

Comparison of the Reproduction and Ecology of the Jemez Mountains Salamander and the Sacramento Mountain Salamander

by
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Resources Development Internship Program
Western Interstate Commission for Higher Education

THE RESOURCES DEVELOPMENT INTERNSHIP PROGRAM

The preceding report was completed by a WICHE intern during the summer of 1973. This intern's project was part of the Resources Development Internship Program administered by the Western Interstate Commission for Higher Education (WICHE).

The purpose of the internship program is to bring organizations involved in community and economic development, environmental problems and the humanities together with institutions of higher education and their students in the West for the benefit of all.

For these organizations, the intern program provides the problem-solving talents of student manpower while making the resources of universities and colleges more available. For institutions of higher education, the program provides relevant field education for their students while building their capacity for problem-solving.

WICHE is an organization in the West uniquely suited for sponsoring such a program. It is an interstate agency formed by the thirteen western states for the specific purpose of relating the resources of higher education to the needs of western citizens. WICHE has been concerned with a broad range of community needs in the West for some time, insofar as they bear directly on the well-being of western peoples and the future of higher education in the West. WICHE feels that the internship program is one method for meeting its obligations within the thirteen western states. In its efforts to achieve these objectives, WICHE appreciates having received the generous support and assistance of the Economic Development Administration, the Jessie Smith Noyes Foundation, the National Endowment for the Humanities, the National Science Foundation, and of innumerable local leaders and community organizations, including the agency that sponsored this intern project.

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ABSTRACT

In addition to the final report, a doctoral dissertation of greater scope will be submitted at a later date.

National Geographic is currently considering including Plethodon neomexicanus in a book along with the project with which we are currently involved.

Data which has been collected includes the activity cycles, air and habitat temperatures, habitat description, and snout-vent lengths of over 600 salamanders of both species. Histological work on males and females has been concluded, but time has not allowed analysis of this to be completed.

A hibernation study has been started, and data will be collected every other month from October, 1973, to August, 1974. Most of the summer was devoted to the digging of these 12 sites each of which took up to 5 days to complete.

An electrophoretic study analyzed 4 species of Aneides and 7 species of Plethodon. This data is currently being analyzed at Syracuse University.

A study using radioactive tantalum wire has been delayed by the Atomic Energy Commission. They require a pilot laboratory study and this is currently in progress. A history of the use of radioactive material for field studies has been included.

Finally, the current distribution of Plethodon neomexicanus has been included.

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In the following report I will explain what has been done, what delays we have encountered, and what we will accomplish before the completion of the project.

National Geographic Society through Jan Clarkson has expressed interest in our research project. They would like to include the salamander, Plethodon neomexicanus, in their book on vanishing wildlife. We have sent them facts of interest about the salamander and have included our research project outline sponsored by the Forest Service in conjunction with WICHE. They have accepted 7 of our slides of the salamander and the project, and 3 slides taken by Joseph Shaw who has written popular articles on the salamander in New Mexico Magazine and Animal Kingdom. We hope to receive news concerning acceptance by September, 1973.

The activity cycle of both species has been concluded. Air and habitat temperatures, habitat description, and measurements have been taken from over 600 salamanders of both species. From the recorded temperatures and habitat description, we can determine habitat preferences. From the measurements (snout to the anterior tip of the vent) we have used a mathematical technique published by Harding (1949) to determine number and average lengths of the age classes up to the adult. This will also show the rate of growth of the age classes from birth to adult. Representatives of both species have been collected every other week during the active season, and they have been preserved in the laboratory. One testis from each male and the spermatheca from each female have been sectioned and stained histologically and mounted on slides. I have not yet had time to

study these slides, but from them we will learn the reproductive cycles and when mating and oviposition of eggs occur.

Together with the activity cycle, habitat preferences, reproductive cycle, and Harding's Analysis one can chart this against monthly rainfall and temperature to gain insight into the overall picture of natural history of both organisms. Aneides hardyi is much more abundant than P. neomexicanus and hopefully some reasons for this may be ascertained in this comparison.

To avoid extremes of the environment many salamanders retreat underground. In areas with long cold winters salamanders will hibernate until the spring. This is a typical pattern for salamanders, but it is not an absolute rule. On the west coast and in southern areas with mild winters these animals do not hibernate. Neill (1948) published a list of salamanders from Georgia and most did not hibernate. Many species of Ambystoma are active in cold winters. Deevey (1943) found Ambystoma tigrinum moving in snow during March toward their breeding pond. These salamanders have been known to mate under the ice in a pond, and oviposit eggs there.

Friedmann et al. (1969) proposed that Taricha granulosa lowers its red blood cell count and hemoglobin content while in hibernation and undergoes a vascular engorgement within two weeks after coming out. This suggests the mammalian definition of hibernation, but his results are highly questionable. His critical conclusion was based on one laboratory animal. Probably the only physiological changes that salamanders undergo are in response to one or more of the

following: dehydration, starvation, abnormally cold temperatures, and fluctuation in minerals with varying depths in the soil. Will the salamanders choose a low temperature in response to lack of food in order to slow their own metabolism? Is there enough stored food to allow them to exist at a more optimum temperature?

Encounters with hibernating species of Plethodontidae have been made by numerous authors: Blanchard (1933), Grizzell (1949), Vernberg (1953), Cooper (1956), and Taub (1961). Most of these studies have included Plethodon cinereus. Detailed studies with distribution of salamanders within the soil were conducted using Aneides lugubris (Rosenthal, 1958), P. cinereus and Eurycea bislineata (Vernberg, 1953), and P. cinereus (Taub, 1961).

A field experiment has been started using enclosures in each of the two study areas. The enclosures are approximately 3 feet square and 4 feet deep. To insure minimum disturbance of the soil the enclosures were made by removing soil around them leaving a sort of island. This method was patterned after Vernberg (1953). A wire screen was wrapped around the enclosure and the top was sealed with screening. The exit from the area is the bottom. Three thermistor probes were set at 1 foot, 2½ foot, and 4 foot levels. During September, 1973, 20 salamanders representing all known age classes will be toe-clipped, measured, and placed in 6 cages in each study area. Beginning in October soil moisture, soil pH, temperatures of air and thermistors will be recorded, and one trap will be excavated. Number of animal, depth, and measurement

will be recorded, along with description of hibernating condition- i.e. coiled, aggregated, distance from screening. Five adults will be preserved for reproductive data. Six traps will be excavated from October (1973) to August (1974) every other month.

A pilot study has been conducted in the two study areas. Two enclosures had been built in each study area. Excavation of one cage in each area suggested the feasibility of the proposed technique. No mortality had been recorded in either cage. Lack of depth in other studies- 36 inches in Vernberg (1953) and 12 inches in Taub (1961)- had led to over 50% mortality in both studies.

Much data is expected from this study. Growth rates in enclosures over the summer will be compared to those in natural populations. Some insight into growth rates over the winter will be gained. The male and female reproductive cycles which show tendencies not typical of Plethodon in the case of P. neomexicanus and which are only hypothesized in both species should be completed. Cavities both in type and depth for deposition of eggs should be described. No one has found eggs of P. neomexicanus and only a few clutches in rotting logs in A. hardyi have been found. A complete description of both egg clutches should be concluded. Do the animals feed at all underground in the winter?

What is the typical hibernating temperature, moisture, and area? Vernberg (1953) found no tendency to aggregate in P. cinereus and Eurycea bislineata. Most were found with backs against the

wire in a C shaped posture. The animals were not found at the bottom of the 3 foot cage, but at certain depths in response to certain temperature and moisture relationship. Taub (1961) found no P. cinereus below 4°C and felt they would avoid temperatures below 10°C if a higher temperature existed. They also avoided levels below the water table, and Taub (1961) postulated that they may be forced to the surface during heavy rains much like earthworms. In a laboratory study Rosenthal (1958) varied temperature and moisture of the soil, and he found that A. lugubris showed different patterns of selection and behavior depending on the combination of these two factors. For example, in dry conditions they chose the lowest temperature (it ranged from 2° to 12°C) and aggregated. Relative humidity is greatest at low temperatures and aggregation also decreases evaporation. At a constant temperature (12°C) A. lugubris avoided excessively wet and dry conditions. The more dehydrated the animal the wetter the conditions it chose.

In the proposed study moisture, temperature, and profiles of the soil will be measured and analytically compared to the depth and condition of the animal. These results will be compared with the abilities of the two species to withstand desiccation (see Whitford, 1968) and with similar data on temperature and moisture in the species of the two genera in particular and within the family in general. Many different combinations of soil moisture and temperature are available in the enclosure, and it may prove very revealing which condition has priority if any. Moisture is

probably the more critical factor and according to Spight (1968) "amphibians expose more wet surface directly to the air, per gram of body weight, than do any other terrestrial vertebrate." Thorson (1955), Ray (1958), and Littleford et al. (1947) feel that there is a direct correlation between the ability to withstand desiccation and the microhabitat. Amphibians secrete large quantities of dilute urine; they rarely drink; they cannot take up water from saturated air; and their evaporative water loss may be greater than that of from open water (Thorson, 1955). Plethodon neomexicanus experiences a drier habitat than A. hardyi and should have a higher tolerance to water loss. This is indeed the case from the results of Whitford (1968). However, patterns for the two genera show that Aneides is more xeric, has thicker skin, and is more tolerant to water loss (Ray, 1958, and Rosenthal, 1958) than Plethodon. It is interesting from an evolutionary point of view that this reversed relationship exists.

Electrophoresis is a technique that studies differential rates of migration of proteins in an electric field. This is a form of taxonomy which is more sophisticated and may be more revealing than counting grooves or scales. Aneides hardyi was originally named Plethodon hardyi and many have difficulty distinguishing the two species. There also has been disagreement about the origin of P. neomexicanus- whether it came from an eastern or western form. We have collected data on A. hardyi and P. neomexicanus along with 3 other species of Aneides from the west, 2 species of Plethodon from

the east, and 4 species of Plethodon from the west. This data is currently being analyzed by Dr. Ronald Lucchino of Syracuse University in Utica, New York.

A study using radioactive tantalum-182 wire has been postponed until the summer of 1974. We have run into a mountain of red tape in this aspect of our project. We have not yet received permission to do a pilot study in the laboratory. Los Alamos Scientific Laboratories has loaned us a scintillation counter and probe, and Sandia Laboratories have given us the tantalum wire. The wire is currently being irradiated at the Omega Reactor in Los Alamos.

Provided the A. F. C. approves this study we hope to learn activity patterns on a daily, weekly, monthly, and seasonal basis. In addition, growth rates and hibernation sites will be determined from this. Studies using radioactive material for tagging organisms are common. The following is a list which I have compiled of the more important field studies using a variety of radioactive materials.

tantalum-182

Jordan's salamander (Madison and Shoop, 1970), Manitoba toad (Breckenridge and Tester, 1961), and skink (Nelson in Tester, 1963)

cobalt-60

Dusky salamander (Barbour et al., 1969), toad (Karlstrom, 1957), chorus frog (Kramer, 1971), garter snake (Smith, 1971), field vole (Godfrey, 1954), mole (Godfrey, 1955), vole (Harvey and Barbour, 1965), Alaska herring (Wilimovsky in Tester, 1963), shrew (Linn and Shillito in Tester, 1963), and wire worm (Arnason et al., 1950)

gold-198

mice (Kaye, 1960, 1961)

iodine-131

mice (Johanningsmeier in Tester, 1963), and bat
(Gifford and Griffin in Tester, 1963)

phosphorus-32

mosquito (Burger and Taylor, 1949), sturgeon fry
(Shekhanova in Tester, 1963), meadow mice (Miller,
1957), and lemmings (Jenkins, 1954)

antimony-124

bat (Punt et al., 1957)

zinc-65

plover (Griffin, 1952)

calcium-45

ring necked pheasant (McCabe and LePage in Tester, 1963),
and fish (Bogoiavlenskaia in Tester, 1963)

iron-59

trout (Scott in Tester, 1963)

strontium-89

mosquito (Burger and Taylor, 1949)

strontium-90

mallard (Dzubin in Tester, 1963)

rubidium-86

blue grouse (Bendell in Tester, 1963)

radium sulfate

beetle (Tomes and Brian, 1946)

The known distribution of P. neomexicanus has been included in
my account in the American Catalogue of Amphibians and Reptiles now
in press. This distribution is far from complete and the summer of

1974 will be needed to add to this. The soil moisture and pH will be compared from areas that have salamanders with areas that once had salamanders and have now been logged. We hope to gain some insight into the effect of logging from this study. The scope of the project was such that all of the areas of study could not have been completed in one summer.

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