REPORT ON THE ACTIVITIES

OF THE

JACKSON HOLE BIOLOGICAL RESEARCH STATION

SUMMER 1970

L. Floyd Clarke, Director

UNIVERSITY OF WYOMING
Laramie, Wyoming

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RESEARCH PROJECT REPORTS

A Comparative Study of Interspecies Communications

Margaret Altmann
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Project Number 124

Dr. Altmann spent the summer continuing her study of the social behavior of big game species. A detailed report of these activities is not available at this time.

Parasites of Ungulates in the Jackson Hole Area

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Parasitology
Div. Microbiology & Vet. Medicine
University of Wyoming
Project Number 156

Field and laboratory work was continued on elk parasites for two weeks during each of four seasons of the year. During January, April, and August fecal analyses were made to support data gathered in 1968 and 1969. During the hunting season, October 1970, necropsies were made on elk killed by hunters. Lungs were examined and adult *Dictyocaulus* sp. lungworms were recovered and counted. Fecal analyses on over 50 elk were made also.

Data gathered during 1970 is shown as percent incidence of lungworm by seasons in Fig. 1 appended. Lungworm incidence was much like that of 1968 and 1969.

Elk in different habitats have quite different percent incidence of lungworm during the summer. Refuge elk were nearly 100% infected while Teton Park elk showed a 30% incidence and "high country" elk on Big Game Ridge had a 12% incidence. Perhaps migration to the "high country" is affected by the parasite in the lungs.

Some affected elk show extensive emphysema on the periphery of one or all lobes of the lungs at necropsy.

Recommendations are being made to the managers of the National Elk Refuge and the Wyoming Game and Fish Commission to keep all elk off the refuge during the summer.

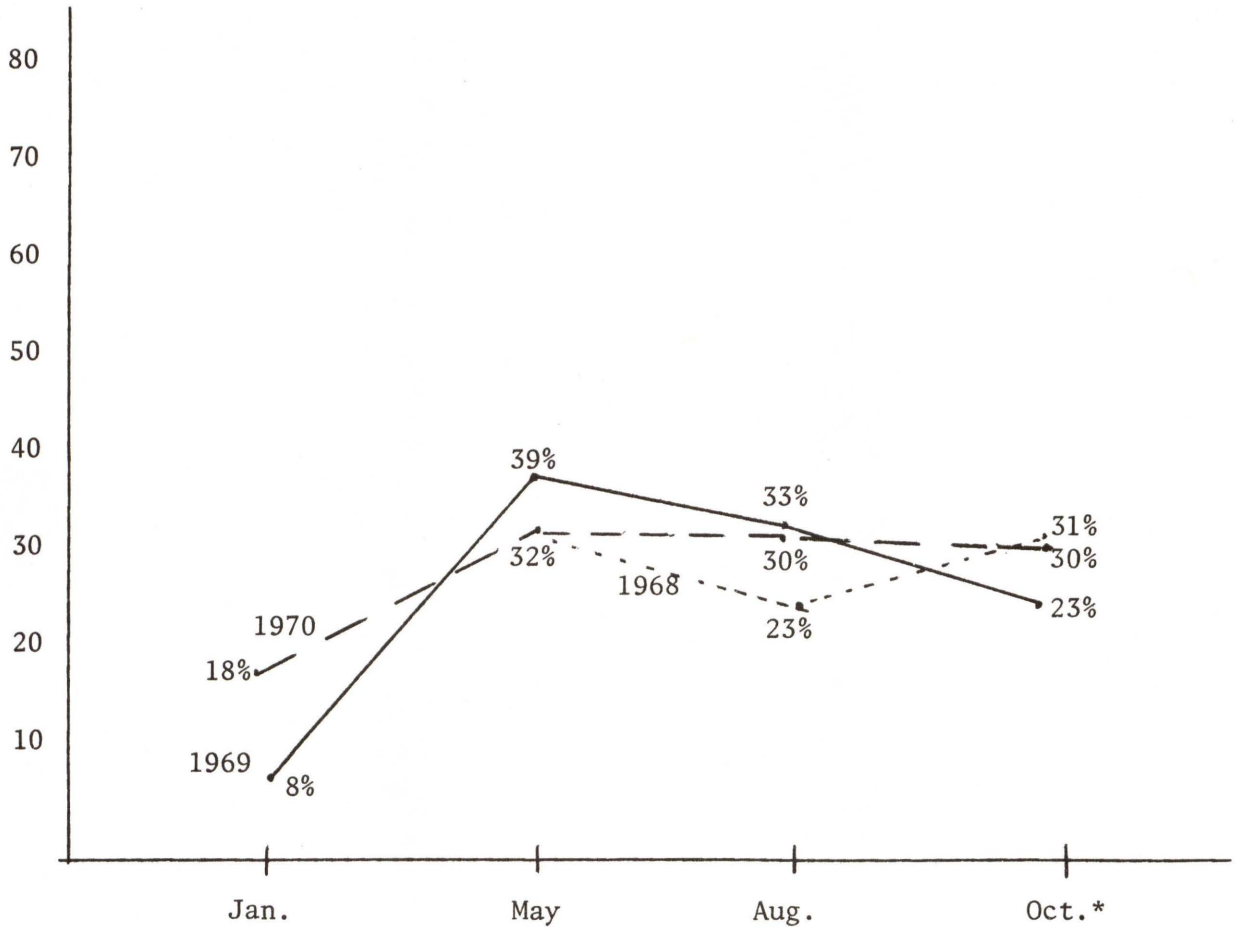

Fig. 1. Percent incidence of the elk lungworm, Dictyocaulus sp. in fecal samples of elk in each of four seasons during 1968, 1969 and 1970. Grand Teton National Park and Jackson Hole Elk Refuge, Wyoming.

*October data is from necropsies for adult worms in lungs and from fecal analyses.

Supported by University of Wyoming.

Studies in Respiratory Physiology:
Respiratory Aspects of Vocalization

William A. Calder
Biological Sciences
University of Arizona
Project Number 161

Thoracic and abdominal movements associated with production of the alarm trill of the Uinta Squirrel (*Citellus armatus*) were followed by impedence pneumography. The alarm is a trill of approximately 22 pulses per second, apparently resulting from synchromesh pulsation of the thorax. Interpretation of respiratory flow patterns will be continued by means of whole-body plethysmography.

Supported by National Science Foundation Grant GB-13249 and the University of Arizona.

Thermal Aspects of Nesting of the Calliope Hummingbird

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University of Arizona
Project Number 179

Environmental challenges to homeostasis can be most severe to the smallest homeotherms. This is a consequence of the inverse relationship of thermal conductance to body mass ($M^{-0.5}$; Herreid and Kessel, 1967; Lasiewski et al 1967) and of surface/volume ratio to body mass ($M^{0.67}/M^{1.0} = M^{-0.33}$). The smallest mammals can retreat to more moderate subterranean microenvironments, while small birds are more directly exposed to variable and extreme conditions. This is particularly true for hummingbirds which breed at higher elevation and latitudes. While some information is available in litt for hummingbirds in California, data for a smaller species of more extreme exposure were needed to verify generalizations for a review of avian thermoregulation. Nest temperatures from two calliope hummingbird nests and a series of nest models were monitored by copper-constant thermocouples connected to recording potentiometers. In addition to recording from the thermocouples, information on nesting microclimates was obtained with an infrared radiation thermometer and with calibrated mercury maximum-minimum thermometers. After fledging had occurred, the nests were collected for laboratory analysis of their insulative values.

Normothermic temperatures were maintained throughout the night during the 15 day incubation and 11 to 12 days of breeding. Minimum air temperatures within 3 m. vertical distance from the nests ranged as follows: 0.2 to 11.5°C in incubation, 1.2 to 13.5°C during breeding, and -0.9 to 10.8°C in the postbreeding to fledging period. Sky temperatures went as low as -20°C, compared to temperatures 0.5 to 1°C above air temperatures, recorded from the undersurface of pine limbs. Thus the thermal importance of the calliope's nesting habits, on an old pine cone directly beneath a large limb is demonstrated in terms of radiation exchange potentials.

Acknowledgements

I am indebted to many individuals for assistance and cooperation in the studies:

Dr. Jack States, for aid in locating nest #2.
Dr. Aelita Pinter, for standing vigil and icing thermocouple reference junction.
Dr. Ellis McLeod, for use of electrical conductors.
Dr. Michael Parker, for handling ropes during collection of nest #1.
Mrs. Michael Parker, for cooperation in the hummingbird feeder moratorium.
Dr. and Mrs. Floyd Clarke, for observations and for tolerating my presence behind their cabin with flashlights at all hours of the night.

Supported by National Science Foundation Grant GB-13249 and the University of Arizona.

Ecology and Behavior of the Coyotes in Jackson Hole

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University of Wyoming
Project Number 168

The preliminary work on this project was completed in June, July, and August of 1969, and the second phase was started in February of 1970 and will continue until September of 1971.

The objectives include both ecological and behavioral aspects of the Jackson Hole coyote population. Scat was collected from designated trails as well as from five denning areas. Ten active dens were located and a trapping procedure was initiated with 18 coyotes marked and released to date. Various aspects of social, non-social, and inter-species behavior were observed and described.

Supported by the New York Zoological Society, Grand Teton National Park, and the Theodore Roosevelt Memorial Fund of the American Museum of Natural History.

Ecology of the Uinta Ground Squirrel in Jackson Hole

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University of Wyoming
Project Number 157

In the summer of 1968 a preliminary survey of areas inhabited by the Uinta ground squirrel (Spermophilus armatus) was conducted in order to indicate the nature of variation among the local environments inhabited by ground squirrels in Jackson Hole.

In order to investigate some aspects of the relationship of squirrel populations to different combinations of environmental factors thought to be of primary significance, two areas were chosen for intensive study in the summer of 1969. Area #1, located adjacent to the Jackson Hole Research Station, represents a mesic bluegrass meadow with a relatively fine soil, and supports a comparatively dense squirrel population. Area #2 is located on a coarse textured glacial outwash plain near Cow Lake amidst a xeric Big sage-grass-forb community and supports a relatively sparse squirrel population.

The live-trapping operation conducted in the summer of 1969 was again carried out in 1970, beginning in April when the squirrels first emerged and continuing on daily until the squirrels went into hibernation in mid August. Each captured squirrel was classified as to sex and age, examined as to condition (of pregnancy, etc.), toe-clipped for individual identification and weighed; and the capture location noted in each case. A total of 181 squirrels was captured in area #1 (in a trapping area of approx. 4.6 acres) and a total of 38 squirrels in area #2 (in a trapping area of approx, 11.5 acres). In area #1, 93% of the adult animals captured had been previously marked in 1969. In area #2, only 33% of the 1969 captures were retaken. In both areas many animals were captured several times (one as many as 60 times in area #1). It was thus possible to obtain information on the degree of ranging over the area and weight increase throughout the summer for individuals, as well as data on population density and structure.

Sixty-eight reproductive tracts and 68 stomachs were collected from squirrels trapped adjacent to both areas between mid April and mid August. Reproductive tracts are being analyzed to indicate the timing of reproductive activity in each area and, combined with data on weight gain, to provide a rough indication of net production of the populations in each area. Stomach contents are being analyzed (plant species being identified) and compared to information on available vegetation in each area to reveal food habits throughout the season. This information will be combined with similar data from the summer of 1969.

In sum: the study is attempting to compare squirrel populations in the two areas with regard to (1) population density and structure, (2) net production (weight increase + reproduction), (3) food habits in relation to available vegetation, (4) timing of activity (daily and seasonally), (5) general behavior, and (6) distribution, home range and dispersal movements of individuals.

Supported by New York Zoological Society.

Raven Distribution, Population Dynamics, and Ecology in Grand Teton National Park

Jane Logan Dorn
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University of Wyoming
Project Number 176

This is a study of the distribution, population dynamics, food habits, relationships to artificial food sources and interaction with other fauna of the common raven (Corvus corax sinuatus Wagler) in Grand Teton National Park and adjacent areas.

The study was initiated on June 1, 1970, and the first summer of work was terminated August 29, 1970. A general survey of raven distribution within Grand Teton National Park was made. The raven population appears to be concentrated on the valley floor; very few birds were seen in the mountain canyons or at higher elevations.

Twelve raven nests were located in the Park. Five of these contained young at the time they were first found. Three of these nests were readily accessible. Mouth color, eye color, feather development, head position and body size of the young in these three nests were noted for later comparison with literature descriptions of known-age nestling ravens. Four young in a Uhl Hill cliff nest were just able to fly when the nest was first visited on June 18, and they were tagged with numbered, orange patagial disks and a federal leg band.

Regurgitated stomach pellets were collected beneath all of the nests for later analysis to obtain information on food habits. Actual feeding site observations were made on ravens whenever possible; however, the disturbing presence of the observer usually terminated any feeding activity, and only qualitative food data could be obtained.

Twenty-six birds were captured with a cannon net at three dump sites within the Park. These were aged using mouth color and feather wear patterns, banded, tagged and released. These individuals will aid in a study of movements of population segments.

This study will be resumed on February 1, 1971 and continued through August 1971. During the winter, distribution and food habits will be studied. A more intensive study of the breeding population is planned for the spring.

Supported by the New York Zoological Society and the National Science Foundation.

Life Habits, Population Dynamics, and Ecology of Mule Deer in Grand Teton Park

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Zoology and Physiology
University of Wyoming
Project Number 177

This study is being conducted within Grand Teton National Park and on adjacent land used by mule deer which use the Park seasonally. The initial field work was conducted from June through August 1970 and will be continued through two additional summers, two winters, and a fall and spring.

The following procedures were used:

(1) Vegetation analyzed quantitatively.
(2) Food habits determined by examining feeding sites.
(3) Distribution, vegetation type use, movements, population structure, natality, and mortality determined by field observations from fixed routes and from vantage points.
(4) Population regulating mechanisms and relationships to the environment and to other faunal species determined by field observations and vegetation analysis.

The vegetation survey of the Park for mapping and typing the vegetation was completed. At least 15 vegetation types will be differentiated.

A total of 119 mule deer was observed including 39 males, 50 females, 8 fawns, and 22 unidentified. Most of the unidentified were probably females. These figures indicate a very low fawn production.

Use of vegetation types in percent was as follows: lodgepole pine 24.1, sagebrush 13.4, grassland 12.1, lodgepole pine and aspen parks 12.1, aspen 10.1, spruce-fir 8.7, willow 8.1, spruce-fir park 6.0, sedge 2.0, serviceberry-buckbrush 2.0, and spruce-cottonwood 1.3. An edge situation was involved in 72.5 percent of the observations.

Observation-by-elevation results were 93 between 6,000 and 7,000 ft., 20 between 7,100 and 8,000 ft., and 6 between 8,100 and 9,000 ft. The range was 6,400 to 8,900 ft.

A total of 1062 instances of use was recorded on 7 feeding sites. Use on forbs was 85 percent, on browse 14 percent, and on grass 1 percent. Important species were *Polygonum douglasii*, *Gilia aggregata*, *Geranium viscosissimum*, and *Lupinus sericeus*.

Most of the above data are biased due to differential accessibilities and will be adjusted later.

Supported by the New York Zoological Society, Sigma Xi, National Park Service, and Wyoming Game and Fish Commission.

Carrying Capacity of Summer Elk Range

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University of Wyoming
Project Number 171

A study was initiated in the spring of 1969 to evaluate the carrying capacity of summer elk range in Teton County, Wyoming. Data collection for the first two years of the study was primarily associated with type classification, animal numbers, use patterns, and forage production and utilization.

The area studied included all summer elk range in Teton County with emphasis placed on the Huckleberry Ridge area. This area was selected because of logistic reasons and provided essentially comparable resources to other areas of summer elk range. Management decisions concerning the Huckleberry Ridge area could in effect be employed for similar summer range.

Survey trips were made to the area during May of 1969 and early June of 1970 to study elk migration and numbers as well as their effect on the early spring flora. This was followed by type classification mapping and unit measurements from aerial photographs. Animal numbers and use patterns were studied by sightings, tracks, and pellet groups. Forage production was achieved by use of a square foot microgrid placed at random on various types seen previously to be extensively used by elk. A double sampling procedure was employed in conjunction with the microgrid which estimated individual species weight. Utilization percentages were also estimated at the same time the other sample measurements were made.

During the summer months of 1969 and 1970 approximately 3,000 samples were taken to determine utilization and production. The area was also typed and classified and observation notes were kept on animal numbers and their pattern of use. Sample results are currently being compiled and analyzed and are to be presented in a Ph.D. thesis. The final results of the study should be available by the first of March, 1971.

Supported by NDEA.

The Variation in and Ecology of Aspen in Wyoming

Neal Hilston and Alan A. Beetle
Division of Plant Sciences
University of Wyoming
Project Number 130

The field work for 1970 consisted of rerunning for the fifth year transects in aspen stands that had previously been selected for the study. These transects were to determine the number of new aspen shoots in each stand, the number of dead trees, and the number of shoots that have matured to a diameter of 6 feet (the size coincided to be a mature tree).

In the fall the year's new growth on 100 shoots in each stand is determined.

Over the last five years the average number of mature trees in the study area has declined, while new shoots showed an increase in number. However, this size has remained the same because of annual browsing.

Supported by McIntire-Stennis Federal funds.

Trace Elements in Small Mammal Hair

John W. Huckabee
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University of Wyoming
Project Number 170

INTRODUCTION

Excesses and deficiencies of environmental trace elements can result in pathological conditions for animals including humans living in a given environment. In some of these cases the environmental level of the trace element has been correlated with hair level of the trace element. Sub-pathological but extra-optimal levels of certain elements may influence animal distribution and occurrence and these levels may be reflected in hair. Some trace elements (Pb, Hg, Cd and others) are important pollutants and their levels in the environment are generally increasing. High environmental Pb levels have been shown to correlate directly with Pb levels in pigeon feathers, and preliminary analyses indicate the same conclusion for Hg in pheasant feathers. It seems reasonable to expect hair might likewise provide a sensitive environmental monitor.

Before the role of hair in trace element management can be determined, it must be shown if there is a species-specific hair trace element complement, or if all species in a given environment show essentially the same hair trace elements.

Many analyses of human hair trace elements have been made, but results are inconsistent due to large differences in diet and the application of cosmetics.

Populations of mice and shrews in the same limited habitat would be less subject to such variables. With species of known home-range size and food habits, it could be asserted that the animals caught in the same traps during the same trapping period represent one small segment of the environment. Differences in their hair trace elements would thus be due to species differences in food habits and metabolism.

METHODS

To test for the existence of a species-specific hair trace element complement, four areas less than two acres in size were sampled for mice and shrews. Two non-mineralized control areas, one a sedge-willow marsh, the other a grassy meadow, were located within 0.25 miles of the Jackson Hole Research Station, Wyoming. Collections were made there in July of 1969. The other two areas were selected for known high concentrations of mercury, gold, and molybdenum. Mercury and gold are found at relatively

high levels at the confluence of Cottonwood Creek and the Gros Ventre River in Teton County, Wyoming. A sedge-willow marsh at this location was sampled in August, 1970.

The molybdenum area is about 1.25 miles below the American Smelting and Refining Company's molybdenum development in the White Cloud Peaks near Challis, Idaho. A sedge-willow marsh there was sampled in July, 1970.

Species caught and tested were Microtus pennsylvanicus, M. montanus, M. richardsoni, M. longicaudus, Clethrionomys gapperi, Zapus princeps, Eutamias sp., and Sorex vagrans.

Neutron activation analyses for trace elements were performed at the National Reactor Testing Station in Idaho. Neutron activation is a highly sensitive and accurate method of elemental analysis. When a neutron is added to a stable nucleus, the nucleus is rendered radioactive. Ordinarily the activity is the emission of beta and gamma rays. The energy of the gamma rays is characteristic for each element ("gamma fingerprints"). Determining the gamma ray energy with a spectrometer will thus name the radioactive elements.

Hair samples averaging about 100 mg were pulled with forceps and washed in 1% non-ionic detergent (7-X O'matic) with agitation on a Burrel wrist-action shaker for 20 minutes. The samples were then rinsed with 2 liters of demineralized water and dried overnight at 100°C. After drying, they were allowed to stand protected from dust at room conditions for at least four hours until moisture equilibrium was attained. The samples were then weighed, packed and sealed in quartz ampules for irradiation.

Irradiations were performed in the Materials Testing Reactor hydraulic rabbit facility at thermal neutron fluxes ranging between 1 and 2 x 10^{14} n/cm^2/sec. for six hours, or after the MTR was shut down permanently, the Engineering Test Reactor at a thermal neutron flux of about 1.7 x 10^{13} n/cm^2/sec. for twenty days. This length of time was much more than necessary, but the ETR had no rabbit facility and the samples had to be left in-tank (near the core) for the full cycle, until the reactor was shut down for refueling.

The samples were allowed to cool for about 200 hours, or until the Na-24, K-42, and Br-82 activity died away sufficiently. After removal from the quartz ampules, elemental content of the hair was determined by gamma-ray spectrometry, utilizing Ge(Li) detectors of about 25, 30, and 60 cubic centimeter volumes, and multi-channel analyzers of 1024 and 4096 channels.

The gamma-ray spectra were analyzed by the Super Gauss program on an IBM 360/75 computer, by the Gamma Analyses Package on a PDP-9 comupter, or by the PKS and 50DT programs, an on-line analysis with a PDP-8 computer. Each program computes the activity (number of gamma rays detected per

unit time) of each gamma ray peak, which is compared with the activity of a standard of known weight for each element analyzed to give quantitative results. It is beyond the scope of this report to discuss the relative advantages of each program.

RESULTS AND DISCUSSION

Tim W. Clarke trapped and identified in 1969, and Franz J. Camenzind identified the species of animals caught in 1970.

At this time, analyses are not complete and conclusions would be premature. Table I summarizes the qualitative results obtained up to the present. This work should be complete by early 1971.

TABLE I

Trace Element Content of Small Mammal Hair, Jackson Hole, Wyoming, July, 1969. ? Denotes Less Than 0.01 mg Present in the Sample

		Elements Detected (T 1/2 > 400 hours)						
Microtus pennsylvanicus	1	Se	Zn	Fe				
	2	Se	Zn					
	3	Se	Zn					
	4	Se	Zn		Sc?			
	5	Se	Zn	Fe	Sc	Sb?		
	6	Se	Zn				Cd	
	7	Se	Zn				Cd	
	8	Se	Zn				Cd	
	9	Se	Zn	Fe				
	10	Se	Zn		Sc?		Cd	
	11	Se	Zn				Cd	
	12	Se	Zn				Cd	
Clethrionomys gapperi	1	Se	Zn	Fe		Sb	Cd	Ag
	2	Se	Zn	Fe			Cd?	Ag?
	3	Se	Zn	Fe				Ag?
	4	Se	Zn	Fe				Ag?
	5	Se	Zn				Cd	Ag?
	6	Se	Zn				Cd	Ag
	7	Se	Zn		Sc		Cd	Ag
	8	Se	Zn		Sc		Cd	Ag
	9	Se	Zn		Sc	Sb	Cd	Ag
	10	Se	Zn		Sc	Sb?	Cd	Ag
Sorex vagrans	1	Se	Zn	Fe		Sb	Cd	Ag
	2	Se	Zn	Fe?		Sb	Cd	Ag
	3	Se	Zn			Sb	Cd	Ag
	4	Se	Zn			Sb	Cd	Ag
	5	Se	Zn			Sb	Cd	Ag
	6	Se	Zn			Sb	Cd	Ag
	7	Se	Zn	Fe?		Sb		Ag?
	8	Se	Zn			Sb		Ag
	9	Se	Zn			Sb		Ag

Supported by grant from Associated Western Universities.

Parasite Studies
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Project Number 167

The following researches were carried out at the Jackson Hole Research Station during the period July 27 to August 2, 1970.

Result of grouse collections: Nil. Hunting of grouse in the vicinity of the Park is not a feasible method of collection in the limited time available. Dr. J. C. Holmes has agreed to make specimens of Brachylecithum available (these are presently in hand); feasibility of studying potential second intermediate hosts in Grand Teton National Park remains to be determined.

Terrestrial snails of three species involved in the life cycle of Brachylecithum orfi were collected along the edge of the Snake River. These will be cultivated in the laboratory and used in carrying out the life cycle of this fluke.

Other parasitological investigations:

Species	No.	Results
Microtus montanus*[x]	6[1]	2 spp. tapeworms, 5 spp. mites, 1 nematode
Mustela spp.*	3	Ticks, mites, lice, flukes
Canis latrans	1	Flukes, tapeworms, nematodes

*Supplied through the kind offices of Dr. A. Pinter.

[1]No. limited owing to population crash in spring, 1970.

[x]Dr. Pinter has made spring and late summer collections of Microtus available; consequently, a somewhat larger sample than is indicated here is available.

Supported by University of Wyoming.

Studies on Trichomycetes Inhabiting the Guts of Diptera Larvae

Robert W. Lichtwardt and Marvin C. Williams
Department of Botany
University of Kansas
Project Number 104

The Trichomycetes are fungi that live obligately as commensals in the guts of arthropods. Our studies dealt principally, but not exclusively, with the order Harpellales that inhabit the midgut and hindgut of aquatic larvae of Diptera. Jackson Hole was selected for these studies because of its wealth of Trichomycete material. These fungi were known to be present through work in the area during previous years by one of us. Though we worked together on some of the same collections of larvae, our objectives were somewhat different:

Robert W. Lichtwardt (July 1-July 10).--The primary purpose was to obtain living *Harpella melusinae* so that suitable fresh sporulating material could be fixed for subsequent electron microscopic observations. This fungus, like other Harpellales, produces spores with appendages. Preliminary studies of this species obtained in Jackson Hole in 1965 showed that these appendages have an unusual ultrastructure. It was possible, during the brief period at the Station, to find and fix *Harpella* as well as several other genera of Trichomycetes.

Marvin C. Williams (July 1-July 24).--Attempts were made to culture several genera of Harpellales. Species of only one genus of endocommensal Trichomycetes (*Smittium*) have been cultured to date. It was not possible to axenically culture any of the other genera, but in the process it was possible to study the morphology and ecology of a variety of Trichymycetes, this being another objective of the investigation in Jackson Hole. A new species, to be called *Pennella simulii*, was discovered in black fly larvae from the headwaters of Third Creek, and a paper is being submitted to MYCOLOGIA for publication: Williams, M. C., and R. W. Lichtwardt, "A new *Pennella* (Trichomycetes) from *Simulium* larvae."

Financial support for M. C. Williams came from the Committee on Systematics and Evolutionary Biology, The University of Kansas (NSF GB-8785), and for R. W. Lichtwardt from NSF grant GB-7072X.

Chromosome Cytology, Reproductive Behavior, and Ecology of the Insect Order Neuroptera

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Project Number 164

The investigations conducted at the Research Station during the summer of 1970 were a continuation of those initiated the previous summer and were conducted in much the same way. Living material of certain important montane species was secured and a preliminary cytological examination was made, in the field, of male testes (meiosis) and of the early embryonic stages in eggs laid by females (mitosis). Additional eggs were allowed to hatch and the resulting larval stages were either preserved for future study and description, or were transported alive back to my laboratory at the University of Illinois. These latter were used to initiate laboratory cultures and these have allowed experimental investigations into such aspects of the biology of the species as their diapause phenology and courtship behavior as well as more detailed studies of their cytology. Additional adult specimens collected during the summer provided information, through the examination of gut contents, on adult food habits and, of course, all field work during the summer added to accumulating knowledge of the distribution of the habitats of different species through the regions studied.

A second feature of this past summer's field work was a collaboration with Professor Sally Hughes-Schrader of Duke University who is currently investigating the mechanics of meiosis in the Hemerobiidae, a family very closely related to the Chrysopidae. The males of the Neuroptera have long been known to possess the cytological peculiarity of having their sex chromosomes unsynapsed during meiosis, although these X and Y chromosomes segregate quite normally during the first meiotic anaphase. Certain European members of the Hemerobiidae belonging to the genus *Kimminsia* have been reported to be exceptions to this rule by forming a true sex bivalent in normal fashion during meiotic Prophase I. Since species of *Kimminsia* are rather specialized neuropterans, it has seemed likely to us that either the observations on the European species have been incorrectly interpreted or these insects have recently evolved a new mechanism for the disjunction of the meiotic sex chromosomes. In either case a reexamination of the meiotic cytology of *Kimminsia* seemed called for and since in the Nearctic Region this is essentially a western boreal group, the region of Jackson Hole was admirably suited to this undertaking. In addition to this study, a number of other species of hemerobiids were collected for Professor Hughes-Schrader's more extended studies of meiosis in this family.

PRELIMINARY SUMMARY OF RESULTS

Cytology of the Chrysopidae - A total of four species, representing the genera *Chrysopa* (2 species), *Eremochrysa* (1 species), and *Meleoma* (1 species)

was secured and examined cytologically. The karyotypes and sex-determining mechanisms of these species are summarized in Table I.

TABLE I - Chromosome Cytology of Species Studied

Species	Karyotype	Sex Determination
Chrysopa apache	2n = 12 (12R)*	X:Y (X>Y)
C. n. sp.	2n = 12 (10R + 2J)	X:Y (X=Y)
Eremochrysa canadensis	2n = 12 (10R + 2J)	X:Y (X=Y)
Meleoma emuncta	2n = 12 (12R)	X:Y (X=Y)

*The abbreviations used for chromosome shape are: R = rod-shaped (acrokinetic) chromosome, with a near-terminal kinetochore; J = J-shaped chromosome, with obviously subterminal kinetochore; V = V-shaped chromosome (metakinetic), with a median kinetochore.

Probably the most important ramifications of these findings are those which relate to the karyotypes of Chrysopa n. sp., Eremochrysa canadensis and C. apache. The new species of Chrysopa is quite similar in appearance and ecology to C. oculata and C. pleuralis, both of which were studied in some detail last year. Cytologically C. n. sp. differs strikingly from both C. oculata and C. pleuralis in the form of the Y chromosome, which is a very tiny element in the latter two species while it is much larger and indistinguishable from the X chromosome in the undescribed species. These three species form a very homogeneous species group within their subgenus which differ strikingly from the other members of the subgenus in their karyotypes. Quite obviously the processes of speciation within this small group of three species has involved important modifications of the sex-determining mechanism.

The securing of specimens of Eremochrysa canadensis and C. apache has permitted the first examinations of the karyotypes of two very distinctive taxonomic sections of the Chrysopidae. E. canadensis is a member of the unusual subgenus Lolochrysa, and the inclusion of a pair of J-shaped chromosomes in its karyotype was an unexpected discovery since the three other species of this genus whose chromosomes are now known (all belonging to the subgenus Eremochrysa) have all 12 of their chromosomes acrokinetic. Whether this difference is simply a unique feature of E. canadensis or will turn out to be distinctive of the subgenus Lolochrysa is not yet known; however, the occurrence of a pericentric inversion in the ancestry of either the species of the subgenus Eremochrysa or of E. canadensis is strongly indicated.

Chrysopa apache belongs to an equally distinctive subgenus of Chrysopa, and the discovery of its karyotype adds yet another example of a taxonomically distinct group of this family possessing a karyotype of 12 acrokinetic chromosomes. Since many of these groups are only very distantly related, their possession of closely similar karyotypes raises the important question of how this similarity was evolved. Other cytological considerations suggest very strongly that ancestral chrysopids had somewhat higher chromosome numbers, in the range of 2n=16, so that it cannot be argued that the common possession of karyotypes with 2n=12 acrokinetic chromosomes in distantly related groups is likely to have resulted from an inheritance from some common ancestor. The possibility, then, is strongly suggested that this wide-spread karyotype represents some sort of efficient solution to the problems of the cellular mechanics of mitosis or meiosis or, perhaps, that it presents an adaptively superior system for the storage or recombination of genotypes. Both of these ideas are worthy of future investigation, as they have general relevance to the study of the factors governing the evolution of genetic systems.

Reproductive Behavior - As noted in my previous annual report, studies of the reproductive behavior of chrysopids necessitates a rearing of virgin males and females. Difficulty was again encountered in achieving this because of the generally low temperatures of the region of Jackson Hole which, in spite of the heating system installed in the lab last year, so slowed down the development of my insects that I deferred investigations of this aspect of the biology of these species until I had returned to the University of Illinois. At the present time Chrysopa apache and Eremochrysa canadensis have been studied in some detail by myself and one of my students and certain obvious differences between each of these species and between these species and others in the family have been recorded. The courtship of C. apache is especially interesting and shows certain similarities to species of the genus Nodita. The exact meaning of these similarities is not yet clear at the moment.

Ecology - Analysis of adult food habits, using stomach contents, has provided the food habits of three of the four species studied during the summer. The new species of Chrysopa is certainly a predator on aphids and certain other small, leaf-inhabiting Homoptera. In this feature it is also like its two other close relatives in the region of Jackson Hole, and the question of just what the detailed ecological differences between these three species actually entail is an intriguing one. C. apache, Eremochrysa canadensis, and Meleoma emuncta all seem to feed on pollen and the complex of fugal species growing on the aphid honeydew which commonly coats the surfaces of leaves during the summertime.

The diapause stage and the approximate environmental control (where present) initiating diapause has been determined for the four species studied during 1970 as well as for the six species brought back to my lab from the field in 1969. These relationships are summarized in Table II.

TABLE II - Diapause Biology of Species Studied in 1969 and 1970

Species	Diapause Stage	Induction of Diapause	
Chrysopa apache	3rd instar larva	facultative	(short days)
C. coloradensis	prepupa	"	"
C. excepta	"	"	"
C. oculata	"	"	"
C. pleuralis	"	"	"
C. n. sp.	"	"	"
Chrysopiella n. sp.	"	obligate	
Eremochrysa canadensis	"	facultative	(short days)
E. punctinervis	2nd instar larva	"	"
Meleoma emuncta	prepupa	"	"

In all of these species except the new species of *Chrysopiella* it has been determined that the presence or absence of diapause in a given generation is largely determined by the length of the environmental photophases, with short days (10 hours light/24 hours) inducing 100% diapause response and long days (16 hours light/24 hours) inhibiting diapause in 100% of the test animals. The particular developmental stage which is utilized for diapause, when it is induced, seems constant for any give species, although different species utilize different stages. I term such a pattern, in which each generation has the potentiality of either developmental pathway, facultative.

In contrast, the pattern of development of the new species of *Chrysopiella* seems to always involve a diapause in the prepupal stage, with environmental signals such as the photoperiod and temperature being completely ineffective in inhibiting the onset of this diapause. I term such a pattern (which incidentally restricts a species to a single generation a year) obligate, since no other developmental pathway is available. Obligate patterns such as that shown by the new species of *Chrysopiella* are somewhat unusual in temperate-zone insects and within the Chrysopidae I know of only one other case. The ecological reasons why these two species of this family depart from the more general pattern of facultative life cycles are presently unknown and are certainly worthy of careful study.

Studies on Meiosis in the Hemerobiidae - As noted above, this investigation is being carried out by Professor Hughes-Schrader of Duke University and I have only received preliminary word from her as to how these studies are progressing since she was away from her laboratory until early October. Material was secured representing six species of the genera Hemerobius (3 species), Kimminsia (1 species), Micromus (1 species), and Wesmaelius (1 species). She has informed me that a study of the species Hemerobius stigma reveals the existence of a chromosomal polymorphism in the Jackson Hole population which she had also encountered in her studies of this species in the vicinity of Durham, North Carolina. In both of these locales, some individuals of the population are heterozygous for a pair of homologous autosomes of dissimilar size so that during meiosis an asymmetrical bivalent is formed. Other individuals of the same population have both members of this pair of chromosomes identical in size and shape. The meaning of this polymorphism is not clear at present, but its presence in two populations separated by a distance of over two thousand miles is certainly suggestive that the adaptive role that it plays is important.

Supported by National Science Foundation grant.

Population Dynamics of Microtine Rodents

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Project Number 110

During 1969-70, crucial information was obtained concerning populations and responses of *Microtus montanus*. In summer and fall of 1969, *Microtus montanus* reached peak densities in excess of 200 mice per acre. Breeding continued into October of 1969. By May, 1970 the densities had decreased to minimum levels (less than 10 per acre). Extremely low densities persisted through the summer and into the fall of 1970. Quite obviously, the peak and crash of the microtine cycle occurred in the winter of 1969-70. In contrast to 1969, breeding had ceased by the first week in September of 1970.

A sample (40) of males was captured alive in fall 1969 and returned to the laboratory at Tulane University. In a controlled experiment, these males demonstrated a strong pineal and gonadal response to green plant supplements in the diet. These results provide strong evidence of the effect of green plant food on reproductive activity, even at the end of the breeding season. In another series of experiments we have demonstrated that the activity cycles of this species are apparently influenced strongly by levels of pineal serotonin. It appears that we have found a component of the biological clock in *Microtus montanus*.

The following publications have been or are being prepared from this study:

Negus, N. C., and P. J. Berger. 1970.
Pineal weight response to a dietary variable in *Microtus montanus*. Experientia (in press).

Berger, P. J., and N. C. Negus. 1970.
Activity rhythms in *Microtus montanus*: the role of the pineal gland. (Submitted to Journal of Experimental Zoology).

Negus, N. C. 1970.
The dynamics of *Microtus montanus* populations in Jackson Hole, Wyoming from 1960-1970. (In preparation).

This study was aided greatly by a grant-in-aid from the New York Zoological Society in 1969.

Natural Stresses and Parasitism

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Project Number 103

The original proposal to study stress in squirrels infected in the laboratory with Leishmania was abandoned after reading a recent report showing malaria in reptiles may be carried by phlebotomine flies that live in ground squirrel burrows during the night. Leishmania is carried by phlebotomine flies so I did not want to risk even the remote chance of causing the establishment of leishmaniasis in local ground squirrels. Since coming to Jackson Hole this summer, however, I have been unable to find the flies in ground squirrel burrows. I used special insect traps placed over burrow openings during the night.

All studies of stress and parasitism in animals have so far involved bringing the animals into the laboratory and subjecting them to various stressors. My plan this year was to study the effect of natural stressors in the field. I selected three areas containing squirrels in approximately the same densities and examined the cecum of each for Entamoeba, coccidia and the pinworm, Syphacia. Thirty animals were trapped from each area and twelve of each of the thirty were used for weighing adrenal glands as an indication of stress. Squirrels were trapped randomly from each area from 2 July to 15 August.

The three areas were: (1) a pasture near Teton Village on the Aspen Ranch where conditions appeared to be normal, (2) fields near the Research Station, Moran, where stressful conditions obtained because another researcher had been walking over the area and trapping almost daily for two months and was continuing his activities during my operations, (3) the highway near Teton Village where squirrels were running across the road much of the day, several of them being killed daily. This area I assumed to be considerably stressful to the animals. Estimates of the numbers of cecal protozoa were made with the aid of a hemacytometer, following procedures developed during other studies, and the total numbers of pinworms were counted directly.

RESULTS

	Aspen Ranch pasture	Research Station	Highway near Teton Village
Average body weight of squirrels in grams	306	286	326
Percent of squirrels infected with amebas	87	97	97
Numbers of amebas per 100 g squirrel body wt.	2407	1985	1845
Percent of squirrels infected with coccidia	60	59	85
Numbers of coccidia per 100 g squirrel body wt.	0.39	0.33	0.28
Percent of squirrels infected with pinworms	53	17	17
Numbers of pinworms per 100 g squirrel body wt.	12	23	16
Mean adrenal weight per kilogram of body weight in milligrams	66	68	106

It can be seen that, judging from adrenal weights, squirrels in the Aspen Ranch pasture were the least stressed, those from the Research Station area were essentially similar to the Aspen Ranch individuals, and those in the highway near Teton Village were subjected to significantly greater stress. The numbers of parasites, however, indicated the opposite condition; the greatest stress occurring in the Aspen Ranch area.

CONCLUSION

All data on the 90 squirrels will have to be analyzed thoroughly before definite conclusions can be reached. Certainly there are significantly larger numbers of some parasites in squirrels of one region compared to another. Assuming there is no essential difference in the opportunity to become infected, increased parasitism may be due to stress. The discrepancy

between adrenal gland weights and relative numbers of parasites may have been due to the fact that the adrenals from only 12 squirrels out of each group of 30 were weighed. Increase in adrenal weight and increase in numbers of parasites are both, normally, indicators of stress. Increase of either may, of course, be due to other factors.

The research was interesting and may prove to be significant. It has, as so often happens, opened the door to further studies. I am deeply grateful for the opportunity to carry on my investigations once more at the Biological Research Station.

Supported by the New York Zoological Society.

Studies on the Kinetics of Uptake of Nitrate and Ammonia by Phytoplankton

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Project Number 165

Swan Lake is an example of a nutrient rich lake (from early summer 1956 until June of this year when a new sewage treatment plant began full scale operation, the north end of Swan Lake received the effluent from a secondary sewage treatment plant at Colter Bay). By comparison, Two Ocean and Jackson Lakes represent nutrient poor lakes. For these reasons the lakes were selected as sites for a study of the uptake kinetics of two nutrients, nitrate and ammonia, in relation to phytoplankton succession in these lakes. Two experiments were also conducted on Jenny and Brooks Lakes.

The kinetics of nitrate and ammonia uptake were studied by adding Nitrogen-15 labeled ammonium chloride and potassium nitrate to samples of lake water. The uptake of Carbon-14 labeled sodium bicarbonate by phytoplankton in lake water samples was also studied at three artificially enriched concentrations of nitrate and ammonia. The Carbon-14 uptake experiments will serve as indices of productivity in the two lakes and it is hoped that they will, by using autoradiographs, provide an additional means of evaluating the assumption that a relationship exists between the kinetics of uptake of nitrate and ammonia and phytoplankton succession.

The basic procedures used in the kinetic experiments are outlined briefly below.

For each kinetic experiment:

1. Routine physical and chemical data was collected from the lake: temperature, light, oxygen, pH, alkalinity, conductivity, Secchi.

2. A representative sample of lake water (approximately 13 gallons) was taken from the study station and brought back to the Research Station.

3. Thirty 1 liter stoppered glass bottles and 22 250 ml stoppered bottles were filled with the lake water containing a mixed population of phytoplankton.

4. Five different concentrations of $KN^{15}O_3$ were added to 15 of the one liter bottles with triplicates at each concentration. Similarly, 5 concentrations of $N^{15}H_4Cl$ were added to 1 liter bottles. The concentrations of nitrate nitrogen added ranged from 6.15 μ gm N/1 to 110.7 μ gm N/1, while ammonia nitrogen

was added in concentrations ranging from 6.28 μ gm N/1 to 175.96 μ gm N/1.

5. To each of the 22 smaller bottles, 1.5 μ curies of Ca^{14}sodium bicarbonate were added. Four of these contained only lake water and C^{14} while the rest were enriched with levels of nitrate or ammonia approximately equal to the low, intermediate, and high concentrations used in the N^{15} experiments. Nine bottles (triplicates at each level) were used for study of C^{14} uptake at different nitrate levels and 9 bottles were similarly used to study C^{14} uptake at different ammonia levels.

6. Both the N^{15} and the C^{14} experimental bottles were placed in incubation racks and placed in the Snake River SW of the Research Station. The racks of bottles were placed at a depth which allowed the light intensity striking the bottle to be approximately equal to the light the phytoplankton would have received in the lake being studied.

7. After incubation for 6 to 24 hours, the bottles were removed from the river and brought back to the Research Station lab for future treatment. The bottles with N^{15} labeled phytoplankton were filtered through glass fiber filters for later analysis with a nitrogen analyzer and a mass spectrometer to measure the amount of the labeled compound taken up by the algae. Several samples were taken from each of the C^{14} bottles and millipore filtered for use as an index of productivity. Further subsamples were taken from each C^{14} bottle and filtered for use in making autoradiographs.

8. With each kinetic experiment performed, measurements of the existing levels of nitrate, ammonia, nitrite, and phosphorus were made on samples of lake water brought back to the Research Station at the beginning of the experiment.

9. Samples of lake water (containing the mixed population of phytoplankton being studied) were also preserved for later determination of species composition.

A total of 28 visits were made to lakes from June 7, 1970 to October 4, 1970. Seventeen uptake experiments were performed, although several of these were incomplete since only N^{15} nitrate was employed (Two Ocean, 6; Swan, 5; Jackson, 4; Jenny, 1; Brooks, 1).

The filters collected this summer in kinetic experiments are currently being analyzed. Analysis of all materials from this summer's research should be completed by the end of this academic year. Preliminary analysis of C^{14} filters taken for productivity measurements is currently in progress. Although C^{14} analysis is incomplete, Mrs. Pontius has some indication that there is a different rate of C^{14} uptake with different concentrations of ammonia but not with different concentrations of nitrate.

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Effects of Environmental Variables on Some Physiological Responses of *Microtus montanus* under Natural Conditions

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Project Number 173

The aims of the study were essentially the same as those described in the report on this project for the summer of 1969. In brief, between May and October, 1970, several physiological parameters were examined in the montane vole (*Microtus montanus*) under natural conditions. The physiological responses of these rodents are being correlated with seasonal changes in several environmental variables. The collection of data was essentially the same as outlined in the 1969 report.

Field observations

Field observations at the Research Station were carried out over three study periods: spring (May-June); summer (July-August); and fall (October).

A. Spring study period (May-June).

Microtus populations had undergone a precipitous decline ("crash") during the winter of 1969-70. In all study areas fresh sign (droppings, grass cuttings) was limited to isolated and widely spaced spots. Voles could be found only in small scattered groups.

Large areas of the meadows were virtually denuded of vegetation. Frequently even the roots of grasses as well as of the willows had been gnawed. However, some areas with heavy mats of dead grass still remained. *Microtus* occurred both in areas of sparse vegetation as well as in spots that still retained the dead grass cover.

Breeding in *Microtus* on a population-wide scale started between the second and third week in May, shortly following the meltoff of all snow in the meadows. Approximately 75% of the females were pregnant by the end of May. Embryo counts ranged from 3 to 7, with an average of 5.3. All of these were first pregnancies of the year, since no lactating females were found and no recent placental scars were observed.

The remaining 25% of the females were beginning to show signs of reproductive activity at the end of May. The only evidence for gonadal recrudescence was a perforate vagina and an increase in uterine turgidity over the infantile proportions seen in sexually quiescent individuals. However, none of these animals had ovulated by the end of May.

Judging from the growth stages of various plants spring in 1970 was later than that in 1969 by approximately two weeks. The reproductive status of Microtus in 1970 also lagged behind the conditions observed in 1969 by approximately two weeks.

B. Summer study period (July-August).

Although Microtus had been breeding since the middle of May, the populations were understandably still at very low levels. Very few well defined runways, characteristic of a Microtus habitat in years of higher population density, could be located. Voles occurred only in small isolated groups, indicating a minimal degree of dispersal by the new recruits into the summer population.

Both subadult and adult Microtus were reproductively active. Embryo counts for subadult females ranged from 4 to 5 (average 4.5); for adult females from 5 to 7 (average 6.3). For the subadults these were first litter pregnancies. All adult females were multiparous. The difference in the average values between females in the two age groups is in agreement with earlier observations (Negus and Pinter, 1966) that litter size in Microtus montanus is related to the age and the parity of the female.

Long-tailed and short-tailed weasels (Mustela frenata and M. erminea, respectively) frequently entered unbaited Sherman livetraps set for Microtus. The abundance of weasels trapped undoubtedly reflects the relative food shortage experienced by the small carnivores as a result of the Microtus crash.

C. Fall study period (October).

Microtus populations were still at a very low level since production during the summer had probably been countered by heavy predation pressure. Once again, voles could be found in small groups only.

Microtus were still reproductively active at this time. Both pregnant and lactating females were trapped. In pregnant females estimated parturition dates fell between October 17-26. However, reproductive activity was confined only to adult animals. Even in this age class reproduction was decreasing: several adult females showed no sign of lactation or ovulation, although placental scars could still be detected. Circumstantial evidence also points to a decreasing reproductive activity in males: the androgen-dependent hip glands which had exhibited heavy sebaceous activity in the summer months were virtually undetectable in males of all age classes trapped during the fall period.

No explanation can be offered at the present for the crash in the Microtus population; a multitude of factors is doubtless involved. However, the crash does not appear to be a density-related phenomenon. Some areas had been trapped considerably more heavily than others over the past years. Consequently, the various populations entered the winter of 1969-70 at

different levels of density. Nevertheless, Microtus disappeared from all study areas. It is also impossible to say at what time between October 1969 and May 1970 the voles had died. The Research Station was visited at the end of January 1970. Although recent sign was located repeatedly, Microtus apparently ventured only infrequently out of their subnivean runways, and were reluctant to enter the traps.

The materials collected during the 1970 study period are currently being processed. This phase of the work is incomplete and the results will not be included in the present report.

The study will continue. The physiological characteristics of voles will be followed and scrutinized throughout the next multiannual cycle of population buildup. Simultaneously information will be collected regarding changes in several environmental variables on a seasonal and a multiannual basis.

I wish to thank Mrs. Allen K. McLean, Touro Research Institute, and Messrs. William E. Donovan and K. Dale Engler, Louisiana State University in New Orleans, for their help in various phases of this study. The financial support of the New York Zoological Society is also gratefully acknowledged.

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Food Habits of the Rocky Mountain Whitefish, *Prosopium williamsoni*

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Project Number 174

From May through October 1970 the food habits of the Rocky Mountain Whitefish, *Prosopium williamsoni*, were studied in conjunction with the National Park Service policy of increasing knowledge of the organisms found in Grand Teton National Park.

The study area was an eight mile section of the Snake River between Lower Schwabacher Landing and the highway bridge at Moose, Wyoming in Grand Teton National Park. Whitefish were obtained by electrofishing and their stomachs were preserved for food composition analysis. The length of each fish was also recorded for grouping of the fish into size classes. Drift and benthos samples were taken during the electrofishing periods for evaluation of the food potentially available to the whitefish. Analysis of the collected materials is presently incomplete. Initial results suggest that Trichoptera and Chironomidae are the most important food items in the diet of the Rocky Mountain whitefish in this section of the Snake River.

Experiments were also conducted to determine if the major source of food for whitefish was from drifting organisms or benthic organisms. Wire pens, one with no bottom (drift and benthos available to feeding fish) and one with a wire bottom (only drift available), were used to contain some whitefish captured by electrofishing. Results of the first experiment were inconclusive, and there was evidence that the fish in the pens had been tampered with the second time the experiment was run.

All the electrofishing done in this study was accomplished through the assistance of Mr. Peter Hayden, various helpers, and National Park Service electrofishing equipment.

Supported by the New York Zoological Society.

The Ecology of Sagebrush on the Glacial Outwash Plains in Grand Teton National Park

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Project Number 169

In the summer of 1970, work was continued into some ecological aspects of the sagebrush community which occurs on the glacial outwash plains of Grand Teton National Park. Twenty one sites were selected so that they covered the possible differences in vegetation which may occur. At each site, over an area of 100 x 200 feet, 40 random one-foot square quadrats were placed. For each quadrat was recorded presence or absence of annuals by species, % cover of grasses by species, % cover of *Eriogonum umbellatum* Torr. var. *subalpinum* (Greene) M. E. Jones, % bare soil, % covered by pocket gopher mounds, numbers or presence of perennial herbs by species, and number of sagebrush seedlings. Also at 13 of the 21 sites, ten transects of 100 foot length were laid out. The transects were used to measure cover due to low sagebrush (*Artemisia arbuscula* Nutt.), big sagebrush (*A. tridentata* Nutt.), other shrubs, *Eriogonum umbellatum* Torr. var. *subalpinum* (Greene) M. E. Jones, bare soil, and pocket gopher mounds. At four different sites ten quadrats of one-foot square each were placed selectively on pocket gopher mounds. For each quadrat was recorded number of sagebrush seedlings, % pocket gopher mound, and numbers of other species growing on or through the pocket gopher mound. Analysis of data has been completed only on the pocket gopher mound-sagebrush seedling relationship.

On casual observation of pocket gopher mounds in the big sagebrush community on Antelope Flats, there seems to be a very close relationship between sagebrush seedling establishment and pocket gopher mounds. This appears to be borne out with data taken from the quadrat placement on pocket gopher mounds. This data is in Table 1.

TABLE 1. The Average Number of Sagebrush Seedlings Per Square Foot of Pocket Gopher Mound at Four Selected Sites.

Site	No. of Seedlings Per Sq. Ft.
Big Sagebrush	
Antelope Flats 1	39.25
Antelope Flats 2	14.94
Big and Low Sagebrush	0.702
Low Sagebrush	0.0

In looking at the data taken on the 21 which were not selectively located, the overall importance of pocket gopher mounds in sagebrush seedling establishment changes. See Table 2 for this data.

TABLE 2. The Average Number of Sagebrush Seedlings Per Square Foot of Pocket Gopher Mound and Per Square Foot of Area not Pocket Gopher Mound at the 21 Sites.

Category	No. of Seedlings Per Sq. Ft. of Mound	No. of Seedlings Per Sq. Ft. not Mound
Big Sagebrush (12 sites)	7.544	0.252
Big Sagebrush & Bitterbrush (3 sites)	5.031	0.0086
Big and Low Sagebrush (3 sites)	8.275	0.495
Low Sagebrush (3 sites)	0.0	0.0604

The t-test was used to compare the average number of sagebrush seedlings per square foot on and not on pocket gopher mounds. In no category, at the 95% significance level, were there significantly more sagebrush seedlings on than not on pocket gopher mounds, and vice versa.

I think that a study on sagebrush seedling survival is necessary in order to determine if pocket gopher mounds are significant in sagebrush establishment on the glacial outwash plains of Grand Teton National Park. All of the sagebrush seedlings sampled were just starting in the 1970 season. Their survival into succeeding seasons could give the necessary data to better show the sagebrush establishment-pocket gopher mound relationship.

Analysis on the remaining data collected is still in progress.

Supported by National Park Service.

Mycological Investigations in Grand Teton National Park

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Project Number 178

I. MICROFUNGI FROM SELENIFEROUS SOILS

In a previous investigation (States, MS Thesis, U. of Wyo., 1966) the seleniferous soils of the Spread Creek anticline, 1.5 miles east of the Elk Ranch reservoir were surveyed for the principal microfungal species. The influence of the element selenium on the composition of the fungal population was found to be distinctive when results were compared to a similar analysis of fungi in a nearby non-seleniferous soil. Several species isolated exhibited the capacity to reduce selenate and selenite to amorphous elemental selenium and volatile selenium compounds in agar culture.

The toxicity of the element selenium to plants and animals has been intensively studied but its relationship to microbial activity in soils is little known. The discovery of reduction and volatilization of selenium by fungi presented some important aspects for further study.

Microfungal investigations of the same soils were initiated this summer with the following objectives:

a. Isolation and identification of soil microfungi capable of metabolizing selenium. These fungi were sought in areas where selenium was most concentrated: in soil near the surface of seleniferous, parent shales, and in the rhizosphere of selenium accumulator plants such as *Astragalus bisulcatus*. Soil samples were taken at the 1, 3, 12, 24, and 36 inch levels along the root systems of *A. bisulcatus* and in soil levels lacking these roots. Seleniferous shales were encountered at the 36 and occasionally the 46 inch levels.

b. Analysis of the vegetative body of *A. bisulcatus* for closely associated microfungi. There exists the possibility that fungi associated with the roots of this plant may facilitate the uptake of selenium. Entire plants in various stages of development were collected during the summer. Since seeds and pods are known to contain high concentrations of selenium, they were harvested to be used in growth experiments, experiments involving the development of the plants from seeds in the presence or absence of microfungi and growth of fungi on extracts prepared from the seeds.

The field work was completed in August and the laboratory experiments are presently underway. The results of the project will be reported at a later date.

II. WOOD DECAY POLYPORES OF GRAND TETON NATIONAL PARK

A collection of wood decay bracket fungi (Polyporaceae) was made in the coniferous and mixed coniferous-deciduous forests of the Park. The primary purpose of the foray was to augment the collections of species in the Polyporaceae present in the cryptogamic herbarium at the University of Wyoming. A list of the fungi encountered and identified is included here. The number of species reported is probably only a small portion of the polypores which occur in the Park. The dry weather which prevailed during the summer was not conducive for the development of fruiting bodies, especially those produced annually. Collections were made between May 15 and August 17, 1970. Several polypores produce fruiting bodies in late summer, at a time when no collections were made. Some fungi found have not been identified.

CHECK-LIST

Gloeophyllum (Lenzites) saepiarium-(Fr.) Karsten. The fungus most destructive to coniferous wood in North America. Found in abundance throughout the Park on dead, usually fallen lodgepole pine in exposed sites. Occasionally on spruce and fir in exposed sites. Distinctive in having lamellae or gills on which the reproductive units are borne.

Gloeophyllum (Trametes) odoratum(Overh.) Imazeki. Found on lodgepole pine, especially on burned or charred wood of this species. Therefore, it can be found in exposed sites of the forest which has been burned over.

Gloeophyllum (Lenzites) trabeum (Pers. ex Fr.) Murr. On aspen. New record.

Fomes subroseus (Weir) Overh. On spruce in the canyons of the Park. Occasional.

Fomes pini (Thore ex. Fr.) Karst. On spruce at high elevations and sites on the dead wood shaded by the canopy. New record.

Fomes nigrolimitatus (Rom.) Egeland. Common on undersurfaces of fallen spruce.

Fomes annosus (Fr.) Cooke. Rare. At base of spruce. One collection.

Fomes pinicola (Swartz ex. Fr.) Cooke. Common on large, dead and downed spruce and occasionally lodgepole pine.

Fomes ignarius (Fr.) Overh. On the branch scars of standing aspen and occasionally large alder and willow that has been downed.

Fomes applanatus (Pers. ex Wallr.) Gill. Common on dead cottonwood and aspen especially in moist sites along waterways. Possibly new record.

Polyporus adustus-Willd. ex Fr. On dead cottonwood and aspen in moist bottomland. Forms annual fruitbodies in late summer.

Polyporus abietinus-Dicks. ex Fr. Very common on downed pine, spruce, and fir. Characterized by violet or purplish pore surface.

Polyporus pargamenus Fries. Very common on dead deciduous trees. Similar to P. abietinus but is not found on coniferous trees and has larger and more pubescent fruitbodies.

Polyporus alboleuteus Ell. & Ev. Common on undersurfaces of spruce and fir logs. Distinguished by its large pores and deep orange-red coloration.

Polyporus leucospongia-Cooke and Harkness. On old logs or stumps of spruce and fir at high elevations. Spongy white upper surface.

Polyporus subchartaceus(Murr.) Overh. Similar to P. pargamenus in habitat and morphology. May be one and the same species.

Polyporus hirsutus-Wulf. ex Fr. On dead wood of deciduous trees. Occasional. New record.

Polyporus mollis Pers. ex Fr. On dead lodgepole pine. One collection.

Polyporus lapponicus Rom. On dead wood of spruce and fir in moist habitats.

Polyporus elegans Bull. ex Fr. Stipitate fruitbody on alder. Common.

Polyporus varius Fries. Similar to P. elegans and can be confused.

Trametes hispida Bagl. Very common on downed cottonwood especially in driftwood and fallen trees along the Snake river.

Trametes sepium Berk. On piled pine fence posts in field near Jackson Lake dam.

Trametes serialis Fries. Similar to T. sepium. Common on dead lodgepole pine logs.

Trametes mollis-(Sommf.) Fr. Occasional on pine and spruce logs.

Polyporus volvatus. Common in occurrence through the Park on the bases of standing lodgepole pine that have been killed by the bark beetles. This species is characterized by a thick rounded margin which extends downward and backward forming a veil-like covering over the pore surface. The fruitbody is therefore globose or compressed globose in shape and yellowish in color. It may be that this species will be an important agent in downing the many trees attacked and killed by beetles.

Note: Members of the genus Poria were collected but have not been identified as yet.

Supported by University of Wyoming.

STUDENT CONSERVATION PROGRAM

Two students worked at the Research Station under the Student Conservation Program. These students were Marion Klaus and Janice Speas. Their program of activities was divided into two major parts, (1) to become acquainted with the various Federal and State agencies concerned with conservation in the area, and (2) to carry out an individual research project. The schedule of activities included the following:

1. An orientation program with Grand Teton National Park Superintendent Chapman, Chief Naturalist Charles McCurdy, and Biologist Peter Hayden, and other personnel and division heads outlining in some detail the activities and responsibilities of the National Park Service, and specifically discussion problems peculiar to Grand Teton National Park.

2. An explanation of the operation of the U.S. Reclamation Service with emphasis on the importance of the Jackson Lake Dam, by Supervisor Braman.

3. Explanation of administration and operation of Teton National Forest by Forest Supervisor Safran.

4. A visit to the Fish and Wildlife Service Elk Refuge. Mr. Blanchard and others discussed the functions of the Refuge including the winter elk feeding program.

5. Explanation of the operation of the Wyoming State Game and Fish Department and its importance in the Jackson Hole area, by personnel of the Wyoming Game and Fish Department in Jackson.

6. The students had the opportunity to visit the Federal Fish Hatchery near Jackson.

7. Each of the students was given an opportunity to observe and participate in the research activities of the investigators at the Station.

8. Attend seminars by research workers at the Station, listed elsewhere in this report.

The usual annual visit to Yellowstone National Park Headquarters at Mammoth was not included in the activities this summer, since both students had visited there on numerous occasions individually.

Following are reports of these students' research projects.

A Survey of the Distribution and Activity of *Drosophila*

Marion Klaus
University of Wyoming

A survey of the distribution of *Drosophila* species in five collecting areas and preliminary observations of their activity cycle was undertaken. All specimens were preserved to be keyed later.

Two types of traps were used in the study. The first consisted of a coffee tin with a large funnel inserted through a plastic lid. The second was a paper cup, either suspended from a branch by a wire or lying at a 45° angle on the ground. The coffee tin trap was unsuccessful, probably because it was too air tight. Paper cup traps worked well in either of the two positions. Flies were removed from the paper cup traps with an oatmeal carton fly collector adapted from the collector described by Spencer (1950). Both ends were removed from the cylindrical carton and a single layer of fine cheesecloth placed over one end. With this collector, several cups could be emptied before it was necessary to transfer the captured flies to vials. The cylinder also served as an anaesthetizer: a large cotton plug was used to localize the flies at the cheesecloth while a second piece of cotton, soaked in ether, was placed on the cheesecloth and temporarily covered with a layer of plastic.

Five areas were designated as collecting sites:

1. Research Station (general vicinity; river bank, picnic area, etc.)
2. Colter Bay Dump
3. Moose Island (North end)
4. Base of Signal Mountain (East end)
5. Lupine Meadows (South end, near Lake trail)

The results of trapping at each of these sites were as follows:

Area	Number of Lures	Total Flies Collected
Research Station	30	45
Colter Bay Dump	25	1
Moose Island	15	0
Signal Mountain, Base	25	28
Lupine Meadows	25	397

Area five yielded the greatest number of flies, whereas four separate days of collecting in Area three yielded no flies.

Activity Cycles

Drosophila activity, as measured by collecting success, was greatest on warm days between 4:30 and 7:30 PM (M.S.T.) in all four study areas which yielded specimens. From mid-July to mid-August, one day of the week was devoted to a careful study of the trap yield at hourly intervals between 6:00 AM and 8:00 PM in Area 1. The only successful collections were those made between five and seven in the evening. No flies appeared in the traps on cold or rainy days. For this reason, few flies were collected during the month of June, and August was the peak month for collecting. The marshy portion of Lupine Meadows (Area 5) consistently produced the largest single collections occuring when the area was warm, but still muddy and wet. Toward the end of August, success decreased as the area became progressively drier. During August, six collections were made in Area 5 at varying times between 1:00 PM and 8:00 PM MST. Following is a tabulation of these collections with average temperatures indicated:

Collection Time (MST) all PM	Average Temperature, °F Dry Bulb	Wet Bulb	Total No. *Drosophila*
1:00	78	68	10
1:30	78	62	1
2:00	78	62	4
2:30	77	61	6
3:00	77	61	4
4:30	79	66	24
5:00	75.5	62	26
5:30	74.5	63	22
6:00	71.6	59.6	58
6:30	69	61.5	47
7:00	66.3	58.5	47
7:30	66	59	59
8:00	--	--	4
8:30	--	--	1

Although overall collecting success was clearly related to temperature, the precise relation is not clear. Light intensity, humidity, wind velocity, and other factors are also implicated.

A more comprehensive study would be required to investigate the parameters of this activity peak and its relation to specific behavior. If adequate collections could be made during July, for instance, the relative importances of light intensity, temperature, and humidity might be more clearly revealed.

The species composition of collections and the species distribution among collections will be the concluding portion of this study. The classification to species of all collections has not been completed at this writing.

Supported by National Park Service.

General Observations on Coyote Behavior

Janice Speas
University of Wyoming

The objectives of this study were to observe the coyote, Canis latrans, in its natural environment during the denning season. This was done in cooperation with Franz Camenzind, doing a three year study of the coyotes in Jackson Hole. Activity near the dens was best observed during the month of June when the pups were approximately two months of age. Later in the summer, the activity of the animals was observed at places other than the original den locations.

The period of pup behavior from June 1st through the 15th can be summarized with the observations made from a den located near the Elk Reservoir. The range of pup activity did not exceed a radius of ten to fifteen meters from the den entrance. The pups were seen drinking at about ten meters from the den. The observer was situated in the open about fifty meters from the den and was unnoticed by the pups, who were seen chewing on and playing with sticks near the den. Though they were not aware of the observer, they were alert and aware of the immediate surroundings. All escape was directed to the entrance of the den, and when attempts were made to disturb the pups, they remained on the mound in front of the entrance in a sitting alert posture. During the observation, an adult coyote howl was heard and there was no apparent reaction from the pups at the den.

The observations from June 15 to June 30 were made in part at three different den locations: Blacktail Butte, Elk Refuge, and Elk Reservoir. Escape behavior was again directed toward the den, but there was no hesitation for the pups to utilize the available natural cover such as sagebrush, willows, draws, ditches, low hills, etc. Although the reports in the literature state that an adult coyote will take to the water when necessary, pups of approximately ten to twelve weeks of age did not cross an irrigation ditch full of water (1½ meters wide by ½ meter deep) when pursued by the observers.

During the month of July observations around dens were harder to obtain. The dens which were previously observed were no longer occupied by the families of coyotes. This may have been due to the greater mobility of the pups, as several were seen moving with the adults, and the activity was not centered around the dens. One of the dens was probably abandoned because of disturbances made by the observers. After the coyotes had moved, closer observations of the dens themselves were made. Within about ten meters of the entrance there was a concentration of small pup scats. Within this radius there were several heavy concentrations of scat. Other things found near the dens included elk remains, sage grouse feathers, other feathers and bones, and sticks. Grass surrounding the entrances was trampled down, and in some cases the sagebrush was shredded.

Observations made from August 1st through the 15th were mostly of pups moving and hunting independently of adults, but still in vocal contact with the adults. Successful hunting was observed when the pups were alone as well as when the pups were with adults. The last two weeks of August there were more sightings of pups moving independently of adults though vocal contact was still kept with the adults, and the pups probably remained in the same range with the adults. By September the adults will have discouraged the family unit to the point of complete independence of the pups, though the pups (apparently litter mates) remain together.

The behavior of an adult around a den that was being observed was noted. The adult was aware of the observer's presence and at all times was watching. A distance of between fifty and one hundred meters was kept at all times, though the animals made a complete circle around me in several hours time. When making the circle, the adult was completely or in part concealed by the sagebrush and/or terrain. Though the adult came within ten meters of the den, it never went up to it. Finally, it lay down, still alert and watching, downwind from the observer's position.

Supported by the National Park Service.

COOPERATION WITH OTHER AGENCIES AND INDIVIDUALS

Among the most important cooperative activities with other agencies and individuals were the following.

1. Wyoming State 4-H Field Program.
   Station facilities were made available for the high school students participating in the 4-H Field Program of the University of Wyoming.

2. Teton Sciences Field Biology School.
   High school students under the supervision of Mr. Ted Major, science instructor at Jackson-Wilson High School, visited the Research Station on two occasions. In addition to an explanation of the Station and its operation, students were given an opportunity to visit with research workers and learn of the various research activities being carried out at the Station. This group of students also participated in a large number of the seminars at the Station.

   Other high school and university groups also made use of the Station facilities and attended seminars.

3. The Research Station cooperated extensively with the Park Service on problems of mutual concern. Grand Teton National Park biologists, Hayden, Loop, and Wood were all very helpful in making suggestions and rendering assistance to the investigators, and likewise, Station personnel cooperated extensively with the Park Service employees.

   Also, contacts were maintained with the Forest Service and Wyoming Game and Fish Department personnel.

4. During the course of the summer a large number of scientists visited the Station. President William D. Carlson and other University of Wyoming scientists visited the Station for short periods. We very much appreciated the visit of President Carlson who gave considerable advice and encouragement to the research workers.

5. Personnel at the Station on numerous occasions served as consultants concerning biological problems of interest and importance to other individuals and agencies in the area. For example, an instructor at the Teton Valley Ranch, which operates a youth school, came for advice on instruction programs for the students.

SEMINARS

The Station continued to present a fine series of seminars during 1970. The investigators at the Station reported on their research activities, and in addition one visitor presented a seminar. The discussions which followed each seminar were also very highly informative and stimulating. The seminars were very well attended by both Station personnel and other scientists in the area. In fact, our seating capacity of about 65 people was exceeded on several occasions, and people sat on the floor and even listened from outside the building.

Following is a list of the seminars presented.

June 25 - Dr. Margaret Altmann - University of Colorado.
The role of fear in the life of big game.

July 2 - Dr. William A. Calder - University of Arizona.
Temperature regulation in birds--a case of convergent evolution.

July 9 - Dr. Robert W. Lichtwardt - University of Kansas.
Morphology and ecology of Trichomycetes.

July 16 - Mr. Jeff Foott - Visitor from San Jose State College.
Sea otters and other things.

July 23 - Dr. Ellis G. MacLeod - University of Illinois.
Reproductive behavior of the insect family Chrysopidae.

July 30 - Dr. Aelita Pinter - Touro Research Institute and Louisiana State University in New Orleans
Environmental control of seasonal pelage changes in Microtus.

Aug. 6 - Dr. Michael Parker - University of Wyoming.
Algae, apple pie, and pollution.

Aug. 13 - Dr. Jack States - University of Wyoming.
Populations of microfungi in seleniferous soils.

Mr. Darold Sabinske - University of Wyoming.
Ecology of sagebrush community on glacial outwash plains in Jackson Hole.

Aug. 20 - Mr. Franz Camenzind - University of Wyoming.
Coyote ecology, population dynamics, and behavior.

Mr. Brenton Costain - University of Wyoming.
Ecology of the Uinta ground squirrel in Jackson Hole.

Refreshments were served at each seminar. Other activities at the Station included picnics and the entertainment of guests. Mrs. Nina Clarke continued to serve effectively as hostess, cook, and entertainer on numerous occasions.

The Library-Seminar building was used extensively by investigators not only as a library and for regular seminars, but for showing of films and holding other meetings related to the research investigations at the Station.

FINANCIAL REPORT
1969-70

November 1, 1969-June 30, 1970

Item	Budgeted	Expended	Carried Over To Next Year's Budget
Research Projects	$ 25.00	$ ---	$ ---
Part-time Assistants	300.00	300.00	---
Equipment	1,853.47	54.75	1,798.00
Supplies	692.71	239.11	451.75
Contractual	740.26	86.74	651.00
Travel	468.39	---	210.60
Fixed Charges	423.00	---	423.00
	$4,502.83	$ 680.60	$3,534.35

July 1, 1970-November 12, 1970

Item	Budgeted*	Obligated or Expended	Unexpended
Research Projects	$ 4,065.00	$4,040.00	$ 25.00
Part-time Assistants	2,500.00	2,078.40	421.60
Equipment	3,063.00	50.00	3,013.00
Supplies	1,741.75	940.88	800.87
Contractual	1,617.00	1,004.70	612.30
Travel	583.60	140.40	443.20
Fixed Charges	523.00	36.00	487.00
	$14,093.35	$8,290.38	$5,802.97

Rent received in the amount of $450.00 was placed in the General Fund of the University.
The New York Zoological Society contributed $500.00 toward the Director's salary in the form of an honorarium.
Grants-in-aid in the amount of $3,000.00 were given to investigators by the New York Zoological Society.

*Includes money carried over from previous year, therefore, does not indicate amounts appropriated for one year.

LIST OF PUBLICATIONS ON RESEARCH AT JACKSON HOLE BIOLOGICAL RESEARCH STATION

University of Wyoming
and
New York Zoological Society

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Patterns of social behavior in big game. Trans. of the 21st No. Amer. Wildl. Conf., March 5-7, 1956. pp. 538-545.

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1957 A study of range condition classes in the Jackson Hole region of Wyoming. Wyoming Range Management Issue No. 104. (Mimeo.)

1960 A Study of Sagebrush. Bulletin 368, University of Wyoming Agricultural Experiment Station, June.

1961 Range Survey in Teton County, Wyoming. Part I. Ecology of Range Resources. Bulletin 376, University of Wyoming Agricultural Experiment Station, March.

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1968 Range Survey in Teton County, Wyoming. Part III. Trends in Vegetation. Research Journal 26, University of Wyoming Agricultural Experiment Station, December.

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