Business	25,476.80	25,476.80			
Engineering	3,730,222.13	3,495,066.13	233,191.00	1,965.00	
Forestry and Natural Resources	400,015.97	179,211.48	219,311.00	1,427.35	66.14
Home Economics	142,747.96	55,395.96	86,152.00	1,200.00	
Science and Arts	2,243,377.60	1,694,072.30	433,070.00	25,998.81	90,236.49
Veterinary Medicine and Biomedical Sciences	2,942,364.17	2,241,546.43	274,833.00	11,612.50	414,372.24
Other*	1,308,940.26	710,194.26	598,746.00		
Total	\$13,051,372.25	\$9,125,639.97	\$3,374,833.00	\$44,761.66	\$506,137.62

*Includes one or more: Library; Audio-Visual; Dean, Graduate School; Dean, Summer Session; administration, etc.

ADVANCED DEGREES AWARDED 1966-1967*

College	Master's Degrees	Doctor's Degrees
Agriculture	20	8
Business	17	-
Engineering	59	19
Forestry and Natural Resources	39	5
Home Economics	11	1
Science and Arts	270	19
Veterinary Medicine and Biomedical Science	22	12
Total	438	64

*Includes August, 1967

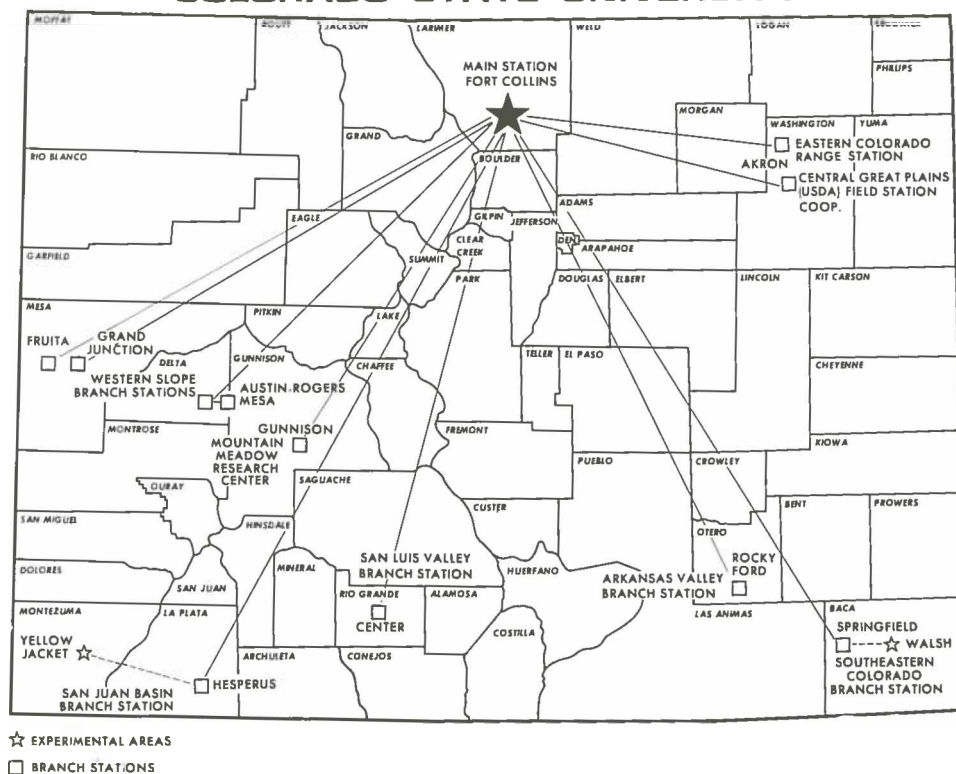
Experiment Station

The Colorado State University Experiment Station is a complex of faculty, graduate students, technicians, laboratories, and field stations located at the main campus at Fort Collins and at nine other communities scattered throughout the state. Most of the scientists involved are both researchers and teachers.

The Experiment Station was created and funded in 1887 by passage of the Hatch Act. Like its counterparts in other land-grant colleges, it was enjoined as an integral part of the institution to promote investigation into the basic principles and useful applications of science relating to agriculture. In 1962 the McIntire-Stennis Cooperative Forestry Research Act expanded the efforts of experiment stations by providing new funding for research in forestry. Since both of these Acts require state matching funds, the Experiment Station is supported cooperatively by both state and federal governments. Over the years the program of the Experiment Station has broadened through contracts and grants to encompass research efforts in all seven colleges of the University.

Cooperative research is conducted with U. S. Department of Agriculture agencies on the main campus and at facilities located at Akron, Greeley, and Grand Junction.

Branch Stations and Experimental Areas COLORADO STATE UNIVERSITY



Natural Resources Center

The Natural Resources Center is organized to focus on the interdisciplinary character of problems encountered by man's development and use of land, water, and atmosphere by providing an organization for integrating research and education in these areas. The center is specifically designed to coordinate work on projects which cut across departmental, college and institutional boundaries.

The center functions through standing committees of multi-college and multi-departmental character. The Water Resources Committee carries advisory responsibilities for programs sponsored by the Office of Water Resources Research, U. S. Department of Interior. During the past year, the center received \$87,500 in an institutional allotment grant. In addition, five matching (federal—non-federal funding) projects were active with a total value of \$192,522.

The Recreation Committee has been active in consultation with the staff of the Public Land Law Review Commission. From this activity a special committee on Public Land Policy has developed.

The Committee on Urbanization of Colorado planned and conducted a seminar entitled, "Community Response to the Dynamics of Urbanization." Participants were invited from policy-making bodies at the municipal and county government levels. Expert consultants from fields such as law enforcement, urban planning, sociology, re-development, community studies, and regional development, served as discussion leaders. This seminar proved to be a highly successful contribution to programs dealing with urbanization problems in Colorado.

The Water Quality Committee served as an advisory body to the State Water Pollution Control Commission during development of water quality standards for interstate streams in Colorado.

The Committee on Liaison with State Agencies maintains close contact with all public entities active in water resources development and management. A representative of this committee attends all regular and special meetings of such state agencies, reports to the center, and facilitates exchange of information.

The center plays a significant role on the University campus, coordinating the academic programs dealing with water resources. The Committee on Education reviews new course and curriculum proposals with a view to strengthening the course content or making the programs more widely useful across the campus.

Faculty Improvement Committee

The duties of the Faculty Improvement Committee (FIC) as stated in the CSU Faculty Staff Manual are:

"The Faculty Improvement Committee is composed of faculty representatives. The committee advises on matters of concern to the faculty, including such factors as working conditions, relationships, recognition, advancement, and other matters which may be recommended to improve effectiveness and welfare of the faculty."

In addition, the FIC is responsible for a modest amount (\$54,228) in research funds. These funds are distributed by an ad hoc committee of five faculty members chosen by the FIC for their record in research. These research funds are granted to faculty members who submit proposals to this committee for the establishment of new research projects on the campus. Sixty-three grants were made to 28 departments for fiscal year 1966-67.

The progress reports for these grants, which are on file in the Office of the Chairman of FIC, indicate that the distribution and use of these funds have contributed substantially to the increasing stature of research at CSU.

University Planning Office

The Planning Office is responsible for the funding, programming, design, construction, space assignment, and space utilization of the total facilities program. During the last year the following facilities concerned primarily with development of research and graduate training facilities were either completed and occupied or placed under construction contract:

FACILITY COMPLETED	SPONSOR	AMOUNT
Engineering Research Center Addition	NSF ¹	\$608,350
Atmospheric Science Facility	NSF	315,000
Irradiation Site Facility	NIH ²	30,277
Radiation Environmental Stresses Laboratory	NIH	179,518
600 Dog Pens	NIH	100,083
700 Dog Pens	NIH	181,158
Mathematics Addition	HEW ³	208,000
UNDER CONSTRUCTION:		
Social Science	HEW	1,745,000
Microbiology	HEW	335,000

¹National Science Foundation

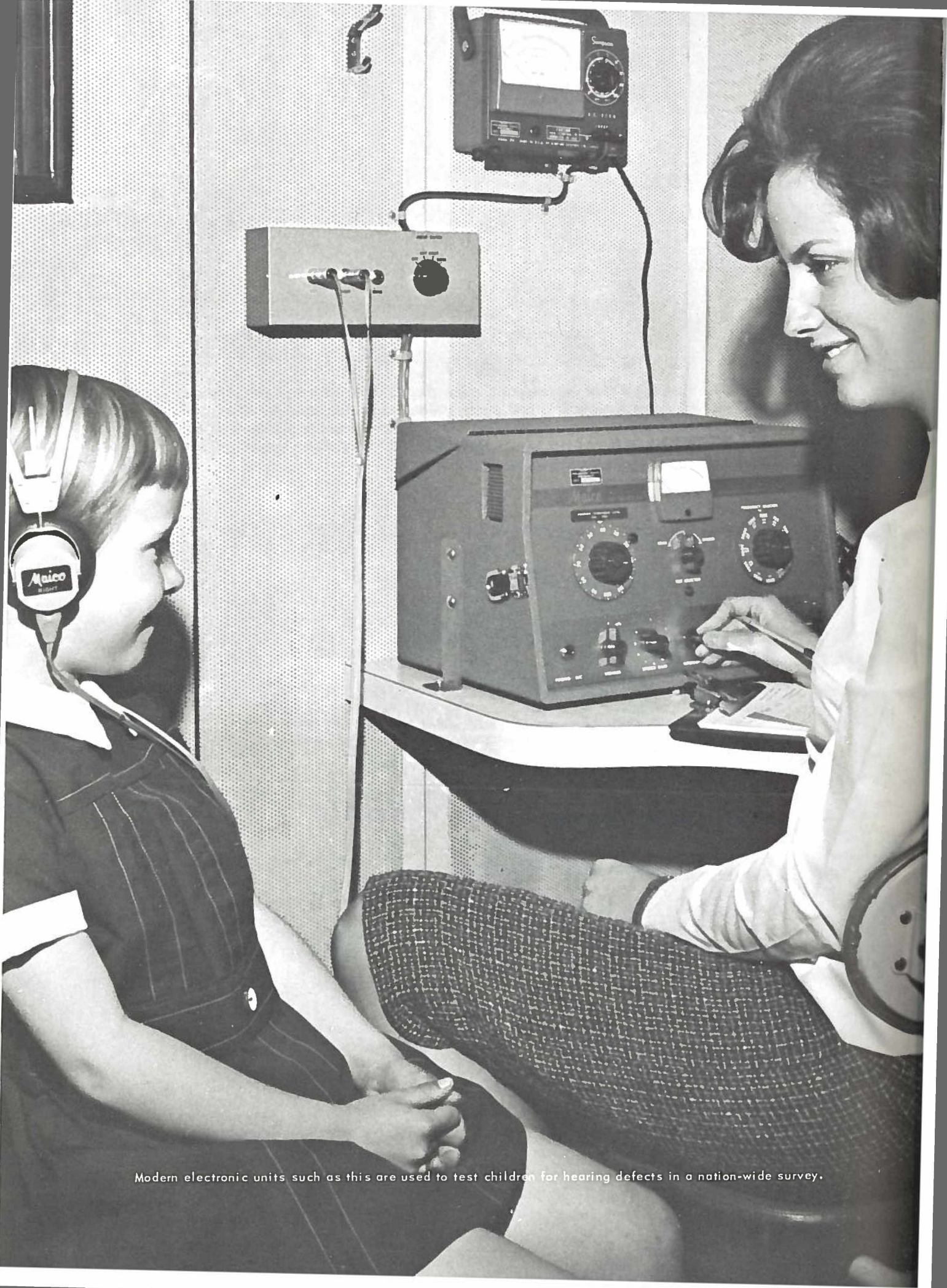
²National Institutes of Health

³Health, Education and Welfare

In addition to the construction program responsibilities the Planning Office works with departmental and administrative committees in developing proposals for additional research facilities and related research grant proposals. It also supervises facilities grant funds and administers proceeds from Research Foundation revenue bonds.

In the last year proposals resulted in (1) construction of a Communicable Disease Center Ecology Laboratory to house a Public Health Service research unit, \$1,300,000; (2) installation of an underground irrigation system for the main campus, \$470,000; and (3) purchase of a research farm, \$200,000. Negotiations are presently under way for other such bond issues.

The University's present strong orientation to the upper division graduate training and research endeavors is reflected in a Five Year Program that calls for a 110 percent increase in existing research space.



Modern electronic units such as this are used to test children for hearing defects in a nation-wide survey.

RESEARCH ACHIEVEMENTS

Agricultural Engineering Advancements

Two advancements of importance and interest to the Colorado agriculturist have recently been developed at CSU.

Two years of work by R.D. Barmington have resulted in development of an onion topper capable of satisfactorily handling onions of the type grown in the Arkansas Valley. The machine adequately topped 98 percent of the onions in a test under conditions which were typical for that area. Incorporation of the topper with other harvester components will be completed for field use in 1968.

The center-pivot sprinkler system for irrigating squares of 160 acres has become very popular because of its effectiveness on undulating land and its labor-saving features. A study of such systems by Dale F. Heermann has resulted in the development of a mathematical model of the center-pivot

sprinkler system. This model makes it possible to simulate and analyze the operating characteristics of the system. The effect of changes in sprinkler head size, pipe size, rotation speed, pressure, or discharge, for example, can be easily studied on a computer using the mathematical model.

The first significant study using the computer model involved the problems of water application. It was found that, although the depth of water application is reasonably uniform over the area served, the rate of application varies greatly from the center to outside radius. Over the outer one-third of the radius, the application rate usually is much higher than the infiltration rate on the soil. This situation results in runoff loss and in some cases soil puddling. The computer model is now being used to study alterations designed to correct this characteristic of the system.

A New Interpretation in American History

Standard historical monographs on the antislavery movement, written in the late 19th and early 20th centuries, portray abolitionists and other antislavery Americans during the pre-Civil War era as humanitarians who sought to eradicate slavery because they considered it the outstanding evil of American society. An article published by Professor Eugene H. Berwanger of the Department of History questions the totality of this former thesis.

In that article, "Western Prejudice and the Extension of Slavery," Berwanger suggests that many antislavery Americans were motivated by their prejudice against Negroes.

In researching the question, Berwanger traced the evolution of anti-Negro legislation in the Old Northwest (as Illinois, Indiana, Ohio, Wisconsin, and Michigan were called) and in the western areas of California, Oregon, and Kansas. He reveals that many political officials and legislators who advocated the abolition or the restriction of slavery to the South also were influential in securing adoption of anti-Negro legislation in their own states or territories. James H. Lane of Kansas and George H. Williams of Oregon, for example, not only objected to slavery but equally objected to Negroes having the right to vote, attending public schools with white children, serving in state militias, or taking advantage of poor relief laws.

Extreme opposition to the spread of slavery into the western United States developed during and following the Mexican War. While such opposition was to be found throughout the country, it gained strength in the Old Northwest and in the newly settled territories of California, Oregon, and Kansas.

One might naturally assume that resistance

to the expansion of slavery would encourage a benevolent attitude toward the Negro race. Berwanger finds the opposite to be true. Although people in the Old Northwest began to accept the dogma of antislavery groups, they approved enactment of discriminatory laws against Negroes.

Articles in the revised Illinois Constitution of 1847 and the Indiana Constitution of 1851 gave the legislatures of these states the right to prevent the immigration of Negroes. In Illinois this article was approved in a popular referendum by a vote of 50,261 to 21,197, and in Indiana by a vote of 113,628 to 21,873. The Illinois legislature reinforced the article by a law in 1853 which punished Negroes who moved into the state and remained for 10 days. A similar situation was found in Kansas. Here, the Free-State group not only demanded that Kansas become a free state but incorporated in its Topeka Constitution a clause excluding Negroes as members of Kansas society. This clause was approved by a vote of 1,187 to 453. In 1859, when the people of Oregon accepted the state constitution, they rejected slavery but also approved the exclusion of Negroes by a vote of 8,640 to 1,081.

Throughout the article Berwanger supports his views with pertinent quotations from a wide variety of contemporary sources: official documents, newspapers, memoirs, and journals.

Berwanger does not completely deny the humanitarian thesis of previous historians. Nevertheless, he interjects the importance of prejudice against Negroes into the antislavery movement. In summarizing his interpretation Berwanger concludes:

"The majority of the people in the Old Northwest and the western territories were not abolitionists. They had little or no de-

sire to interfere with slavery where it existed. As firm believers in the concept that each state should control its own institutions, they abhorred abolition principles. Yet, they opposed the extension of the bondage system in their own states. Various reasons, including racial prejudice accounted for this. If 79.5 percent of the people of Illinois, Indiana, Oregon, and Kansas voted to exclude the free Negro simply because of their preju-

dice, surely this antipathy influenced their decisions to prohibit slavery within their states. At least George W. Julian, the well-known militant abolitionist, thought so. At a Fourth of July celebration in the small hamlet of Raysville, Indiana, in 1857, he described the antislavery expressions of some of the people as 'superficial and sickly' because they were based on a 'a perfect, if not supreme hatred' of the Negro."

Bovine High Mountain Disease

That domestic cattle breeds have difficulty in adapting to high altitude has been recognized for years through their development of high mountain or brisket disease. This non-infectious disease, occurring in cattle residing at high mountain altitudes, is characterized by high pulmonary (lung) arterial blood pressures and gradual failure of the right side of the heart, which pumps blood through the lungs.

The disease has been recognized in the high mountain valleys of Colorado since the end of the 19th century. There is some evidence it was present even earlier, in the cattle of the Spanish Conquistadores during the South American expeditions of the 16th century. In modern literature, the first report pertaining to this disease was made in 1915 by Glover and Newson of CSU. For the past decade the disease has been under study by Drs. A. F. Alexander and D. W. Hill of the Departments of Pathology and Physiology. Although much has been learned, many facets of the problem remain unknown.

Bovine high mountain disease is recognized not only in the Rocky Mountains of North America but also in the Andes Mountains of South America. Although most

cases develop in animals living at altitudes above approximately 7,000 feet, an occasional individual living under 6,000 feet is affected. The overall incidence of the disease is estimated to be between 0.5 and 2% of the cattle residing above 7,000 feet, with a direct relationship existing between altitude and incidence. All ages and both sexes are affected, although in Colorado higher incidence is seen in animals under one year of age. The occurrence of the disease also appears to be higher in animals newly imported into the high altitudes than in native animals. In Colorado there is a further definite seasonal variation with the occurrence being highest in the fall, winter, and early spring; development of clinical cases frequently is noted after a period of inclement weather.

Clinical signs in an affected animal include swelling in the brisket area, pulsation of the jugular vein, and, frequently, a profuse fluid diarrhea. The animals tend to show labored breathing and upon forced exertion may collapse and die. Removal of affected animals to lower elevations results in spontaneous clinical recovery in approximately 50 percent of the cases. Autopsy re-

veals that affected animals have an accumulation of large amounts of fluid in the body tissues and cavities, along with other changes characteristic of right-heart failure. Microscopic examination of the lungs reveals an increase in thickness of walls of the small pulmonary arteries.

CSU research has demonstrated that normal cattle taken from a low to a high altitude develop an increase in pulmonary arterial pressure. This apparently is due mainly to increased resistance to the flow of blood through the lungs. The magnitude of this increased pressure—pulmonary hypertension—varies. The normal average pressure in cattle at 5,000 feet is 25-30 mm of mercury; in some animals moved to high altitudes only moderate pulmonary hypertension develops (average 40-50 mm of mercury), while in others the pressure continues to rise with time, reaching average values of 75-110 mm of mercury.

The evidence shows that the high altitude-induced pulmonary hypertension, and thus high mountain disease, appears to be directly related to the lower levels of oxygen in the air at these elevations. The manner and mechanism whereby the low atmospheric oxygen influences the pulmonary vessels is not known. Initially the stimulus appears to constrict the pulmonary arterioles. The small vessels may, in turn, thicken. In some instances resistance to blood flow through the lungs, with resultant pulmonary arterial pres-

sure, will continue to increase until the right side of the heart begins to fail and the animal develops the clinical signs of high mountain disease.

Why one animal may develop severe hypertension and another only moderate hypertension is unknown. There have been indications that an animal's genetic makeup may play an important role in its susceptibility to the disease.

For the past three years the genetic hypothesis has been under intensive study at CSU. Two genetically different groups of cattle, based on the members' susceptibility or resistance to the development of severe pulmonary hypertension and/or congestive heart failure at high altitude, have been established as parent breeding stock. Susceptible animals are those not necessarily native to high altitude which developed uncomplicated high mountain disease at altitudes of 8,000 feet or higher. Resistant animals are those that were raised and resided, with low pulmonary arterial pressure, at altitudes greater than 9,000 feet. Second generation calves of these parent groups have been studied extensively in the CSU altitude chamber and during prolonged exposure to natural mountainous environment. Although these studies are still in progress results to date indicate the two groups of calves may differ in responses and ability to adapt to mountainous environment.

Cattle Nutrition Research

Among factors influencing the rapid development of Colorado's cattle feeding industry is the beef cattle nutrition program in CSU's Department of Animal Science.

Within the last decade Colorado has become one of the leading cattle feeding states in the nation, a development which has also contributed to such related industries as

packing and meat processing, banking, and transportation.

Each cattle feeder tries to produce high quality beef as economically as possible. Proper nourishment for the cattle is essential to this objective. Research has established many of the important nutrients and how much of them is required. The common feeds, such as grains, can provide an abundance of certain nutrients. Since energy (calories) is the nutrient required in abundance by feedlot cattle and grains are used for this purpose, considerable attention has been given recently to the processing of grains.

CSU researchers were initially responsible for a new method of preparing flaked corn. When corn is processed carefully to produce an excellent "flake," feedlot cattle require about 10 percent less food to produce the same amount of gain as cattle which are

fed the conventional cracked or ground corn. This could conceivably mean a savings of over \$4 million per year in Colorado if all feedlot cattle were fed flaked corn or milo.

Other means of preparing grains for feedlot cattle have been and are being investigated. High moisture or reconstituted grains are ensiled to increase the nutritive value of the feeds.

The beef animal is not as efficient as might be desired in converting raw materials, such as grain, silage, or hay, into edible meat and by-products. Nevertheless, strides have been made to improve efficiency of production. Electronic devices are being improved for use on animals and in the feedlot equipment to measure such things as frequency of feeding and choice of feeds or supplements. These further experiments will help make cattle feeding an even more scientifically oriented business.

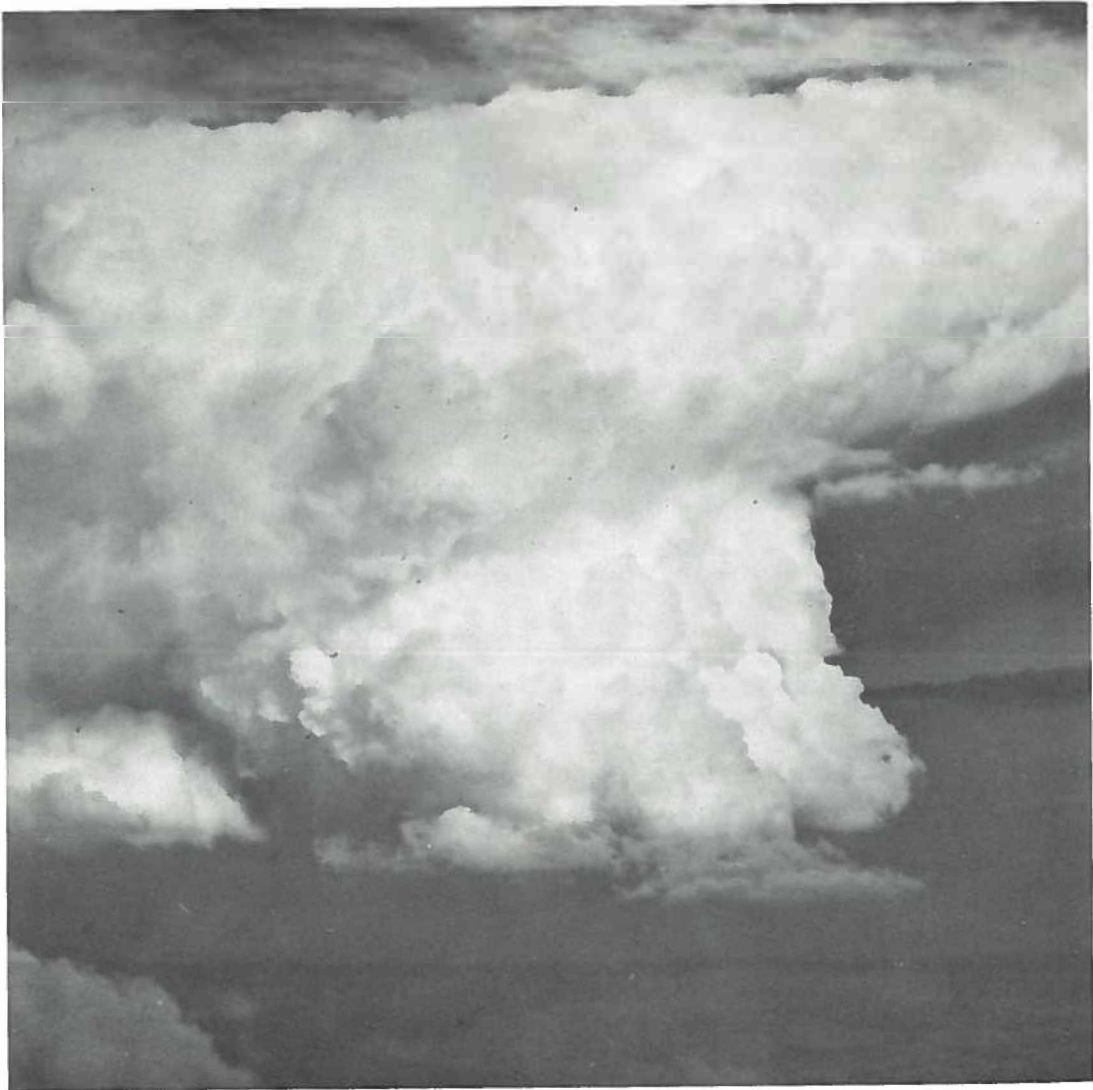
Cumulus Cloud Influence on Environmental Air Flow

Vertical momentum transfers, rainfall, and condensation heat by cumulus up and down drafts have a highly variable and often very significant effect on surrounding wind conditions and future weather patterns. Under National Science Foundation (NSF) and Environmental Science Services Administration (ESSA) sponsorship, William M. Gray and a number of his graduate students have been studying these influences from a variety of viewpoints.

The cumulus cloud is established by the convergence of low-level (below 1 km.) winds. This convergence is greatly affected by variations of surface frictions. These fric-

tional variations are being studied at several locations. At one such location, the Line Island Region of the Central Tropical Pacific Ocean, the Department of Atmospheric Science participated in an NSF-sponsored field program in March and April of 1967. A Department of Atmospheric Science Project Report (No. 116) titled "A Statistical Study of the Frictional Wind Veering in the Planetary Boundary Layer," by B. R. Mendenhall, describes some of this work.

Flight data from research aircraft flying into tropical storms having intense cumulus activity are also being analyzed. It has been shown that the vertical momentum transfers



"Pretty as a picture," these cumulus clouds have a big effect on our wind and weather patterns.

by the cumulus have a variable but often highly significant effect on the surrounding air flow.

Since the tropical storm requires distinctive flow and cumulus activity, environmental air flow conditions and cumulus activity associated with development of these storms are under investigation. The environmental wind conditions associated with tornado development are also being studied. The development of both the tornado and the

tropical storm requires intense cumulus activity, but the surrounding air flow conditions are very different. Tropical storms require a minimum of zero troposphere wind flow, while the development of tornados requires very intense vertical wind shear in the lower half of the troposphere.

The dynamics of the interaction of cumulus clouds with their environmental air flow is a subject that must be much more fully understood before global weather analysis and forecasting can become a reality.

Dietary Fats and Ketosis

The body uses various kinds of food fats in various ways. Dr. Jacqueline Dupont, of the Department of Food Science and Nutrition, is studying the development of ketosis when a high percentage of the diet is fat. Ketosis is a condition which results when the body can't use the available fat fast enough and "ketone bodies" accumulate in the blood. Ketosis commonly occurs in diabetics; it also occurs when the body is using a large amount of fat (as in starvation) or when an excessive amount of fat is eaten.

In this study, rats were fed diets containing 75 percent of calories as beef tallow or

corn oil. The diets contained excessive amounts of these fats and would have been quite unpalatable to man. Using radioactive tracers, the ketone bodies were followed throughout their metabolism. Both groups of rats were able to use the fats for energy at a very rapid rate, but rats eating beef tallow accumulated "ketone bodies" in their blood while those fed corn oil did not. This means that there is some basic difference in the way the two fats are used for energy. Dr. Dupont is trying to find out what that difference is.

Electric Sign Industry Study

A CSU College of Business research team has completed the first major comprehensive investigation and analysis of the electric sign industry in the United States.

This project began in 1966 when the National Electric Sign Association commissioned the research team to conduct an economic, historical and statistical analysis of

the electric sign industry. The team was composed of Drs. Harvey L. Vredenburg, C. Robert Patty and Forest C. Carter.

Team members visited and studied the operations of individual companies, both custom and mass producers, from coast to coast and from Texas to Minnesota. The team also discussed industry problems with past and present customers, suppliers and component part manufacturers, capital suppliers from both banks and loan agencies, advertising agency people, public relations firms, architects, lawyers, designers, labor union officials, city planners, and other government officials at city, state and federal levels.

Specific objectives achieved in this pioneering study are enumerated below:

1. Development of statistical information on the composition and economic significance of the industry.
2. Preparation of a factual description

of the historical development and current position of the industry.

3. Definition of major managerial, operational and legal problems peculiar to the industry.

4. Development of a professionally recognized and authoritative body of knowledge of the industry and its operating practices.

5. Development of foundation research information for use in subsequent study of specific problems, in order to spawn new concepts, recommendations, and new horizons for the industry.

6. Discovery of new avenues for developing increased professionalism within the industry.

The information gathered from these investigations was assimilated, analyzed, and published in a full-length book bearing the title, "A Historical, Economic and Statistical Study of the Electrical Sign Industry."

Electroanesthesia

Electroanesthesia is a state of unconsciousness and analgesia produced in an animal or man by passing an electric current through the brain. The advantages of electroanesthesia are: (1) instant recovery of the patient when the current is turned off; (2) high toleration by patients who are poor surgical risks; and (3) economy.

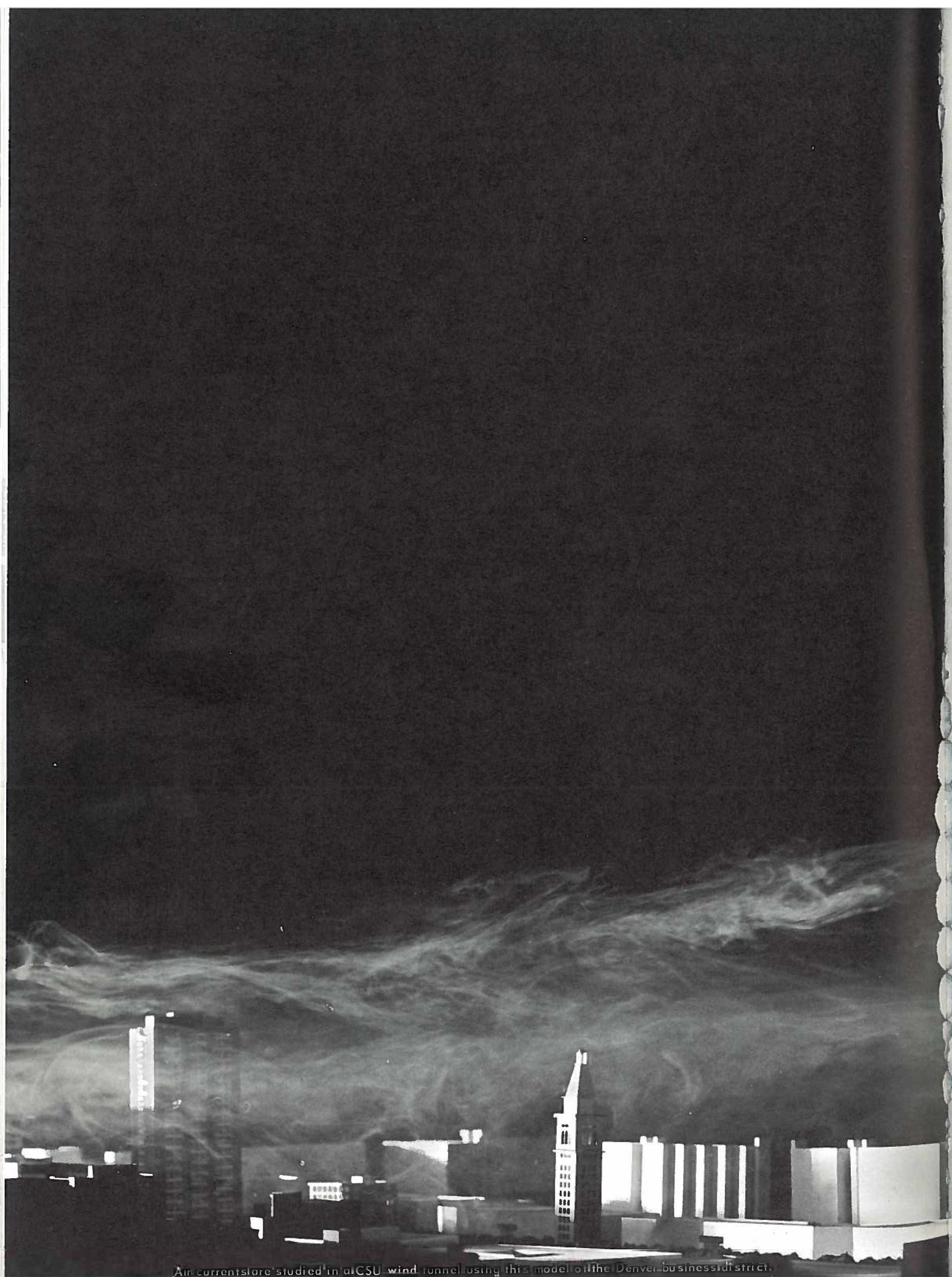
Various types of electrical stimulation such as direct current, alternating current, and combinations of the two, including various wave forms and frequencies, have been used by Drs. Reginald A. Herin, David R. Metcalf and Robert E. Edgar to produce anesthesia in dogs. They found that an al-

ternating current of 50 to 80 milliamperes at 2000 cycles per second produces the most effective anesthesia. In another study, now in progress, they are attempting to determine just how electricity produces anesthesia in the brain.

Although electroanesthesia has been used in numerous human patients throughout the world, the results obtained have been inconsistent. Further research is therefore required before this method of anesthesia can be used routinely in human medicine. The results of the present study being conducted by research scientists here at CSU may help to shorten the delay in its routine use in man.



This pressure chamber may help man find new ways to fight high altitude diseases in cattle.



Air currents are studied in a CSU wind tunnel using this model of the Denver business district.

Environmental and Structural Aerodynamics

The Fluid Mechanics Program of the College of Engineering has pioneered in the design and extended use of wind tunnels for basic research on winds in the lower atmosphere, and effects of wind on man's earth-based activities.

Thermal and flow controls in the Army meteorological wind tunnel permit close simulation of mean wind and turbulence characteristics, for a wide range of inversion and lapse conditions. The wind-over-water tunnel allows simulation of water wave interaction with the atmosphere.

A new environmental wind tunnel, having a test section 8 by 12 by 60 feet, will allow close simulation of air flow over urban areas. This will make it possible to study air pollution problems and problems of structural and architectural design. Basic research on turbulence and turbulent diffusion in the Fluid Dynamics and Diffusion Laboratory continually reveals new facts about the fluid mechanics of shear layers. This knowledge has permitted the confident use of these flows as realistic model winds in many important applications.

Recent research into environmental problems includes a study for the Navy of stably stratified flow and the transport of contami-

nants by the atmosphere. The only practical method of making a study of this type was to construct a 1:12,000 scale model of Point Arguello in a wind tunnel. This same technique can also be adapted for air pollution studies in urban areas, and studies of air motion for purposes of weather modification.

A current study of air flow over San Bruno Mountain near San Francisco illustrates the use of aerodynamic models in planning engineered environments. This study will result in several terrain modifications which can be achieved by excavation to alter wind currents.

Simulated winds, created in special wind tunnels, permit realistic studies of gust pressures and wind forces on tall and flexible structures. As the complexity of large cities increases, the need for laboratory studies of this kind becomes more urgent. No other methods exist to predict what wind conditions are likely to be.

The research group responsible for these studies includes Dr. J.E. Cermak, Professor-in-Charge, and Drs. E.J. Plate, V.A. Sandborn, W.Z. Sadeh, R.N. Meroney, J. Ostrowski, and E.C. Nickerson.

Field Crop Breeding

Efficient field crop production demands continual search for new and improved varieties to meet consumer and processor demands. During the past few years identification of superior germ plasm has made possible the release of a number of improved crop varieties through the Department of Agronomy's plant breeding and evaluation program. Included were two grain sorghum restorer lines which are parents of three hybrids (Colorado 585, Colorado 604, Colorado 606) and a silage corn hybrid (Colorado 400S).

As a result of cooperative regional and national studies conducted in many areas of the state, 14 new crop varieties have been released and recommended for production because of their superior yield, quality, and other agronomic characteristics. They include wheat (Scout, Warrior, Lancer, Gaines, Crim), barley (Wocus), oats (Russell), dry beans (Idaho 114), alfalfa (Uinta and Cody), and grasses (Jose tall wheatgrass, Oahe intermediate wheatgrass, Luna pubescent wheatgrass, and Latar orchardgrass).

In addition, a new corn variety, two new wheat varieties, and a new millet variety were released in 1967 for production in the state in 1968. Phillips 67, a new synthetic corn variety adapted to dryland conditions in northeast Colorado, combines the desirable characteristics of hybrids with those of open pollinated varieties. This variety has been shown to yield 11 percent more than Phillips County Yellow Dent, an open pollinated variety, and nearly as well as the

best hybrids tested in the area. It has a more dependable year-to-year performance than hybrids, yielding better than hybrids in unfavorable growing seasons and nearly as well as hybrids in favorable years. Its seed is less expensive since the grower can save seed for future planting as is done with open pollinated varieties. Dr. D.W. Crumpacker produced this variety by combining, as a synthetic, six out of 125 lines previously developed by the Experiment Station from Phillips County Yellow Dent during the period 1958-63.

Two new varieties of hard red winter wheat (Trader and Trapper) are being released jointly by the Colorado and Nebraska Experiment Stations for production in 1968. These varieties are high yielding, stem-rust resistant, and have excellent milling and baking quality. These lines, developed in Nebraska, have been intensively investigated under Eastern Colorado conditions by Dr. B. C. Curtis. They are as good as Warrior in yield and quality and also have the advantage of being resistant to stem rust which periodically reduces yields.

A selection of a foxtail type millet developed by David Deschamps, a farmer in eastern Colorado, has been purified and evaluated by G. O. Hinze. This selection matures much earlier than, and is superior in yield to, other varieties now grown. This variety, named Wray, was recommended for production in 1968. Seed supplies have been increased and seed stocks will be maintained for release through certified seed production channels.

Fresh Meat Color

A problem frequently encountered in marketing prepackaged meat is that it turns brown. This makes it unacceptable to the consumer, which in turn results in considerable economic loss to both the retail merchant and the homemaker.

It has also been found that this brown pigment, metmyoglobin, catalyzes oxidation of the unsaturated fatty acids in meats. This results in off flavors in the cooked product. In addition, there is evidence that the oxidizing fat may speed destruction of the heme pigments, which include both the red and brown pigments, causing further discoloration.

The addition of a commercial antioxidant to meat protects the flavor and in addition appears to protect the color. Work by Dr.

Barbara Greene, of the Department of Food Science and Nutrition, is concerned with comparing loss of heme pigment with degree of oxidation. Although this work is in its initial stages, there is evidence that such a relation exists, since samples containing an antioxidant also contained more total pigment.

Methods of measuring myoglobin are also being tested. Myoglobin is the primary muscle pigment, although hemoglobin is also present in small quantities. There is evidence that hemoglobin and myoglobin may react differently in meat. Therefore, the proportions of the two pigments present in the muscle may have an important bearing on the retention of color in meat.

Grass-Alfalfa Mixtures

Pasture studies conducted by the Range Science Department at the Eastern Colorado Range Station have proved conclusively the following benefits of including alfalfa in mixtures with both cool and warm season grasses when seeding high-plains ranges:

Intermediate wheatgrass-alfalfa pastures produced an average of 51 percent more forage, had 67 percent greater carrying capacity when spring drouths were not a problem, and gave 21 pounds greater seasonal gain per head than did intermediate wheatgrass pastures without alfalfa.

Beef production averaged 25.5 pounds per acre for intermediate wheatgrass pastures, 44.4 pounds for intermediate wheatgrass-alfalfa pastures, and 38.5 pounds for native range on comparable sandy soil.

Intermediate wheatgrass, used as the cool-season grass, had high seedling vigor which produced quick stands and was the preferred forage species in early season. However, it proved susceptible to spring drouths and had little grazing resistance.

Warm season grasses (blue grama, side-

oats grama, and sand lovegrass) seeded with alfalfa produced 93 percent more forage in 1965 than similar blocks without alfalfa.

Heifers grazing these stands spent from two to three times as long on those blocks with alfalfa as on the blocks of pure grass.

Guided Acoustic Waves

The nature of echoes produced when an acoustic pulse strikes an elastic object is significant in the development of several fields such as mine and submarine detection and non-destructive testing. The echo structure can be quite complicated for even the simplest elastic configuration, such as solid spheres and cylinders. To understand the nature of these echoes, a systematic search must be undertaken to separate echoes arising from different parts of the elastic "target."

The acoustics group in the Department of Physics, under the direction of Professors Ralph R. Goodman and Samuel W. Marshall, has developed both a theoretical technique and an experimental method of separating certain important components of the total echo.

The most recent contribution of the acoustics group is the discovery of a method to separate a class of echoes arising from what are called circumferential waves. This class of acoustic waves was shown to exist by a mathematical analysis and it was shown that it is possible to create a type of acoustic wave which travels along the surface of a target. As the wave travels, it radiates acoustic energy into its surroundings, giving rise to a part of the echo. The special nature of the way these waves travel on the surface made it necessary to devise a method of cre-

ating them without exciting other types of waves. Experimentally it was then found that this is possible if the acoustic wave strikes the target at special angles and in special areas of the target's surface. This method has been applied primarily to cylinders. The presence of the circumferential waves is detected by a sensitive acoustic receiver. Experiments are carried out in a tank nine feet in diameter, filled with approximately five feet of water. The acoustic sources, targets, and receivers are all immersed.

Recently, one type of circumferential wave has been observed to go around a solid aluminum cylinder as many as thirteen times. The oscilloscope photograph of the echoes from this wave shows each pulse representing the echo produced by one circumnavigation of the wave. From these photographs the speed and rate of radiation of acoustic energy can be measured. These results are then compared with the theoretically calculated properties of these waves for verification of the theory. The type of circumferential wave studied is analogous to an important type of seismic wave observed after earthquakes, known to geophysicists as a Rayleigh wave.

The work described above is sponsored by the Office of Naval Research. It has led to other projects at Colorado State University, such as laser-produced acoustic signals.

Leaf Analysis

The leaf analysis method for determining nutrient needs of Colorado fruit trees is now feasible because of a nine-year Department of Horticulture study by Dr. Ewell Rogers at the Western Slope Branch Station. (Recommendations based on leaf analysis research conducted in other parts of the country are not applicable to Colorado orchards).

Dr. Roger's study involved years of surveying growers' practices, including rates and kinds of various fertilizer applications on experimental orchards and subsequent correlation with yields and fruit quality. Analysis of this sort is complicated by the fact

that fertilizer applications to fruit trees frequently do not produce yield and quality differences until some years later.

A 1967 leaf analysis survey taken from 420 fruit trees in orchards of 53 growers revealed that 77 percent of the trees were deficient in zinc, 57 percent in iron, 10 percent in manganese, and 4 percent in potassium. Apples, pears, cherries, and prunes were among the fruits surveyed. Since 1957, over 11,000 leaf samples have been analyzed chemically to develop methods of interpretation necessary to make analysis helpful to the grower.

Man-Machine Systems

Within the concept of man and machine working together (Manned Missions) to solve problems and achieve goals, it is necessary to consider man as a sub-system or component part of the total system. The problems of this relationship between man and machine are being investigated by CSU's Mechanical Engineering Department.

Machines function in predictable pre-determined ways. Man's performance, on the other hand, is limited by his physiological and mental condition and capacity. Moreover, man has proved to be an unreliable judge of his own capacity, often exerting himself to the point of critical exhaustion in an heroic spirit.

To analyze manned missions, computer programs based on modern network theory

have been developed. These programs can determine whether total systems (a 20-man astronaut team for example) can accomplish a given goal, and redesign the system to meet new problems.

Some method of measuring man's capacity to perform physical tasks was required. Experiments were initiated, and it was determined that a man's physical work output is directly proportional to his rate of heart beat. This makes it possible to keep a continual record of each crew member so that his reserve of work capacity can be counted as part of the entire system's operation.

Experiments are now being conducted to find a similar measurement of man's capacity to do mental chores.



A variety of prickly poppy, found in Colorado as a weed, has new value as a medicine.

National Speech and Hearing Survey

Since 1965 the Department of Hearing and Speech Science has been developing a method to survey a sampling of school-age children in the United States. The survey method is designed to provide an estimate of the prevalence of speech and hearing disorders in public school children in grades 1-12.

A stratified national sample of 40,000 subjects was drawn from a modified sampling frame of over 40,000,000 school children enrolled in public schools throughout the United States. This sample will serve as the population to be surveyed.

Six 27-foot-long mobile units, with four survey team members assigned to each, will travel in predetermined regions of the United States to collect speech and hearing behavior data on the 40,000 subjects located in the sample schools. A total of 135 school districts will be surveyed. In addition to the

24 survey team members working in the field, seven members of the central office staff are located at CSU. Dr. Forrest M. Hull is project director and Dr. Roy J. Timmons is the research coordinator.

At present one survey team is screening 22 sample school districts in seven Rocky Mountain states. Collection of data on the sample of 40,000 subjects will begin in October, 1968.

All data are stored and analyzed by the statistical laboratories at CSU.

It is anticipated that results of the survey, which is supported by the U. S. Office of Education, will yield prevalence figures useful in planning professional training programs, as well as services for speech and hearing handicapped school children in the nation.

Native Plants as a Source of Medicinals

The prickly poppy, a two- to four-foot thorny plant with large white blossoms, grows as a noxious weed along the Front Range of the Colorado Rockies from Boul-

der to the Wyoming border, and in southern Colorado. Dr. F. R. Stermitz, Department of Chemistry, reports that chemical analysis of the plant shows it contains several new alka-

loids, complex natural compounds often found to have medicinal value. The isolation, purification, and proof of molecular structure of these interesting substances has provided important chemical knowledge regarding the manner in which plants are able to produce such compounds.

Perhaps of more importance, these new alkaloids have been found to possess both analgesic (pain-killing) properties and the ability to stop variations in the rhythms of the heartbeat. These are the first compounds to be discovered which have both types of medicinal action within the same substance. The analgesic testing was done by the National Institutes of Health in Bethesda, Maryland; the heart activity tests were performed at the University of Oregon Medical School in Portland, Oregon. Testing has as yet been done only in animals; whether these results will be applicable in humans is not known.

In addition to having been isolated from the prickly poppy, the alkaloids have also been synthesized in the laboratory. This has

been done in order to modify the chemical structure of the compounds in a search for increased physiological activity.

Of the three distinct species of prickly poppy (the genus *Argemone*) which occur in Colorado, only one contains alkaloids which have promise of useful medicinal action. Although alkaloids have been isolated from the two prevalent species in the close neighborhoods of Fort Collins and Boulder and in southern Colorado, these alkaloids proved to be devoid of physiological activity. It is the somewhat more restricted species which grows in an area from several miles north of Fort Collins to the Wyoming border, which contains the active compounds. Other sources of these potentially useful alkaloids are the poppies of Wyoming, Nevada, Arizona, and Mexico, but they do not occur in any other parts of the world. Because of the discovery of a unique relationship of alkaloid content with botanical class, possible additional valuable poppy species among the many occurring in Mexico have been pinpointed and await chemical analysis.

Poisonous Snakebite

Human beings have traditionally, and with cause, been fearful of and puzzled by the violent action of venoms from poisonous snakes. The amount of venom injected by these creatures is usually very small, but in many cases the results are fatal. The effects of a poisonous snakebite result from the combined effects of complex protein components present in the venom. Systematic scientific study of snake venoms, emphasizing the physiological and drug-like actions of the

venoms, was begun about 30 to 40 years ago. But only recently have many scientists intensified their investigations of the chemical nature of snake venoms.

Snakebites are a serious problem in many parts of the world. In North America, including Mexico, 300 to 500 people die annually from snakebite. In the United States an estimated 2,000 to 3,000 individuals are bitten each year by rattlesnakes (*Crotalus*) and copperheads and water moccasins (*Ag-*

kistrodon), resulting in the deaths of only about 15 persons.

In South America, annual snakebite deaths range from 3,000 to 4,000. In southern and southeastern Asia (excluding China) 25,000 to 35,000 succumb to snakebite each year. Since identification of poisonous snakes is hampered by the fact that there are about 2,000 types in a great variety of forms and sizes, a better understanding of snake venom action and of the cause of death would facilitate more effective treatment.

Snake venom research at CSU is done in the Department of Biochemistry by three postdoctoral fellows and five graduate students under the direction of Dr. Anthony T. Tu. Three main projects now are under investigation.

The first project, sponsored by the National Institutes of Health, will determine the chemical properties of snake venom toxins responsible for necrosis and hemorrhage. One of the most striking characteristics of envenomation by snakes of *Crotalidae* (such as rattlesnakes) and *Viperidae* families is the vast amount of hemorrhage and local tissue destruction, which in many cases is not prevented by the use of antivenin. Through extensive use of serum antivenin, the death rate in the United States has been reduced considerably. Thus, the real problem from snakebite here is tissue damage

and the possible disfunction or complete loss of a finger, hand, arm, or other limb.

The second project, supported by the Division of Direct Health Service of Public Health Service, concerns chemotherapy of snake poisoning. Although antivenins are effective they are also highly specific. They thus may in many cases be ineffective for the bites of species widely separated in the phylogenetic tree. Incision and suction are used commonly in the absence of antivenin or as emergency first aid, but the effectiveness of this practice has been the subject of controversy among the experts. Therefore, Dr. Tu's group is trying to develop an effective chemical treatment to replace both the serum treatment and the painful practice of incision and suction.

The third project, supported by the Office of Naval Research, will determine the chemical properties of sea snake venoms. Sea snakes are those serpents which live in oceans, especially along coastlines and in estuaries. Sea snake venoms usually are more toxic than those of terrestrial snakes—sometimes, for instance, as much as 300 times more toxic than copperhead venom. For this project Dr. Tu and his graduate student, Paul M. Toom, went to Southeast Asia and the Far East last summer and collected 2,000 sea snakes. The venom obtained from these snakes is now being characterized at CSU.

Predicting Campground Use

The investment of tax dollars in outdoor recreation facilities demands that responsible agencies have effective methods to determine probable use of those facilities. Lack of such

methods in the past has resulted in overdevelopment of facilities in some areas and underdevelopment in others.

One way to determine probable use of a

proposed recreation area is to compare it with similar areas already in use. It then becomes necessary to know something about the recreation requirements of the people who are likely to use the proposed facilities. Previous studies indicate that a variety of recreational patterns exist within the total population. These patterns often can be explained by such characteristics as age, occupation, and income of persons in the total population. Some recreation sites tend to attract larger numbers of local users than users from outside the area, while the converse can be found in other sites. The physical characteristics of the sites, their location relative to other similar sites or to major recreation areas, and their distance from

major highways are factors which will affect amount of use they will receive.

This Department of Recreation and Watershed Resources study is analyzing the relationship of these factors with recreation visits. Results are organized to permit use of data processing techniques to provide planners with an objective method of predicting, with a high degree of confidence, the amount of recreation use to be expected at potential recreation areas.

This study is a continuation and refinement of one initiated during the summer of 1966. Data were obtained during the summer of 1967 on the kinds and amount of use found in selected campgrounds administered by the Bureau of Land Management in western Colorado and southeastern Utah.

Project Blackout

Today's trend in electrical power system design is toward interconnection of the entire continental United States. The growth of power systems has been and is so rapid that this interconnection should be realized within the next decade. The consolidation of smaller power networks into a vast system has many advantages. For example, power can be shared across time zones to power systems at a peak load from other systems which already have passed their peak demand period.

Customer service reliability is increased since power from some outside region can be made available to a region which has suffered a power failure. The amount of reserve generating capacity necessary to han-

dle forced outages also is reduced as system size increases.

Interconnection also has its disadvantages. System faults are no longer localized effects. They can spread in a complex pattern and cause a chain reaction throughout part or all of the interconnected systems. Since large networks are so complex, the effect of faults can neither be anticipated nor corrected before breakdown and loss of electrical service occurs. The human mind cannot react fast enough nor with enough comprehension to operate or control such a system. Presently, the solution of the stability problem requires approximately three hours of computer time and represents only 60-90 seconds of real time. This period for

solution-finding must be reduced drastically to permit proper corrective procedures to be carried out before breakdown.

The present research in CSU's Department of Electrical Engineering is directed toward development of a mathematical model which is appropriate for use in conjunction with the digital computer. The mathematical model should minimize computer facilities required and maximize speed with which the diagnostic and corrective information is obtained.

Specifically, this research involves the study and solution of a large number of simultaneous algebraic and/or differential equations by digital computations. As a direct consequence of this study, an examination of the desired input information for most effective digital processing is being carried out. Also, the formulation and processing of the system of differential equations to obtain stability criteria is a primary objective. The solution to these problems will help to improve system reliability and prevent major blackouts.

Psittacosis Infections in Cattle and Sheep

Diseases of newborn animals are common but not well understood. During the past two years, the Department of Microbiology has made a concerted effort to identify viral and other infectious agents as possible causes of disease in newborn calves. These studies led to the identification of several disease entities of Colorado sheep and cattle, all caused by a group of specific infectious organisms, classified as psittacosis agents.

These agents have been known for several decades as a capricious cause of disease in birds as well as parrot fever and other diseases of man. The importance of these agents as pathogens in sheep and cattle became clearly evident only during recent years. The psittacosis agents, comprising a large number of antigenically related microorganisms, are of a peculiar nature. They may have had bacterial ancestors, but they grow and replicate now only in living animal cells, thereby causing disease. The same techniques for studying viruses are em-

ployed to study psittacosis agents.

In several herds calves afflicted with enteric disease were examined. Psittacosis agents were isolated from intestinal tracts of a high proportion of these calves. When healthy experimental calves were inoculated with a representative isolate they became sick and died.

These agents also infect cows. In pregnant cows, psittacosis agents have a predilection for infecting the placenta and the developing fetus, which leads frequently to abortion. This disease condition, called epizootic bovine abortion, has occurred in California and other western states. A potentially dangerous infectious disease of cattle was also identified in Colorado, for the first time. Similar intestinal infections and psittacosis-induced abortions can also occur in sheep.

Some calves experimentally given the psittacosis agent had severe inflammation of the joints, a condition called arthritis or polyarthritis. Earlier studies showed that a spe-

cific form of polyarthritis in sheep is caused by psittacosis agents. This disease is widespread in nearly all sheep-raising countries and the causative agent also was identified during the past two years as a cause of polyarthritis epizootics in Colorado sheep.

The research work documenting psittacosis agents as inducing arthritis in animals is acknowledged as one of the most significant recent advances in studies on infectious arthritis. The knowledge gained from investigations of psittacosis-induced arthritis in ani-

mals has enabled other investigators to prove that such agents also are associated with certain forms of arthritis in man.

The CSU investigations described were pioneered by Dr. J. Storz, and were made possible through close cooperation with Dr. K. P. Altera, Dr. R. E. Pierson, Dr. J. R. Collier and Dr. L. C. Faulkner of CSU. Researchers from the University of California, Utah State University and the Southwestern Medical School, University of Texas, also cooperated in phases of these studies.

Radiation Effects on Uranium Miners

The news media have in recent times reported an abnormally high incidence of lung cancer in uranium miners. The resulting high degree of concern about radiation exposures of uranium miners by the U. S. Congress and several federal agencies is a new phenomenon. The problem itself, however, has existed for many years. Under a research contract with the U. S. Atomic Energy Commission, CSU has been investigating the sources of exposures in mines and methods of controlling and evaluating the exposures of individual miners.

The noble gas radon is produced by the radioactive decay of the radium associated with any uranium-bearing ore body. Some of the radon diffuses from the rock into the mine work spaces where it may undergo further decay to form radioactive particles. When the contaminated air is inhaled, some of the radioactive particles are deposited in the bronchial tree, irradiating the cavity lining. A direct correlation between cumula-

tive inhalation exposure and incidence of lung cancer has been observed.

Using a mobile laboratory at an operating uranium mine, the graduate students studying with Drs. Adrian H. Dahl and Keith J. Schiager, Department of Radiology and Radiation Biology, have measured the internal deposits of radioactive mine aerosols. Radiation exposure can be reduced by the use of suitable respirators which are available to uranium mining companies.

Several graduate students are conducting studies of the correlation between the physical characteristics of the mine atmosphere and the amount of deposit in the respiratory tract. Methods of routine monitoring of exposures to individual miners are being developed and tested. Because of the complexity of the problem and the economic importance of uranium mining to this region, a continuing program is predicted for this three-year-old study.

Ruminant Glucneogenesis

Sheep and cattle are both susceptible to ketosis, a disease associated with the termination of pregnancy that is somewhat analogous to diabetes mellitus in humans. However, while diabetes is due to an inability to use carbohydrate that is present, the development of ketosis is due to a lack of carbohy-

rate formation in the body. We are investigating the factors that control and limit carbohydrate formation during various stages of gestation in sheep, goats, and cattle.

Increasing our knowledge of why an animal develops ketosis will increase our ability to institute effective preventive measures.

Seeding Survival and Development

Factors affecting re-establishment of trees on cutover or burned forest areas are being studied in a regional research project among forest scientists in six Western states. The CSU Department of Forest and Wood Sciences, a participant in this program, has been concerned primarily with investigation of field survival of planted tree seedlings.

Lodgepole and ponderosa pine seedlings grown from different seed sources and planted in different locations before transplanting are being observed in a continuing study which started in 1962. Measurements of top and root growth as affected by environmental conditions help evaluate seedling vigor and success of planting.

Root growth obviously is an important factor in the establishment of tree seedlings, but little is known about root development during the months immediately after seedlings are planted. Such studies have been discouraged by the time-consuming and often tedious work of excavating and sketch-

ing the roots of even small trees. The time required to sketch root systems was reduced by about one-half by a technique developed by Lester Pinkerton in a study just completed under the direction of Dr. C. W. Barney. They blueprint the entire root system to show vertical distribution; it still is necessary to sketch the horizontal spread of roots as the seedling is dug out.

Their study shows that roots of recently planted lodgepole and ponderosa pines usually are seriously constricted by the planting hole and fail to develop the long lateral roots characteristic of natural seedlings. Natural seedlings also develop deep penetrating "sinker" roots along the laterals, but "sinker" roots of planted seedlings, if they develop at all, usually originate within the disturbed soil of the planting hole.

Determining whether the apparent abnormalities of the root systems of planted seedlings will affect survival and establishment will be the objective of continuing research.

Sex Lures in Insect Control

With increasing frequency entomologists are investigating potential sex, food, and ovipositional lures of insects to attract and manipulate populations of economic species. Sporadic control of aphids by ladybird beetles is well known, but there is still the problem of artificially inducing predators into infested fields in sufficient numbers to overwhelm insect pests.

Research by Dr. R. G. Simpson and Lonnie Sower, a graduate student, has been directed toward reducing the need for insecticides by using an attractive substance to increase predatory insect populations in selected areas. The attractant in this case is a sex lure—an odor secreted by one sex to attract the other. This odor is produced only by individuals ready for mating. Sex lures are probably the most potent physiological substances known; in some cases it requires only a few hundred molecules to stimulate the male. Each insect species tends to have its own distinctive odor.

The females of two predator beetles (*Collops bipunctatus* and *C. vittatus*) were found to secrete a sex lure from glands on the thorax and abdomen which can be turned

inside out, similar to the pocket on a pair of trousers. Chemical extracts isolated from the glands of females of the two species were found not to be species specific; that is, the sex lure from a female of one species elicited premating responses from males of the other species.

Extracts from the females of *C. bipunctatus* stored for thirty-two days at -23.3°C continued to induce premating responses from the males. Minute glass rods rubbed on the female glands to obtain the natural lure elicited responses from males somewhat better than extracted lures. Clipping various numbers of segments from the antennae and exposing the beetle either to a female or the extracted lure showed that the male antennae act as a "nose" for the beetles; no premating response by males was observed when three or fewer segments remained, but increasingly more response was noted as four or more segments were left intact.

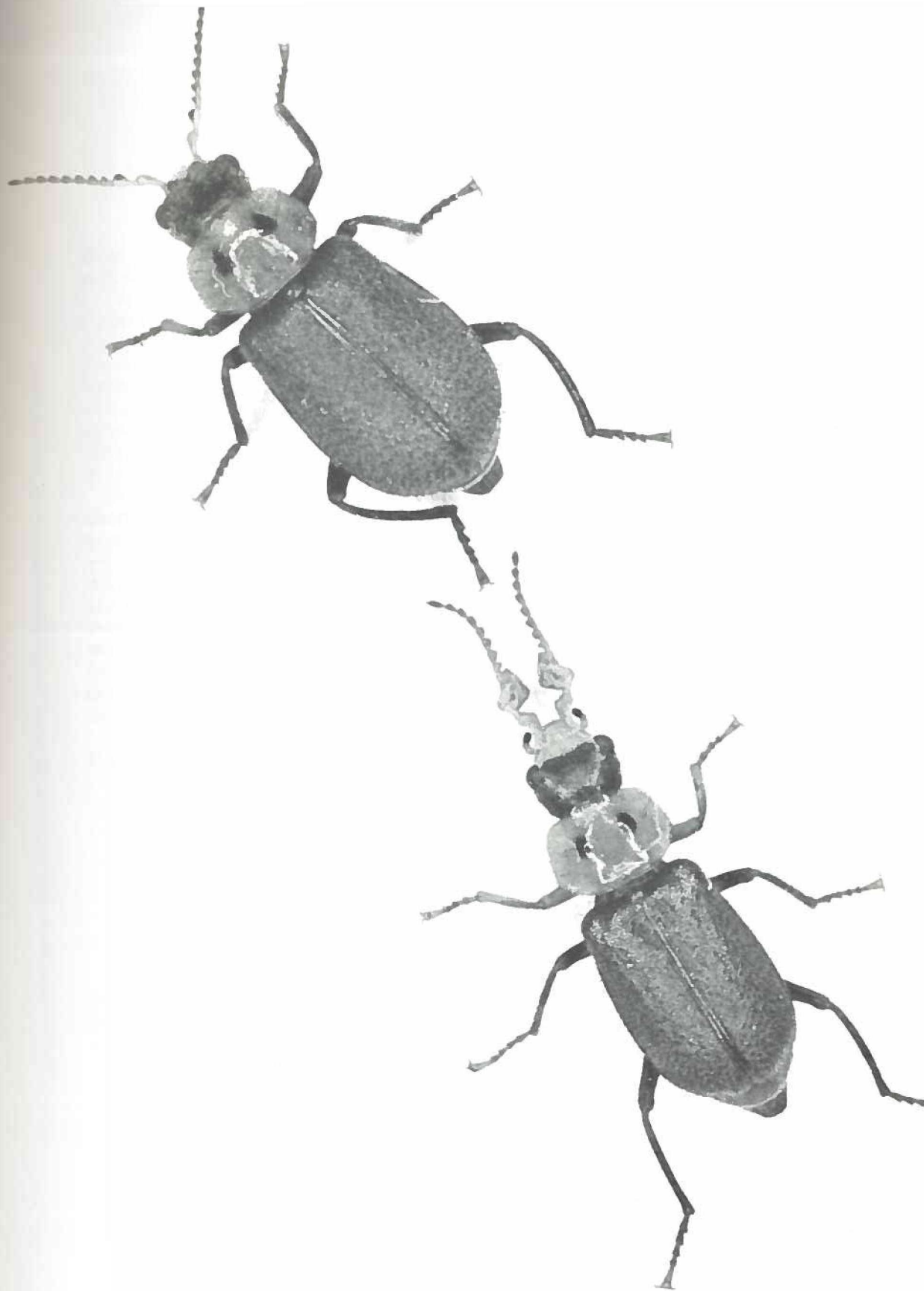
Purification of the crude extracts and field testing remain to be accomplished to learn whether manipulations of large populations will be possible.

Soil Mites and Their Role in Nature

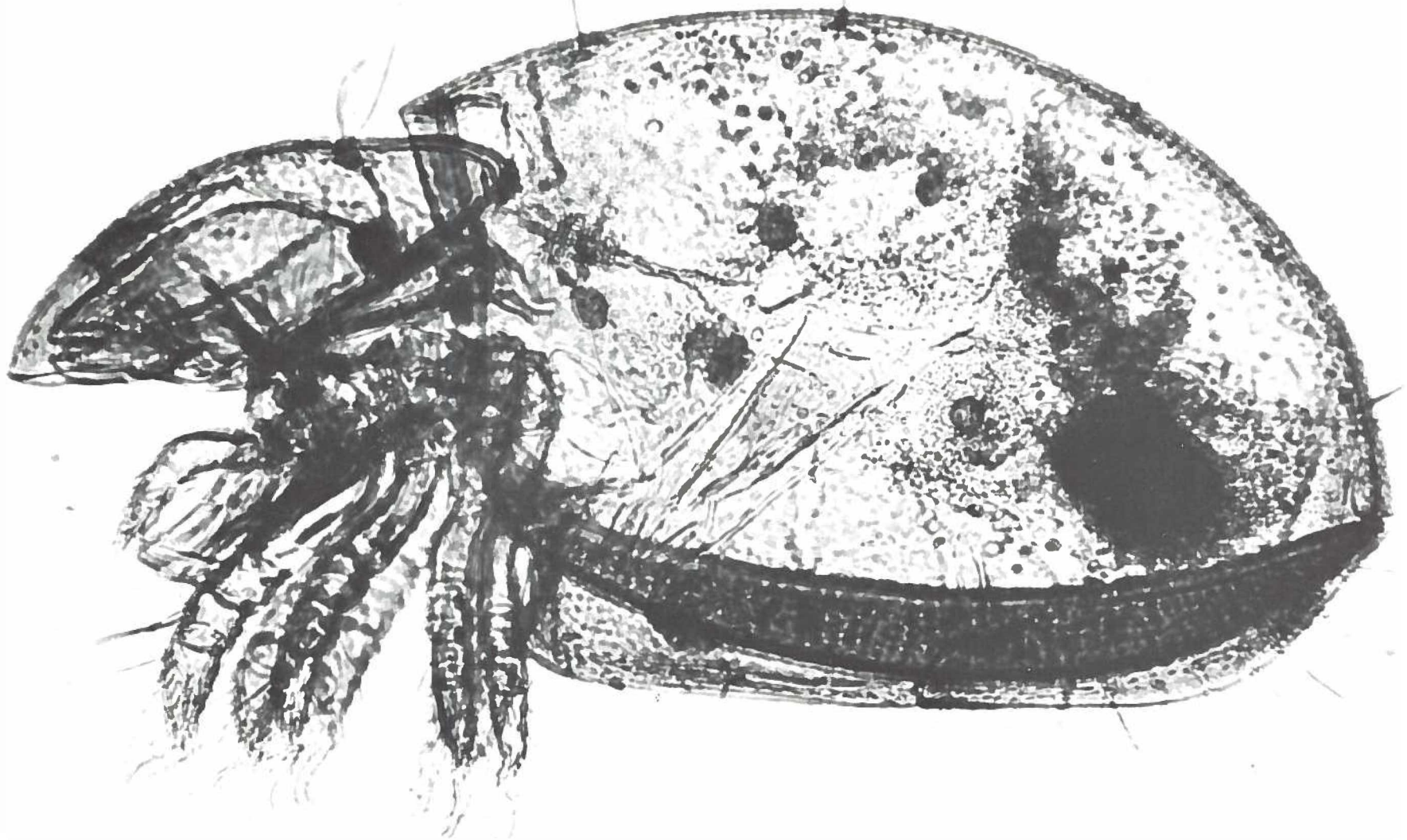
In recent years interest has been generated in the study of free-living mites of the soil because of their contribution to the biomass, their importance in the energy flow within the soil, their role in the bioecology,

and their relationships with various soil flora.

A population of half a million microarthropods is found in forest floors with humus, fewer in drier soils or sod. Mites ac-



Studies of insect reaction to sex lures will lead to better control of insect pests.



The soil mite (shown here magnified 125 times) is a mixed blessing to both man and beast.

count for 83 percent of the population in such circumstances.

The Oribatid or "beetle" mites are particularly important among the worldwide microarthropods that inhabit the first one to five inches of the soil (litter, duff, and humus layers). They function as indicators of conditions in the microhabitat, as important agents in the ecological succession of their earthly community, and as primary reducers of organic matter in the formation of humus.

Oribatid mites also act as agents for transmission of certain tapeworms which infect livestock. In Russia 40 species of these mites are known as intermediate hosts of tapeworms; only about a dozen species are implicated in the United States. These mites swallow the intermediate stage of the tapeworms and then crawl on the grass stems and leaves above the sod, where they in turn are eaten by cattle and sheep and thus pass on the tapeworm.

Research by Dr. T. A. Woolley of the Department of Zoology includes identifica-

tion of these mites and investigations of their biology. He had determined many new species found in the soils of Colorado taken from the alpine regions to the grassy plains. One kind that reduces woody material to humus is the box mite. It bores into twigs and pine needles, feeding as it goes. Like the termite, it depends on a bacterial organism in its digestive tract for the breakdown of cellulose in its food. Another of these beetle mites is an inhabitant of the litter and an expert in camouflage. The shed skins of the immature forms are carried on the backs of succeeding stages.

Much is yet to be learned about these microdenizens of the earth's surface and the details of their roles in the ecology of the soil. This research has taken Dr. Woolley to Europe on two occasions and is directed toward the classification and biology of many unknown species, as well as an understanding of their important roles in the formation of humus.

Studies in Atmospheric Dynamics

Current CSU studies in large-scale atmospheric dynamics seek answers to physical and mathematical questions about circulation of the Earth's atmosphere.

This is an extremely complex undertaking for several reasons:

First, we cannot consider the atmosphere as if it existed only by itself, like a mantle around the Earth, influenced only by the action and reaction of its own parts. Unfortunately for the researcher, outside energy sources also influence the atmosphere. One

major outside energy source is solar heating; another is heating from land masses which vary widely in their ability to absorb, hold and release heat.

Second, mathematical models of atmospheric interactions can be made only in approximate terms. This is somewhat like picturing the "average" American family only in approximate terms of income, number of children, and so on.

In the case of the Earth's atmosphere, however, a compromise must be made: the

approximation must be general enough to be widely applied, yet specific enough to be meaningful. Great care is needed in making these approximations, since they later will be used in numerical computations which are, themselves, subject to considerable complication. At every step, these mathematical models of the Earth's atmosphere must be checked if final results are to be meaningful.

If the atmosphere is represented in two dimensions—a horizontal slice of the troposphere, as it is in most weather maps—we can arrive at exact solutions of the mechanical energy exchange between the mean flow and any single wave. But real conditions include more than one wave, and so no exact solution is possible. Thus, to deal with real conditions, even in two dimensions, we are forced to adopt numerical predictions.

Now, add to these conditions the fact that the atmosphere is not really two-dimensional but three-dimensional, that potential energy often is released by overturning of the atmosphere or "inversion," and that outside energy sources influence the precariously balanced state of the energy exchange process. Representing the Earth's atmosphere by a mathematical model then becomes considerably more involved.

Yet, such a model seems, at present, to be the best approach to the problem. The continuing search for procedures that will make these numerical predictions meaningful has led to the establishment of some satisfactory computing procedures. We have designed and are carrying out experiments to solve these physical and mathematical problems.

Trout Microhabitat

Avid fishermen think they know where fish live in a stream. Based simply on where they have caught fish previously, they say that "this is a good fishing hole" or "this is a poor fishing hole."

It is, however, more difficult to be scientific about the judgment of where the fish are. The Colorado Cooperative Fishery Unit is conducting a series of projects to measure precisely the areas in which fish live—their microhabitat. The research thus far has been conducted by graduate research assistants M. Gary Wickham and Richard Baldes, under the direction of Dr. Robert E. Vincent. A fellowship from the Sport Fishery Research

Foundation has provided partial financial support.

Research thus far shows that, in a small stream, trout spend 95 percent of the time in an area amounting to only 15 percent to the total stream. Within this 15 percent area is a "focal point" that represents only 3 percent of the total stream area utilized by the fish. Fish movements away from this focal point are characteristically short in time (6 percent) but relatively large in area (25 percent of available stream area).

A major environmental feature controlling microhabitat is water velocity. To allow more accurate measurement of the relation-

ship between water velocity and microhabitat, a flume six feet wide and 80 feet long was constructed on the Pingree Park Campus. Water flows can be held constant or duplicated at any level up to eight cubic feet per second (cfs). Objects placed in the flume create various water conditions. Constant temperature measurement, water level recording, and a direct-reading velocity meter permit accurate duplication and measurement of environmental conditions.

In this study, both Brown and Brook trout were introduced into the flume and permitted to select a focal point area. At a low flow of 1.3 cfs, the water velocity at the focal point selected was 0.4 feet per second. At a

high flow of 7.0 cfs, the velocity at the focal point was 0.6 feet per second. Flume areas with a velocity above 0.7 feet per second were utilized only for movement up, down, or across the stream. An area of less than three square feet was not used, even when the velocity was suitable.

The study shows that fish spend a large portion of their time in a small section of the stream bottom, and this section has a water velocity of between 0.4 and 0.7 feet per second. To save energy, a fish spends much of the time in the focal point, which must be near an area of fast velocity into which it can make quick movements for food.

Turkey Boning

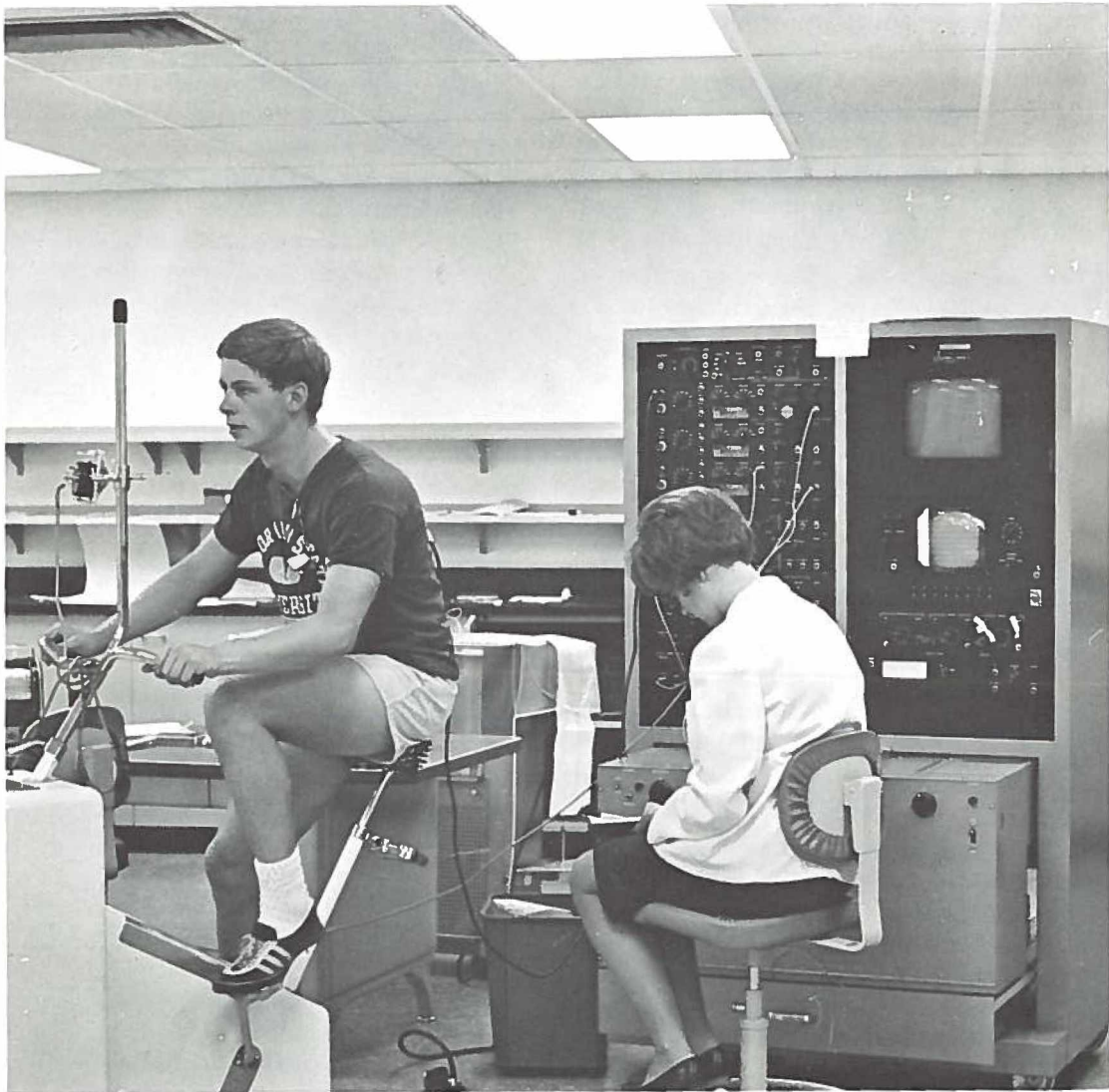
A new technique with practical commercial application has been developed for removing turkey meat from the bone. A study was designed to evaluate a "hot-boning" technique for processing and boning turkey meat one hour after slaughter. The one-operation process eliminates many steps now necessary in cold boning, including evisceration, chilling, freezing, and thawing of the entire carcass.

Comparison of the two methods indicates that hot boning will save a considerable amount of time and money in processing meat for turkey rolls and other turkey meat products. Labor required for the hot boning technique was significantly less than that for cold boning (total cost—18 cents per bird, compared with 39.6 cents per bird for cold boning). The hot boning method did not sig-

nificantly affect either tenderness or yield of the uncooked bird, or carcass loss.

Further studies on edible yield of turkey parts from frozen carcasses indicated that the breast and thighs account for approximately 57 percent of the total carcass weight and 65 percent of the total edible meat. The neck, a portion which generally is considered to yield a small amount of meat since it accounts for only 4.5 percent of the total carcass, yielded 40 to 60 percent edible meat and about 4 percent of the total carcass meat.

Total meat yield did not reflect the distribution of meat in the separate parts of the turkey. The yield of meat from the prime cuts (the breast and thigh) is the most important consideration in purchasing turkey carcasses for further processing.



New ways to pre-determine man's physical capabilities are developed and tested in the laboratory at CSU.

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