REPORT ON THE ACTIVITIES

OF THE

JACKSON HOLE RESEARCH STATION

SUMMER 1964

L. Floyd Clarke, Director

PHYSICAL FACILITIES

During the past year the University of Wyoming appropriated $7356.00 for the construction of a Library-Seminar Building. Plans are underway at the present time for this construction. Also, on September 17, 1964, the New York Zoological Society appropriated $10,000 to be used for construction of three new cabins and a pole fence to enclose an additional area, which will approximately double the total enclosed area, for expansion of the research area. Other improvements are also included in this appropriation.

These appropriations were very greatly needed for both the improvement and expansion of the Research Station operation. Plans call for the elimination of the present bunkhouse, which is in a state of very poor repair, and the use of one of the buildings moved into the area from Moran for a bunkhouse. The three new cabins will replace this unit as living quarters for research workers. The Library-Seminar building will be used to relieve the congestion in the existing zoology laboratory both by providing library space, which is now in the zoology laboratory, and by providing office space for some of the investigators.

Another major development involved the completion of a 20-year Use Permit agreement with the National Park Service to replace the existing 5-year contract. This new agreement will make possible planning for the future on a permanent basis, which was not possible under the shorter term lease. We certainly appreciate the demonstrated interest of Dr. Fairfield Osborn, President of the New York Zoological Society, Mr. Fred Fagergren, Superintendent of Grand Teton National Park, and other personnel in connection with the development of this research facility.

The Station continues to improve the general laboratory, library, and other facilities. A considerable amount of graveling of roads and Station repair occurred during the past summer. In addition, through the generosity of Grand Teton National Park, a building was moved in from Moose and was repaired and furnished for use by investigators. This was placed in use during the latter part of the summer.

It is indeed a pleasure to be able to report that all of these developments which have been in the planning stage for some time are now in the process of complete realization. Without the complete cooperation of the University of Wyoming, Grand Teton National Park and the New York Zoological Society these improvements would not have been possible.

A Comparative Study of Interspecies Communications

Margaret Altmann
University of Colorado
Project Number 124

The second observational research season of the project, a comparative study of interspecies communications in wild, freeranging ungulates was carried out without interruption during the 1964 summer and fall period. In contrast to previous research seasons in the same area we encountered in 1964 rather complex difficulties in the gathering of the observational data. The difficulties were caused mainly by disturbance of the game animals through the extensive tree-spraying program. The general disturbance in the end, however, provided to some extent information on some new aspects of our problem. This will be shown at a later point in this report.

Our particular focus of interest was aimed at the analysis of signal-chains which transmit a message between different species in the ecological web. The species selected were again the Wapiti elk (Cervus canadensis), the Wyoming moose (Alces alces) and the American bison (Bison bison). The main types of their communications are expressed by use of gesture, facial expression, vocalization and by olfactory means. To the well known types we added the "position effect" of group or individual. We are aware of the fact that in most situations not a single but two or more of these signal systems are involved in sending and receiving a message. The concept of redundancy providing alternate systems, as a device to safeguard message transmission in cases of failure or deficiency of one signal-type,was also explored.

In last year's research report we had stated that communications concerning the security complex provided a good source of information. This was corroborated in more detail by this year's observations. The species specific patterns caused by graded intensities of warning and alarm messages under various environmental conditions, revealed the presence of both major categories of communication types: The iconic and the arbitrary type (P. Marler, 1961, in Journal Theor. Biol., 1961, 1, 295-317).

The iconic signal-type, which represents a direct physical relation to the information conveyed, comprised a large part of the security signals we observed in transmission across the species line. The arbitrary type of message in which the signal and the reaction to the signal are clearly different and separable behaviors is relatively rare. But in both research periods we found in a number of cases reaction-chains transmitting the alert and alarm message across the species line three and four times. Each species did react in its own species pattern.

We found also that the high visual effectiveness of the herd-oriented elk featured far-reaching warning signals (gait changes), while the non herd-oriented moose after reading a message showed the warning in a closeup facial and posture expression. Most of the warning messages do not carry just a simple all or none character. They frequently provide also graded or scaled information about the intensity or gravity of the

danger. Thus a slightly alarmed moose, for example, will show the "alert" posture and facial expression which will, in turn, cause a group of elk in the same area to freeze and scan the environment. This would be a light reaction. A seriously disturbed moose in high alarm will cause an elk-group to execute their own full flight reaction involving the noisy, crashing breakaway characteristic of their species.

The transmission of messages containing negative character was observed to occur frequently within species groups as well as between different species. Thus we noticed that a predator (grizzly bear or a black bear) engaged in a non-hunting activity like foraging clover blossoms or berries, was not causing an alarm reaction in nearby grazing mule-deer and elk. The non-aggressive mood of the bear is "read" by the other species in his environment. Such a signal of security had only temporary character and was terminated when the bear showed changes in intention by gesture and gait. Another type of negative message was conveying non-hostile intentions, when two animals meet at close quarters. This consisted in "looking past" not looking straight at the other animal and in a slight deflection of the direction of walking.

Distinct seasonal fluctuations in sensitivity to message-transmissal within and between species were observed. Such findings led at first to seemingly conflicting results, but showed later on as more observations were made, a clear picture. During the breeding season, for instance, a decrease in response to messages from other species is manifest. This is particularly noticeable in the male for the strong olfactory and vocal signals which take on a ritual character in that period (example: bugling and wallowing in elk), and provide specialized information for the species members. In some cases, however, we found that a message of seasonal connotations like the bugling in elk can take on a deterring character for another species and induce avoidance.

In contrast to our previous research seasons in the Jackson Hole area the social dynamics of the elk and moose were severely affected by the pine-bark beetle spray program (April - August). While there had been limited area spray projects before, the impact of the now enlarged program was heavily felt, in particular since the carrier fluid of the active chemical ingredient was no longer a water base, but Diesel-oil. The strong smell and enduring character of the Diesel-oil pervaded the whole forest acreage far beyond the actual area of spray-application. The effects on behavior of the elk and moose in those areas of the pine-bark beetle spray project was obvious. Interrupting and obscuring the olfactory orientation, the elk groups and individuals showed a more erratic and less cohesive social pattern.

The activity and presence of the spray crews in otherwise remote areas caused additional effects of disturbance, which were particularly severe in the months after calving, when sensitivity to disturbances and intrusion is at its highest point in elk and moose populations. Our observations showed that the usual tendency of elk and moose to resort to an alternate habitat in case of disturbance in their first choice location, had been abandoned, since a simple, unilateral pressure was

not prevailing. The coming and going of the spray teams and their supply vehicles created multilateral and often concentric pressures, which caused prolonged excitation and displacement in the elk. In moose the disturbance was not quite as pronounced, since the areas of spraying only partly overlapped with moose home ranges.

The stepped up excitement and restlessness of both species (moose and elk) led to increased signal-sending and receiving. As the excitement became widespread the readiness to react was reinforced, the reaction itself intensified.

For us, as observers, this change in environmental situation provided a unique source of information. While the work of evaluation of these observations is still in progress, we can state at this point that possibly damaging results of the prolonged disturbance of the elk and moose may show in the months or years to come. The calf crop, the juveniles and the older animals will be likely to show the impact more than the adults in the prime years. These considerations concerning the impact of human disturbances will need much attention and further study, since also the increasing influx of tourists and roadbuilding activity will have to be dealt with.

A research seminar on problems of communications between species was presented by me at the Jackson Hole Research Station on July 2nd, 1964.

Among the many professionally interested visitors were Dr. Arne Peterson from St. Olafs College, Minnesota; Professor O. J. Harvey of the University of Colorado; Mrs. Olaus Murie, Moose; Mr. Bill Jackson from the U.S. Forest Service; Dr. David Love, University of Wyoming; and the director of the National Park Service, Mr. George Hartzog.

To the director of the Research Station, Professor L. F. Clarke, and Mrs. Clarke goes my sincere appreciation for their encouragement and hospitality. The interest and friendly cooperation of my colleagues at the Research Station and at the U.S. Forest Service and National Park Service is also highly appreciated.

Assisted by Kenneth Johnston, University of Colorado.
Supported by National Science Foundation, GB-946.

Trends in Vegetation in Teton County, Wyoming

Alan A. Beetle
University of Wyoming
Project Number 130

During 1964 new range research was begun in Teton County, Wyoming. The project is concerned largely with determination of "trends" in vegetation patterns. Its objectives are: (1) to study methods of determining trend or lack of it, and (2) to evaluate the prevalence, the direction, and the speed of trends found in Teton County vegetation.

Changes in vegetation in Teton County proved easy to find. As a basis for comparison plots studied during 1955-1960 (see Wyoming Agricultural Experiment Station Bulletins 376, and 400, for reports of this research) were restudied. The same survey techniques were used in the same localities, often on the same day of the year, and often by the same examiner. As in the previous study every effort was made to determine what natural patterns remained in the vegetation, and to use these relic areas as guides for description of condition classes other than natural. The field work in 1964 was analyzed under three categories (1) stability, (2) trend, and (3) disturbance.

In analytical synecology some of the factors contributing to stability (climax) are: (a) species tolerance, (b) soil stability, and (c) age of the dominants. Some of the factors contributing to trend are: (a) control of fire, (b) post-glacial changes in climate, (c) geological disturbances.

Disturbances are due to the recent activities of man, and include: (a) fencing, (b) trailing, (c) elk feeding programs, (d) dams, (e) introduction of cattle, horses, and other animals, (f) highways and excavations, (g) irrigation, (h) predator control, and others.

Assisted by David Clarke, University of Wyoming.
Supported by the Wyoming Natural Resource Board, the Teton National Forest Permittees Association, and the Wyoming Agricultural Experiment Station.

Some Aspects of Plant and Animal Distribution as Affected by Geologic Formations

Kenneth L. Diem and Garth S. Kennington
University of Wyoming
Project Number 112

During June and early July northern pocket gophers were trapped on similar rock formations of different ages in Yellowstone Park and in Idaho. These extensive collections are being used to check earlier findings with respect to the variability and intensity of natural radiation and other aspects of the original study reported on in the years since 1961. Samples of parent rock strata were also collected from each of these areas and they are being analyzed for mineral composition.

Supported by University of Wyoming.

Population Study of Canada Geese in Jackson Hole, Wyoming

Ralph W. Dimmick
University of Wyoming

Project Number 113

Following is a summary of this three year study which was completed this summer.

Periodic censuses of the population of Canada geese were made from the air and from the ground. Nesting surveys were conducted by searching the study area on foot or in a boat. Each year since 1956 (except 1959) molting geese have been trapped and banded at Turbid Lake, Yellowstone National Park, Wyoming. Data from this source were used to compute mortality and survival rates for the Jackson Hole population. In 1963 colored neck-collars were placed on 284 geese to obtain information about the timing of movements, size of the population migrating through Jackson Hole, and the breeding area of geese which molt at Turbid Lake. Hydrological data were obtained from the Bureau of Reclamation, the U.S. Weather Bureau, and the U.S. Geological Survey. Climatological data were provided by the U.S. Weather Bureau for stations at Jackson, Moose, and Moran, Wyoming

Flocks of geese spend the winter along the Snake River drainage of northwestern Wyoming in Lincoln County (Star Valley) and Teton County (Jackson Hole). During the period 1952-64 the wintering flock in this drainage varied from 441 to 1061, with a mean of 659 geese.

The spring migration of geese into the breeding ground is not obvious, primarily because of the presence of geese which spent the winter there, some of which may remain there to breed. Courtship activity commences during late February and early March. Selection of the nest sites extends from late March to late May. In most years, the initiation of nesting in Jackson Hole coincides with the disappearance of snow from the nesting areas.

One hundred forty-five nests were located in Jackson Hole; 51.0 per cent of these nests were grouped in three small areas. Seventy-one per cent of all nests found were on islands. The mean distance to water for 140 nests was 45.7 feet. Nest sites were usually located close to good feeding areas. Sandy substrates were preferred for nesting when this substrate was available. Cover types most often selected for nesting were shrub (32.4 per cent) and driftwood (26.9 per cent). Concealment of nests ranged from poor to excellent, with no preference indicated for any of four categories used. Geese tended to select nest locations with excellent or good visibility of the surrounding terrain. Vegetative lining of the nest hollow was always material found in the immediate vicinity of the nest. Defense of the nesting territory was observed often, both on the Snake River and on marshes and ponds throughout the study area.

Sixty-two per cent of all nests for which fates were determined were successful, 35 per cent were destroyed and three per cent were deserted.

Birds were the most serious nest predator. Flooding was not an important cause of nest destruction, primarily because many nests were in areas not susceptible to flooding, or were completed before flooding occurred. In some years, the management practices of Jackson Lake Dam have reduced the total volume of water downstream in the Snake River, and have helped prevent some losses to flooding which may have otherwise occurred. Manipulation of water in the Snake River, however may have reduced the desirability of this river as a nesting area for Canada geese, and may have contributed to the apparent decline indicated by a comparison of the population reported in 1947 with that found in this study.

The peak of hatching occurred between May 16 and 30 in 1962 and 1964. The peak of hatching was about two weeks earlier than this in 1963, primarily because a lack of snow cover on the nesting areas made nest sites available sooner. Mean clutch size varied annually from 4.9 to 5.5 eggs with a mean of 5.2 eggs for 114 completed clutches. Mean brood size was 4.7 for 61 broods observed during 1962 and 1963. Mortality of the goslings appeared to be negligible. Non-breeding geese and unsuccessful breeders left the nesting areas to pass the flightless period. Molting concentrations totaling 970 geese in 1963 and 747 geese in 1964 were located on five areas in Jackson Hole and Yellowstone National Park.

The autumn migration through Jackson Hole begins in late July and continues through late October or early November. In 1963 an estimated 2260 geese passed through Jackson Hole during the autumn migration. Major wintering areas outside Wyoming for geese banded at Turbid Lake are in central Arizona and southern California.

Trends in the population during the breeding season were determined from aerial surveys of the Snake River conducted by the Wyoming Game and Fish Commission since 1952. The population was generally highest in the earliest part of this period, declining during 1958-62, then increasing in 1963 and 1964. The results of two independent aerial censuses made each breeding season were compared with nesting studies and ground counts to more precisely determine the population in Jackson Hole during the study period. The mean population during the breeding season was 287.3 geese. Breeding pairs each year comprised 40.2 to 47.0 per cent of this population, averaging 43.5 per cent for the 3-year period. The sex ratio among 333 adults sexed at Turbid Lake in 1963 favored males 1.2:1. The survival analysis utilized 345 recoveries from 1350 geese banded as adults. The average annual mortality rate for the composite banding class (1956, 1957, 1958 and 1960) was 37.13 per cent. Adjusted to incorporate estimated juvenile first-year mortality, this rate was 39.66 per cent. A comparison of trap return information with band recovery data indicated that the latter may overestimate mortality rates in older age classes of Canada geese.

A comparison of the average annual mortality rate with the average annual increase from natality indicated a 2.1 per cent decrease in the population from one breeding season to the next. The proper interpretation of these data relating to natality and mortality was thought to be that the population was neither steadily decreasing or increasing, but fluctuating around a mean of slightly less than 300 geese.

Supported by Wyoming Game and Fish Department

A Study of the Plant Ecology of the Willow Flats

William C. Edwards
University of Nebraska
Project Number 121

This was the second summer of a proposed three summer research project on the Willow Flats area west of the Research Station. The majority of research involved two main lines: a continuation of work on the willows and associated species of vascular plants in the area and research on the life cycle of the bog birch Betula glandulosa Michx.

The willows which were collected and tagged last year were relocated and recollected. In addition several species which were not collected last year were collected and tagged. The willows collected last summer were sent to Dr. George Argus during the winter, and his identifications will accompany the specimens which will be deposited in the Rocky Mountain and Grand Teton Park Herbaria.

An area was located where the bog birch was relatively abundant, and 100 sites were established and information was obtained on height, catkin production, growth pattern and associated species of vascular plants. Weekly for eight weeks 100 twig samples of birch were collected and information on growth rate, duration and pattern plus leaf production was obtained. Twig and shoot collections were also made and these will be kept alive for greenhouse studies to be conducted at the University of Nebraska. A seed collection of birch was made and germination tests and observations on seedling growth will also be made at the University of Nebraska.

Information on distribution of the birch was also obtained by extensive reconnaissance in the valley floor and up into several high mountain valleys.

Both Yellowstone and Grand Teton Park Herbaria were also utilized extensively for obtaining information on distribution and identification of the specimens collected.

Next summer the work will be continued on the willows, birch and identification and analysis of the rest of the vascular flora in the area.

Supported by the New York Zoological Society.

Comparative Ethology of Solitary Wasps

Howard E. Evans
Harvard Museum of Comparative Zoology

Project Number 115

General remarks: Studies of this type are of necessity rather opportunistic, i.e., one has to take advantage of the species abundant in the area that season. Most solitary wasps exhibit large fluctuations in abundance. For this reason, my research this year developed along somewhat different lines than anticipated.

1. Determination of factors involved in orientation to clusters in Steniolia obliqua. A good deal was learned about the general features of clustering in 1961. I wished further to determine whether these insects secrete a pheromone which guides them to the cluster each evening, or whether they merely remember visual cues (as they do with respect to the nest). I found only one cluster this year, and this contained only 60 wasps at its maximum. My experiments were therefore limited and could not be repeated. So far as they go, these experiments indicate that a pheromone is not involved, but that the clustering sites are found in much the same way as the nesting sites. I doubt if it will be possible to go further in this area, as the population of Steniolia is declining steadily (D. Lowrie has sent me his data over several years). I have been unable to find the species in other parts of Jackson Hole. Any reports of clusters elsewhere would be welcomed.

2. Nesting behavior of Stictiella emarginata. I located this species in some numbers near the station in 1961, but did not have time to study it. This year I collected only two individuals and, after a prolonged search, was quite unable to locate any nests. This is an unusual species structurally, and may exhibit some unusual behavioral features. The prey consists of moths.

3. Further studies of Bembix amoena in Yellowstone. I studied a colony at South Entrance in some detail in 1961. I wished to make a brief comparative study of a colony at some distance away, to determine how well the supposed distinctive features held up. A large colony near Madison Jct. served very well and demonstrated that the behavior is subject to little variation, at least over that range. This colony is very heavily parasitized, and I obtained much additional data on parasitism.

4. Ethology of Ammophila (sp. as yet undetermined) at the Cattlemen's Bridge. This species was remarkably abundant this year, and I spent much time working on it. The behavior proves to be the most advanced and complex of any American sp. of this genus which has been studied. For one thing, the females maintain more than one nest at a time, a feature proved for only one other digger wasp (of any group), the European Ammophila pubescens. I was unable to do complete justice to this species this year, and will need to spend more time with it, marking all individuals in the colony. This year I marked only five, and obtained complete day-to-day records for only one.

5. General survey of the digger wasps along the Snake River between the station and the Cattlemen's Bridge. This was begun in 1961 and will need another one or two summers, at least, to complete. I wish to learn not only the spp. present (there may be 50 or more) but their parasites and prey. There are many inter-relationships among these species; for example, three spp. of Philanthus prey upon other wasps, several of the wasps share the same parasites, etc. In general, there is little or no competition for prey or nesting sites. Many of the wasps are little known (one studied in 1961 had to be described as new). The following are some of the species involved (some are abundant and conspicuous, others scarce, small, and/or secretive):

Well studied spp.

Bembix spinolae
Steniolia obliqua
Hoplisoides nebulosus
Oxybelus quadrinotatum
Episyron 5-notatus
Nitelopterus evansi
Podalonia robusta
Plenoculus davisi

Spp. studied this year

Philanthus (3 spp.)
Cerceris (2 spp.)
Xylocelia sp.
Ammophila sp.
Stenodynerus sp.
Crossocerus sp.
Tachysphex (3 spp.)

Spp. as yet unstudied or virtually so

Stictiella emarginata
Dienoplus sp.
Astata (3 spp.)
Anoplius tenebrosus
Pompilus (4 spp.)
At least 10-20 other spp.

Publication: Much of the data gathered will be used in a book-length manuscript now approaching completion, titled "Comparative ethology and evolution of the nyssonine sand wasps" will eventually be forthcoming, and I would hope some day to prepare a report on the ecology and inter-relationships of the wasps occurring along the Snake River at and near the station (item 5 above).

Supported by National Science Foundation, Project No. G17497.

An Ecological-Physiological Study of Moose

Douglas B. Houston
University of Wyoming
Project Number 125

Fourteen months of research have been completed on the cooperative National Park Service, Wyoming Game and Fish Commission, and University of Wyoming moose ecology study.

A knowledge of population dynamics is vital to the understanding of the ecology of the moose. Approximately 400 moose jaws have been collected from hunter killed animals in an attempt to determine the age structure of the population. Jaws from winter killed animals have also been collected to determine the sex and ages of those animals dying on the winter ranges. Over 80 reproductive tracts have been collected from female moose killed in areas adjacent to Grand Teton Park. Examination of these tracts should provide valuable information about minimum and maximum breeding ages, and age specific ovulation and pregnancy rates. During the fourteen month period covered by this report an attempt was made to classify all animals observed into sex and age groups. Over 700 animals have been so classified. These classifications, repeated at different times of the year, coupled with the jaw and reproductive tract collections will yield information on the population dynamics of this moose population.

It is one thing to describe the population dynamics of a moose herd and quite another to explain and understand the factors influencing natality and mortality. Studies of food habits, weather conditions and animal behavior have been initiated in an attempt to evaluate these factors as possibly being responsible for limiting the population. Briefly, the seasonal forage preferences of the moose are being studied in all major habitat types. Winter use condition and trend transects on key forage species have also been established. Over one thousand willow plants are examined annually to determine effects of various intensities of moose utilization. Biochemical analysis of the "quality" of major forage species under various conditions of use is being completed. Quantitative descriptions of the various willow communities in relation to soil types, water conditions, and moose utilization has been undertaken. Also under study is a detailed analysis of climatological conditions as they might influence food availability and moose mobility.

A total of 56 moose have been ear tagged using succinylcholine chloride delivered by a projectile syringe. Repeated observations of these animals have yielded valuable information on the size of home ranges, distribution, and sizes of resident and migratory segments of the population. The individually marked animals will also yield information on pregnancy rates, minimum breeding ages, etc. to augment other information of this type. Blood samples are being taken from some of these animals during the tagging process. Biochemical analysis of these samples may yield a quantitative description of the condition of these animals under different and varying environmental stress situations.

Supported by Grand Teton National Park.

Third Creek Waterfowl Study

John W. Huckabee
University of Wyoming

Project Number 131

The marshes of the Third Creek area in Grand Teton National Park have been occupied by a wide variety of waterfowl. The objectives of this study were (1) determine the extent of waterfowl utilization and production, and (2) to determine what major factors influence the nature of existing waterfowl populations.

The study area encompasses an area of approximately seven square miles. Two permanent streams, Second Creek and Third Creek, and Swan Lake lie within the area. Numerous beaver dams on both streams have provided natural water impoundments of variable sizes. The study area is largely a mosaic of willow, grass and sedge bounded by Jackson Lake on the south, coniferous forests of spruce-fir (*Picea* - *Abies*) and lodgepole pine (*Pinus contorta*) on the west and north with some aspen (*Populus tremuloides*) and cottonwood (*Populus*) on the northeast. Second Creek forms the eastern boundary of the unit.

Preliminary examination of census data indicates that the mallard (*Anas platyrhynchos*) was the most abundant species throughout the study period. The green-winged teal (*Anas carolinensis*) was a close second. During the short migration periods the numbers of gadwall (*Anas strepera*) and the American merganser (*Mergus merganser*) did exceed the mallard and green-winged teal.

The ring-necked duck (*Aythya collaris*) was the most abundant diving duck throughout the study period. A large concentration of migratory drakes was observed using Swan Lake in October.

Information on breeding activity, molt, behavior, and predation is currently being tabulated and will be included in the thesis publication.

Supported by the New York Zoological Society.

Habitats of the Spiders of the Genus Pardosa in the Jackson Hole Region

Donald C. Lowrie
California State College, Los Angeles

Project Number 119

A final study of three weeks duration of the habitats of the species of spiders of the genus Pardosa in the Tetons was finished this summer. The areas of high altitude lakes, the rock piles of talus slopes, and most of the length of the Gros Ventre River were investigated for these spiders. Six trips were made to critical localities in addition to incidental checkings of some localities where some special problems existed. Over two hundred specimens were collected from nearly 30 different situations. The current list of 18 species of Pardosa to be found in the Jackson Hole area are as follows:

P. altamontis	P. tesquorum
P. anomala	P. tetonensis
P. coloradensis	P. tristis
P. distincta	P. uintana
P. dorsalis	P. uncata
P. fuscula	P. utahensis
P. moesta	P. wasatchensis
P. solituda	P. wyuta
P. steva	P. xerampelina

Due to cold, and snowy weather some collecting was poor but even this has added evidence of climatic conditions which prevent or reduce the movements of the spiders. Some distributional records were obtained for the rare species but, in general, there were few additional records and they still seem to be uncommon in the Hole. This may be due, as indicated by the collecting elsewhere in the West, to the fact that some of these have their northern, eastern or southern limits in the vicinity of Western Wyoming. This is the final phase of this study since the remaining information on the less common species, which would be useful to ascertain, would take much more time to determine than has been necessary for obtaining the bulk of the data so far.

Supported by the New York Zoological Society.

Environmental Influence on Parasitic Infection

Glenn A. Noble
California State Polytechnic College
Project Number 103

This work has been a continuation of the investigation of ground squirrels under stress and their pinworm infection. My assistant, Mr. Joseph Choi, and I subjected groups of the Uinta ground squirrel, Citellus armatus, to the stress of reduced night-time temperatures and noted the effect on the numbers of the cecal pinworm, Syphacia citelli, compared to controls.

Each experimental group of ten animals was placed in a box approximately one meter square and given the drug stilbazium iodide for two days to remove the pinworms. After two more days on a diet of unmedicated food, each squirrel was given, via a stomach tube, 500 infective worm eggs in Ringer's solution. Every night for two weeks (the approximate period of the life cycle of the parasite) the squirrels were stressed by the removal of all grass or other possible bedding material and by placing two kilograms of ice in the pen. Control animals, in groups of ten, given similar treatment but with electrically warmed pens at night were also provided with paper bedding material and cardboard tubes for burrows.

The night-time temperature within the cold-stressed pens went down to about 5° C whereas that in the control boxes did not get lower than about 16° C. Temperatures within the cardboard tubes, when occupied by squirrels, remained approximately the same as the body temperature of the rodents, or about 34° C. At the end of two weeks the squirrels were sacrificed, weighed, adrenal glands weighed and a count made of the numbers of pinworms.

The average adrenal weight in the field animals before bringing them to the laboratory was 21 mg per kilogram of body weight. In the stressed animals it was 110 mg whereas in the control group it averaged 81 mg. Thus in the stressed group there was an increase of adrenal weight of 424 per cent as compared to field animals, and an increase of 286 per cent as compared to the controls. The results definitely indicated that under the conditions of the experiment the animals were under stress.

Pinworm numbers in the two experimental groups of squirrels are shown in the following table.

	Stressed	Controls
Total Number of Squirrels	47	36
Number Infected	20	6
Average Number of Worms in Infected Squirrels	11.5	2.83
Average Number of Worms in All Animals	4.89	0.56

The results show that there was a 305 per cent increase in numbers of worms in the infected stressed animals over those in the controls and a 772 per cent increase in numbers of worms in all the stressed animals over those in all the controls.

Assisted by Joseph Choi, California State Polytechnic College.
Supported by the National Science Foundation.

Plant Ecological Studies in Grand Teton National Park

Edward Oswald and John H. Rumely
Montana State University

Project Number 123

Research was conducted in the Grand Teton National Park during the period June 15, 1964 to September 15, 1964 on the ecology of the lodgepole pine (*Pinus contorta*) communities. During the period the following data were collected.

Approximately 350 species of plants were collected representing 87 genera and 54 families. The collection sites include the Gros Ventre campground area, Blacktail Butte, the Sagebrush flats east of Moose, Antelope Flats, Timbered Island, Burnt Ridge, Signal Mountain, Willow Flats, Lozier Hill and surrounding areas, the Pacific Creek Area, Emma Matilda Lake margin, Two Oceans Lake margin, Cascade Canyon, Death Canyon and Taggart Lake Trail.

A very distinct line between forest and grassland occurs in the east ecotone of Timberland Island. One hundred and twenty 0.5 x 1 meter plots were laid in 24 lines of 5 plots each radiating out from the forest margin, the lines being 100 meters apart, to check the homogeneity of the vegetation.

A comparison was made among the Random-pairs method, Quarter method and 10 x 10 meter plot method to find the most applicable method for sampling the tree cover. The Random-pairs method appears to be most satisfactory. Seven hundred eighty Random-pairs points were taken, sampling various exposures and geologically different sites with a minimum of 25 points at any one site.

Daubenmire coverage determinations were made at every other Random-pairs point to sample the understory vegetation. The method appears satisfactory for the herb layer but not for the shrubs.

Four browse plots were laid in different sites to determine the effects of browse on the saplings and relate this to availability. The distance between each tree, its size and present condition were recorded for each tree species that occurred in the plots. In addition to this, 23 trees were tagged in various habitats and similar data were recorded of the trees in the immediate vicinity of the tagged trees; sampling an area approximately 20 ft. in radius of the tagged trees. The "browse data" was taken from an approximate total of 550 trees.

Four 15 x 15 meter plots were laid out in areas where the forest appears to be advancing onto the grassland. The distance between trees, the size of the trees, their present condition and species were recorded and photographs taken of each plot.

Fifty-eight increment-bore samples were taken from trees of various exposures along with the diameter of each tree for the purpose of making age to diameter relationships and also to date fires, etc.

Nine soil sample holes were dug 30-36 inches deep to sample the different soil horizons. The different geological formations were sampled and included Timbered Island Moraine, Jackson Lake Moraine, Burnt Ridge Moraine, Dry Hollow, Outwash Plain (Bull Lake Outwash) and the Pinedale Outwash Plain. Soil samples were also taken from a large "elk salt-lick" occurring on Timbered Island and from the upper six inches under a heavily sprayed lodgepole pine tree.

A few seedlings, mostly lodgepole, were collected and brought to the laboratory for tests on growth habits. Also cones of lodgepole pine and fir trees were collected to test seed germination, etc.

Supported by Grand Teton National Park.

Social Organization Among Colonies in Ants

Gerald Scherba
San Bernardino State College

Project Number 80

The population of mound nests of Formica opaciventris, under observation since 1957, was again examined. Since 1957 the total population has declined 16% with a corresponding decrease in the proportion of more active mounds. Average mortality rate is 10.4%; average birth rate, 9.9%. Brood was present in 85% of the mounds.

On the basis of the information available so far, the colony life history appears to be as follows. New mounds are formed by budding of workers, brood and queen from an established nest. Mortality rate of these bud nests is high, but if the nest survives, winged males may be released during the August mating flights after the second year of existence. Some years after founding, and only once during the life of a single colony, the colony will produce and release winged virgin queens. These queens will mate, then return to the nest of origin. The colony will grow in size, produce brood, release bud nests, and, with the end of egg production or death of the queens, the colony will become senescent and die. The population of colonies is, however, maintained by the production of bud nests.

Evidence has been accumulating over the years which seems to support the concept of a social organization existing among this population of mounds. The evidence from visiting behavior and from the division of reproductive function among the mounds has been detailed in earlier reports. Additional findings now indicate that feeding sites and bait placed among a group of nests are shared by the workers from different nests. This is in marked contrast to the behavior of other species of ants.

An incidental, though interesting find, was that of a Braconid wasp, believed to be parasitizing workers of opaciventris. The wasp hops onto the abdomen of the ant and presumably deposits an egg through the ant's anus.

Assisted by John Cummings, University of California, Riverside.
Supported by National Science Foundation Grant 23423.

Melanophore-Stimulating Substances in Amphibia

William Thurmond
California State Polytechnic College

Project Number 122

Work begun on this project last summer revealed that grafts of the hypothalamus from embryos and albino larvae of the salamander, Ambystoma tigrinum melanostictum caused melanin dispersion to occur in the melanophores of larval albino hosts of the same species. This summer a similar study has been extended to the adult. Various areas of the brain of hypophysectomized adult salamanders have been transplanted to albino larvae to determine the specific source of this melanophore-stimulating substance reported earlier.

Adult salamanders were caught near Colter Bay Village, Grand Teton National Park, Wyoming, in late June and early July. Embryos, up to the tailbud stage, were collected from a small pond approximately 5 miles from the summit of Togwotee Pass, Teton National Forest, Wyoming, from June 16 to June 29.

The procedure used in these experiments involved three steps. Adult salamanders were hypophysectomized to remove the source of the known pigment granule dispersing substances, intermedin from the pars intermedia and adrenocorticotropin from the pars distalis. Second, albino larvae that were to be used as hosts for tissue grafts were prepared by removing the epithelial hypophysis at the tail bud stage. And third, one to two weeks after the above operations the adult salamander was sacrificed and parts of the brain were transplanted adjacent to the punctate melanophores and in the subcutaneous tissue of the albino larvae and observed daily for periods up to four weeks. A total of 282 grafts from the adults were transplanted to albino larvae and studied this summer.

Two types of controls were prepared. Relatively small segments of two pars intermedia were transplanted into eight albino larvae to serve as "positive" controls. The melanophores of these hosts showed maximum melanin dispersion and gave a black appearance to each larva for a period of 4 weeks. Twenty-eight "negative" controls were prepared by grafting tissues from the roof of the cerebral hemispheres (4), habenula (8), cerebellum (4), and medulla (12). Only 3 of these grafts caused melanin dispersion the first day and by the third day after transplantation none of the grafts were causing melanin dispersion in the host's pigment cells.

Forty of 42 grafts from the median part of the ventral hypothalamus posterior to the optic chiasma evoked pigment responses in the hosts that lasted at least 12 days whereas only thirteen of the 41 grafts from the lateral wall of the ventral hypothalamus in the same area evoked pigment responses that lasted 12 days.

Tissues from the superior colliculus (8), subcommissural organ (3), dorsal hypothalamus (20), and ventral thalamus (6) gave no response or only weak responses that generally lasted one to three days and in only 3 instances as long as 5 days. On the other hand grafts from the preoptic nucleus area (4) in general evoked melanin dispersion in the albino larvae that lasted 4 to 5 days and in 5 instances grafts from the anterior preoptic nucleus evoked strong responses that lasted from 7 to 14 days.

To summarize the work for this summer it has been shown that adult brain tissue from the tiger salamander will evoke melanin dispersion in melanophores of albino larvae and that essentially 100% of the grafts from the median ventral hypothalamus give a strong and sustained response. On the other hand between 30 and 40 percent of the grafts from the lateral half of the ventral hypothalamus and 10-15% of the grafts from the preoptic nucleus area give a similar response. Grafts from other areas of the brain either do not evoke a pigment response or cause only a weak response for 1-3 days.

This substance has not been identified but it can be said with confidence that it is not due to diffusion or by contamination of intermedin from the pars intermedia or by ACTH from the pars distalis. Because of the recent work of Novales ('63) where he used cultured melanophores to test the effect of various substances, it is very doubtful whether serotonin could be the cause of the melanin-dispersing activity reported here. Other substances which should be studied for their effect upon Ambystoma albino larvae are acetylcholine and the corticotrophic releasing factor that has been identified in the mammalian hypothalamus.

Supported by New York Zoological Society.

SEMINARS

Weekly seminars were held at 7:30 P.M. each Thursday at the home of the Director. These seminars proved to be stimulating to the research workers at the Station as well as many interested visitors. The following is a list of the seminars presented during the summer.

Margaret Altmann - Comparative study of ungulate interspecies communication.

Howard E. Evans - Wasps as predators.

Glenn A. Noble -Squirrels under stress.

William C. Edwards - Plant ecology of the Willow Flats.

Ralph W. Dimmick - Population study of Canada geese in Jackson Hole.

William Thurmond - Melanophore stimulating substances in Amphibia.

Gerald Scherba - Social organization among colonies in ants.

C. S. Thornton - Regeneration in Amphibians.

LIBRARY

Periodicals previously subscribed were continued. Current periodicals were made available to the research workers before being filed in the stacks. We continue to receive reprints from research workers of previous years. The total number of titles of published data resulting from work at the Station is now well in excess of 100. Current National Park Service and Forest Service publications and information are made available to investigators. Reports on research projects, Annual Reports and other information related to the Station operation are made available. The September-October, 1964 issue of The Wyoming Alumnews contains a well illustrated article entitled, "Research at the Foot of the Tetons", which covers the summer activities of the Research Station. Also, an article concerning the Research Station appeared in the August 1963 issue of American Zoologist.

Our library facilities will be greatly improved by construction of the Seminar-Library building which will be completed in the summer of 1965.

A list of the reprints of publications which we have available on research conducted at the Station is included as an appendix to this Report.

IMPORTANT VISITS TO STATION

Among the highlights of the summer's activity was a visit from George B. Hartzog, Director of the National Park Service, and other eminent visitors connected with the National Park Service. Dr. Hartzog expressed a keen interest in the operation of the Station and promised full cooperation in plans for its development. Certainly, over the years the interest and cooperation of the National Park Service and Grand Teton National Park personnel have improved and have greatly strengthened the research operation. The research workers at the Station had an opportunity to visit with Mr. Hartzog individually and as a group with respect to their individual research projects and the ways in which these activities could contribute to the objectives of the National Park Service.

We were fortunate again this summer in having a visit from Dr. Fairfield Osborn, President of the New York Zoological Society. He demonstrated, as in the past, the keen interest of the New York Zoological Society in the program of the Research Station. This is evident by the fact that after discussion of our needs for improvement, he was able to obtain the $10,000 appropriated by the Society for the development of the Station facilities.

Many other eminent visitors came to the Station during the past summer. These included foreign scientists who are interested in observing the operation of an inland research facility as well as many eminent educators from this country. The list of names is too long to include in this report.

COOPERATION WITH OTHER AGENCIES AND INDIVIDUALS

The relationship with Grand Teton National Park continued to improve chiefly through interests of Superintendent Fagergren, Chief Naturalist Willard Dilley, and Park Biologist Glen Cole. Cooperation with the Forest Service continued to be close with Robert Casebeer and his temporary replacement, Mr. Alred.

Mr. Willard Dilley served as a member of the Advisory Board in selection of the research projects. The University cooperated where possible in making recommendations for the employment of Park Service personnel.

The objectives of the Research Station involving cooperation with the National Park Service have been clearly outlined and agreed upon. Reference is made here to a summary of these objectives in the 1963 Annual Report.

Specific cooperative projects with Grand Teton National Park this summer were: (1) An ecological-physiological study of moose by Douglas Houston, and (2) Plant ecological studies in the Park by John Rumely and

Edward Oswald. These projects were supported directly by Grand Teton National Park. In addition a number of other projects of interest to the Park, including waterfowl, range, and elk management studies, were pursued at the Station.

The Station continues to work on cooperative projects with the Wyoming Game and Fish Department. This summer these included, (1) A population study of Canada geese in Jackson Hole by Ralph Dimmick, and (2) Ecology of cutthroat trout by Peter Hayden.

The Wyoming Game and Fish Department and the National Park Service provided the necessary permits to carry out all research projects.

Station personnel were available for consultation services by many State and Federal agencies in the area and elsewhere.

FINANCIAL REPORT
1963-64
November 1, 1963-June 30, 1964

Item	Budgeted	Expended	Carried Over To Next Year's Budget
Part-time Assistants	$ 200.00	$ 200.00	$ ---
Equipment	621.56	543.05	78.51
Supplies	724.13	332.13	392.00
Contractual	2,060.24	1,505.82	554.42
Travel	229.96	74.26	155.70
Fixed Charges	132.00	---	132.00
Extraordinary Expense	52.54	---	52.54
	$4,020.43	$2,655.26	$1,365.17

July 1, 1964-November 20, 1964

Item	Budgeted*	Expended	Unexpended
Research Projects	$1,034.00	$1,034.00	$ ---
Part-time Assistants	1,600.00	1,400.00	200.00
Equipment	778.51	476.25	302.26
Supplies	1,142.00	619.70	522.30
Contractual	1,397.42	710.34	687.08
Travel	410.70	146.27	264.43
Fixed Charges	264.00	36.00	228.00
Extraordinary Expense	127.54	79.05	48.49
	$6,754.17	$4,501.61	$2,252.56

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

Rent received in the amount of $1,019.60 was placed in the General Fund of the University.
The New York Zoological Society contributed $500 toward the Director's salary in the form of an honorarium.
Grants-in-aid in the amount of $1800.00 were given by the New York Zoological Society.
Grand Teton National Park grant to Houston ($1,500) and to Rumely.
National Science Foundation Research Grant (Noble) - $4,171.20.
Source of financial support of other projects has been indicated at the conclusion of summaries appearing in this Report.
The New York Zoological Society gave $10,000 for construction of 3 cabins, a pole fence and miscellaneous capital outlay.
The University of Wyoming appropriated $7,356.00 to construct a Library-Seminar building.

LIST OF PUBLICATIONS ON RESEARCH
AT
JACKSON HOLE BIOLOGICAL RESEARCH STATION

University of Wyoming
and
New York Zoological Society

Altmann, Margaret

1951 Patterns of herd structure in free-ranging elk. Abstr. Anat. Rec., 3(3):74.

1952 Social behavior of elk, Cervus canadensis nelsoni, in the Jackson Hole area of Wyoming. Behavior 4(2).

1953 Social graces in elk society. Bul. N.Y. Zool. Soc., Animal Kingdom, 56(3):66-72.

1956 Patterns of herd behavior in free-ranging elk of Wyoming, Cervus canadensis nelsoni. Zoologica, 41(2):65-71.

Two marking devices for large land mammals. Jour. of Wildl. Mgt., 20(4):464. With Richard D. Taber and Anton de Vos.

1958 The flight distance in free-ranging big game. Jour. of Wildl. Mgt., 22(2):207-209.

Social integration of the moose calf. Animal Behaviour, 6(3-4):155-159.

1959 Group dynamics in Wyoming moose during the rutting season. Jour. of Mammal., 40(3):420-424.

1960 Moose runs from Sandhill Crane. J. of Mammal., 41(4):525.

The role of juvenile elk and moose in the social dynamics of their species. Zoologica 45, Pt. 1:35-39.

1961 "Teen-age" problems in the wilderness. Animal Kingdom, 64(2):41-44.

1963 Naturalistic studies of maternal care in moose and elk. Chapter in Maternal Behavior in Mammals Ed. by Harriet L. Rheingold. John Wiley & Sons, pp. 233-253.

Seniors of the wilderness. Animal Kingdom, 66(6):181-183.

Armitage, Kenneth B.

1959 Behavior patterns of juvenile yellow-bellied marmots (Marmota flaviventris nosophora Howell). Anat. Rec., 134(3):529.

1961 Frequency of melanism in the golden-mantled marmot. J. of Mammal., 42(1):100-101.

1962 Social behaviour of a colony of the yellow-bellied marmot (Marmota flaviventris). An. Behav., 10(3-4):319-331.

Bangham, Ralph

1951 Parasites of fish in the Upper Snake River drainage and in Yellowstone Lake, Wyoming. Zoologica, 36(III).

1953 Studies on monogenetic trematodes: Dactylogryidae from Alaska, Wisconsin and Wyoming. Am. Mid. Nat., 50(1):206-217. Published by John D. Mizelle and Francis O. Webb using Bangham's material.

Hypocaryophyllaeus gilae n. sp. (Cestoda: Caryophyllaeidae) from the Utah chub, Gila atraria, in Wyoming. Proc. Helm. Soc. Wash., 20(2):113-117. Published by Jacob H. Fischthal using Bangham's material.

Baxter, John W.

1960 Aquatic Hyphomycetes from Wyoming. Mycologia, 52(4):654-655.

Beetle, Alan A.

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.

1962 Range Survey in Teton County, Wyoming. Part II. Utilization and Condition Classes. Bulletin 400, University of Wyoming Agricultural Experiment Station, December.

Beetle, Dorothy E.

1956 Habitats of terrestrial Mollusca in Jackson Hole, Wyoming. Jour. Colo.-Wyo. Acad. Sci., 55(8):43.

1957 The Mollusca of Teton County, Wyoming. The Nautilus, 71(1):12-22.

1960 Noteworthy records of Wyoming mollusca. The Nautilus, 73(4):155-157.

A checklist of Wyoming recent mollusca. Sterkiana, No. 3.

Bliss, L. C.

1956 A comparison of plant development in microenvironments of arctic and alpine tundras. Ecol. Mon. 26:303-337.

Carpenter, Charles

1953 Aggregation behavior of tadpoles of Rana p. pretiosa. Herpetologica, 9:77-78.

An ecological survey of the herpetofauna of the Grand Teton-Jackson Hole area of Wyoming. Copeia, 3:170-174.

Trapping technique for aquatic salamanders. Herpetologica, 8:183.

1954 A study of amphibian movement in the Jackson Hole Wildlife Park. Copeia, 3:197-200.

Craighead, Frank C.
1951 A biological and economic evaluation of coyote predation. N. Y. Zool. Soc. and the Conservation Found. July (booklet)

Craighead, John J.
1952 A biological and economic appraisal of the Jackson Hole elk herd. N. Y. Zool. Soc. and the Conservation Found. November (booklet)

Craighead, Frank C. and John J. Craighead
1949 Nesting Canada geese on the Upper Snake River. Jour. Wildl. Mgt., 13(1):51-64.

1950 The ecology of raptor predation. Trans. 15th No. Amer. Wildl. Conf., pp. 209-223.

Cummins, George B. and John W. Baxter
1962 Nomenclature, life histories, and records of North American Uredinales. Madrono, 16(6):201-203.

Denniston, R. H.
1948 Certain aspects of the behavior of the Wyoming moose. Jour. Colo.-Wyo. Acad. of Sci., 3(6):55.

1949 The development of a calf moose. Jour. Colo.-Wyo. Acad. of Sci., 4(1):58.

1956 Ecology, behavior and population dynamics of the Wyoming or Rocky Mountain moose, Alces alces shirasi. Zoologica, 41(3):105-118.

Edwards, William C.
1964 A preliminary investigation concerning the plant ecology of the willow flats on Jackson Lake, Jackson Hole, Wyoming. Proc. 74th Annual Meeting of the Nebr. Acad. of Sciences, May 1 & 2, pp. 6-7.

Emlen, John T.
1952 Social behavior in nesting cliff swallows. The Condor, 54: 177-199.

1954 Territory, nest building, and pair formation in the cliff swallow. The Auk, Vol. 71.

Evans, Howard E.
1962 The geyser-loving digger wasps of Yellowstone. The Explorer (Cleveland, Ohio), 4:6-11.

1963 Predatory wasps. Scientific American, 208(4):145-154. April

The clustering wasps--and why they cluster. Audubon Mag., 65(4):236-237. July-August.

Notes on the prey and nesting behavior of some solitary wasps of Jackson Hole, Wyoming. Entomological News, 74(9):233-239.

1964 Observations on the ethology of digger wasps of the genus Steniolia (Hymenoptera:Sphecidae: Bembicini). Amer. Mid. Nat., 72(2):257-280. (With J. E. Gillaspy)

Findley, James S.

1951 Habitat preferences of four species of Microtus in Jackson Hole Wyoming. Jour. Mammal., 32(1):118-120.

A record of moose speed. Jour. Mammal., 32(1):116.

A tame red fox cub. Jour. Mammal., 32(1):117.

1954 Reproduction in two species of Myotis in Jackson Hole, Wyoming. Jour. Mammal., 35(3):434.

French, Norman R.

1955 Foraging behavior and predation by Clark Nutcracker. The Condor, 57(1):61-62.

1959 Life history of the Black Rosy Finch. The Auk, 76(2):159-180.

Distribution and migration of the Black Rosy Finch. The Condor, 61(1):18-29.

Gilligan, James P.

1954 Wildlife values in western wilderness area management. Jour. Wildl. Mgt., 18(4).

John, Kenneth R.

1957 Comparative rates of survival of normal and deformed chub, Gila atraria Girard, in Two Ocean Lake, Teton County, Wyoming. Proc. Pa. Acad. of Science, 31:77-82.

1959 Ecology of the chub, Gila atraria with special emphasis on vertebral curvatures in Two Ocean Lake, Teton National Park, Wyoming. Ecology 40(4):564-571.

Kennington, Garth S.

1957 Influence of altitude and temperature upon rate of oxygen consumption of Tribolium confusum Duval and Camponotus pennsylvanicus modoc Wheeler. Physiol. Zool., 39(4):305-314.

1961 The influence of temperature and atmospheric pressure on the rate of oxygen uptake in Tribolium confusum. Ecology, 42(1):212-215.

Laycock, William

1953 Ecological notes on the pocket gopher in Wyoming. Jour. Colo.-Wyo. Acad. of Sci., 4(5):41.

1957 Seasonal periods of surface inactivity of the pocket gopher. Jour. of Mammal., 38(1):132-133.

1958 The initial pattern of revegetation of pocket gopher mounds. Ecology, 39(2):346-351.

Levi, Herbert W. and Lorna R. Levi

1951 Report on a collection of spiders and harvestmen from Wyoming and neighboring states. Zoologica, 36(LV):219-237.

A report on land snails of the Jackson Hole region, Wyoming. The Nautilus, 65(2):60-65.

Lowrie, Donald C. and Willis J. Gertsch

1955 A list of the spiders of the Grand Teton Park area, with descriptions of some new North American spiders. Amer. Museum Novitates, No. 1736.

McHugh, Tom

1958 Social behavior of the American buffalo (Bison bison bison). Zoologica, 43, Pt. 1, No. 1, April 4, 1958.

Miller, Dwight D.

1955 A study of sex combs in Drosophila affinis and Drosophila athabasca. Trans. of the Amer. Microscop. Soc., 74(2):191-197.

Nakamura, Mitsuru

1950 A survey of Pasteurella tularensis infection in the animals of the Jackson Hole area. Zoologica, 35(II):129-131.

Negus, Norman C.

1950 Breeding of three-year-old females in the Jackson Hole Wildlife Park buffalo herd. Jour. of Mammal., 31(4):463.

Fluctuation in the population of Neotoma cinerea (woodrat) in Jackson Hole, Wyoming. Jour. of Mammal., 31(2):196-197.

Habitat adaptability of Phenacomys in Wyoming. Jour. of Mammal., 31(3):351.

1959 Mammals of Jackson Hole, Wyoming. Jour. of Mammal., 40(3):371-381. With James S. Findley.

1964 Evidence for echolocation in shrews. J. Exp. Zool., 156(1):19-38. With Edwin Gould and Alvin Novick.

Noble, Glenn A.

1953 An intestinal amoeba from the prong-horned antelope. Trans. of the Amer. Microscop. Soc., 72(3):249-252.

1958 Coprozoic protozoa from Wyoming mammals. J. Protozool., 5(1):69-74.

1961 Stress and Parasitism. I. A preliminary investigation of the effects of stress on ground squirrels and their parasites. Exper. Parasit., 11(1):63-67.

1962 Stress and Parasitism II. Effect of crowding and fighting among ground squirrels on their Coccidia and Trichomonads. Exper. Parasit., 12(5):368-371.

Patterson, Robert L.
1952 Sage Grouse in Wyoming. Sage Books, Denver, Colorado.

Rausch, Robert
1949 Paradilepis simoni n. sp., a cestode parasitic on the osprey. Zoologica, 34(1).

Rausch, Robert and Everett Schiller
1949 A contribution to the study of North American cestodes of the genus Paruterina Fuhrmann, 1906. Zoologica, 34(1).

Reed, John F.
1948 Botanical investigations in the Jackson Hole Wildlife Park. Jour. Colo.-Wyo. Acad. of Sci., 3(6):40.

1950 The meadows of the Jackson Hole Wildlife Park. Jour. Colo.-Wyo. Acad. of Sci., 4(2):53.

1952 The vegetation of the Jackson Hole Wildlife Park, Wyoming. Am. Mid. Nat., 48(3):700-729.

Roofe, Paul G.
1960 The rate of flow of blood through capillaries in the olfactory lobe of the brain of Amblystoma tigrinum. Anat. Rec., 138(2):159-162.

1961 Blood constituents of Amblystoma tigrinum. Anat. Rec., 140(4):337-340.

Weights and linear measurements of the body and of some organs of the Tiger Salamander. Anat. Rec., 141(1):35-44. (With Homer B. Latimer and Lily S. Feng.)

Salt, George W.
1952 The relation of metabolism to climate and distribution in three finches of the genus Carpodacus. Ecol. Mon., 22:121-152.

1957 An analysis of avifaunas in the Teton Mountains and Jackson Hole, Wyoming. The Condor, 59(6):373-393.

Scherba, Gerald
1961 Nest structure and reproduction in the mound-building ant Formica opaciventris Emery in Wyoming. J. of the N. Y. Ent. Soc., 69:71-87.

1963 Population characteristics among colonies of the ant Formica opaciventris Emery (Hymenoptera: Formicidae). J. of the N. Y. Ent. Soc., 71:219-232.

Simon, James R.
The American elk or wapiti. Wildlife Series No. 1, Jackson Hole Wildlife Park.

The Wyoming or Yellowstone moose. Wildlife Series No. 2, Jackson Hole Wildlife Park.

Smith, Dixie R.

1959 Changes in interspecific associations as related to grazing pressures. Jour. Range Mgt., 12(6):309-311.

1960 Description and response to elk use of two mesic grassland and shrub communities in the Jackson Hole region of Wyoming. Northwest Science, 34(1):25-36.

1961 Competition between cattle and game on elk winter range. Wyo. Ag. Exp. Sta. Bull. 377, 16 pp.

Solheim, W. G.

1960 Mycoflora Saximontanensis Exsiccata. Centum XI and XII. U. of Wyoming Publ. 24(3 & 4):22-33; 34-55.

Spencer, Warren P.

1950 The Drosophila of Jackson Hole, Wyoming--a taxonomic and ecological survey. Am. Mid. Nat., 43(1):79-87.

Thornton, Charles Stead

1956 Epidermal modifications in regenerating and in non-regenerating limbs of anuran larvae. J. Exp. Zool., 131(2):373-394.

The relation of epidermal innervation to the regeneration of limb deplants in Amblystoma larvae. J. Exp. Zool., 133(2):281-300.

1957 The effect of apical cap removal on limb regeneration in Amblystoma larvae. J. Exp. Zool., 134(2):357-382.

1958 The inhibition of limb regeneration in urodele larvae by localized irradiation with ultra-violet light. J. Exp. Zool., 137(1):153-180.

1960 Influence of an eccentric epidermal cap on limb regeneration in Amblystoma larvae. Dev. Biol. 2(6):551-569.

Regeneration of asensory limbs of Amblystoma larvae. Copeia, No. 4, pp. 371-373., Dec. 30.

Tiner, Jack D.

1951 Observations on larval carnivore ascarids in rodents. Jour. Parasit., 37(Sup.):21-22.

1952 Speciation in the genus Ascaris: Additional experimental and morphological criteria. Jour. Parasit. 38(Sup.):57.

1953 The migration, distribution in the brain, and growth of ascarid larvae in rodents. Jour. Infect. Dis., 92:105-113.

Fatalities in rodents caused by larval Ascaris in the central nervous system. Jour. Mammal., 34:153-167.

Williams, Olwen

1959 Food habits of the deer mouse. Jour. of Mammal., 40(3): 415-419.