REPORT ON THE ACTIVITIES
OF THE
JACKSON HOLE BIOLOGICAL RESEARCH STATION
SUMMER 1956

L. Floyd Clarke, Director

IMPROVEMENT OF PHYSICAL FACILITIES

Improvements continued during the past year.

1. As a result of Rural Electrification which was installed in 1955, additional electric outlets for lighting the grounds, and rewiring and additional wiring to various buildings was completed. The laboratory was provided with additional electrical appliances.

2. The central propane tank system installed during 1955 proved very effective. This system was further extended and improved last summer.

3. Plans were completed and approval obtained for obtaining housing and furnishings from the Jackson Lake Lodge Company at Moran. The units which are in the process of being moved this fall include:

    a. The old Crandall Studio which is to be used for additional laboratory, library, and storage space.

    b. Two living units to be furnished in a manner similar to the other living units.

    c. One building to be converted into shower rooms and toilet facilities. This will require the installation of two wash basins, two toilets, two showers, and a septic tank.

    The New York Zoological Society generously made an appropriation to assist in carrying out these plans for improvement.

4. The two old houses which are known as the Grimmacy place were put in usable condition for research workers last summer. These houses were in poor condition and required considerable repair and renovation before they could be utilized. Among other necessary repairs was the reroofing of these buildings. Since these houses are some distance from the Station and since we do not anticipate continuing to use them, electricity was not provided. Light was furnished by Coleman lanterns.

5. Additional cinder blocks were purchased and the project to replace the wooden supports under the cabins was continued.

6. The logs in all buildings were oil treated. The oil was applied by spray on the large buildings and with a brush on the small ones.

7. The research workers hauled gravel to resurface the roadway entering the Station.

8. A new sign was constructed and placed at the entrance of the area. This sign states: BIOLOGICAL RESEARCH STATION of the NEW YORK ZOOLOGICAL SOCIETY and the UNIVERSITY OF WYOMING.

9. Constant attention was given to the general care and upkeep of the buildings and grounds.

No plans for addition of living units in excess of those mentioned above are anticipated. No attempt will be made to provide for all of those applying to do research. The large number of applicants will, however, give us an opportunity to select those research workers who will make the most significant contribution to the research program of the Station.

SUMMARY OF RESEARCH PROJECTS CARRIED OUT IN 1956

A Study of Social Behavior Patterns in Moose of Wyoming

Dr. Margaret Altmann
Project Number 77

The project in its second summer was carried out according to plan from May 21, 1956 to September 5, 1956 at the Research Station. The resulting data and material were highly satisfactory. Moose individuals as well as moose groups were found to be well within reach. The information from previous research years made it possible to save much time and effort in locating suitable moose cases for observation. Because the principal investigator was able to be present earlier than expected in the moose habitat it was possible to observe moose just before, during and after parturition. The various stages of calf rearing and integration into social patterns could be followed in detail.

During this season the marking of moose was purposely discontinued in order to prevent behavior disturbances. Recognition of individuals was possible in most cases by an improved method of observation and record keeping. The head features, in particular the "bell" and dewlap provided a good marker for individuals. A new Bausch and Lomb Balscope Sr. (30X) made it feasible to observe details at long distance from vantage points at will.

Among the results of this summer's investigation are some findings on "sliding territoriality" of the moose cow with a calf. It became apparent that the defense of a zone around the calf is practiced by all moose dams. This defense reaction is in most cases one of gesture threat, not an actual fight. The ears are folded back, the head is raised to level it with the neck and the front feet are stamped. The reaction of the intruding moose was, even if it was a large, powerful bullmoose, a hasty detour in small steps with slightly folded back ears. No attempt to fight or retaliate was seen. The extent of the defense area was decreasing toward fall. Current observations are conducted to trace the extinction or transformation of this reaction at the onset of the mating season.

An interesting sidelight on variations of behavioral patterns was provided by a young moose cow in a tourist area of Yellowstone Park. The investigator stood silently in cover observing this moose, when it showed distinct signs of alarm and flight. A few moments later three cars with noisy tourists (14 people) stopped, unloaded and approached the animal without cover. The moose recovered composure, walked back close to the highway and resumed grazing. Careful approach was in this case the aggression, noisy approach the harmless event.

Control observation and repeats on last year's data have strengthened the evidence for many findings and yielded comparisons with other ungulates. The most startling fact emerged that the moose has phases of very contrasting behavior types. Social and solitary, cooperative and aggressive behavior phases all in one year's cycle. On the basis of these findings work is continued at a high intensity. The change of the original research program to permit continuation of this project into the fall and winter situations is therefore highly appreciated.

(Grant from National Science Foundation.)

Ecology and Behavior of the Yellow-bellied Marmot (*Marmota flaviventris*)

Kenneth B. Armitage
University of Kansas
Project Number 82

Ecology

Several marmot colonies were visited in the Teton Mountains for the purpose of making a subjective analysis of habitat selection. All of the colonies were centered on the south facing slopes where there was grass and sufficient talus to provide burrow sites. All sites which have been visited in the two years of study have been located where the snow is likely to melt comparatively early, where there are food plants, and where there is something (boulder, cabin, fallen tree) to burrow under.

Melanism

Several sites where melanistic marmots are found were visited to determine the relative abundance of the melanistic form. They averaged about 25% of all the animals which were observed during the visit.

Population and Behavior

The adult population at the colony site decreased by one third between 1955 and 1956. There were forty-five young in 1955 and nineteen in 1956. The sex distribution in the young of 1956 showed nine males, five females, and five undetermined. In the two years of study, sixteen adults have been identified and all of them were females. Only one adult marked in 1955 was recovered in 1956.

Female 524 changed her home range in 1956 from the observed home range in 1955. The home range pattern during the summer was essentially of the same nature as in 1955. However, during the

period that the animals were going into hibernation, the home range pattern broke down and several animals visited areas where they had never been seen previously. Dominance relationships between individuals also broke down during this period.

During the summer, observations further substantiated the previous observations that some animals are dominant to others, but no "peck" order has been distinguished. Female 524 had dominated the adults at two burrows in 1955, but in 1956 ignored those sites, but added a different burrow north of the previous ones and by her aggressiveness, caused a small adult to abandon the new burrow.

Several postures were described and photographed: two sunning postures, a standing and sitting alert posture, a greeting posture, dominant and recessive postures, and two forms of locomotion.

Some of the calls were tape recorded, but this project must be pursued further.

Considerable data on the summer movements of the young were collected. The young still tended to maintain their family groups by late August. This was evident when the young first emerged in the morning. During the day the groups tended to disperse.

Temperature data for 1955 and 1956 indicate a gradual rising of the temperature through July and a drop in early August. The latter might be the stimulus for hibernation for those animals physiologically prepared.

Among others future study should include factors which initiate hibernation, population changes, movement of the young in early summer, analysis of calls, and individual relationships.

Effects of Sewage Effluent on the Ecology of Swan Lake,
Grand Teton National Park, Wyoming

George T. Baxter and L. Floyd Clarke
University of Wyoming

Project Number 75

In the summer of 1956 a weekly sampling program was initiated to determine the effects of the introduction of the effluent from a secondary sewage treatment plant upon the ecological conditions in Swan Lake, Grand Teton National Park, Wyoming. The chemical analyses included the determination of dissolved oxygen, free CO_2, alkalinity, pH, phosphates, nitrates, nitrites, and ammonia. The study of biotic features emphasized the analysis of plankton and bottom fauna populations. Coliform counts were also made.

Use of a newly constructed trailer park and public camp grounds at Colter Bay was initiated in June, 1956. The sewage from these installations undergoes primary and secondary treatment and the effluent enters the north end of Swan Lake. The first flow of sewage effluent probably entered the lake in late June or early July, 1956. No measure was obtained of the rate of flow into the lake.

Dissolved oxygen at the three sampling stations (surface and bottom) varied between 3.0 and 6.5 ppm. with but slight differences between stations and between surface and bottom waters until July 17 when the oxygen content in the surface water at Station 3 rose to 8.1 ppm., dropped to 6.1 and 7.0 on August 1 and 7 respectively and then rose again to 8.7 and 8.3 on August 14 and 21, respectively. This condition is explained by the plankton bloom observed at Station 3 at this time (see below). A low O_2 of 2.1 was measured in the bottom water at Station 3 on August 7.

The CO_2 concentration and pH were nicely correlated with the oxygen content and plankton conditions at Station 3. Free CO_2 varied between 2 and 9.5 ppm. during the summer then reached a low of 1 ppm. in the surface water at Station 3 on August 14, and a high of 12.5 in the bottom water at Station 3 on August 7. The pH remained quite constant at all stations during the summer, varying between 7.0 and 7.45, then rose to 7.6 and 7.7 in the surface water, Station 3 on August 14 and 21 respectively, and a low of 6.9, bottom Station 3, August 7.

Laboratory analysis of the oligonutrients (phosphates and nitrogen compounds) showed a very low nutrient content in the lake in general. Right at the outlet of the sewer pipe a very high nutrient content could be measured but this high content disappeared very rapidly and was practically gone outside a radius of some 150 feet from the sewer pipe outlet.

The population of benthic organisms was similar to that found in 1955. A mean density of 53.5 organisms per 6 inch dredge sample at Station 1, and 34.3 organisms per dredge sample at Station 3 compared almost exactly (probably by coincidence) with the figures obtained in 1955. These mean figures consisted of a mean of 34 per cent oligochaeta, 27 per cent Tendipedidae, 37 per cent Chaoborus and 2 per cent Mollusca at Station 1, and 37 per cent oligochaeta, 11 per cent Tendipedidae and 52 per cent Chaoborus at Station 3.

The net phytoplankton was found to consist primarily of the following genera: Astrionella, Staurostrum, Dinobryon, Ceratium, Mallomonas and Volvox. Zooplankters found in the samples were predominately the rotifers Keratella cochlearis, Polyarthra sp., Triococerca sp. and Pedalia sp. Common crustaceans were Daphnia sp., Ceriodaphnia laticaudata, Bosmina longi rostris and Cyclops bicuspidatus.

Only a small percentage of the plankton samples taken in 1956 have been analyzed quantitatively. Only one definite trend has been definitely established: coincident with the chemical conditions noted which were indicative of a large amount of photosynthetic activity in the surface water at Station 3 in late August, counts showed a bloom of the unicellular green alga Mallomonas reaching a density of an estimated 474,000 cells per liter on August 8 at Station 3. In general this bloom of Mallomonas, followed closely by a less conspicuous bloom of Volvox, began near the outlet of the sewer pipe in early August and continued through the month and brought about the chemical conditions noted above. More detailed quantitative analysis of the plankton samples will be required before the history of the algal blooms resulting from the fertilizing effect of the sewage effluent can be described in detail.

Tentatively it would appear that, as a result of the rather complete mineralization of the raw sewage by the treatment plant, and the remarkable ability of the organisms and suspended organic materials in Swan Lake to absorb and metabolize the nutrients being introduced, no catastrophic changes in the ecology of Swan Lake may be anticipated if the rate of inflow of sewage effluent does not exceed that which occurred in 1956.

(Supported by the University of Wyoming.)

Sagebrush-Grass Competition
Alan Beetle
University of Wyoming
Project Number 64

During the year the program of study on sagebrush sites and populations has been intensified. There can now be recognized six distinct species in the big sagebrush group which occur in Wyoming. Of these Artemisia cana, A. nova, and A. viscidula are uniform in occurrence but A. tridentata may be divided into four ecotypes, A. arbuscula into two, and A. tripartita into two. The distribution pattern of these types has been determined. Further study is now underway to characterize these areas as to site to determine evolutionary relationships and to relate Wyoming sagebrush types to sagebrush patterns occurring in other western states.

(Financed by Wyoming Agriculture Experiment Station through Interregional Research Program.)

Factors Affecting the Ecology of the Teton National Forest
Alan Beetle and Collaborators
University of Wyoming
Project Number 85

This project intends to study community ecology in the Teton National Forest; to study and identify poisonous plants of the Teton National Forest; to determine environmental changes attributable to livestock and elk population; and to establish qualitative and quantitative objectives of management for the development of range condition classes in Teton County. The first year of a projected five years on this study was spent in the location of relict and protected areas, and in studying these areas in relation to both game and livestock ranges. Principal attention is being paid to areas within the Teton National Forest.

(Grant from Wyoming Natural Resources Board to Wyoming Agriculture Experiment Station.)

Ecology of Cattle Helminth Worms
Ralph F. Honess
University of Wyoming
Project Number 90

The object was to determine the survival of the eggs and free-living larvae of intestinal nematodes of cattle on summer ranges and winter pastures.

Work on the project has been done in Teton County. The free-living stages were found on spring pastures within three weeks after the snow melted. They were found on forested summer ranges before cattle were there this year. All of the cattle range on the forest is used by game also. There is no way to distinguish between free-living larvae having their origin in game from those having their origin in cattle. It is not known, therefore, if the free-living stages found were from eggs in the feces of cattle left the year before or from eggs in more recent feces from game.

On the forest ranges the time for the hatching of the egg and the development of the larvae to the infective stage required from seven to 21 days.

Feces of cattle on the summer range was examined for the eggs of intestinal nematodes. The information obtained has not been studied closely. The indications are, however, that there was little change in the percentage infected. The average number of eggs per gram of feces did not increase and may have decreased slightly.

This study will be continued over a five-year period.

(Financed by Wyoming Agricultural Experiment Station.)

Population Dynamics of the Utah Chub, Gila atraria, in Two Ocean Lake

Kenneth R. John
Franklin and Marshall College

Project Number 88

The chub, Gila atraria (Girard), population of Two Ocean Lake presents a favorable opportunity for a study of the origin and survival of deformed members of a natural population. About 1% of the chubs are afflicted with curvature of the spine. The pattern of the deformity in individuals varies from a moderate, scarcely detectable type to extremes in pronounced lateral and vertical flexures.

Preliminary investigations, carried out during the summer of 1956, were intended to provide information on the methods and techniques best suited to capturing the chub alive so that they might be returned to the lake after processing for the records. During the spawning season, which began in the latter part of June and ended in early August, large quantities of adult chubs were captured with traps designed after the standard hoop net. Immature chubs are largely segregated from adults and frequent shallow waters near shore thus being readily captured in seines during daylight hours. Seining operations conducted at night proved very effective in capturing adult chubs. Gill nets capture large numbers of chubs, but because they damage the fish fatally and because the removal of the fish from the mesh is time-consuming, gill nets are used primarily to sample the population over deeper waters and to provide a reference for comparison on the composition of the samples taken with other types of gear. The total catch from Two Ocean Lake during the summer of 1956 was 20,003 chubs.

Secondly, the work this summer was designed to show which methods might be used in obtaining fertilized eggs for breeding experiments to investigate the role played by genetics in the production of deformed chubs. Successful crosses of all possible combinations of parents were made between normal and deformed fishes and the eggs were carried through hatching. However, owing to inadequate facilities for controlling experiments, the results showing the percentages of deformed offspring produced by various crosses do not lead to any conclusions on the cause of the deformities. This aspect of the work will receive priority attention next year.

Chub populations in Emma Matilda Lake, Enos Lake, and the Snake River were sampled in a search for information on the occurrence of deformities outside of Two Ocean Lake. One deformity in a sample of about 2000 fish was found in Enos Lake. Similar deformities, of low frequency, were found in Richardsonius balteatus hydrophlox, and Catostomus fecundus in Two Ocean Lake, and in Richardsonius of Emma Matilda Lake.

A variety of chub predators feed at Two Ocean Lake: cut-throat trout, great blue heron, pelicans, gulls and mergansers. But no measure of the rate of predation was obtained.

The data on hand are presently being analyzed to find the frequency of deformities per year class and thereby to provide information which might show whether or not the survival rate is different for normal and deformed chubs. The same information will serve as an index to measure changes in the chub population in the event of a measurable change in the predator population.

(Grant from National Science Foundation.)

Metabolic Differences Associated with Altitude

Garth Kennington
Lawrence College
Project Number 79

This project is concerned with certain physiological aspects of altitude, particularly those affecting animal metabolism. It has now run through two summers, a preliminary phase extending through the summer of 1955 and a more extensive study of selected leads followed up during the summer of 1956.

During the first summer it appeared that rather definite differences in rate of oxygen uptake were present in certain groups of arthropods, notably the ant, where the same or closely related species existed at different altitudes. In the report for 1955 reasons were enumerated showing why the ants provide unusually favorable material for this type of study. The work of the summer of 1956 is essentially a continuation of and expansion of this aspect of the project begun in 1955.

With the help of Dr. Gerald Scherba, who made the identification, a single species of carpenter ant, Camponotus pennsylvanicus modoc, was found to live over a range of more than 3000 feet altitude in the Jackson Hole area, from a colony in the Research Station grounds at 6750 feet to colonies in the neighborhood of Two Ocean Mountain on Togwotee Pass at elevations around 10,500 feet. This species, along with Tribolium confusum, the flour beetle, formed the principal focus of the work of 1956.

I shall not attempt in this report to give final results on the experiments of the summer since the data require considerable further analysis. However, some trends appear which suggest the general direction of the results. As the data of last summer indicated, the groups occurring at higher elevations continued to

show a higher oxygen uptake per unit weight (gram) per unit time (hour). This difference appears to be significant and points to some sort of increase in the metabolic rate. There are a number of possible causes for such a response. The effect of temperature is already well known in this respect. Prosser (Biological Reviews, vol. 30, 1955) says, "In general, animals from cooler waters tend to develop faster than those from warmer waters when observed at the same intermediate temperature.....cold water forms have a higher metabolic rate." Temperature may well play a major role in the results observed in these experiments. However, since changes in oxygen pressure are also relatively constant and important aspects of altitude, it seems desirable to examine this factor as thoroughly as practicable for its possible contribution. As might be expected, an important task in solving this problem revolves around the difficulty of separating oxygen pressure and temperature as factors in the environment. It is clear that even though temperature and pressure chambers were constructed to operate at the different altitudes involved, one would still be faced with the necessity of assessing the effects of long term acclimatization which may or may not be counteracted by a relatively short period in a temperature or pressure chamber. Consequently, it was decided to approach the problem from another point of view and run a sort of "temperature spectrum" for each of the altitudes involved, with the hope of presenting situations where differences between temperature and pressure effects might appear.

The experiments were designed as follows:

	STATION ALTITUDE (6750')	TWO OCEAN MOUNTAIN (10,500')
Station altitude groups	5° 10° 15° 20° 25° 30° Degrees Centigrade	5° 10° 15° 20° 25° 30° Degrees Centigrade
Two Ocean Mtn. groups	5° 10° 15° 20° 25° 30° Degrees Centigrade	5° 10° 15° 20° 25° 30° Degrees Centigrade

The table shows that each group was subjected to a series of experimental temperatures in each altitude. These data are to be analyzed as soon as possible. It is hoped that they might offer some clues as to the relative effects of temperature and pressure on metabolic rates of these forms.

This project must still be properly considered to be in its initial stages. At the same time, results are appearing which suggest that a well-conceived and well-executed program of research along these lines might throw some light on the possibility of a

physiological acceleration in high altitude forms which enables them to get through their life cycle in considerably less time than do their low altitude relatives. As stated before, temperature may play a major role, but the role of oxygen pressure is still in doubt, as Prosser (earlier citation) puts it, "Oxygen availability has not been thoroughly investigated as a factor limiting the range of a species or isolating populations." He says further, "Curves relating metabolism to oxygen pressure, the limits of T_c (critical pressure) concentration on the metabolic patterns associated with differences in tolerance of anaerobiosis might be investigated with profit." This statement, made in the summer of 1955, almost exactly expresses the general aim of the present project.

(Grant from New York Zoological Society.)

Life History of *Microtus richardsoni macropus*

Norman C. Negus
Tulane University
Project Number 87

During the summer of 1956, various aspects of the biology of *Microtus richardsoni* were investigated. Data were gathered particularly in regard to the following:

1. Altitudinal and habitat distribution in the Jackson Hole region.
2. Characteristics of the preferred habitat.
3. Reproductive phenomena
   a. Litter sizes
   b. Number of litters per year
   c. Age of sexual maturity
   d. Length of breeding season
4. Pelage sequences.
5. Behavior (in captivity).
6. Size range in a population.
7. Periods of activity.
8. Burrow sites and characteristics of burrow systems.

Data regarding reproduction, pelage, and size range is presently being analyzed in the laboratory.

Three substantial colonies of *Microtus richardsoni* were located during the summer. Numerous streams were studied from 6700 feet to 11,000 feet elevation, in order to determine the altitude range of the species in the region. Colonies known to be in existence in 1948 and 1949 were revisited. With one exception these colonies were no longer extant. The physical and vegetational characteristics of the preferred habitat were determined. On the basis of cuttings

and food caches, a list of plant species was compiled that are used extensively as food. Two burrow systems were excavated for purposes of determining their extent and nature. A number of specimens were live-trapped, and certain aspects of behavior were observed in captivity, such as swimming, diving, defensive positions, and vocalization, etc.

More than 80 specimens were obtained for examination in the laboratory. A more complete and detailed report will be submitted upon completion of the laboratory work.

Information still desirable:

1. Data on home range and territorialism.
2. Additional reproductive data.
3. Data on growth rates.
4. Further analysis of habitat and competition with related species.

(Grant from New York Zoological Society.)

Intestinal Protozoa in Jackson Hole Mammals

Glenn A. Noble
California State Polytechnic College

Project Number 86

GENERAL PROCEDURE:

1. Demonstrate presence of and identity of protozoa.
2. Determine if these organisms are parasitic, commensal or coprozoic.
3. Examine soil for cysts or motile protozoa which might become coprozoic.
4. Cultivate protozoa in the laboratory.
5. Make permanent stained slides.

METHODS:

1. Fecal samples from the following animals were examined for protozoa by the direct smear method: elk, bison, moose, bear, coyote, marmot, horse, cattle, sheep.
2. Thirteen soil samples were taken from various areas frequented by the host animals.
3. Fecal samples and soil samples were moistened and placed in tight-fitting plastic containers and stored in a refrigerator which was maintained at approximately 4° C.
4. Representative samples were also kept in similar containers at room temperature.

5. Fecal samples were boiled for 20 minutes and, after cooling, were mixed with fresh untreated soil samples to increase the organic content of the latter.
6. Cultures were made using a proteose-peptone fluid medium and a peptone-yeast extract agar slant. These cultures were kept at room temperature and at 4° C.
7. All samples were checked daily for the first two weeks and about every other day thereafter. Permanent slides were made whenever new organisms appeared.

RESULTS: In most samples continued refrigeration resulted in an increase in numbers and variety of protozoa. There was thus established a COLD CULTURE which demonstrated the presence of soil protozoa in the animal intestine. Some of the flagellates were motile in fresh droppings and in cold culture. Motile amoebae did not appear until after several days of refrigeration. Following is a summary of the hosts and the protozoa found in their feces after refrigeration: Elk - Amoebae, Copromonas, Monas, Cercomonas, soil ciliates. Bison - Amoebae, Copromonas, Monas, Cercomonas, soil ciliates. Moose - Amoebae, soil ciliates. Bear - Coccidia, small flagellates. Coyote - small flagellates. Marmot - Coccidia. Horse - Amoebae, Copromonas, Monas, Cercomonas, soil ciliates. Cattle - Amoebae, Copromonas, Cercomonas. Sheep - Amoebae, Copromonas, Cercomonas, Monas, soil ciliates.

The amoebae probably belonged to the Genus Valkampfia. After several days to several weeks of cold culture there appeared in the fecal samples of elk, bison, horse and sheep a large (50 to 70 microns) binucleate amoeba whose taxonomic position has yet to be determined.

SIGNIFICANCE: A completed study of these protozoa would throw light on the following problems:

1. Morphology and identity of coprozoic forms, which has received little attention.
2. Identity of truly parasitic forms, which have been confused with coprozoic species.
3. Adaptation of protozoa to soil and fecal environments and to warm and cold temperature.
4. Host-parasite relationships.
5. Transfer of parasitic fauna from one host to another.
6. Parasitic zoonoses.

REQUIRED FURTHER WORK:

1. Thorough study of fresh material to identify true parasites.
2. Extensive examinations of soils for free-living species.
3. Special study of moose, bear, antelope and deer.
4. Culture experiments with soil and fecal samples using many types of culture media.
5. Continued microtechnique using phase microscopy and special staining processes such as the Feulgen method for

demonstrating nucleic acids.

6. Experiments to determine viability of cysts under varying periods of desiccation and other environmental conditions.
7. Determination of possible pathogenicity of these protozoa to elk and other hosts.

(Grant from National Science Foundation.)

Altitudinal Distribution of Ant Communities

Gerald and Coral Scherba
Chico State College, Calif.
Project Number 80

Objectives - During this second season the goal of the project has remained the analysis of ant faunal characteristics and relationships within distinct communities, and the comparison of these parameters of the ant fauna in biotic communities at increasing altitudes. We expect that this study will lead to an increased understanding of biotic communities in general, and the highly important ant fauna within them, in particular, and to a better understanding of the changes in biotic communities that occur with increasing altitude.

Procedure - Operationally the project has been divided into three phases:
Phase 1: collection of ants in distinct plant communities at increasing altitudes together with observations on their nesting site, associations with other ants, relation to other animals and effect on the vegetation.
Phase 2: a statistical description of the ant fauna of 5 selected communities, Big Sagebrush, 6500 ft., Lodgepole Pine, 6500 ft., Big Sagebrush 8500 ft., Spruce-Fir, 8500 ft. and Alpine Tundra, 10,500 ft. In this phase the composition, relative density, nesting sites and spatial distribution of the ants on a single selected stand are determined by quadrat sampling.
Phase 3: analytical investigation of community dynamics within the ant fauna obtaining a quantitative measure of diurnal periodicity of foraging activity, vertical stratification, food preferences, territoriality and home range of the dominant species.

Results - In addition to the communities at which we have collected during 1955 we have collected the ant fauna of the following communities:

1. Grass meadow, 6500-7000 ft.
2. Grass-sedge meadow, 6500-7000 ft.
3. Grass-sedge-willow flat, 6500-7000 ft.
4. Gravelly streamsides, 6500-7000 ft.
5. Grass-sedge meadow, 8500-9000 ft.

Collecting was made at several stations in each type of community. Ants have been preserved in alcohol for determination.

Most of our attention, however, has been focused on the statistical description and analysis of the ant fauna of the Jackson Hole Big Sagebrush community at 6700 ft. In proceeding a stand was selected on the glacial outwash plain south of Signal Mountain. The area was mapped, coordinates assigned within the stand and the location of L-shaped paired quadrats, 5 x 50 meters, was randomly determined by picking numbers from a hat. On the basis of 19 such quadrats we find that there are 15 species of ants present within the stand with an average density of 0.12 nests per square meter or 29.63±2.87 nests per quadrat.

TABLE I

AVERAGE SPECIES AND NEST DENSITY PER QUADRAT SAMPLE

	Mean± S.E.	Standard Deviation	Coefficient of Variability in %
Density	29.63±2.87	12.55	42.30%
No. of Species	6.31±0.51	2.21	35.02%

Of these 15 species,however, four of them comprise 76.2% of the total number of nests found. Further attention therefore, was concentrated on these four species, Tapinoma sessile, Formica oreas comptula, Formica neogagates and Myrmica lobicornis fracticornis.

We then asked this question. How do these four species partition the food and nesting resources of the community in order to coexist? The nesting site of each of the four species is tabulated below with the predominant nesting site for each species underlined.

TABLE II

NESTING SITES OF FOUR DOMINANT SAGEBRUSH COMMUNITY ANTS

	In Soil	At Base of Sage	Under Rock	Under Dung	Mound Nest
Tapinoma sessile	51	139	11	7	0
Formica oreas comptula	8	38	9	0	42
Formica neogagates	50	8	3	0	0
Myrmica lobicornis fracticornis	46	11	1	0	0

From the table it is apparent that Tapinoma sessile, Formica oreas comptula and Formica neogagates are each most abundant at different nesting sites while Formica neogagates and Myrmica lobicornis fracticornis are in competition for nesting sites in the soil; actually Myrmica nests in the soil under wild buckwheat pads while F. neogagates nests in bare soil so that each of the four major species in the

Sagebrush community nests predominantly in a separate microhabitat. It is this relationship that suggests to us the testable hypothesis that the availability of suitable nesting sites is one of the most important factors limiting the nest density in this community. In terms of the relative importance of the different nesting sites, for a total of 565 ant nests, nesting sites were distributed: in soil - 38.3%; at base of Sage - 41.5%; under rock - 10.7%; mound nest - 8.0%; under dung - 1.5%.

Data were also collected on differential food preferences and activity periods which tentatively indicate that while there are broad overlaps in food preferences between each of the four species the time of maximal foraging activity differs for each species.

At the end of the season numbered stakes were placed next to 100 nests in a census of ant mounds on Moose Island in the Snake River. The population of mound nests is of two species, Formica fusca and Formica opaciventris with definite relationships between the two species. It is large, between 500 and 600, and offers an unusual opportunity for population studies and certain other problems connected with mound nests.

Summary and Conclusions

1. The ant fauna of 12 distinct plant communities ranging over 4,000 ft. in altitude has been collected at 55 stations in Western Wyoming, together with pertinent observations.

2. In the Big Sagebrush community of Jackson Hole there are 15 species of ants with an average density of 29.63 ± 2.87 nests per quadrat or 0.12 nests per square meter.

3. Four of these 15 species constitute 76.2% of the total nests, and hence may be considered dominants.

4. Distribution of nesting sites is such among these four species that each is most abundant at a different nest site. This strongly suggests that suitable nesting sites may be an important limiting factor in determining population size and density in the sagebrush cummunity.

5. Food preferences overlap, but there are differences in the time of maximal foraging activity from species to species within the community.

6. The ant population of Moose Island, estimated at 500-600, offers an unusual opportunity for a wide variety of ecological studies.

(Grant from New York Zoological Society.)

An Evaluation of Certain Exclosures

Dixie R. Smith
University of Wyoming

Project Number 89

The purpose of this study was to gain a more complete knowledge of plant communities in the Jackson Hole region as they exist without undue disturbance. Also included in the study were the effects of variables such as exposure, altitude, soil, and use on the plant cummunity.

The following relict areas have been found suitable for use in this study:

1. Goosewing Study Plots
2. Upper Slide Lake Exclosure
3. Buffalo River Exclosure
4. Jackson Elk Refuge (2 exclosures)
5. Gilcrest Unit Exclosure
6. Camp Creek Unit (2 exclosures)
7. Jackson Watershed Area
8. Big Game Ridge Exclosure

Both Elk and Moose Island were deemed unsuitable for use in this study; Elk Island because of fire damage and comparatively heavy game use and Moose Island because of the trampling effect caused by large numbers of game animals using it to cross the Snake River.

Frequency and abundance of species occurring within the plant community are determined by use of the square foot quadrat. Number of samples required is estimated by methods outlined by Snedecor and Oosting.

A botanical analysis has been completed on the big sagebrush community in the Jackson watershed area, and the Upper Slide Lake exclosure. Preliminary surveys for use in estimating sample size have been completed for plant communities in the other relict areas.

Permanent photographic transects have been established for the study of effects of snowfall patterns and resultant available winter range on plant communities.

Work on this project will be resumed June 1, 1957.

Swan Lake Research and Flora of Jackson Hole Area

W. G. Solheim
University of Wyoming

Projects Number 75 and 81

Swan Lake Project: Weekly collections of the phytoplankton in Swan Lake were made by Dr. L. Floyd Clarke, the investigator and coworkers during the period from June 18 to July 20. Collections were continued through the month of August by Drs. Clarke, George Baxter and coworkers. In addition the investigator made collections at weekly intervals of attached and bottom algae from June 18 through July 20.

Some progress has been made on the identification of the plankton algae but much work is yet to be done. This work is of necessity slow due to lack of time and literature. Outside aid is being secured to carry on this phase of the project.

Jackson Hole Flora Project: Collecting of the mycological flora of Jackson Hole was continued in 1956. The very dry weather conditions prevailing during the summer of 1956 kept the fleshy fungi at a minimum. Conditions were, however, quite favorable for the development of parasitic fungi and many valuable collections were made. The fungi are in part being sent to specialists for identification. The remainder are being determined by the investigator and by graduate students in mycology working under his supervision.

No special effort was made to do any general collecting of flowering plants. Only plants of special interest were taken. Among these was a species of *Delphinium* not previously reported from the region. The flowering plants are being determined by Dr. C. L. Porter.

(Supported by University of Wyoming.)

Influence of Nerves on the Regeneration and Regression
of Limbs in Amphibia

Charles S. Thornton
Kenyon College

Project Number 68

During the summer of 1956 the influence of both nerves and epidermis on limb regeneration was analyzed by means of transplants to the dorsal fin of Amblystoma larvae. All combinations of nerve tissue, muscle, skeleton, epidermis and apical epidermal cap were implanted. The results of these implantations will be analyzed during the winter at Kenyon.

(Grant from National Science Foundation.)

SEMINARS

An outstanding series of seminars was held during the summer with the following people participating. These seminars were held in the director's house. Slides and other visual aids were presented. Refreshments were served during the informal discussion periods which followed the lectures. This contributed to the informality of the occasion.

Margaret Altmann - Comparative study of social behavior in some wild ungulates of the U.S.A. and Europe.
Charles S. Thornton - Influence of apical cap removal on limb regeneration in Amblystoma.
Garth S. Kennington - Influence of altitude on animal metabolism.
W. G. Solheim - Plant ecology in the Jackson Hole region.
Alan A. Beetle - Significance of sagebrush and grass distributions.
Gerald M. Scherba - Microclimate modification in ant mounds.
Kenneth Armitage - Ecology and behavior of the yellow-bellied marmot.
Norman Negus - Ecology of rodents; Distribution of weasels.
Glenn A. Noble - Intestinal protozoa of mammals.
George T. Baxter - Limnology of Swan Lake.
Kenneth John - Observations on the Avoidance of obstacles by blind fishes.

Slides of wildlife and scenery were projected on several occasions for the enjoyment of the families of research workers. Informal conferences on station problems of mutual concern were held with station personnel. Campfire sings and picnics were held about once each week in which all participated.

LIBRARY

The library books and journals are readily available for Station personnel. Some new books have been acquired and all subscriptions to periodicals continued.

Reprints continue to come in from research workers of previous years. These are made available as needed. A list of the reprints from publications which we have available on research conducted at the Station is included as an appendix to this report. Other papers are now in the process of being published. Duplicate copies of all reports of research workers during the past two summers are being prepared for use by the personnel at the Station. One copy is kept on file in the Department of Zoology at the University.

COOPERATION WITH OTHER AGENCIES

Research workers at the Station cooperated with the Park Service, Forest Service, and Wyoming State Game and Fish Department exchanging ideas and mutually assisting each other to the benefit of all concerned. The Park Service personnel utilized the station laboratory including the museum for study. The relations with all these agencies were most freindly and helpful. We especially appreciate the cooperation of Mr. Frank Oberhansley, superintendent of Grand Teton National Park, Mr. Harry C. Parker, Chief Naturalist, Mr. Wilcox, district Ranger, Mr. Kranenberg, Cheif Engineer, and other Park Service personnel; and Mr. Arthur Buckingham, supervisor of the Forest Service and other Forest Service personnel.

CONTRIBUTIONS TO VISITING SCIENTISTS

Approximately 200 people visited the Station during the summer. These visitors included many who were interested in various projects. Many of these contributed valuable suggestions to the research workers and in return received information of significance to their own scientific interests.

Because of the favorable location of the Research Station, it is able to render a service to the many scientists who visit the Jackson Hole area each summer either as members of scientific conventions or as individuals on vacation or on scientific projects in the area. As an example, the Rocky Mountain Section of the American Psychological Society held meetings at the Jackson Lake Lodge. Several behaviorists at this convention visited the Station to consult with the research specialists engaged in behavior studies. Among other conventions held at the Lodge in which members were interested in the research at the Station were the meetings of the Wyoming State Medical Society and a sectional meeting of Geologists. Among individuals who came to the Station to consult on scientific matters of concern to them were scientists from the U. S. Park Service; Wyoming Game and Fish Department, Federal Fish and Wildlife Service, U.S. Forest Service including the Regional Forest Pathologist, and other individuals too numerous to mention representing research agencies and institutions of higher learning. The following list of visitors might indicate the wide range of interest in the Station.

Dr. Ralph Ames, Head Department of Botany and Plant Pathology, Utah State Agricultural College.

Dr. Dale Bohmont, Head of Department of Agronomy, University of Wyoming Agricultural Experiment Station.

Dr. C. R. Carpenter, Head Department of Psychology, Pennsylvania State University, and Coordinator Animal Behavior Research Program, New York Zoological Society. Officially representing the New York

Zoological Society, gave valuable advice on projects underway and plans for the development of the Station.

Eugene Cronin, Botanist, U.S.D.A.

Dr. Frank C. Craighead, Supervisor of Rocky Mountain Sheep Refuge, Las Vegas, Nevada.

Miss Elizabeth Cushman, Student Conservation Corps Representative of the National Parks Association, to discuss the ways in which the Research Station can cooperate in the Training Program for the Student Conservation Corps.

Norberto Dellacroce, Italian Institute of Biology, Novara, Italy, on special assignment for biological study in this country.

Arthur S. Hale and J. Norvel Brown, Federal Fish and Wildlife Service.

Dr. E. H. Hen, Behaviorist, Department of Psychology, University of Chicago.

Dr. James L. Mickle, Forest Pathologist, Intermountain Forest and Range Experiment Station.

Dr. Fairfield Osborn, President, New York Zoological Society. Valuable advice on business operation, plans for improvement, and research projects which could be developed were given to the director.

Alec and Sig Overfeldt from Germany, in this country on special assignment for biological study.

Mr. Harry C. Parker, Chief Naturalist, Grand Teton National Park. And many other biologists from the Park Service.

George Post, Biologist, head of Wyoming Game and Fish Research Laboratory.

George Treichel, employed by New York Zoological Society to make extensive studies of African wildlife.

Dr. Eugene S. Tunnell, University of Colorado Medical Center.

Dr. C. A. Whitney, Psychiatrist, Veterans Administration Hospital and University of Utah Medical School.

Donald E. Wilbert, Range Specialist, Wyoming Game and Fish Department.

PROJECTS FOR 1957

Margaret Altmann - Behavior of moose.
Kenneth Armitage - Behavior of yellow-bellied marmot.
Alan Beetle - Sagebrush-grass competition; Factors affecting the ecology of Teton National Forest.
L. Floyd Clarke and George Baxter - Limnology of Swan Lake.
Ralph Honess - Ecology of cattle helminth worms.
Kenneth John - Population dynamics of Utah chub in Two Ocean Lake.
Garth Kennington - Influence of altitude on animal metabolism.
Norman Negus - Taxonomy and ecology of rodents.
Glenn Noble - Intestinal protozoa of mammals.
Gerald Scherba - Ecology of ants.
Dixie Smith - Evaluation of certain exclosures.
W. G. Solheim - Aquatic plants of Swan Lake; Fungi of the area.
Charles S. Thornton - Regeneration of tissues in Amphibia.

Applications for the initiation of new projects have been received.

FINANCIAL REPORT
1955-1956

October 1, 1955-June 30, 1956

Item	Budgeted	Expended	Carried Over to Next Year's Budget
Part-time Assistants	$ 850.00	$ 850.00	
Equipment	500.31	500.31	
Supplies	305.68	305.68	
Contractual	1406.68	292.91	$1113.77
Travel	170.11	78.99	91.12
Fixed Charges	72.00	72.00	
	$3304.78	$2099.89	$1204.89

July 1, 1956-October 1, 1956

	Budgeted	Expended	Unexpended
Part-time Assistants	$1000.00	$ 350.00	$ 650.00
Equipment	800.00	308.45	491.55
Supplies	464.00	359.36	104.64
Contractual	1741.77	755.89	985.88
Travel	491.12	190.56	300.56
Fixed Charges	36.00		36.00
Extraordinary Expense ...	147.00	123.05	23.95
	$4679.89	$2087.31	$2592.58

$560.20 received for lodging at the Station 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 $1600 were given by the New York Zoological Society.
Grants from the National Science Foundation amounted to $9200.
$7500 supplied by Interregional Research Program to Wyoming Agricultural Experiment Station for sagebrush study; $5300 for cattle helminths study.
$2000 from Natural Resources Board for range studies.

LIST OF PUBLICATIONS ON RESEARCH
AT
JACKSON HOLE BIOLOGICAL RESEARCH STATION

University of Wyoming

Altmann, Margaret

1951 Patterns of herd structure in free-ranging elk. Abstr. Ant. 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.

Bangham, Ralph

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

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. Nov. (booklet)

Craighead, Frank C. and John J. Craighead

1949 Nesting Canada geese on the Upper Snake River. Jour. Wildl. Man., 13(1):51-64.

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

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.

Certain aspects of the development and behavior of the Wyoming moose. Anat. Rec., 105(3).

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.

Findley, James S.

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

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

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

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

French, Norman R.

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

Gilligan, James P.

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

Laycock, William

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

Levi, Herbert W. and Lorna R. Levi

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

Miller, Dwight D.

1955 A study of sex combs in Drosophila affinis and Drosophila athabasca. Trans. of the Amer. Microscopical 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 Mam. 31(4):463.

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

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

Noble, Glenn A.

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

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.

Salt, George W.

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

Spencer, Warren P.

1950 The Drosophila of Jackson Hole, Wyoming--ataxonomic 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. Jour. Exp. Zool., 131(2):373-394.

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.

1953 Fatalities in rodents caused by larval Ascaris in the central nervous system. Jour. Mam., 34:153-167.