AN ABSTRACT OF THE THESIS OF

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Title The Herpetology of Benton County, Oregon

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Prior to the present work, no detailed study had been made of the amphibians and reptiles inhabiting Benton County, Oregon. Very little has been published on the precise ranges, the habitat preferences, and the mode of life history of these animals as they are found in Benton County and adjacent areas. This lack of knowledge has existed as a considerable handicap to students desiring to do work with these forms, in that they have had little knowledge of where each species or subspecies occurs, or their habits throughout the year.

The present paper was undertaken with the objectives in mind of studying the natural history of the local amphibians and reptiles as completely as possible, although the subjects of distribution within the area and of habitat preferences have received the greatest attention. In presenting the results of the study, I have included data and conclusions drawn from field experience, supplemented with laboratory examinations, and have attempted to co-ordinate these with existent knowledge. In addition, I have pointed out, and often quoted extensively from, relatively little-known papers that seemed to bear on certain particular aspects.

Benton County is well situated for a study of this type. The county actually lies in somewhat of a huge basin. To the south, the Calapooia Mountains near Eugene provide an east-west mountain link between the Cascades and the Coast Range. High hills likewise connect these ranges in the latitude of Portland. These hills furnish dispersion routes between the two main mountain chains. From the standpoint of broad habitat types, the county includes, or is very close to, coastal forests, typical Coast Range, Coast Range foothills, and the Willamette Valley.

There occur with certainty in Benton County 9 salamanders, 4 toads and frogs, 3 lizards, 6 snakes, and one turtle. In addition, there are doubtful records or the possibility of the occurrence of 3 toads and frogs, one lizard and 2 snakes. Each of these doubtful records or possible additions have been briefly discussed in order to indicate the status of our knowledge.

Each of the known species of Benton County is presented in detail. Careful descriptions are given where it is felt that the literature is inadequate. Emphasis is placed on accurate identification of both adults and young. Distribution in Oregon is presented briefly, followed by a more detailed account of Benton County

distribution, including locality records. A map for each species shows these data. Habitat preferences are discussed at length, with descriptions of particularly fruitful collecting sites included in many cases. All known phases of reproductive activity are discussed. Food and feeding are treated of where facts are known. A section on general habits deals with daily and seasonal movements and migrations, hibernation, enemies, voice, captivity and economic implications. Unsolved problems are suggested for each species.

Photographs are provided for clarification of difficult identifications and for elucidation of various habitats.

THE HERPETOLOGY OF BENTON COUNTY, OREGON

by

ROBERT MACLEOD STORM

A THESIS

submitted to

OREGON STATE COLLEGE

in partial fulfillment of
the requirements for the
degree of

DOCTOR OF PHILOSOPHY

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I am indebted to a number of people for assistance rendered in the course of this study. This assistance has come through oral encouragement, the presentation of specimens, the contribution of field obsevations, and more intangibly, through the general co-operation of a number of individuals.

I am particularly indebted to Dr. K. L. Gordon, my major professor, who has often stimulated a flagging interest, and who has never failed to offer helpful suggestions when these were needed. In addition, Dr. Gordon has freely loaned much valuable equipment, has provided transportation on many field trips, and has collected a very appreciable proportion of the specimens used in this study.

Mr. Fred G. Evenden, Jr. has very generously turned over his field notes to me, and these have in many cases contributed much toward the account of a species. Mr. Evenden has further consistently brought in any unusual material or field obsevations, which he may have gathered, and has given these to me for my use.

Mr. Donald Darling of Lacomb, Oregon has collected in the Willamette Valley for several years. He has supplied me with information, and has been most generous in giving me full use of any of his data.

A number of students, in Dr. Gordon's classes, or quite apart from classwork, have been very helpful in

collecting specimens. Mr. Vincent Roth has been an energetic and conscientious collector, and has given me much useful information. Other students who have been similarly helpful are Mr. Robert Yancey, Mr. William Thompson, Mr. Alvin Aller, Mr. Charles Cutress, Mr. Philip Dumas, Mr. David Eakins, Mr. E. L. Jaramillo, Mr. L. M. Sinsabaugh, Mr. Floyd Ellertson, Mr. and Mrs. Richard Ritland, Miss Louise Boise, and Mr. Francis Ives. To all of these people, I am grateful for specimens and information.

Dr. Robert L. Livezy and Dr. William Graf both collected in this area, and incorporated certain of their findings in their theses (28, p.1-73 and 19, p.1-93). I have drawn upon these papers for certain observations, and take this opportunity to express my gratitude.

My wife, Carol O. Storm, has helped to some extent on field trips. Her greatest contributions, however, have consisted of patient understanding, practical and valuable criticism, and continual encouragement. For her help, I am most deeply appreciative.

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INTRODUCTION

General

Prior to the present work, no detailed study had been made of the amphibians and reptiles inhabiting Benton County, Oregon. Gordon's monograph (18, p.1-82) published in 1939, summarized the then available knowledge, and indicated the occurrence of several species of both classes in the county. Very little has been published on the precise ranges, the habitat preferences, and the mode of life history of these animals as they are found in Benton County and adjacent areas. This lack of knowledge has existed as a considerable handicap to students desiring to do work with these forms, in that they have had little knowledge of where each species or sub-species occurs, or of their habits throughout the year.

The present paper was undertaken with the objectives in mind of studying the natural history of the local amphibians and reptiles as completely as possible, although the subjects of distribution within the area and of habitat preferences have received the greatest attention. In presenting the results of the study, I have included data and conclusions drawn from field experience, supplemented with laboratory examinations, and have attempted to coordinate these with existent knowledge. In addition,

I have pointed out, and often quoted extensively from, relatively little-known papers that seemed to bear on certain particular aspects. It is felt that the result will present later workers in this area with a more concise source of information, from which to start their own studies.

Work on this project was started in September of 1941, and carried on until June of the following year. Interrupted until March, 1946, it was then resumed and carried on until February, 1948. Although time available for field trips was considerably shortened by necessary curricular work, these were carried out to a considerable degree, so that a number of localities, scattered throughout the county, were visited at least once. Field collecting was not resorted to in the first phases of the study, but as the value of this practice became increasingly apparent, more specimens were taken. Approximately 300 specimens representing all of the forms present, have been catalogued and studied. In addition, numerous individuals have been superficially examined in the field, and data recorded. At times, through my own collecting efforts and the contributions of friends, so many specimens have accumulated that it was impossible to preserve all of them. Most of these were at least carefully identified and their sources recorded.

Previous Studies in the County

The first published work, involving detailed study of a local form, was Dr. A. C. Chandler's study of Triturus (3, p.1-24), published in 1918. This is primarily a study of food habits, but includes many facts on other phases of the life history. Chandler did most of his collecting about a mile west of Corvallis.

During the late 1930's, a considerable amount of collecting was done in western Oregon by William Graf, Stanley G. Jewett, Jr. and Kenneth L. Gordon. Much of this collecting was within or close to Benton County. These workers presented the results of their collecting in a brief article in Copeia, July, 1939 (20, p.101-104). This article was probably the first to demonstrate the widespread occurrence through western Oregon of several little-known amphibians. Almost simultaneously with the above paper, Dr. Kenneth L. Gordon published his monograph on the amphibians and reptiles of Oregon (18, p.1-82). As mentioned earlier, this summarized the then available knowledge, and included the collection records of the paper by Graf et al. William Graf, at almost the same time as the above two papers were written, incorporated his collecting and observations into his master's thesis (19, p.1-93). This has not been published, but is available locally as

a good source of information, particularly on the methods of collecting many comparatively rare forms, and on the care of certain forms in captivity.

Robert Livezy's thesis for the Master's degree (28, p.1-73) was submitted in August, 1943. Observations on amphibians and reptiles found in a small portion of the oak belt west of Corvallis were included. Livezy's account of Triturus in his area is particularly useful.

Systematic List of the Amphibians and Reptiles of Benton County

Unless otherwise noted, the following list adheres to the fifth edition of the check-list by Stejneger and Barbour (47, p.1-260). The list includes all the forms known to occur within the borders of the county.

Class Amphibia
Order Caudata

Suborder Mutabilia
Family Salamandridae

1. Triturus granulosus granulosus (Skilton)

Family Ambystomidae

2. Dicamptodon ensatus (Eschscholtz)
3. Rhyacotriton olympicus (Gaige)
4. Ambystoma gracile gracile Baird
   see Dunn, 1944 (7, p.129-130).
5. Ambystoma macrodactylum Baird

Family Plethodontidae

6. Plethodon dunni Bishop
7. Plethodon vehiculum (Cooper)
8. Ensatina eschscholtzii eschscholtzii Gray
9. Aneides ferreus Cope

Order Salientia

Suborder Costata
Family Ascaphidae

10. Ascaphus truei Stejneger

Suborder Linguata
Family Hylidae

11. Hyla regilla Baird and Girard

Family Ranidae

12. Rana aurora aurora (Baird and Girard)
13. Rana catesbeiana Shaw

Class Reptilia
Subclass Diapsida
Order Squamata

Suborder Sauria
Family Iguanidae

14. Sceloporus occidentalis occidentalis (Baird and Girard)

Family Anguidae

15. Gerrhonotus coeruleus principis (Baird and Girard)
16. Gerrhonotus multicarinatus scincicauda (Skilton)

Suborder Serpentes
Family Boidae

17. Charina bottae bottae (Blainville)
see Klauber, 1943 (25, p.83-90).

Family Colubridae

18. Coluber constrictor mormon (Baird and Girard)
19. Pituophis catenifer catenifer (Blainville)

20. Contia tenuis (Baird and Girard)
21. Thamnophis ordinoides ordinoides (Baird and Girard)
22. Thamnophis sirtalis concinnus (Hallowell)

Subclass Synapsida
Order Testudinata

Family Testudinidae

23. Clemmys marmorata marmorata (Baird and Girard)
see Seeliger, 1945 (40, p.150-159).

Doubtful Records and Possible Additions

The following annotated list includes those species, which have not been included in the previous list nor in the species accounts, but which either have been doubtfully recorded in the county, or occur near the borders of the county and may be found within it in the future. A brief discussion follows each species to indicate the status of our knowledge.

Bufo boreas boreas (Baird and Girard) Northwestern Toad. Although apparently absent from the central part of the Willamette Valley, this toad has been recorded from Oregon City to the north, from Roseburg to the south, and from the coast near Florence. To the east, the toad is present in the high Cascades. These indicate an ability to survive in varied habitats, and it seems possible that the form may eventually be found within Benton County.

Rana boylii boylii (Baird), California Yellow-legged

Frog. Three specimens in the O. S. C. collection are labelled simply "near Peoria and Brownsville". Peoria is situated on the east bank of the Willamette River, about 8 miles south of Corvallis. The record is obscure, however, and I feel that it should be entirely discounted. Fitch (14, p.148) stated that he had seen these frogs at the mouth of the Mackenzie River near Eugene in Lane County. Since the Mackenzie enters the Willamette at this point, the record puts the yellow-legged frog in the upper end of the Willamette Valley, and more precisely, in the Willamette River itself. This point is about 20 miles from the southern border of Benton County, and it seems quite possible that the frog may occur that much farther downstream. However, it is possible that suitable habitats are not available along the Willamette. The frog seems to prefer streams having rocky beds, preferably solid stone. Breeding is done in rock-bottomed overflow pools of such streams. Persistent collecting along the Willamette may, however, reveal this frog's presence in the county.

Rana pretiosa pretiosa (Baird and Girard), Western Spotted Frog. Although recorded by Graf (19, p.51-52) at Peoria and on Muddy Creek (?), not a single specimen in the O. S. C. collection belongs to this sub-species. Certain specimens, labelled pretiosa pretiosa belong either

to the sub-species luteiventris, or are red-legged frogs (Rana aurora). Gordon (18, p.64) records the frog from Coos County and from Clatsop County, which would indicate its occurrence through the Coast Range between. However, I feel that it is absent from Benton County, and that it is either of uncertain taxonomic status, or occurs in the Cascades and northward. This frog presents an excellent problem in taxonomy and distribution, and its true status must await such studies.

Eumeces skiltonianus skiltonianus (Baird and Girard), Western Skink. Gordon (18, p.71) gives Corvallis as a locality record for this form, but no exact location is available. Graf (19, p.64) states that it "has been reported from, but so far not collected in Benton County". No specimens from Benton County are present in the O.S.C. collection. I have collected several of this species on an open stony ridge 4 miles south and one mile west of Monroe. This is about 1½ miles south of the county line. Toward the summit of this hill are several rock outcrops, and the open south slope below these is littered with well-imbedded small stones. These rocks rest on other rocks, etc., there being very little soil present. This results in plentiful cracks and spaces extending well below the surface of the ground. The lizards were found by energetically turning over and digging out rocks. This

type of habitat is not, to my knowledge, repeated anywhere in Benton County. However, if such hillsides are found in the county, particularly the southern part, it is probable that Eumeces will be present there.

Diadophis amabilis occidentalis Blanchard, Northwestern Ring-neck Snake. The status of this snake in Benton County is somewhat of a mystery. Graf (19, p.68) says that it has been taken in the hills west of Corvallis, and that it is neither common nor rare in that region. He states that "generally two or three are brought in every spring". Mr. Fred Evenden's personal notes contain a reference to a specimen of this snake, which he found on April 18, 1942 beneath a board on the south slope of Bald Hill, 3 miles west of Corvallis.

On October 4, 1941, while collecting in an open area around an old ranch, approximately 5 miles southwest of Philomath, a companion and I came upon the large stump of an old fir that had been sawed off near the ground. Near an opening at the base of the stump, 4 ring-neck snakes were coiled together on the ground. Whether these were breeding or going through pre-hibernation behaviourisms was not determined. At that time, no specimens were collected, and this is unfortunate, since that constitutes the only time I saw this form in Benton County. No specimens from the county can be found in the O. S. C.

collection.

These records seem to indicate that Diadophis occurs within the county limits. However, until more is known of its distribution and habitats, it was thought best to omit it from the species accounts. It seems probable that in both Diadophis and Eumeces, we are dealing with species that are at the northern edge of their distribution on the west side of the Willamette Valley.

Crotalus viridis oreganus (Holbrook), Pacific Rattlesnake. Reports of the occurrence of this snake in Benton County crop up regularly from various parts of the county. The most persistent rumor is that they once occurred on a hill about 3 miles west of Corvallis, known as "Baldy". It seems probable that they may have been present there at one time, but I believe that they have been completely exterminated in that area. The nearest point at which rattlesnakes occur with certainty is the open ridge, 4 miles south and one mile west of Monroe, mentioned under the account of Eumeces skiltonianus. Here, they den for the winter in recesses at the base of the rock outcrops toward the summit of the ridge. I believe that such rocky crevices running deep into the ground are necessary for hibernation of the snake, and that lack of such situations presents a limiting factor to the rattlesnake's spread northward.

Mr. Bill Carpenter of Monroe has, for several years, visited dens in that vicinity in order to shoot the rattlesnakes as they emerged in the spring. In 1946, he stated that he had killed 58 rattlesnakes that spring, and in previous years had killed as high as 87. The snakes usually come out of hibernation on warm days between late March and the middle of April. Mr. Carpenter has told me that there are a number of dens in hills southwest of Monroe, but that insofar as he knows none are within the Benton County limits.

Geography and Physiography of Benton County

Benton County is well situated for a study of this type. It lies at the west side of the Willamette Valley, toward the southern end of the valley. The eastern part of the county includes the flat valley floor adjacent to the river, but westwardly the land slopes upward to include a sizeable portion of the Coast Range mountains. Streams on the eastern slopes of these mountains drain into the Willamette River, by way of the Long Tom, Mary's and Luckiamute Rivers. Streams of the western edge of the county drain into the Alsea and Yaquina Rivers, which are coastal streams. The county actually lies in somewhat of a huge basin. To the south, the Calapooia mountains near Eugene provide an east-west mountain link between the

Cascades and the Coast Range. These hills furnish dispersion routes between the two main ranges. A similar situation occurs in the lower end of the Willamette Valley, where high hills connect the Cascades and Coast Ranges at about the latitude of Portland. From the standpoint of broad habitat types, the county includes, or is very close to, coastal forests, typical Coast Range , Coast Range foothills, and the Willamette Valley. The rather central location of the county in these types makes it accessible to species invading from either north or south. Three reptiles apparently reach their northern limits (on the west side of the Willamette Valley) in Benton County, and one amphibian reaches its southern limit here.

The Willamette River forms the eastern border of the county. The river here is comparatively sluggish, and this fact plus the fact that it carries a considerable load of sediment combine to create numerous channels and sloughs. The floor of the valley is a very flat alluvial plain, sloping gently to the north. Because of its heavy load of sediment, the river is unable to cut down, and adjacent land does not slope toward the river. The average elevation of the valley floor is near 250 feet.

At the southern edge of the county and across the northern part between Corvallis and the county line,

eastward spurs of the Coast Range extend to within a few miles of the river. In spots, these reach an elevation of well over 1000 feet. In addition to these spurs, there are a number of isolated hills or buttes, which attain heights between 400 and 800 feet. Noteable examples are Coffin Butte (732 feet), Country Club Heights or Weigand Hill (c. 450 feet), Bald Hill (752 feet), and Winkle Butte (463 feet).

The first foothills of the Coast Range slope up from the valley floor at distances varying from 2 or 3 to 7 or 8 miles from the river. The general aspect of the Coast Range hills is that of a dissected plateau or upraised peneplain (10, p.460). The general crest level is probably between 1700 and 2000 feet, but a few peaks go over 3000 feet. Mary's Peak (4,097 feet) is the highest peak of the Coast Range. The mountains are quite devoid of extensive rock outcrops or precipitous cliffs. Fenneman (10, p.460) states that structurally "the range is a low anticlinorum". "Dips do not generally exceed 10 deg. but in exceptional cases rise to 25 and even 35 deg."

Climate

Westerly winds predominate, and bring a comparatively mild climate to all of western Oregon. Probably 40 to 60

per cent of the rainfall occurs during the winter months of December, January, and February, so that the entire area becomes very dry during the summer. In the Willamette Valley, temperatures average 65° in July, and 39° in January.

The winters are generally very mild, sub-freezing temperatures being unusual. The relatively high temperature plus the high rainfall make the winter months an active season for many amphibians. The average precipitation in the valley is 40-45 inches. In the Coast Range, temperatures are somewhat less extreme on the lower west slopes, and average somewhat cooler toward the summit. Rainfall averages around 60 inches at the western edge of the county, and increases to upwards of 70 inches toward the summit of the Coast Range. In wet years, rainfall may exceed 100 inches on the western slope of the mountains.

Some snowfall occurs at higher levels in the Coast Range, but is usually persistent only on the upper slopes of Mary's Peak. Here, several feet of snow may accumulate, so that parts of the summit retain snow patches into the early spring months.

Vegetation and Habitats

On the basis of vegetation, Benton County can be

divided broadly into forested and non-forested areas. These areas coincide roughly with the Coast Range and Willamette Valley portions of the county. Each division can be further subdivided. The principal tree of the Coast Range is Douglas fir. Once practically continuous over the Coast Range hills, the fir has been intensively cut for lumber, and fires have taken their toll. Few primitive stands remain, but where they do, the habitat is one of large trees, forming a continuous canopy, which excludes almost all vegetation beneath except for moss species, which form a thick mat on the forest floor. The course of streams through these forests is usually marked by a deciduous growth of alder, maple, and a few species of shrubs, which furnish a dense shade during the summer.

A few acres at the top of Mary's Peak are devoid of trees, and this is apparently a natural condition, due to altitude and climatic factors.

In burned and lumbered areas, the vegetation soon becomes practically impenetrable, particularly on north slopes, providing no grazing is carried on. Ferns and herbaceous growth are followed by a number of shrubs and small trees, which are eventually replaced by a second-growth fir. Such dense growths seem to present an undesirable habitat for the herpetofauna. Growth along

streams in these opened areas is usually more vigorous, so that they tend to remain densely shaded. In areas where pasturing occurs, on the other hand, the vegetation remains much more open. This is especially true on south slopes, where extensive open areas may develop, with scattered brush and small trees, and numerous old logs and stumps. Such areas are favored habitats for certain forms.

The larger valleys in the Coast Range have been much utilized for agriculture, so that there is considerable open area along the courses of the larger streams and rivers. The edges between forest and open areas support a number of forms.

Moving eastward toward the main valley, more ranch clearings are encountered, and the firs give way to the small Garry oaks, which cover much of the foothill region. These oaks vary greatly in the size of individual trees, and in the density of the stands. The more open stands are most inviting to certain forms, and the small openings in mixed fir and oak seem to be the most utilized, particularly by reptiles.

It is noteworthy that many foothills and a number of the more isolated hills in the valley present the almost uniform pattern of open shrub-dotted lower south slopes, oak-covered upper south slopes, and mixed fir and oak, or

fir alone on the north slopes. Oak woods are relatively free of undergrowth, whereas second-growth fir forests are richly supplied with an understory of shrubs and deciduous trees.

The floor of the valley is largely given over to agriculture, and consists in the main of open grain fields. The courses of the streams are, however, marked by a usually dense vegetative growth, mainly deciduous (Alnus, Acer, Salix, Fraxinus, Rhus, Corylus, Ribes, Populus, Rubus, etc.) but containing a good scattering of conifers (Pseudotsuga and Abies). In places, such growths may become quite extensive, particularly where there is a considerable flood-plain. In some higher areas, large stands of scrubby oak may occur.

The very flat nature of the valley plus the heavy sediment loads of the streams, produce numerous floods in the winter. Receding waters leave many temporary ponds, which last into the summer sometimes. Many of these support a considerable amount of aquatic vegetation. At certain points, marshy areas occur, the most extensive being located 12 miles south of Corvallis at Bruce Station. Water throughout much of these marshes is shallow, and a typical marsh vegetation is present. Sloughs along the Willamette are deep and permanent. Aquatic vegetation grows densely in most of these, particularly along the

shallow shores.

A discussion of these habitats as they apply more particularly to each species is included in each species account. In addition, certain habitats are discussed in greater detail.

Presentation of Each Species

The greater part of this paper is made up of detailed accounts of each of the species of amphibians and reptiles known to occur in Benton County, Oregon. The manner of presentation of each species necessarily varies somewhat, but it adheres more or less to the following general plan:

First appear sections on description and identification of the species or sub-species. Detailed descriptions are presented, where it is felt that available literature is inadequate in this respect. Where sexual differences or individual and/or seasonal variations exist, these are described. A number of measurements and counts are given for each species, with the intention of presenting somewhat typical figures for each form in the county. The only catalogued specimens examined are in the collection of the Oregon State College Museum of Natural History, designated (O. S. C.). All measurements are in millimeters, and were made on preserved specimens unless stated otherwise. Measurements on amphibians follow the directions given in

Storer (49, p.25-30), unless otherwise noted. Measurements and counts on lizards follow Smith's directions (45, p.27-30). Measurements and counts on snakes adhere to directions by Schmidt and Davis (39, p.24-35). Turtle statistics follow Pope (36, p.3-30).

Detailed descriptions of the young, particularly larval forms, are given in many cases, since these are often difficult to identify.

A second main section deals with distribution. The distribution in Oregon, as well as it is now known, is presented in order to locate the species with reference to Benton County. This is followed by an account of the species' distribution in Benton County, based on locations where specimens were collected or positively identified. A list of localities is given to strengthen the basis of the distribution given and to guide future workers.

A single map sheet is located in each species account. The larger map shows the assumed distribution of that species in Benton County, with the actual location records marked with dots. A smaller map indicates the Oregon range.

The distribution discussions are followed by a discussion of the habitat preferences of each form. In many cases, detailed descriptions of particularly rich

collecting sites are given. In every case, an attempt is made to summarize the habitat preferences of the form, insofar as these are known. In several forms, particular emphasis has been placed on this section of the account.

Under a section on reproduction, all known phases of this aspect of the animal's life are discussed. These include dates, time, locality and manner of mating; if oviparous, description of the eggs, laying habits, number of eggs, where deposited, care of, hatching time, etc.; if viviparous, time of birth, number of young, etc.; length of larval life; metamorphosis; and growth characteristics. An attempt is made to avoid including well-known facts.

Under food habits, types and amounts of food eaten, methods of obtaining food, and the effects of environment on feeding are presented where facts of new interest have been discovered.

A section on general habits deals with such varied topics as daily and seasonal movements and migrations, hibernation and aestivation, enemies and defense, and voice.

A final general section includes remarks on the economic implications of the form, and its behavior in captivity. It should be mentioned here that very little was done with captive animals, so that scarcely any data are available for presentation.

TRITURUS GRANULOSUS GRANULOSUS (SKILTON)

OREGON NEWT

DESCRIPTION OF ADULTS. This is the most common salamander of Benton County, and is easily identified by its brownish dorsal areas and contrasting yellowish ventral color. The brown on the back may vary from a yellowish tan or reddish brown through darker shades to a very dark brown. The ventral coloration varies from a rather pale yellow to bright orange. Terrestrial stages of both males and females exhibit a relatively dry-appearing granular skin, and lack any evidence of the tail "fin". At the time of breeding, external changes appear, which are slight in the female but very marked in the male. The female becomes somewhat less granular, so that the skin appears smoother, but still exhibits a roughened surface. Males, on the other hand, become very smooth, the skin appearing swollen and "slimy". Males further develop a conspicuous dorsal and ventral keel on the tail, and in general appear much larger than the females.

The largest individual measured during this study was a male, collected April 3, 1948, and having a total length of 218 mm. This is considerably larger than most specimens seen. A noticeable size variation has been observed between breeding populations in different areas. Populations on the main valley floor tend to average smaller in

individual size than populations in the eastern hills of the Coast Range. The measurements below were made on preserved specimens, numbers 1, 2 and 3 representing OSC numbers 42, 38 and 36 respectively. No. 1 is an aquatic breeding male, whereas Nos. 2 and 3 are terrestrial stages.

	1	2	3
Sex	M	M	F
Head and body	78	67	64
Tail	94	72	68
Depth of tail at base	12	7	8
Head length	19	17	15
Head width	16	13	14
Forelimb	23	22	20
Hind limb	23	22	21
Axilla to groin	31	30	30
Axilla to snout	28	23	23

SEXUAL DIMORPHISM. In general, it can be said that the terrestrial males are very similar to the average female, but that the aquatic male during the breeding season differs markedly. However, there exists a difference in the vents of the two sexes which is apparent in even the terrestrial stages. In the female, the vent is situated as a small longitudinal slit at the apex of a small cone-like projection, and is directed in a postero-ventral direction. In the male, the vent-slit is about twice as long and situated on a rounded oblong swelling. It is directed more ventrally. During the breeding season, the vent of the male becomes "greatly swollen and strongly protuberant, the sides ridged and grooved, the

opening with short free filaments" (2, p.73).

The dorsal color of breeding males varies within the same population from very dark brownish-black to a light yellowish-tan. Whether this is dependent upon length of time in the water is not known. Ventrally, the color is usually bright orange but may be of lighter stages toward the yellow side. In many breeding males, the soles of the feet and spots at the ventral bases of the thighs become intensely black. Other males show only faint indications of this pigmentation.

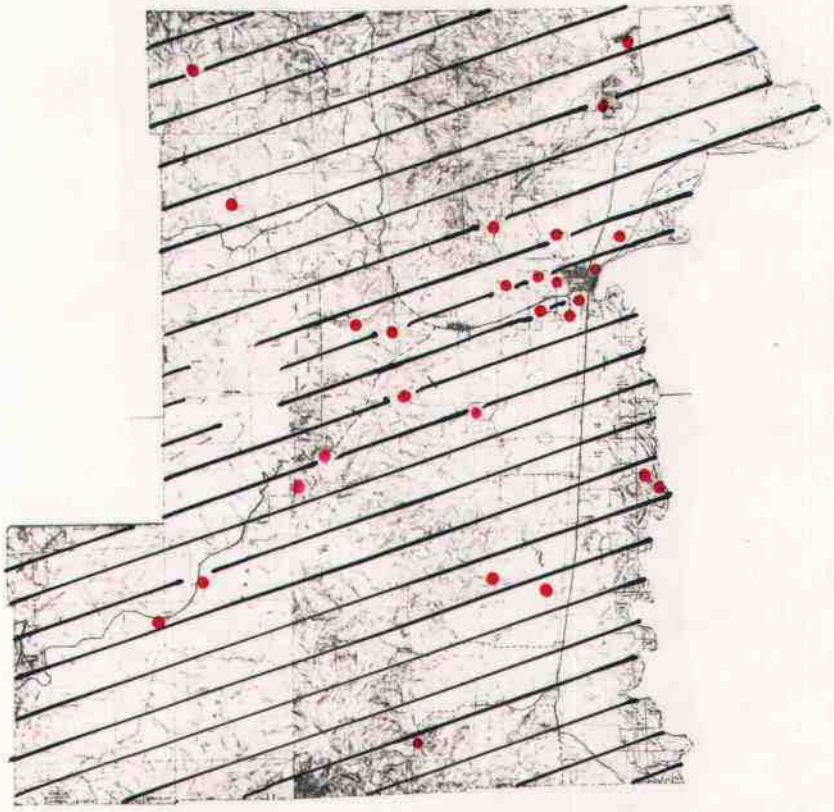
DESCRIPTION OF LARVAE. At the time of hatching the larvae are approximately $\frac{1}{2}$ inch (13 mm.) long. The "tail fin" extends from just in back of the head around the tail and forward to the vent position. The larvae are light in general coloration, with dark pigment concentrated in a longitudinal band on the dorsal side of the body adjacent to the base of the fin, and in a shorter, wider band on the ventro-lateral aspect of the trunk.

As the larvae become older, the pigment becomes more diffuse, and they appear generally darker. A 53 mm. larva described from life appears as follows: dorsal ground color bright yellowish-tan overlaid with numerous fine spots of dark pigment, these being concentrated in an ill-defined narrow strip along the base of the dorsal "fin", and at the junction of dorsal and ventral colorations.

These are the locations of the more intense pigmentation of the younger larvae. In addition, there are a number of very pale flecks aligned on the sides of the trunk between the axilla and groin, higher up on the lateral aspect of the trunk, and at the base of the dorsal "fin" on the tail. A faint but definite dark line extends from the forward corner of each eye to the corresponding nostil. The iris of the eye is brassy yellow, with a dark line crossing it antero-posteriorly through the pupil. Ventrally, the ground color is grayish on the chin, becoming a pale yellow posterior to the gular fold. The gills are conspicuous, and curve upward and forward. The dorsal fin fold reaches its greatest width about opposite the vent.

DISTRIBUTION IN OREGON. Triturus granulosus granulosus occurs throughout western Oregon from approximately the Cascade crest westward to the coast. (Map 1, p.25)

DISTRIBUTION IN BENTON COUNTY. The following records of occurrence indicate a wide distribution within the county. The records given are taken from the collection records in the Oregon State College Museum of Natural History (OSC), from the author's field observations (RMS), and from field observations made by Fred G. Evenden, Jr. (FGE): Coffin Butte, 10 miles N of Corvallis; near the Mary's River, 3½ miles N of Summit (OSC 23 and 24); Mary's River, 2 miles NW of Blodgett (OSC 35 and 36); Arboretum Pond,



Distribution of Triturus granulosus granulosus

Macdonald Forest (RMS); Dixon Creek area, 2½ miles N of Corvallis (FGE); Stewart Lake, 1½ miles NE of Corvallis (RMS); Dixon Creek, near Corvallis High School (FGE); sawmill pond near Oak Creek, 4 miles NW of Corvallis (RMS); pond at Oak Creek bridge, 1 mile W of Corvallis (RMS); ponds on west campus of Oregon State College, ½ mile W of Corvallis (RMS); Avery Park (FGE); south end of Brook Lane, 1 mile SW of Corvallis (RMS); pool beside road, 3 miles SW of Corvallis (RMS); sawmill pond, 3½ miles W of Corvallis (RMS); 3½ miles up Wood's Creek road from U. S. route 20 (RMS); 2½ miles W of Philomath (RMS); Well's Creek area (RMS); near Evergreen Road, 5 miles SW of Philomath (RMS); Bull Run Creek, 4 miles S of Philomath (RMS); Alsea Mountain area (c. 1250 ft.) (RMS); north road to Peoria Ferry at old gravel pit (RMS); slough at Peoria Ferry (RMS); marsh at Bruce Station, 12 miles S of Corvallis (FGE); north fork of Alsea River, ½ mile below route 34 bridge (RMS); confluence north and south forks Alsea River (RMS); Glenbrook, 5 miles W of Monroe (RMS). (Map 1, p.25)

HABITAT. It is evident from the locality records of this form that it is widespread in Benton County. The data for this study is hardly sufficient to assign definite habitat limitations to Triturus, although accumulations of water suitable for breeding purposes constitute

one of the most important limiting factors. Permanent ponds are the favored breeding sites, but pools and small ponds that last well into the summer, plus slow-moving streams and rivers are likewise acceptable.

The most favorable breeding site observed in Benton County is an artificial lake in the Macdonald Forest. This was created by damming up a canyon, the lake now covering between 2 and 3 acres, and going to a depth of perhaps 20 feet. The lake lies in thick second growth fir, but is surrounded on three sides by open roadway. There is a considerable growth of cattail and other aquatic vegetation around the shallow edges of the pond. At the height of the breeding season in early spring, Triturus occur in this pond in enormous numbers. On April 13, 1946, two students went to the pond to collect salamanders for embryological experiments, and they returned within three hours with approximately 200 of the animals. The combination of sufficient quiet, permanent water plus an abundance of under-water vegetation to which to attach the eggs undoubtedly contributes greatly to the high numbers of salamanders at this location.

Triturus was never collected nor seen on the higher slopes of Mary's Peak, and their absence there is doubtless due to a lack of breeding pools, the more precipitous slopes of the peak tending to shed surface water rapidly.

That the limiting factor here is not one of altitude is born out by Chandler's statement that he has found the newts in abundance in the Cascade Mountains of Oregon at an elevation of approximately 6000 feet (3, p.5). Here, mountain lakes provide opportunities for reproductive activities.

REPRODUCTION. According to Chandler (3, p.7), in the vicinity of Corvallis, mating does not begin until the latter part of the winter, usually in February, and continues well into summer, mating pairs having been found as late as July 14. Graf (19, p.27) states that "breeding may begin as early as December and continue until late June. However, these early and late cases are extremes and are exhibited usually only by scattered individuals". In my own experience, the earliest winter date on which a copulating pair was found was November 15, 1947. There is no doubt that there is a certain amount of activity late in the year. Whether eggs are deposited at this time or carried over to the following spring is more of a problem. Larvae have been collected in February, which by their size (near 25 mm.) could neither have been larvae of the preceding spring and early summer nor of recent hatching. It has been tentatively assumed that a few eggs are deposited late in the fall or early in the winter.

As the breeding season begins, males usually appear

first in the breeding ponds. Livezy (28, p.30) states that he found males in the water of a small breeding pool in his study area, in the middle of February, and that females appeared with them by the end of February. During the late winter and spring of 1947, several visits were made to two overflow pools located beside Wood's Creek, some 5 miles west of Philomath. Unfortunately, ditches were dug late in April for the purpose of draining the larger of these two ponds, and the consequent lowering of the water probably disturbed the normal course of events. However, observations made there tend to bear out the trend of Triturus breeding elsewhere in the county, and they are given here as an indication of this trend.

On January 22, a single male was seen in the larger pool. On February 12, the males reached a peak of approximately 36 animals in the two pools, and thereafter their numbers were less on each visit. By February 25, only 5 males could be counted in the two pools. On April 8, only 2 males were evident. The first female was seen on February 2, and on February 12, 7 were counted. On February 25, 25 females were seen which was the highest number recorded in that area. On April 8, 12 females were counted.

These number curves are followed approximately by Triturus elsewhere in the county, although there are

admittedly few counts to base them upon. They indicate arrival of the males first, followed shortly by the females. They further show a peak of mating activity in late February and early March, followed by a rapid disappearance of the males, the females remaining to deposit eggs, although they too seem to be leaving rapidly by mid- or late April. This program doubtless varies in different years, depending upon the weather, and proof of its validity must rest on many careful counts over a period of years, in a number of different breeding areas.

Copulation occurs once the males and females are together in the water. Males in the water often congregate near some point at the edge of the pool, where the females have been entering the water. On February 18, 1947, the following observation was made at one of the pools on Wood's Creek. A small seepage trickle drained into the main pool on its north side (exposed to sunlight on this particular day). One female was seen in this trickle, approximately one foot from the water. At the point where the seepage entered the pool, 2 pairs were in copulation. In addition, there were one unattached female and two single males. This phenomenon of waiting at the water's edge for entering females has been observed several times in other localities. Whether the females always enter by certain restricted routes or whether the males congregate

at a point where a female has already entered is not known.

Early in the season while air temperatures and water temperatures are quite cool, copulation is a rather dispirited affair. The salamanders tend to remain quietly on the bottom or move sluggishly, mating encounters being more or less by chance. As temperatures become warmer, the males seek more aggressively for females. The males swim fairly rapidly and in a course parallel to the bank, and an entering female may be pounced upon and tustled about by several of them. This may account for accumulations or "balls" of slamanders seen in ponds where the animals are very numerous. I have never seen more than eight males around a female, but have been given accounts of large solid balls of Triturus. Graf (19, p.30) speaks of having seen several such "swarms" during late summer and early fall, a time which would obviate breeding as a causative factor. Sticks thrown into the water within two or three feet of roving males are sufficient to turn them rapidly from their course for a short dash of investigation.

Smith (46, p.255-262) has given a careful account of mating behavior in Triturus torosus and states that although the behavior in T. similans (now granulosus) is

not well known, it probably follows similar patterns. Parts of this account will be quoted at length here, in order that a more complete picture may be presented. Smith summarizes the amplectic posture as follows:

> "There is a basic posture in which the male, assuming a dorsal position, clasps his forelegs around the female immediately posterior to the pectoral girdle. The hind legs of the male may hang free or be pressed across the cloacal or pelvic region of the female; the position of the hind legs varies in different pairs and stages of mating. The lateral lips of the male cloaca become distended to form a saddle over the dorsum of the female." (46, p.256)

According to Smith, the male rubs his cloaca laterally and axially across the dorsum of the female, at the same time exhibiting a clutching reflex by which the hind feet are contracted spasmodically across the cloacal region of the female. This reflex increases in frequency with sexual excitement, and may reach 70-80 per minute. Apparently, this reflex has an excitatory function for it results in lateral separation of the cloacal lips for reception of the spermatophore. A further feature present in amplectic males is the tendency to hook the chin over the rostrum of the female, at times wagging the head from side to side so as to rub the rostrum of the female. This "wagging" is accompanied by undulations of the tail.

In Triturus torosus, "the total time of amplexus is extremely variable. Insemination may be effected within two or three hours, but in several instances captive pairs

under continuous observation have remained in amplexus eight and ten hours, and intermittently for two or three days" (46, p.256). The sexual excitement aroused during amplexus is climaxed when the male dismounts by moving anteriorly over the head of the female. The male then stops in front of the female and deposits a spermatophore on the substratum. Following this, the male moves slowly away, followed closely by the female, whose nose is touching the cloaca of the male or is within an inch of it. As the female passes over the spermatophore, it sticks to the distended lips of the cloaca. This is the ideal pattern, and may be interrupted in many ways, e. g. the female often refuses to follow the male after the latter has dismounted. "It is of interest to note also that the male retrns to the female whether she accepts the spermatophore or not" (46, p.257).

Smith believes that hedonic glands in the submandibular region of the male "condition" or "quiet" the female, and that abdominal glands appear to direct the female so that she will pass over and receive the spermatophore. This entire fascinating phenomenon has reliable applications to certain phylogenetic aspects, but these cannot be discussed here.

I have noted most, if not all, of these varied actions during the mating of Triturus granulosus, but have

recorded no detailed observations. In one instance, a pair was seen in ventral juxta-position, but this can be considered accidental.

Egg-laying occurs within one or two weeks after fertilization. According to Livezy, he first observed a female depositing eggs on March 5 (28, p.30). Chandler (3, p.7) implies that egg-laying does not begin until April. Evenden (personal notes) collected a few eggs of this species on February 2. It is my opinion, as mentioned above, that a few eggs may be laid in early winter, but that breeding activity slows down as the weather becomes colder. As temperatures rise, mating and egg-laying increase. Since certain years may see long fairly warm periods as early as January or February, whereas others remain cold well into March, a considerable variation in laying time can be expected. This opinion is born out by Twitty (55. p.75), who states of Triturus granulosus in California:

> "Triturus granulosus is clearly the most aquatic of the California newts. In fact the actual spawning season itself is distributed over a longer period of the year than in the others. Within a given locality, or even in the same body of water, I have found females spawning, or with eggs in the oviducts, from late December until May or June. However, the season of most active spawning appears to lie principally within the months of March and April."

The slightly more clement weather in northern

California probably accounts for this extended season through the winter, but careful phenological records over a series of years might demonstrate a similar activity in this area.

Egg-laying is undoubtedly at its height when spring has progressed to the point where several days of agreeably warm weather follow one another, and this usually first occurs in late March or early April. No attempt has been made in this study to determine what water temperatures are critical, but such information would be desirable.

The eggs of Triturus granulosus are deposited singly or in small clusters, although single eggs are certainly not the rule. Livezy (28, p.30) states that by the last week of March, "females were laying single eggs rather thickly" on the leaves and stem of water moss and water buttercup. "No clusters of eggs were ever found, but eggs were laid closer together on the very thick water moss than on the water buttercup." In my own experience, the broken and dead stems of sedges hanging down into the water are favored locations for egg deposit. In the Arboretum Pond, Macdonald Forest, eggs are numerous on the dead fragments of cattail stems, which lie matted on the bottom in shallow water.

At no time was I able to watch closely the process of

egg laying. However, on April 8, 1947, two females were observed in one of the pools near Wood's Creek, which by their actions were depositing eggs. These newts were nosing among water hemlock in a shallow end of the pool, and from time to time they would seize a stem between the hind legs and remain with this pressed against the cloaca for several seconds (exact times were not checked). Subsequent examination of several of these stems showed a few freshly-deposited eggs. Fitch (12, p.635) makes this contribution:

> "Two single females, evinced interest, in a peculiar manner, in different sticks floating on the surface. One would nose along a stick and then turn to bring her cloaca to an adjacent position. At the same time she would grasp the stick firmly between her hind legs."

Bishop (2, p.74) says of the eggs that they

> "have a diameter of 1.85-2. mm; with their envelopes they average about 3.3 mm., but may reach 4 mm. There are three conspicuous envelopes in addition to the vitelline membranes, the 2 inner ones about equal in thickness, and together about $\frac{1}{2}$ the diameter of the outermost."

Chandler (3, p.8) states that the larvae hatch in about thirty days, this period of course varying with the temperature. Eggs collected by Evenden (personal notes) on February 17, and kept in an outside aquarium, hatched on March 13. The average water temperature during this time was approximately 45° F. The recently hatched larvae

have been described earlier. They will be compared, insofar as possible, with the larvae of other pond-breeding forms under the discussions of those species.

Bishop states that the larvae may attain a length of 55 mm. and transform in the fall of the year in which they were hatched, or spend an additional winter and spring in the water and reach a length of 70 mm. before transforming in June and July (2, p.74). Both possibilities occur within Benton County. Certain breeding pools dry up during the summer and it can be assumed that the larvae within them must transform or die. On the other hand, larvae have been collected in late winter which measured over 50 mm. and could only have been hatched in the preceding spring.

Chandler's discussion of age groups is of interest here.

> "At Corvallis it seems evident that sexual maturity is not reached until at least the fourth year, and perhaps after the fifth year, since the transformation does not take place until the second summer. Sexually immature transformed individuals are found in the fall varying in length from 58 to 135 mm., sizes which represent two and probably three different broods. The specimens transformed during the summer just past vary from 58 mm. to 65 mm. in length. The larger individuals, varying from 85 mm. to 135 mm., probably represent water-dogs in both the second and third years of adult life. The smallest sexually mature specimens are from 105 mm. to 110 mm. in length. These are probably developed from eggs laid four years before." (3, p.9)

I believe that the majority of the salamanders breed

in the third spring following their hatching, when they are three years old. Young transformed adults, from eggs deposited the same year range in length from 43 mm. to slightly over 50 mm. Young which have transformed in the year following their deposition as eggs measure in the neighborhood of 66 mm. to 76 mm. Young of the second year are from 90 to 120 mm. long, and finally breeding adults in the third year range from about 135 to 170 mm. in length, there being some difference in lengths according to sex. There is a scarcity of measurements of younger specimens in the present study, a deficiency which might well throw the above data into error.

FOOD AND FEEDING. Chandler's study (3, p.1-24) deals at length with the feeding habits of this species in the Corvallis region. Among other conclusions, he states that hard-bodied, vigorously struggling organisms are usually rejected. "Smooth-contoured or soft-bodied organisms, varying in size from mosquito larvae to medium-sized tadpoles, are the favorite foods; e. g., mosquito larvae, molluscs, larval salamanders, eggs, and tadpoles." (3, p.20) In experiments, which he carried out, the only kind of food which was definitely given preference over mosquito larvae was tadpoles and larval salamanders. Chandler concluded from his studies (3, p.20) that "there is no food which, under natural conditions, would be more ideal in every

respect than mosquito larvae."

During the spring of 1947, Mr. Fred Evenden Jr. examined the stomachs of 104 specimens of Triturus, collected from different localities in western Oregon (9, unpublished manuscript). He found a total of 50 different food items from all localities. Animal food was taken about 96% of the time, and the predominant class of food was insects. In his study, mayflies are the most important food item.

GENERAL HABITS. It seems quite certain that young adults live a terrestrial existence, following their transformation. At no time in the course of this study have I found other than breeding adults in an aquatic environment. On the other hand, there are several references in my notes to young adults found within logs or under objects on the ground. On February 2, 1942, 2 immature specimens (no lengths recorded) and one mature female were found under rotting logs near a slough in Linn County.

On April 13, 1946, a 3½ inch specimens was found in the central part of a 3-foot rotting log, near a very small stream some 4 miles west of Philomath. On May 17, 1947 a young Triturus of 70 mm. in total length was collected between two logs in an open area near the Mary's River, north of Blodgett. On November 8, 1947, a young specimen about 2 inches long was collected beneath a half-imbedded

board, under the leaf mat below a maple tree, about 100 feet from Bull Run Creek. Evenden (personal notes) collected 3 young, approximately 2½ inches long under a slab of wood northwest of Corvallis, and estimated that they were 250 yards from the nearest water. This was on April 10, 1947.

In all of these cases, the newts were found fairly close to the water, and it is thought that the recently transformed specimens do not wander far from their birthplace during the first year. On the other hand, older animals may be found at a considerable distance from water. A newt of adult size was seen crossing a fire trail on Alsea Mountain on October 20, 1947. This animal was at least ¼ and probably ½ mile from suitable breeding water. It is probable that the salamanders never get much more than a mile from the water.

After sexual maturity has been reached, the newts move to the breeding pools as mentioned above. A certain amount of unsolved mystery enters in here, since the vast majority of animals recorded in the author's notes as seen going toward water have proved to be females. It is quite possible that the males move toward the water gradually throughout the winter, so that their influx is not very noticeable. On the other hand, it may be that they return to the water at a much younger stage, living in pools

until they are mature. This latter possibility will be discussed at greater length in later paragraphs. Females can be observed in numbers as they approach the pools, usually during February. On February 6, 1942, and again on February 8 of that year several females were detected on the ground, crawling toward the pond in the arboretum of Macdonald Forest. Several females have been seen headed down a seepage trickle toward one of the main pools on Wood's Creek.

On December 6, 1941, a single male was found in the small pool formed in the cavity left by the roots of a large windfall fir. This animal was a fully matured specimen, but was still in the rough granular skin, typical of the terrestrial existence. On February 8, 1948, two males, 116 mm. and 139 mm. long were collected beneath slabs of bark in an open fir grove next to a small slough in Linn County. Both of these animals possessed inactive gonads, which seem to indicate that they would not breed during that year. These two cases taken together, although admittedly very meagre evidence, tend to support the idea that entrance of the males into the water occurs gradually throughout the winter.

The problem of what happens to the newts following the breeding season is still not entirely solved. Chandler (3, p.6) thought that the adults remained in the water

throughout the greater part of the year, living in the larger slow-moving streams, or in larger ponds and sloughs. In October and November, according to him, they leave the water, wander for several weeks, then "hibernate" in stumps or other protected terrestrial situations. They return to the water for breeding in January and February.

Graf (19, p.29-30) states that Triturus were found, during his study, to be present in permanent ponds, to a greater or lesser extent throughout the year. He quoted Taylor (unpublished) as believing that the adults lived in the larger streams and lakes, migrating upward in the smaller tributaries to spawn. Graf substantiated this belief by catching adult Triturus on a hook baited with a worm and fished near the bottom of the larger lowland streams, during the summer. He felt that the animals took up a terrestrial existence only long enough to reach larger bodies of water. Graf's final argument involved pointing out that if such terrestrial species as Plethodon, Dicamptodon, and even Ensatina sought out water or the water's edge during the dry months, then surely a semi-aquatic form like Triturus must spend the summer months in the water.

These theories are strengthened by Twitty's statement (55, p.75), quoted in part above, and completed here:

> "Unlike rivularis, granulosus may remain in the water for long periods subsequent to mating and there is virtually no season of the year, except during the period of flood, when adults of this species cannot be found in these streams. Triturus granulosus is clearly the most aquatic of the California newts."

I would be inclined to agree with Graf, except for a certain amount of evidence that both males and females leave the water after breeding, and take up a terrestrial existence until the next breeding season arrives. Personal notes on the matter are all too scarce, but a few examples can be given. On June 1, 1946, a male was seen moving up a brushy slope, about 50 feet from a small tributary of Wood's Creek. If this animal were seeking deeper water, it would have been most simple to follow downstream. It should be noted that three males were seen the same day in a small pool of this tributary. Evenden (personal notes) reports finding a number of specimens travelling through the woods on June 13, 1946, near Breitenbush River, Marion County. No information is given on their sexes. On May 5, 1947, Evenden reports seeing 3 newts heading away from a pond near Abiqua, Marion County. Again, there is no information on sex.

Livezy (28, p.29-32) gives several observations, which are of interest here. He noted that the skins of the newts in a pool in his study area became quite rough and granular during May, even though the animals had not yet left the

water. This was true of both males and females. This is considered a preparation for a terrestrial existence. Livezy also states in another paragraph that by "the first week in April egg laying activities all but ceased, and the number of animals rapidly diminished until only scattered individuals could be found." Unfortunately, no indication is given as to the dispersion of these animals, but since Livezy's study area lies in the oak foothills northwest of Corvallis, it can be assumed that the disappearing animals took up a terrestrial existence in the immediate area. It is difficult to believe that the salamanders would make their way a quarter-mile or so to the nearest creek, then return the following year, the return involving a rather steep climb of several hundred feet.

In another paragraph, Livezy (28, p.29) records that on the 10th of October, 1942, following the first heavy rain of the season, a number of females and some males were seen heading away from the water at one end of his area. These animals were moving quite rapidly, and Livezy went to the trouble of following several to determine their destinations. "In all cases the salamanders eventually crawled into crevices and holes in the ground or under the larger branches and logs that were strewn about over the ground." One wonders when the salamanders return to the water between May and October, but Livezy throws no light on this.

It is obvious that this problem is far from satisfactorily solved. In my opinion, it can only be solved by an intensive study over several years of some 5 or 6 good breeding pools and their Triturus inhabitants. These breeding areas should include at least one each of the isolated pool or pond type as in Livezy's study area, or in Macdonald Forest, the type found next to or connected with a stream, and the type found in a slow-moving portion of a river or stream. It is quite possible that the behavior of newts breeding in these different areas is entirely different, following the breeding season. A method of marking the young and adults must be devised, and this will probably involve some system of tattooing the skin of the venter. Periodic careful searches will have to be made in areas adjacent to these breeding sites, and the more often observations can be made the better. I regret at this time that I can contribute nothing more substantial to the solution of this problem, since it has always fascinated me.

On February 12, 1948, the pond in the arboretum of Macdonald Forest was completely drained as part of an ichthyological experiment. No herpetologists were present at that time, but I was able to talk with several who had witnessed the process. These men all agreed that there were great numbers of "orange-bellied" salamanders in the pond,

and that as the water fell, they became so concentrated as to completely cover areas of the receding shoreline. The author could not visit the pond until February 28, by which time it lacked about four feet of being completely refilled. Many Triturus were evident in the water as might be expected, but a certain aberrant behavior was noted. Several individuals were found on the land adjacent to the pond, crawling away from it. These were both males and females. Two males were found on land that had apparently died by desiccation through their water-adapted skins. Several males seemed in a weakened condition. Finally, one departing female that was killed and opened contained a full set of well-developed eggs. One can speculate as to whether drainage of the pond depleted the food supply or whether it somehow disturbed certain innate reflexes in the newts, which upset their normal pattern of behavior.

ENEMIES. The larvae are undoubtedly preyed upon by fish, larger larvae, adult salamanders, and even by certain aquatic insects. I have observed large specimens of the red-spotted garter snake feeding on the larvae in a shallow roadside pool. The adults are probably quite distasteful to most animals. Cutaneous glands in adult Triturus secrete a poison that is fairly potent. Taylor (54, p.183) found that the animals were highly susceptible to even small

quantities of their own poison. Breeding males are apparently especially poisonous, according to Taylor. I have heard tales of chickens dying as a result of eating adult newts, but can recount no authentic instance. During the winter of 1947-8, a female mallard duck was brought into the Fish and Game laboratory at Oregon State College, whose crop contained an adult male Triturus. This duck had been found dead, and it can probably be assumed that she either choked to death on this rather large morsel (an unlikely occurrence), or that poison from the newt brought about her demise.

ECONOMIC VALUE. As mentioned in the section on feeding habits, Chandler (3, p.1-24) was convinced that Triturus is of value in the control of mosquitoes, and his careful study seems to bear this out. He ended his article by offering several suggestions for the practical use of "water-dogs" as mosquito controls, even giving statistics on the effective number of newts per volume of water. To the best of my knowledge, no accounts are at hand of the actual following of Chandler's suggestions. However, the enormous numbers of Triturus present in western Oregon may have a very direct bearing on the fact that this area is relatively free of mosquitoes during the summer months.

PROBLEMS. A number of problems in connection with this species have been pointed out in preceding sections. The

outstanding problem continues to be the behavior of the newts during the non-breeding season. Only diligent collecting in small areas, combined with the marking of individuals and careful observations, will contribute toward a solution.

DICAMPTODON ENSATUS (ESCHSCHOLTZ)

PACIFIC GIANT SALAMANDER

DESCRIPTION. This is the largest of the Oregon salamanders. An adult male collected in the Cascades of Linn County, Oregon measures 10-9/16 inches (268 mm.) in total length and is the largest Oregon specimen available for measurement. No specimens of this size were collected in Benton County, the following measurements being those of two young adults, the first collected near Dixon Creek north of Corvallis, the second from Fall Creek, Lincoln County, at the west edge of Benton County.

	1	2
Sex	F	F
Head and body	91	90
Tail	65	57
Head length	20	20
Head width	20	19
Forelimb	24	23.5
Hind limb	28.5	28
Axilla to groin	38	40.5
Axilla to snout	34	35

The only live adult I have seen in Benton County escaped into a pile of branches and logs, but its total length was estimated at near 8 inches, and it appeared to be lacking about an inch of its normal tail growth.

The smallest transformed individual measured has a total length of 4-5/8 inches (117 mm.), and is a female collected near Portland, Oregon.

The larvae of this form likewise attain large size, and there is considerable reliable evidence that they are neotenic. A larva, in the Oregon State College Natural History Museum has a total length of 9-1/16 inches (230 mm.) but has no collection data. This specimen contains many eggs up to 3 mm. in diameter. Graf (19, p.36-37) mentions larvae of just under 12 inches, but gives no precise measurements. The smallest larva measured from Benton County has a total length of 43 mm.

Identification of the adult Dicamptodon is not difficult. The stout body and large, strong limbs probably resemble most closely the adult structure of Ambystoma gracile. However, Dicamptodon lacks the very conspicuous swollen parotoid glands of that animal. The pattern of coloration is quite distinctive. Ventrally, adult animals are grayish flesh-color, but dorsally, they exhibit a sinuous pattern of brown to almost black mottlings and blotches on a lighter ground color. In live individuals, the dorsal ground color is bright brassy in some specimens, in decided contrast to the much darker markings. In preserved material, this difference is much less striking but still apparent. This intricate pattern covers almost all of the dorsal portions of the animal, but is usually brightest on the head and shoulders.

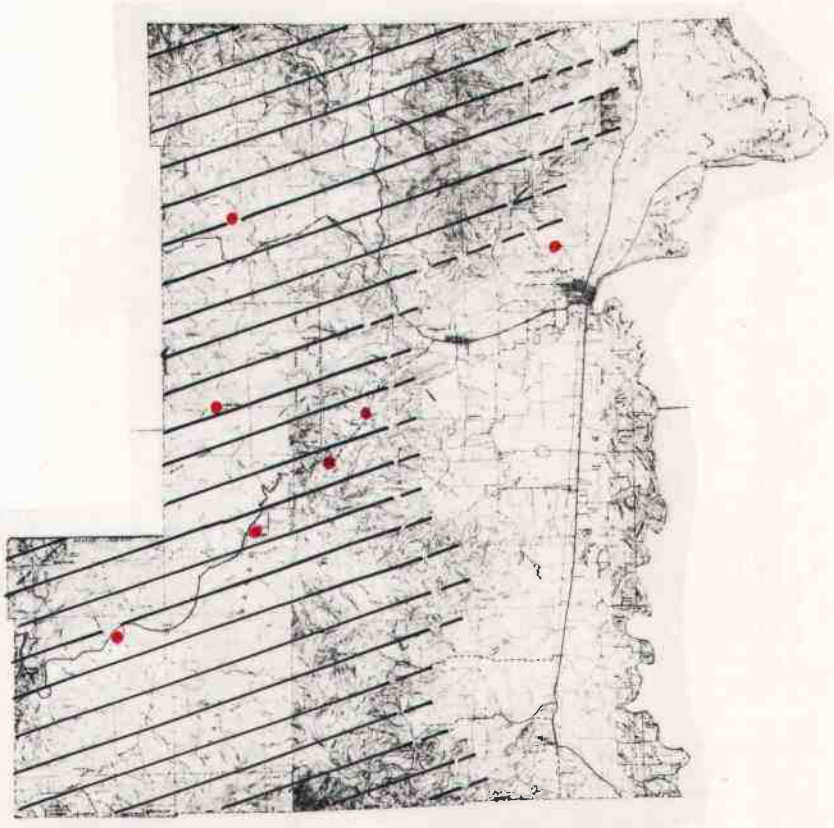
IDENTIFICATION OF LARVAE. The larvae are characterized by confinement of the dorsal fin to the tail region only, and by comparatively short gills. The larger larvae can be confused with no other form in Oregon because of their size, but smaller specimens show considerable similarity to the larvae of Rhyacotriton olympicus, which likewise possesses short gills and has its dorsal fin confined to the tail region. An excellent comparison of the two larval forms has been given by George S. Myers (31, p.125).

> "The snout is much shorter in Rhyacotriton and the end much rounder and less bluntly shovel-shaped than that of Dicamptodon when viewed from above, though in side view the muzzle of the smaller form is much blunter and more bulldog-like. The shallow groove that runs upward and backward from each nostril of Rhyacotriton is not evident in Dicamptodon.....Perhaps the most stiking difference in color is the bold, irregular, smoky light-dark-and-light mottling or marbling of the dorsal-caudal fin of Dicamptodon, which never appears in the other genus. Rhyacotriton is speckled, under the brown ground color of the dorsum, with irregular black dots, while the variegation of the duller, more grayish dorsum of Dicamptodon is caused entirely by irregular small light areas. I have never seen a Dicamptodon larva with any markings on the clear whitish venter, but the yellow under surface of Rhyacotriton almost always has a sprinkling of at least a few dark flecks.
>
> "The best recognition character for larval Rhyacotriton lies in the appearance of the eyes and their position in relation to the short snout. The eyes are directed more dorsally than those of Dicamptodon of like size, and the peculiar configuration of the snout makes them seem to be pointed more anteriorly. They appear very round and staring, and somewhat 'crossed' when viewed from the front."

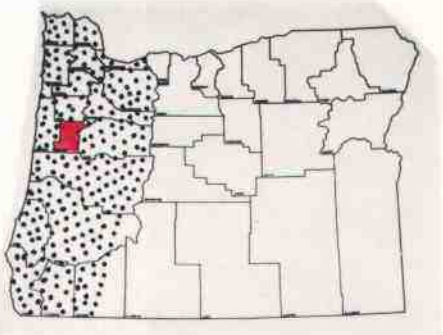
This comparison has been quoted at length because both larvae tend to occur in a similar type of habitat, and both are more easily found than are the adults. Correct identification will be important in future distribution studies.

DISTRIBUTION IN OREGON. Dicamptodon ensatus occurs in western Oregon, including the western slope of the Cascades. Until further collecting is done, it can be assumed that the eastern edge of its range swings westward in the southern Cascades, but the extent of this is not known. (Map 2, p.53)

DISTRIBUTION IN BENTON COUNTY. In Benton County, Dicamptodon is probably confined to cold permanent streams and rivers or their vicinity. The adults are considered animals of the dense fir forest. Graf (19, p.32) speaks of the larvae as being common in Muddy Creek, but no specimens are available. Although dirty and sluggish, Muddy Creek is deep and permanent, having its source in the Coast Range hills of the southern edge of the county. It is possible that the depth insures cold enough water for survival of the salamanders. Actual records in the county are as follows: Mary's River, 2 miles NW of Blodgett (OSC 9and11); Dixon Creek, 1.5 miles NW of Corvallis (OSC 5); headwaters of Parker Creek, Mary's Peak (RMS); Rock Creek at route 34 bridge (RMS); Well's Creek, 1 mile from its confluence with



(— — — occurrence uncertain)



Distribution of Dicamptodon ensatus

Greezy Creek (RMS); Ernest (?) Creek, near its confluence with Spencer Creek (RMS); Alsea River ? (19, p.36).
(Map 2, p. 53)

HABITAT. As mentioned above, only one adult of this species was encountered in Benton County during the course of this study. Any statement on habitat preferences of the adults lacks, therefore, personal observations. Since the larval stages appear to be confined to cold, permanent streams, adults can be expected in adjacent forests of virgin, or more often, second growth, conifers. Within these forests, there are a multitude of sufficiently moist retreats -- moss-covered rotten logs; crevices in stones, thick mats of duff and moss on the forest floor, rodent burrows, etc. Apparently a long dry period during the summer may force the adults into the water, for Graf (19, p.34) tells of capturing two adults from pools in a small tributary of Fall Creek (Lincoln County). This occurred in July at a time when the forests were extremely dry. Mr. George Buckingham, Jr., who lives and works on the Corvallis Water Preserve, a large primitive tract on the east slope of Mary's Peak, bears this out in oral communication. He states that the large "blue" salamanders are very common up there, being found in logs and under bark during the winter, but returning into the streams as the forests become drier.

The larvae tend to occupy different parts of the streams according to their size. Small larvae, one to three inches in length burrow into the coarse sand and fine gravel in the shallow riffles of the stream. At times, they have been found in gravel so situated that a small lateral branch of the stream seeped through it very slowly. They can usually be obtained by holding a dip-net perpendicular to the current some three feet downstream from the riffle, then digging into the sand and gravel with hands or digging tool. The current washes them into the net.

Larvae in a size group of approximately 3-7 inches are better able to protect themselves. On April 26, 1947 a Dicamptodon larva of approximately 6 inches in length was raised to the surface while using a single salmon egg in fishing for trout in Wood's Creek. This specimen apparently stayed near the bottom of one of the deeper pools of this comparatively small creek. However, in a case where the stream is more precipitous with only a few small pools, these medium-sized larvae may take refuge among the stones in the riffles of the stream. On May 10, 1947, 3 larvae from 5-6 inches long were obtained in the headwaters of Parker Creek on Mary's Peak. These were captured by holding dip-nets below a riffle and raking out the stones and coarse gravel. On May 17, 1947, a 5-inch larva was collected resting on a gravelly portion of the bottom of

Mary's River, above Blodgett.

Larvae of more than 6 or 7 inches in length will be found in the deep pools of the larger creeks and rivers. No personal observations can be brought to bear on this matter, but Graf (19, p.36) indicates this as a result of his work. In summary, small larvae are usually found among the gravel of shallow riffles in small streams, medium-sized larvae frequent the deeper pools of small streams or may be found among the stones of riffles in streams that are too precipitous to have many pools, and the largest larvae dwell in the deeper pools of the large streams and rivers.

REPRODUCTION. Little is known of the breeding habits of this form. During the course of this study, no eggs were found. Henry and Twitty (21, p.248-250) give an account of collecting the eggs of Dicamptodon in San Mateo, California. An adult female of this species was collected close to "numerous large amphibian eggs fastened singly on the surface of a timber...which had been partially submerged in a rapidly running stream. About 70 eggs were collected and were brought to the laboratory." This took place on June 19, 1937 and the larvae were at the "tail-bud" stage of development, and were all completely albino. To aid future workers, their description of the eggs is quoted here:

> "The average diameter of 10 of the capsules, which were very uniform in size and round in shape, was 8.3 mm. (measured to the nearest .5 mm). The pedicels extended an average of 5.7 mm. from the periphery of the capsule to the point of attachment. The jelly was soft and easily ruptured. Dissection revealed the wall of the capsule to consist of a single coat of jelly about 1 mm. in thickness within which the embryo was closely fitted, but permitting movement when the egg was tilted."

A picture of the timber with attached eggs accompanies the article.

It is reasonably well established that these salamanders are neotenic in western Oregon. Graf, Jewett, and Gordon (20, p.101) state that they collected larvae with fully developed sex organs, and that they opened females containing eggs which appeared matured and ready for laying. A larva with a total length of 9-1/16 inches (230 mm.) in the Oregon State College Museum collection (OSC 1) contains many closely packed eggs up to 3 mm. in diameter. Unfortunately no collection data accompany this specimen.

FOOD AND FEEDING. Little information is available on this score. During the present study, an examination was made of the stomach contents of several specimens in the Oregon State College Museum of Natural History. This indicated a catholic taste among the larvae for all of the aquatic invertebrates. A total of 13 stomachs were examined, of which 9 were larvae and 4 were transformed. Of these, 5 were empty, but this loses significance due to

lack of data as to how long the specimens may have been kept alive after capture. Of the larval stomachs, one contained a small lamprey, one contained caddis fly larval cases, 3 contained crayfish, and 3 held aquatic snails.

Of 4 transformed specimens, beetles were found in one stomach, grasshoppers in one stomach, isopods in one stomach, and terrestrial snails in one stomach. This is admittedly an inadequate sampling. A large adult Dicamptodon is doubtless able to attack and devour mice, small snakes and lizards, frogs, and other salamanders, but verification must await further studies. An adult of approximately 8 inches, while in an aquarium, devoured a Dicamptodon larva, close to 5 inches in length, although they had lived together peaceably for almost 3 months. During this time, they received no food and hunger may have precipitated this cannibalism.

GENERAL HABITS. Gordon (18, p.53) states that the adults come out usually at night. Bishop (2, p.176) states that he collected adults of this species under logs and bark on the steep slopes of China Gulch at Gualala, California, and this would indicate that they take shelter during the day. However, evidence is at hand to show that the adults are perfectly willing to emerge during the day. On May 24, 1947, while searching for Rhyacotriton larvae in pools of Storm Creek in the Cascades of Linn County, a large adult

(OSC 19) was seen to emerge from a grassy area, drop over a stone ledge about 2 feet high, and enter a hole in the rocks. It had apparently been foraging among the vegetation.

On September 9, 1947 following 3 days of constant rain, the first of the fall, an adult Dicamptodon nearly 8 inches long was observed on the top of a drift jam (logs, branches, etc.) in Well's Creek, Benton County. This was at 4:30 in the afternoon. While observed, this animal remained motionless but alert, and ran with surprising speed into the interstices of the jam when an attempt was made to capture it. A similar observation was made by Robert Morris, who collected an adult of similar size, which was resting on top of a pile of drift in a small creek running into Yaquina Bay, Lincoln County. The animal started for the water as the observer approached. This occurred on October 22, 1947 following a previous day of rain after a considerable dry spell.

J. S. Diller (5, p.907-908) has given an early account of a fight between a salamander and a snake. Mr. Diller gave no name to either species, but from his description of the participants, the fight was between an adult Dicamptodon about 8 inches long and a specimen of Thamnophis sirtalis about 2 feet long. This occurred 12 miles west of Riddle in Douglas County, Oregon. The fight was watched at intervals for a period of three hours. The salamander kept a firm grip on the snake at the "base of the right jaw and

neck." The snake could not bite the salamander, but writhed constantly. The salamander simply held on, and when last observed, the snake was practically dead. At that time, the salamander had shifted its hold to directly in front of the snake with a deep hold on its upper jaw, covering the nostrils. Which first attacked the other in this contest of endurance will never be known, but the incident reveals much concerning the capabilities of this powerful salamander.

Few notes are available on captive specimens. It has been found in the present study that the larvae, although accustomed to cold mountain streams, will stay alive for several months in a mason jar of water, if this is kept in a refrigerator.

The adults are capable of inflicting painful wounds with their teeth, if improperly handled, and do so with a very rapid lateral slashing movement of the head and forepart of the body. Although no actual experience is known of, one might also expect them to seize and hold on if sufficiently aroused.

PROBLEMS. This form is so imperfectly known that any phase of its activities can be profitably investigated. The upper limits of its size are often guessed at, but actual measurements are very few. Size in connection with age is unknown. The extent to which it enters the floor of

the Willamette Valley is very imperfectly known. Quite possibly, it is common as a larva in the Willamette River. The season and manner of mating are entirely unknown. To what extent neoteny is prevalent in this area and how it compares with other sections of the animal's range are interesting problems. Food studies of a qualitative nature should be made, especially of the larger larvae, since these may be capable of capturing certain fish. More knowledge of the terrestrial life of the adult is very desirable, including their habitat, daily and seasonal movements, and the density of their occurrence.

RHYACOTRITON OLYMPICUS (GAIGE)

OLYMPIC SALAMANDER

DESCRIPTION. Rhyacotriton is a comparatively small salamander, usually not measuring more than 4 inches in total length. A salamander of cold, shaded mountain stream areas, it is readily separated from other Caudata of that habitat by its lack of a nasolabial groove plus its coloration. The color dorsally is dark brown, flecked with small white specks and with somewhat larger irregular black spots. The dorsal color becomes a lighter brown on the tail. Ventrally the animal may be cream yellow to almost orange, and is sparingly flecked with white and with a few brownish spots. The mid-dorsal line is deeply depressed and the eyes are strongly protuberant. No specimens from Benton County are available for description, but a female from the Cascades of Linn County has the entire dorsal surface, including the limbs, thickly mottled or speckled with black. The following dimensions are of an adult female collected May 24, 1947 in Storm Creek, near the South Santiam highway in Linn County (OSC 111).

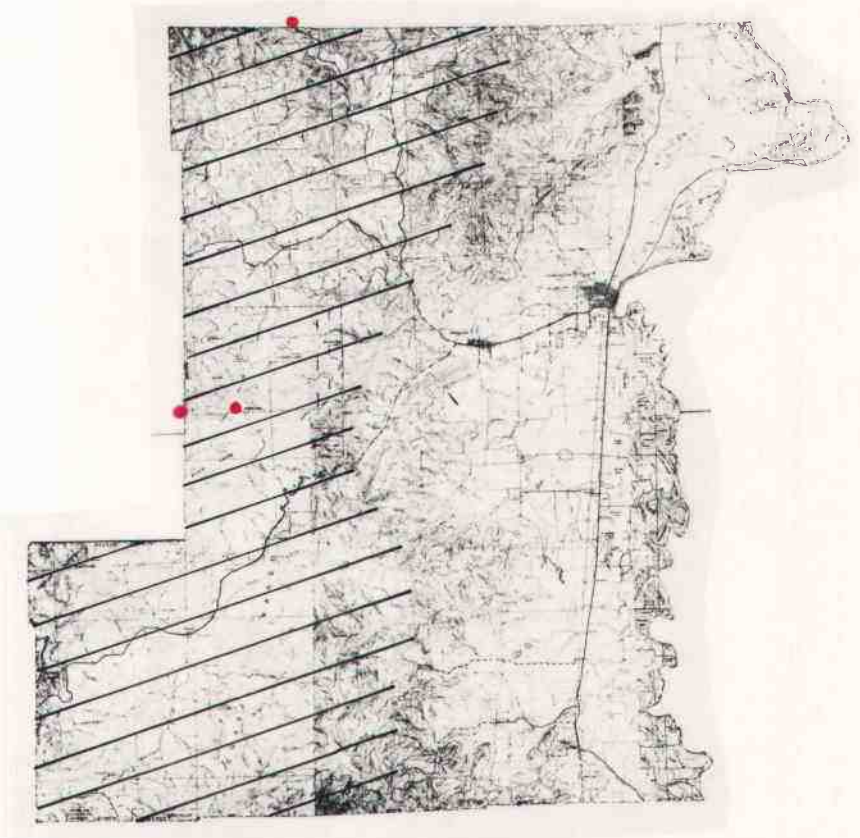
Sex	F
Head and body	51
Tail	38
Head length	11
Head width	8
Forelimb	10.5
Hind limb	13
Axilla to groin	29
Axilla to snout	15.5

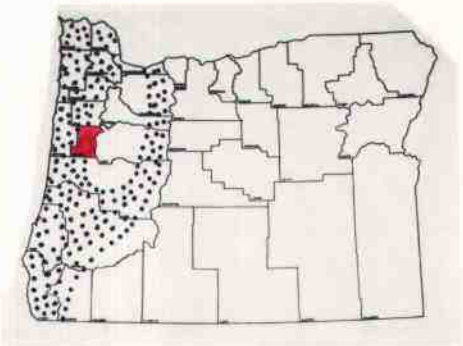
SEXUAL DIMORPHISM. Bishop (2, p.181) states that "the sexes may be distinguished by the form of the vent. In the male the sides of the vent are produced into squarish lobes behind, the outer angles light-tipped and visible from above."

DESCRIPTION OF LARVAE. Identification of Rhyacotriton larvae was largely covered under Dicamptodon ensatus (p.51) Two larvae collected on the north slope of Mary's Peak are 57 mm. and 41 mm. in total length. Briefly, they are brown above shading to bright yellow beneath, the dorsal surface and upper sides being flecked with black spots. The gills are very small and stumpy.

DISTRIBUTION IN OREGON. This form can be considered comparatively rare in Oregon until collecting proves otherwise. It is probably distributed over most of western Oregon in higher areas, although not reaching into the higher Cascades. It is apparently absent from the southern Cascades and from most of Jackson County west of these. (Map 3, p. 64)

DISTRIBUTION IN BENTON COUNTY. Rhyacotriton has been collected in the following localities in or near Benton County: Luckiamute River, just into Polk County north of Hoskins (19, p.37); Fall Creek in Lincoln County (19, p.37); headwaters Shotpouch Creek on Mary's Peak (OSC 106 & 107). It is probably restricted to the Coast Range hills of Benton





Distribution of Rhyacotriton olympicus

County, where cold and permanent mountain streams are available for breeding. (Map 3, p. 64)

HABITAT. On July 15, 1947, I worked along a small creek on the northwest slope of Mary's Peak (headwaters of Shotpouch Creek). This stream flows mainly over coarse gravel and occasionally over bed rock. It is well-shaded by first growth hemlock and by a stream bank growth of shrubs and small trees. Several shallow riffles were encountered where the stream riffles through sand and fine stones. These riffles were dug into with hands and pick, and in this manner 4 Rhyacotriton larvae were seen, of which 2 escaped in the roiled water. The animals were 2-4 inches beneath the surface of the gravel. Graf (19, p.37-38) likewise collected several larvae in the Mary's Peak and Fall Creek areas by turning over rocks and debris in small mountain streams. Fitch (12, p.637) found 5 young specimens, of which 3 retained stumpy gills, in a deep, heavily-shaded ravine near the Rogue River. "They were dug out from under rock slides, several inches beneath the surface in the saturated basal layer of pebbles and rocks, through which water was seeping slowly." An adult female collected in the Cascades of Linn County, May 24, 1947, was resting beneath the overhanging bank of a small pool in Storm Creek.

In summary, it can be said that Rhyacotriton is restricted to the vicinity of cold, densely-shaded mountain

streams. Apparently, it is unable to endure very much warming or drying. The extent to which the adults wander terrestrially is unknown, but it can be expected that they must remain in a very cool, moist situation. More will be said of this under habits.

REPRODUCTION. Little or nothing is known of the mating or egg-deposition in this species. Bishop (2, p.181-2) mentions the discovery of single salamander eggs in a stream in the Olympic Mountains of Washington, which probably belonged to this form. They were attached to the lower surface of a stone in running water. Eggs deposited in the laboratory of Noble and Richards (33, p.19) by use of pituitary injection appeared as follows: Each egg is large and without pigment, the yolk having an average diameter of 4.5 mm., without the three envelopes which surround it. The average number of eggs deposited is five. The female collected on May 24, 1947 in Storm Creek contained 7 ovarian eggs, which averaged between 4 and 5 mm. in diameter.

Slater (43, p.136) records several larvae collected in southern Washington with lengths of from 50 to 69 mm., but Bishop (2, p.182) considers the usual size as smaller, citing one specimen with reduced gills of only 31 mm. However, the five larvae in the OSC collection (Nos. 106-110) measure 57, 41, 55, 58 and 68 mm. in total length, and all

show very small gills. I am of the opinion that in this case reduced gill size is not indicative of impending metamorphosis. Perhaps Graf (19, p.39) is right in believing that this form may be paedogenic like some other Ambystomidae.

GENERAL HABITS. The following account is quoted from observations made by Slater (41, p.44):

> "It has been stated that R. olympicus 'is usually found under stones and moss in small streams' but this, I believe, is because the collectors have hunted for them only during the day. R. olympicus hides under stones and moss during the day, but at night it emerges and crawls about over them in search of food. On many night trips along small streams in the Olympics during the past few seasons, I have collected these salamanders on stones and moss a few feet away from the water. At the same time, very few specimens would be revealed by turning over the stones in the stream bed."

CAPTIVITY. Graf (19, p.38) states that this was the least hardy of the salamanders kept in captivity. However, by placing the salamanders in a gallon jar with a quantity of moss and an inch of water in the bottom, they were kept alive for 8 months in a regrigerator. I kept an adult alive for several weeks by this method.

PROBLEMS. One of the most interesting problems seems to be the length of larval life in this form, and whether or not the larvae become sexually mature before transforming. Collecting records are very few in all of western Oregon, and it would be of interest to determine to what extent the form follows the mountain streams downward into

the valleys. Mating procedure and egg-laying have never been observed, and consequently nothing is known of the time or manner of these phenomena. Feeding habits are not recorded, nor is much known of the year round behavior of the animal in response to climatic changes.

AMBYSTOMA GRACILE GRACILE BAIRD

NORTHWESTERN SALAMANDER

DESCRIPTION. No adult material is available from Benton County upon which a description can be based. I was unable to find even one specimen during the course of this study, and the species must be considered comparatively rare in the area surveyed. A medium-sized transformed salamander of this form was found near Corvallis by Mr. Don Darling on May 4, 1947, and this is the only available collection record. This specimen had a total length of about 5 inches, but unfortunately was lost before further analysis could be made of it. Measurements are given here of the only two adult specimens in the Oregon State College Natural History Museum. The first of these (OSC 43) was collected Nov. 7, 1926 at Silverton, Marion County, Oregon. The second (OSC 44) is devoid of collection data.

	1	2
Sex	F	F
Head and body	97	100
Tail	89	102
Head length	26	24
Head width	18.5	20.5
Forelimb	26.5	30
Hind limb	32	33
Axilla to groin	51	46
Axilla to snout	35	33

No personal measurements can be given of small adult

forms, the above mentioned specimen, collected by Don Darling being the only one I have seen. Bishop (2, p. 128-129) states that the smallest fully adult female measured by him had a total length of 5-3/4 inches (146 mm.) and a tail length of 2-3/8 inches (61 mm.); the smallest fully adult male measured 5-5/8 inches (143 mm.) and 2-13/16 inches (71 mm.) in these respective dimensions.

That the salamanders transform at sizes considerably smaller than this is evident from certain accounts in the literature. Gertrude M. Smith Watney (57, p. 14-15) speaks of specimens measuring 90 mm. (3-9/16 inches) and 75 mm. (2-15/16 inches) at transformation. Storer (49, p. 76) mentions that the smallest metamorphosing larva in a series of 84 specimens taken on Mt. Rainier, Washington measured 108 mm. (4¼ inches). The sizes of larvae will be further discussed under the section on reproduction.

The maximum size of larvae must take into consideration the fact that in many areas, Ambystoma gracile has been found to be paedogenic. Watney (57, p. 16) records a specimen of 140 mm., taken at 2500 feet in British Columbia. Slater (42, p. 234) witnessed the deposition of eggs by a female larva of the same length (140 mm.). Storer (49, p. 76) states that the largest larva in the aforementioned series from Mt. Rainier was 160 mm. Two larvae (OSC 82 & 83)

collected by myself in September, 1946 at an elevation of about 5000 feet in the Cascades measured 133 mm. and 113 mm., and both contained developing eggs. It has not been discovered in this study whether or not this species is neotenic in Benton County, but the author feels that the possibility is quite plausible and that larger larvae can be looked for.

The adults are easily recognized by the combination of a stout dark-colored body plus conspicuously enlarged parotoid glands and a conspicuous glandular ridge along the dorsal surface of the tail. Probably the only adult salamander that they may be confused with in western Oregon is Dicamptodon ensatus. The latter lacks the enlarged parotoid glands and glandular tail ridge, and in addition exhibits a mottling or marbling of a darker pattern on a lighter ground color. The coloration of Ambystoma gracile is well described in various books, and will only be briefly mentioned here. The animals are deep brown to almost black above, with the parotoids and tail ridge being a distinctly lighter brown. The ventral color is a lighter brown, sometimes approaching bluish or flesh color. "Legs and feet colored dorsally like the back and ventrally like the belly." (2, p.130)

Slater (42, p.234) collected a series in a small lake in the Olympic Mountains of Washington, which possessed

yellow markings on the dorsum. He states that

> "the yellow markings have no definite pattern, are irregular in size and shape, range up to 1 mm. in diameter, and are scattered over the whole dorsal surface, including the head, to halfway down the sides and on the tops of the limbs and toes. There are not many mid-dorsal spots and on top of the tail they are very small."

Although this coloration has not been recorded from other localities in the literature, it is cited in some detail here, in the possibility that it may appear in western Oregon.

IDENTIFICATION OF LARVAE. This is somewhat more difficult, and since it is my intention to facilitate local herpetological research, a considerable effort will be made here to clearly characterize these larvae. Young larvae may be confused with those of Triturus granulosus and Ambystoma macrodactylum, and it is quite possible to confuse the larger larvae with those of Dicamptodon ensatus. I can contribute little to the rather inadequate material in the literature on newly hatched larvae. Watney (57, p.14) states that at the time of hatching, the larvae measure 14 to 15 mm., and that the general body color is brown with yellowish markings. Bishop (2, p.132) mentions that some pigment is concentrated along the sides of the dorsal keel, and is interrupted at short intervals by yellowish spots. He adds that the ventral keel actually extends forward to a point slightly anterior to the vent, and that the vent

opens through the keel.

More material is available for larger larvae, although much of it is either from outside Benton County, or the source is unknown. The two smallest larvae available (OSC 85 & 86) measure 66 and 63 mm. respectively, in total length. In these, the dorsal keel arises at a point between the gills, widens gradually to a point at least 6 mm. posterior to the vent, then tapers very gradually to a point about 1 cm. from the end of the tail, where it slopes more abruptly toward the pointed tip. Ventrally, it extends forward to the anus. The head from above appears wide and shovel-shaped. In both specimens, the width is 92 mm. In profile from above, the sides widen gradually from the gills to a point about 4 mm. ahead of these, where they round off and converge slightly to just behind the eyes. Here they run roughly parallel for 2-3 mm. then curve smoothly toward the broadly truncated tip. The eyes lie about 1 mm. within this dorsal profile.

The color in these preserved specimens is distinctly on the light side. The ground color dorsally is a pale yellow. This is mottled and etched with irregular dark markings which tend to be somewhat more concentrated along the base of the dorsal keel, and which carry less distinctly into the dorsal and ventral keels. Ventrally, these larvae are unmarked, being a pale cream color. Watney (57, p.15)

states that the "color of the larvae in life is brown or olive-green mottled with yellow and black", so it is probable that the two specimens described possessed a darker ground color in life.

The toes of these larvae are comparatively long and slender. In the front feet, toes 1 and 4 are practically equal in length, as are toes 2 and 3, the latter two being definitely longer. In the rear feet, toes 1 and 5 are the shortest and almost equal, 2 and 4 are longer and practically equal in length, and toe 3 is the longest. These feet characteristics constitute a definite difference from larvae of T. granulosus, where the toes are noticeably rather short, those of the forefeet being 1-4-2-3, in order from the shortest to the longest, and those of the rear feet being 1-5-2-4-3.

Finally, the vomerine teeth of these larvae occur in two patches. Each begins at a point slightly posterior to the interior nare, then curves forward just inside the nare and roughly in line with the curve of the upper lip. The patches do not meet in the center but are separated by about the length of the nostril choana. The individual teeth are numerous within a patch, numbering at least 50 on each side. They tend to occur roughly in 4-5 rows toward the anterior part of the mouth. In older larvae, the teeth are more numerous, and the forward arch is somewhat flattened,

but is still conspicuously toward the front. In some older larvae, there is a tendency for the teeth to be separated into 4 patches, each lateral area mentioned above, being narrowly divided opposite the internal nares.

As mentioned above, larger larvae may perhaps be confused with larvae of Dicamptodon. In most instances, the presence of the dorsal "fin" running onto the back plus larger gills in the Ambystoma will be sufficient to separate the forms. However, in Ambystoma nearing transformation, the dorsal keel disappears and the gills become shrivelled so that there is a considerable similarity. In addition to habitat preferences, certain other differences are apparent. In all of the larger Ambystoma larvae in the OSC collections, light or yellowish spots are apparent, usually in rows along the latero-ventral junction and just above the lateral line on the trunk. Dicamptodon larvae are uniformly darker and lack these yellow spots. In Ambystoma, the parotoid areas and the glandular ridge on the tail are already obviously apparent, at least in larvae over 90 mm. Finally, in lateral profile of the head, the rostral area ahead of the eyes is always more or less concave in Dicamptodon larvae, whereas it is convex in those of Ambystoma.

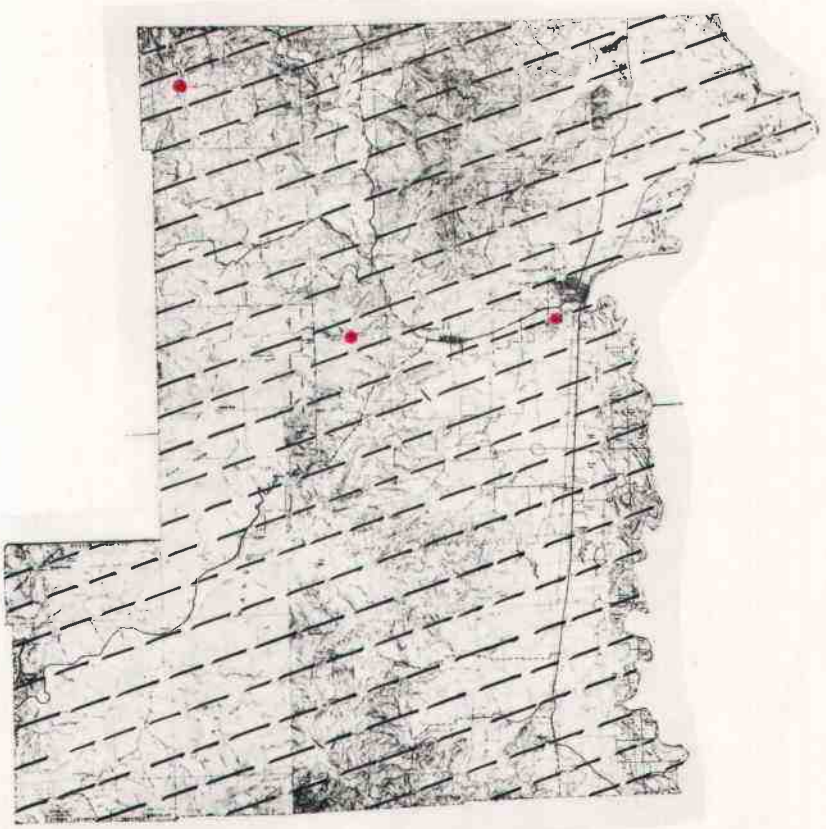
DISTRIBUTION IN OREGON. Northwestern Oregon from the coast into the high Cascades in suitable habitats. Probably absent from the southern Cascades of Jackson and Klamath

Counties, but southern limits here are unknown. Known to be present in at least the coastal counties of southwestern Oregon (Map 4, p. 77).

DISTRIBUTION IN BENTON COUNTY. As mentioned above, records are very scanty for this area. I have 4 localities in my notes, 3 based on the finding of eggs, and one on the collection of a young adult by Mr. Don Darling. Graf, Jewett, and Gordon (20, p. 101) record the species from "near Corvallis, Benton County", but do not enlarge on this. The 4 available records are as follows: egg mass, collected in Arboretum Pond, Macdonald Forest; several empty egg masses in a small pool 3½ miles N of Summit, near Mary's River; egg masses in overflow pool near Wood's Creek, 6 miles W of Philomath; young adult collected on Country Club Heights, 1.5 miles SW of Corvallis. In addition to these records, I have collected eggs of this form in a small slough, some 4 miles S of Corvallis in Linn County. (Map 4, p. 77)

HABITAT. It would appear from the above records, few as they are, that Ambystoma gracile occupies a considerable part of the county, encompassing both fir forest and lowland areas. Suitable water for breeding is of course a necessity, but apparently a large volume of water is not a prerequisite. The empty egg masses found N of Summit were in a pool of about 10 feet by 4 feet in size and

Map 4



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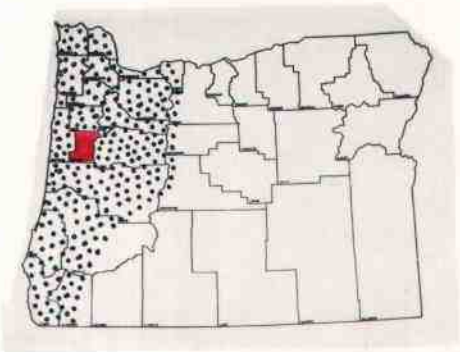


Distribution of Ambystoma gracile gracile

probably 2 feet deep. This was located some 15 feet from a small creek. There were at least eight of these egg masses in the pool. It is thought that the animals probably prefer a colder aquatic environment for breeding than do Triturus, but the evidence is hardly sufficient. Where the adults spend their terrestrial period is not known. The specimen found by Mr. Darling had wandered into a small excavation in the ground, from which it was unable to escape. This excavation lay in a small area of second growth fir, well supplied with underbrush, and was at least ¼ mile from the nearest water. If the form is paedogenic in this area, the sexually mature larvae doubtless dwell in the deeper holes of larger streams and rivers. In this connection, it is greatly to be regretted that only non-herpetologists were present when the pond in Macdonald Forest was drained. In my opinion, this is one of the most likely spots to look for neotenic larvae, since it most nearly resembles situations in the Cascades, wherein such larvae have been found. Further remarks on habitat preferences of this form in Benton County would be of little value in view of the lack of personal observations.

REPRODUCTION. In the area studied, eggs are deposited as early as late February, since a mass was found in the Wood's Creek area on February 25, 1947. An egg mass collected on April 13, 1946 contained larvae ready to break

out of their capsules. No accounts of the mating activities were encountered in the literature. It can be assumed that it is similar to other ambystomids, in that there is dorsal amplexus followed by the laying down of a spermatophore, which is picked up by the female. The actual deposition of the eggs has been observed by Slater (42, p. 234). Due to the lack of local observations, Slater's account is quoted in full here, since it tends to give a good general idea of reproduction in this form.

> "On February 23, 1931, Howard Hubbel and I were observing amphibians in a small pond near a street which crosses South Tacoma swamp. The water temperature was 60° C. (should be F. RMS) At this time, the salamanders were migrating up the stream. Nearly all of the Ambystoma gracile appeared to be gravid females, though only one in ten were transformed adults. No courtship activities were observed. Nearly a hundred bunches of eggs of this species were fastened to the vegetation at the edge of the pond.
>
> "A female larva, 140 mm. long, clasped a stem and in 62 minutes deposited 45 eggs, progressing only slowly along the stem for about 2 inches during the process, her only visible movement. This probably completed her egg-laying for the year, since no more eggs were deposited after we brought her into the laboratory, nor did she show any signs of transformation after some months of captivity. The eggs developed normally.
>
> "The eggs of A. gracile .....are fastened to sticks, such as willow branches or small limbs of fallen trees, from 6 to 24 inches under the surface of the water, in ponds. If firmer sticks are not available, the heavier grasses and herbs are used. The masses are from 2 to 6 inches long and from 2 to 3 inches thick and contain from 30 to 270 eggs. The outer layer is clear and firmer than any of the amphibian jellies I have seen. The inner envelope

> is 6 to 7.5 mm. in diameter and the jelly is much less firm. In some preserved egg masses, an outer envelope of 11 to 15 mm. in diameter can be observed. The egg itself is 2.5 to 3 mm. in diameter; at the animal pole it is brown to black and at the vegetal pole cream-grey to white."
>
> "The eggs are deposited from January to July 20 in this county depending upon the season and altitude....The eggs hatch in two to four weeks, according to weather conditions, and the first year the larvae may grow to 6 inches at lower altitudes and 3 inches in the higher altitudes, where the growing season is only about 3 months for these animals."

There is very little to add to this interesting account. I would emphasize that the large firm egg masses of these animals are like no others found in this area. A peculiarity often observed in these egg masses, especially the older ones, is a fine growth of a green alga, lining each egg capsule and giving the entire mass a greenish cast. Storer (49, p.83-84) has discussed this phenomenon at some length (observing it in what he mistakenly thought were Dicamptodon ensatus eggs), speculating on how the algal cells gained admittance to the egg capsule, the cells being non-mobile, and what their purpose was there. He felt that the cells were carried into the female reproductive tract along with the spermatophore, but he was unable to discover a reason for their presence.

Watney (57, p.14-16) has contributed notes on the growth of these forms, which although based on observations near Vancouver, British Columbia, are probably somewhat applicable

in western Oregon. She states that the larvae are 14-15 mm. long upon hatching. Storer (49, p.84) gives hatching lengths of 15-17 mm. in California specimens. According to Watney, the larvae remain in the water until the second spring, at which time some of them transform. She collected larvae 50-80 mm. in length in February, and states that larvae are usually 75-90 mm. long upon metamorphosis. Many larvae fail to transform remaining in the water as paedogenic forms for an unknown length of time. Mention is made of one larva kept in the laboratory for 4 years with no apparent degeneration of gills or reduction of caudal fin.

FOOD AND FEEDING. I can bring almost no personal observations to bear upon this question. Watney (57, p.14) states that the larvae are evidently carnivorous from the first, since they will bite at portions of earthworms when only a few days old. The following statement concerning a captive animal is somewhat enlightening:

> "Like most others of the species, the larva was a voracious feeder, coming for food at any time, and showing little preference in the kind of food. After metamorphosis, however, it refused to take the food offered to it and generally swam away. The desire to eat returned to some extent after a time....."

I can contribute the fact that when one of three live larvae brought in from the Cascades died, the border of its tail fin and its gills were largely devoured by the other two.

PROBLEMS. Perhaps the first problem is to determine more exactly how common this form is in Benton County and other parts of western Oregon. When considerably more collecting has been done, more light will also be thrown on habitat preferences of the animal. The problem of whether or not the larvae are paedogenic in this area is a fascinating one, which can be largely solved by careful observations of suitable breeding areas in the late winter and early spring. The use of a fish hook and worm in stream and river holes would perhaps yield larger larvae of Ambystoma gracile.

AMBYSTOMA MACRODACTYLUM BAIRD

LONG-TOED SALAMANDER

DESCRIPTION. The following description is from a live female collected February 28, 1948, one mile W of Corvallis (OSC 230): Dorsal ground color deep brown. On the head, this color covers the front of the snout, except for a narrow line along the upper lip, its lower edge then running posteriorly to the ventral edge of the eye. Behind the eye, the dorsal ground color ends abruptly at a deep groove, which runs somewhat sinuously from the posterior corner of the eye to the former gill area. On the trunk, the dark dorsal color ends quite abruptly at a line running through points about 2 mm. above the limb insertions. On the tail, the ground color becomes somewhat lighter brown and grades rather gradually to the lighter ventral color. A mid-dorsal stripe on the trunk is formed by a very irregularly-edged band of bright yellowish-green. This averages 3-4 mm. in width on the trunk, where it is interrupted throughout almost its entire central part by a narrow strip of the ground color. The entire top of the head is mottled with about equal proportions of the ground color and a somewhat browner green color. This mottling becomes finer toward the snout. Opposite the vent, the dorsal band narrows considerably and becomes more yellowish,

finally practically disappearing about 10 mm. from the end of the tail. A few small spots of the green can be seen near the lateral edge of the dorsal ground color. The upper surfaces of the limbs are a somewhat paler brown with a few grayish-green flecks. This color is interrupted next to the body by encroachment of the ventral coloration. Ventrally, the animal is flesh-colored on the chin, throat and chest, dark gray on the abdomen, and light tan on the tail. The undersurface is moderately flecked with minute silvery flecks, which become abruptly thicker on the sides of the trunk and tail and on the remaining surfaces of the limbs where they give these parts a gray aspect. The iris of the eye appears dark, thickly flecked with dark gold. A row of minute pores run from just back of the nostrils, above, then down behind the eyes. A few similar pores are present in the parotoid region and are scattered sparingly along the general dorso-lateral aspect of the trunk.

In the following table, No. 1 was collected near Corvallis in April, 1947 and is No. 88 in the OSC collection. No. 2 is the specimen just described. Both are sexually mature specimens. Measurements on No. 2 were made on a freshly-killed specimen.

	1	2
Sex	F	F
Head and body	54	66
Tail	53	55
Head length	13	13.4
Head width	10	9.5
Forelimb	16	16
Hind limb	19.5	18.5
Axilla to groin	34	34
Axilla to snout	20	20

IDENTIFICATION OF ADULTS. The adults can only be confused in the area studied with large individuals of Plethodon dunni. Aside from the infallible presence of a nasolabial groove in the latter (sometimes difficult to detect in the field), it has been noted that the dorsal band of P. dunni usually possesses a relatively even edge compared to the very ragged edge of the band in the Ambystoma. In addition, the band of P. dunni tends to run onto the head as solid color, whereas the top of the head in the present species is quite mottled. The length of the toes is decisive. In A. macrodactylum, the longest rear toe is about equal in length to the distance between the anterior corners of the eyes of that animal. The longest rear toe of P. dunni nowhere near equals the distance between the anterior corners of the eyes, being about equal in length to the antero-posterior diameter of the eye. Lastly, whereas P. dunni possesses conspicuous patches of parasphenoid teeth, these are entirely lacking in A. macrodactylum.

DESCRIPTION OF LARVAE. No information is available for a description of the newly hatched larvae. More can be said of the older larvae and the recently transformed young. Slater has stated (42, p.235) that in Washington the larvae transform at sea level in July, while in the high mountain ponds, most of the larvae do not transform until the beginning of their second year. Evidence at hand indicates that Benton County specimens all transform in their first year. Since the average total length of 14 recently transformed specimens is 55 mm., the longest being 60 mm., one can expect most larvae to be under 60 mm. in total length.

Larvae of 45-60 mm. show superficial resemblances to larvae of both Triturus and Ambystoma gracile. The larvae of the present form tend to appear darker than either of the others. Dorsally, they are a dark greenish-brown, obscurely mottled with dark brown and black. They lack the reddish brown color and light marking of Triturus larvae, and are somewhat darker and not as conspicuously marked as comparable-sized larvae of A. gracile. The iris of the eye is uniformly dark, and there is no dark line from the anterior corner of the eye to the snout. The dorsal keel is widest some distance behind the vent as in A. gracile. However, a definite difference is evident in the relative lengths of the rear toes of the two forms. In Ambystoma

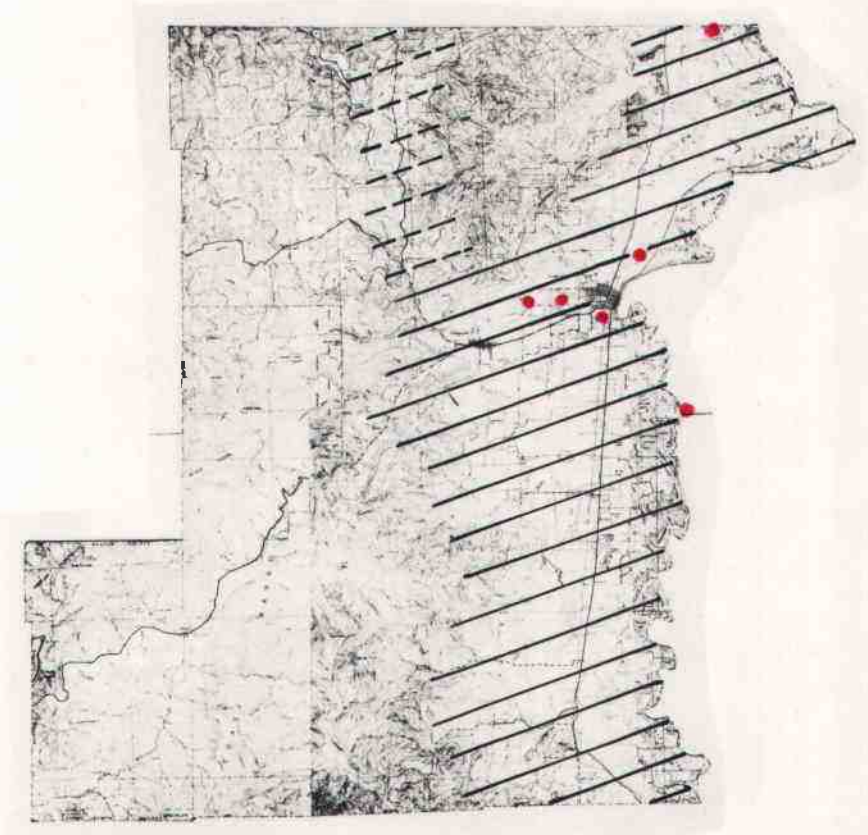
macrodactylum larvae, the order of length of the toes from the shortest is definitely 1-5-2-4-3, whereas it will be recalled that in A. gracile, 1 and 5, and 2and 4, are almost equal. Furthermore, the toes are noticeably long and slender. Other characteristics which will aid in making identification of these larvae decisive are: (1) The sites of the large gland cells surrounding the eye in the adult are marked by rows of small dark dots in the larvae; (2) the costal grooves are conspicuous and extend across the abdomen; (3) the vomerine teeth occur in four patches, two larger patches curving forward and medially anterior to the nares, and two smaller patches lying behind the nares. The appearance is quite similar to the teeth of A. gracile, but in this case there are usually less than 50 teeth in the combined patches on one side.

As mentioned above, the young appear to transform in this area at approximately 60 mm. At this time, there is a change in coloration, which is described in the following description taken from live specimens: Dorsal ground color very deep brown or black, becoming somewhat lighter laterally. A mid-dorsal area about 2 mm. in width and extending back from the head appears a bright metallic green. This stripe is made up of close-set, irregular blotches, with the darker ground color showing between the blotches. This bright color begins to narrow at the base of the tail and

tapers to nothing about halfway to the tail-tip. The top of the head is finely sprinkled with white; the sides are more sparsely sprinkled with white but the flecks are larger. The dorsal surfaces of the limbs are dark with scattered white flecks, the darker color lightening next to the body. The ventral side is dirty gray, with faintly greenish iridescent specks forming narrow bands on each side of the mid-ventral line in the trunk area. The underside of the tail shades to darker toward the tip.

DISTRIBUTION IN OREGON. This form is the only Caudata occuring extensively east of the Cascades in Oregon. It is found in the mountainous areas of the entire northeastern part of the state, is found throughout the length of the Cascades, and is widespread throughout western Oregon. (Map 5, p.89)

DISTRIBUTION IN BENTON COUNTY. Ambystoma macrodactylum has been recorded from the following locations in Benton County (two records included from just outside the county): records are from the OSC collection, and from personal observations of the author (RMS): Independence Road, Polk County, 12 miles N of Corvallis (OSC 89); Stewart Lake, 1.5 miles NE of Corvallis (OSC 90); 1 mile W of Corvallis (OSC 59, 91 & 105); 3 miles W of Corvallis (RMS); junction Mary's River and S. P. Railroad at SW edge of Corvallis (RMS); near Willamette River, Linn County, 4 miles SE of



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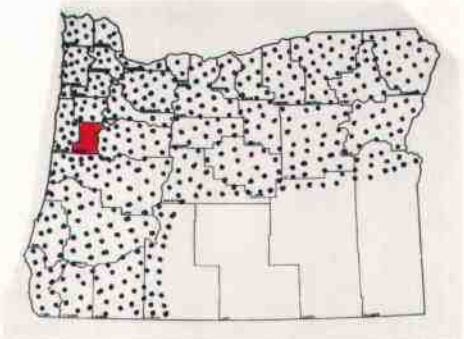


Distribution of Ambystoma macrodactylum

Corvallis (RMS). (Map 5, p. 89)

HABITAT. It is my opinion that distribution of this form locally is limited by suitable breeding areas in possible conjunction with underground rodent burrows near the water's edge. The few known breeding ponds in the area are permanent or semi-permanent (lasting until early summer) ponds and are usually adjoined by open ground of a pasture type. For this reason, Ambystoma macrodactylum is probably rare or lacking in the coniferous-covered hills of the Coast Range. The shallow edges of the pasture-bordered sloughs adjoining the Willamette River appear to be ideal. I have introduced the rodent burrow factor on the basis of certain observations. First, although probably quite common in the lower areas of Benton County, the salamander is seldom seen, and then usually at the time of breeding. Secondly, a large proportion of the lowlands of the county is heavily infested with moles and pocket gophers. Many areas are "honeycombed" with the burrows of these animals. If the salamanders were to spend the majority of their terrestrial existence within these burrows, they would be able to travel extensively in search of food, and they would seldom be seen.

The following observations support this theory. On May 26, 1947, I dug into the cracks formed by the drying of the soil around a semi-permanent pond 1 mile W of Corvallis. The cracks were sufficiently close together so

that the earth could be pried out in large lumps. In this manner, 18 recently transformed Ambystoma macrodactylum were seen in about 30 minutes, of which 16 were captured. At various points, underground burrows were encountered from 6 to 12 inches below the surface, and several of the salamanders were in these. Apparently the transformed animals leave the water, enter a crack, and remain at its moist innermost limit until the continued drying of the soil extends the crack to a burrow. I believe that the young then remain largely within these burrow systems until ready for breeding.

On February 7, 1948, Mr. John Brooke, Mr. Aryan Roest, and other students were collecting zoological material along a slough some 4 miles south of Corvallis in Linn County. An old rowboat, partially imbedded in mud near the edge of the water was partly lifted by various members of the party. Mr. Brooke then looked beneath it and stated that he saw a considerable number of salamanders. He collected as many as he could, but said that the majority disappeared into burrows. He had captured 9 fully mature adults. A week later I went to this area, but could find no salamanders under the displaced rowboat. I noted, however, a considerable network of small (mice?) and larger burrows. On the opposite side of the slough, a large slab of bark, which extended from the water up onto the shore, was turned

over. A large A. macrodactylum was seen just as it disappeared into one of a maize of small tunnels. These ran into higher ground, and although several were rapidly uprooted in the immediate area, the animal was not seen again.

Such evidence is largely inferential, of course, and can only be corroborated by exploring gopher and mole burrows during seasons of the year other than the breeding season -- a somewhat herculean task. A certain measure of success might be obtained by burying cans or jars in the burrows so that wandering amphibians would fall into them and be trapped.

It is of interest that Fitch, during his studies in the Rogue River Valley (12, p.636), concluded that the adults were subterranean in habit, except for the breeding season.

Several adults of this form have been found at the site of a burned sawmill, some 3 miles west of Corvallis. Here a large area of abandoned orchard is littered with pieces of bark and wood.blocks, many of which are imbedded to a depth of 5 or 6 inches. It is under these deeply imbedded objects that the salamanders have been found, mainly in late spring. Unfortunately, no notice was made at that time of whether or not tunnels entered these cavities. Fitch (12, p.636) records finding 5 under logs, 1 under a

board pile, and two in holes around roots of trees in an orchard.

REPRODUCTION. In the Corvallis area, the adults gather near breeding water in late winter, probably during February. Specimens have been collected or seen under objects at the water's edge on February 7, 14, 28 and 29. Fitch (12, p.636) mentions that during the breeding season he found numbers of this species together under boards in mud at the edges of ponds or ditches containing their eggs. He states that freshly laid eggs "have been found between mid-February and mid-March, but none later." During courtship, according to Slater (42, p.236), "the males of A. macrodactylum clasp the female just back of the forelimbs and give her peculiar short shakes; the males also clasp small amphibians of other species and shake them."

No information is available on the deposition of eggs in this area. A brief account by Slater appears to be the most useful and is quoted here at length (42, p.235-6)

> "Ambystoma macrodactylum usually deposits its eggs a little earlier than does A. gracile and prefers even smaller ponds. Here at sea level the difference in time of deposition may be a few weeks.....If the pond is shallow, the eggs are deposited singly or in bunches up to 10 on the bottom. The salamanders prefer the shallow portions of the pond, and if it is deeper, with no shallow places the eggs may be fastened to grass hanging in the edge.
>
> "The egg of A. macrodactylum is 2.5 mm. in diameter, black at the animal pole, with the lower

> two-fifths at the vegetal pole light gray. The two envelopes do not show very clearly; the inner is 6 to 7 mm., and the outer 12 to 17 mm. in diameter, depending on the age of the egg. They hatch in five to fifteen days and may transform at sea level in July, while in the high mountain ponds most of the larvae do not transform until the beginning of their second year.
>
> "From a female 127 mm. in length 184 mature eggs were taken."

Recently transformed young were collected in Benton County on May 26, 1947, but I felt that their metamorphosis was hastened by the drying up of their breeding pond. Fred Evenden collected a specimen still showing gill scars at the edge of Stewart Lake on July 2, 1946, and I believe that this later date is more normal, Stewart Lake being a permanent pond.

Mittleman (30, p.83) in connection with his study of a large series of specimens found that sexual maturity is attained at a snout-vent length of 38 mm. in males, and about 39 mm. in females.

FOOD AND FEEDING. If this species is largely subterranean as suspected, its diet probably consists largely of various terrestrial invertebrates, of which earthworms may constitute a major item. Fitch (12, p.636) transferred several salamander larvae to an aquarium together with larvae of the Pacific tree frog.

> "The salamanders attacked the tadpoles and bit at them whenever they came within reach. Several

> times a salamander was found swallowing a tadpole whose diameter exceeded that of its own body. The prey was swallowed either head first or backwards. The salamanders caught and killed several tadpoles too large to be swallowed. By the time the last one had disappeared, the salamanders were already attacking each other, and most of them had mutilated fins. They ate small strips of raw meat and chopped earthworms."

PROBLEMS. A more thorough knowledge of the year-round habits is desirable. Methods have been suggested to solve this. The age of the breeding adults is not known, and only collecting of the terrestrial young can help to solve this. The extent to which the species extends westward into the Coast Range will not be known until more collecting records are available.

PLETHODON DUNNI BISHOP

DUNN'S SALAMANDER

DESCRIPTION. Typical specimens of this form are easily distinguished from typical individuals of the following species (Plethodon vehiculum). On the other hand, certain confusions have arisen in my mind concerning the identity of a number of very dark Plethodon collected in Benton County. This matter will be discussed below.

The largest Plethodon dunni collected in the Benton County area is a male, taken April 27, 1947 (OSC 196), with a total length of 125 mm. (c. 5 inches). In life, this specimen appeared as follows: Dorsal ground color dark brown, fading to slate ventrally. Sides flecked with conspicuous olive-green flecks. Dorsal stripe running from snout to within ½ inch of the tip of the tail, colored a bright greenish-tan. This stripe heavily mottled with brown on head area (with a few minute white flecks on the rostrum), on the trunk area, and on about the first ½ inch of the tail. The remainder of the stripe on the tail is clear, but with irregular edges. Dorsal leg surfaces evenly mottled with a lighter yellowish green and brown, except basally where the lighter color predominates. Sides of head conspicuously flecked with greenish. Throat flecked

with white and very pale yellow. Scattered light cream-colored flecks on ventral surfaces of trunk and tail.

This description is rather typical of all Benton County adults, and adheres fairly closely to the original description of P. dunni (1, p. 169-172), based on specimens taken near Portland, in Multnomah and Clackamas Counties. Younger individuals fit this description quite closely, except that in these the dorsal band is relatively clear and free from the darker mottlings.

I have noted the following peculiarities of coloration in comparing P. dunni with P. vehiculum. In dunni, the color of the dorsal band is usually a duller greenish-tan, compared with the yellowish-green or various shades of red of vehiculum. The conspicuous flecking on the sides of the trunk in dunni extends practically to the edges of the dorsal band; in vehiculum, the dorsal band is adjoined on each side by a definite band of uniform dark, almost black coloration. The dorsal band in dunni does not reach the end of the tail, being replaced by an area of very dark, almost black coloration on the last 2 or 3 to 15 mm., depending on the size of the individual. Lastly, the dorsal limb surfaces appear more mottled in dunni than in vehiculum.

A number of melanistic individuals have been found, mainly of small size, which until recently I have

classified as P. vehiculum (see 2, p. 280). However, certain puzzling facts have arisen to throw doubt on the simplicity of this arrangement, and I am now inclined to believe that either both species produce melanistic individuals, or that hybridization occurs, the black individuals resulting from this cross. OSC No. 195 was collected April 27, 1947 in company with both P. dunni and P. vehiculum. In life this specimen was colored as follows: Dorsal ground color deep brown, flecked on trunk with not over 2 dozen light flesh-colored areas, each about .5 mm. in diameter. No dorsal stripe evident. Tail likewise deep brown in color, with no flecks in distal 4/5. Top of head mainly deep brown, with a few minute whitish flecks. Venter light slate; chin paler; both with flesh-colored flecks, but more prominent on chin. No flecks on ventral surface of tail, except immediately posterior to vent. A few scattered flesh-colored flecks on the deep brown dorsal coloration of the limbs.

This individual measures 114 mm. in total length, approximately 10 mm. more than the published maximum for Plethodon vehiculum (2, p. 278). In addition, the tail is definitely laterally compressed distally -- a comparatively reliable structural characteristic of P. dunni. On the other hand, it possesses 16 costal grooves, counting one each in axilla and groin, and this tendency toward a higher

count is to be found in typical Benton County P. vehiculum. The vomerine teeth number seven on each side, which number is within the range of either dunni or vehiculum. The specimen appears to be more definitely dunni than vehiculum, and if these are two full species and the species concept is adhered to, then it appears that melanism occurs in P. dunni.

Smaller individuals are extremely difficult to diagnose. In the light of present knowledge, separation on the basis of color is impossible. Separation on a structural basis is difficult, since such characteristics as vomerine teeth, gonads, and tail shape, are incompletely developed in young individuals. Examination of internal organs gives evidence that Plethodon vehiculum reaches sexual maturity at a snout-vent length of 40-45 mm., whereas P. dunni matures sexually at a snout-vent length of 55-60 mm. However, since the majority of dark individuals found have had a snout-vent length below 40 mm., no comparison can be made on this basis. I have been unable to determine to a certainty to which of the two species these small dark individuals belong. The following record seems indicative of melanism among P. dunni, but is by no means conclusive.

On July 1, 1947, I collected along the edges of a small tributary of Rock Creek, this stream entering Rock Creek just above the dam in the Water Preserve. Seven plethodont

salamanders were collected from beneath rocks at the edge of this stream, varying in total length from 38 mm. to 90 mm. Two of these (OSC 209 & 211) showed the typical coloration of Plethodon dunni, whereas the other five (OSC Nos. 207, 208, 210, 212, and 213) were dark individuals, lacking entirely the dorsal band. No typical specimens of P. vehiculum were found.

In view of this unsolved difficulty in identification, it is thought advisable to omit these dark-colored specimens from all considerations of range, habitat preferences, breeding habits, etc.

The following measurements are from typically colored specimens of Plethodon dunni. Nos. 1 to 6 represent OSC Nos. 196, 197, 194, 198, 185, and 190 respectively. OSC 190 is the smallest individual of Plethodon dunni that I have measured.

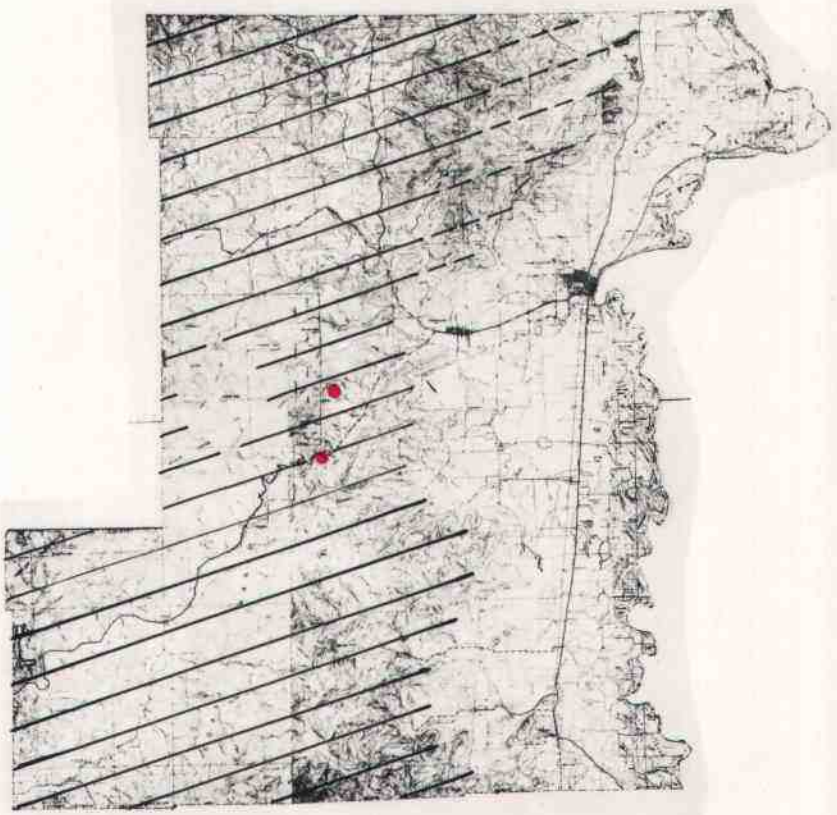
	1	2	3	4	5	6
Sex.....	M	M	F	M(?)	Immature	
Head and body..	64	60	68	44	32	20
Tail.....	61	62	55	37	25	11
Head length....	13	13	16	10.5	7.5	5
Head width.....	9	9	10	6	5	3.5
Forelimb.....	15	12.5	14	10.5	6.5	4.5
Hind limb.....	17	16.5	16.5	11.5	9	5.5
Axilla to groin	36	33	38	24	16	10
Axilla to snout	19	18	20	14	10.5	7

SEXUAL DIMORPHISM. According to Bishop (2, p. 244), the head of the male usually widens abruptly back of the eyes, the vomerine series are shorter, and the tail is

proportionally longer. In addition, I have noted that the legs tend to be proportionally longer and heavier in the male, and that whereas the vent of the adult female is merely a simple slit, that of the adult male has the sides extended posteriorly in a small flap on each side.

DISTRIBUTION IN OREGON. Probably occurs throughout the fir-forested areas of western Oregon. It has been collected only on the lower slopes of the west flank of the Cascades, and has not been found yet in Jackson and Josephine Counties of southwestern Oregon. (Map 6, p. 102)

DISTRIBUTION IN BENTON COUNTY. Due to the possibilities of confusion with Plethodon vehiculum, the following records are based entirely on specimens in the OSC collection. I have other records in my notes, but now feel that these may be based on mistaken identifications. The following two records are reliable: Wells Creek area, about 7 miles SW of Philomath (OSC Nos. 183-191, 194, 196-198); middle fork of Rock Creek, Corvallis Water Preserve area (OSC Nos. 209 & 211). These appear to indicate a very restricted distribution within the area, but I feel that this form will actually be found throughout the well-forested coast hills of the county. No Plethodon have been found on the upper slopes of Mary's Peak, so that the species apparently has upper limits within the county. Its lower distribution is limited by the extent of well



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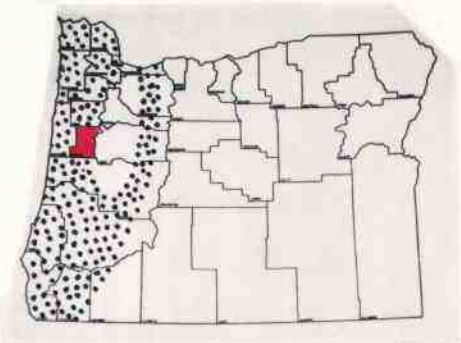


Distribution of Plethodon dunni

shaded, moist areas, which remain cool the year around. The extent to which it reaches eastward in hills north of Corvallis is as yet problematical. (Map 6, p. 102)

HABITAT. A cool temperature seems to be the main limiting factor of this form. According to Graf (19, p.40)

> "Both Plethodon dunni and Plethodon vehiculus are frequently found inhabiting the same habitat with Rhyacotriton, that is, the very small mountain streams and shallows of the larger streams. Particularly are they to be found in such semi-aquatic surroundings during the advanced summer months when the forests are apt to be quite dry. Earlier in the season they are commonly found under logs, partially decayed logs and stumps."

My own experience indicates that Plethodon dunni is found at somewhat lower altitudes than Rhyacotriton, although their ranges probably overlap. They are not as dependent on cold mountain streams as Rhyacotriton.

The most successful collecting area for this species (as well as the following) lies at an elevation of approximately 750 feet in the Well's Creek area. Although only about one mile from the open fields comprising the Greezy and Rock Creek Valleys, this area is actually 3 to 4 miles within the approximate eastern edge of the Coast Range foothills. Much of the area is covered by old second-growth forest, but this is abutted by hundreds of acres of more recently-lumbered land, now grown thickly with shrubs and small trees. The area of Plethodon concentration lies

roughly between these two types. A small tributary of Well's Creek flows through the floor of a narrow canyon, whose sloping walls are grown to areas of both old second-growth fir and more recent brush and younger trees. The course of the stream is densely shaded by alders, willows, and riparian growth. At some time in the past, a lumbering road was bulldozed up the floor of this valley, and "paved" with large planks, most of which are still present.

At one point, the road-making operations exposed a large face of bed rock, which seems to be a small-grained sandstone. This now rises about 10 feet above the road, and the top overhangs by one or two feet. The decaying sandstone breaks off in slabs, and several cracks run deeply into it. Opposite this face, the small creek has cut sharply beneath the lumbering road so that about 10 feet of the stream's edge are overhung by the planks of the road. The light in this area is quite dim, particularly beneath the edge of the road. A total of approximately 50 Plethodon salamanders have been taken, in 3 collecting trips, from within cracks and beneath slabs in the rock outcrop, from under planks of the old logging road, and from under stones or in the open at the edge of the stream, beneath the road. I now believe that most of these were P. vehiculum, but several were definitely Plethodon dunni. The three largest P. dunni were beneath the planks of the

logging road. The smallest were found beneath stones at the edge of the stream. Most of the salamanders were found here on June 1, 1946 and April 27, 1947, after the forest had begun to dry up. However, on September 9, after a few fall rains had fallen, a few specimens (dunni or vehiculum ?) were found in the rock debris left by earlier digging in the outcrop, but none could be found along the stream. Either the stream had dried up earlier, forcing all individuals into the more moist rock, or the stream individuals had reacted more quickly to the advent of the rains and had scattered into the forest.

In summary, I believe that the population of Plethodon dunni tends to be concentrated near the swift-flowing rocky streams in the lower elevations of the Coast mountains. Here they survive warm dry spells by burrowing into rock cracks, by getting beneath large objects on the ground, and by remaining at the edges of the streams beneath large rocks. It is quite probable that they wander through the woods during the rainy season, taking temporary refuge beneath the duff on the forest floor. I have never collected any specimens more than a few feet away from small streams, but have not made careful searches through the forest in the winter. A last note of interest should be added. Rotting rock outcrops in shaded spots near mountain streams should always be investigated carefully

to a depth of 2 or 3 feet, if the searcher desires to determine the presence or absence of Plethodon. The facility with which these animals reach considerable depths in what appears to be practically solid rock is little short of amazing.

REPRODUCTION. Nothing is known of the mating habits or the time and place of egg-deposition in this species. A female collected April 27, 1947 contained at least 2 dozen ovarian eggs up to 2 mm. in size. Her total length was 123 mm. A female, 133 mm. in total length, but accompanied by no collection data, contains about 12 ovarian eggs, from 3.5 to 4 mm. in diameter. In view of the fact that the eggs are probably deposited during the summer dry season, it is reasonable to assume that they are laid in a moist terrestrial situation, beneath a log or board, or in a cavity under a rock. It is not likely that sufficient space is available in rock outcrops for egg deposition.

FOOD AND FEEDING. No information is available on this phase of the animal's activities. It is probably nocturnal in its feeding activity. Specimens kept in captivity for a short time fed readily on termites.

GENERAL HABITS. As intimated above, it is quite probable that this species moves seasonally between the streamside moist habitats, occupied during the dry summer months, and the duff-littered forest floor, where it can survive

during the rainy winter months. Nothing is known of the extent of either its daily or seasonal movements.

Specimens of Plethodon have been kept for at least two months in captivity, and so long as they were kept moist, seemed able to endure an average room temperature of 65°-75° F.

PROBLEMS. To me, the outstanding problem in connection with this species is the true taxonomic status of the melanistic individuals. If "hybridism" exists between P. dunni and P. vehiculum, a re-working of their relative taxonomic positions may be necessary. If the dark individuals are produced occasionally by both species, then this should be carefully proved by securing eggs from each species and following them to hatching. The fact that eggs of neither species have been found in nature adds greatly to the difficulties involved. Considerable data can be contributed to the solution of this problem by careful collecting to determine the limits of the range of P. vehiculum, followed by extensive collecting where it is known that only P. dunni occurs.

The species occurs commonly enough in limited areas so that sufficient numbers can be collected for studies on size groups, growth, and food habits. It is hardy enough in captivity so that possible field observations on breeding could be supplemented by laboratory data.

PLETHODON VEHICULUM (COOPER)

WESTERN RED-BACKED SALAMANDER

DESCRIPTION. Individuals possessing the typical coloration of this species are easy to recognize. The dorsal band in these is definitely some shade of red. The band is bordered on each side by a definite dark area without flecks, then shades gradually to the slate-colored venter. The lower sides and venter are heavily mottled or flecked with irregular small white spots. In this form, the color of the dorsal band extends to the tip of the tail.

Many individuals are encountered in which the dorsal band is other than some shade of red. Bright yellowish-green or tan are common variations, and specimens with these colorations can easily be confused with similarly-colored P. dunni. However, the solid dark areas along the sides of the band are always present in vehiculum, whereas dunni is invariably flecked with light colored markings to, or nearly to, the edges of the band. Other differences were pointed out in the discussion of Dunn's salamander.

Dark individuals, lacking the dorsal band entirely, were discussed at length in the preceding account. The possibility that these may be either P. dunni or P. vehiculum, or that they may be both makes it impossible to include them with either species in this paper. It is of interest that

during this study, no dorsally-banded individuals of Plethodon vehiculum were collected that showed any great amount of ground color diffusion into the dorsal band. On the other hand, certain individuals of Plethodon dunni showed very heavy mottling of the dorsal band by the darker ground color. This evidence does not support Bishop's statement concerning P. vehiculum that "In some (individuals) the band may be strongly flecked with black, in others almost obliterated, leaving only a very narrow lighter line on each side to indicate its limits." (2, p. 280)

The following measurements are given from Benton County specimens. Nos. 1-4 represent OSC Nos. 205, 182, 199 and 203 respectively.

	1	2	3	4
Sex	M	M	Immature	Immature
Head and body	53	40	33	29
Tail	40	32	17	22
Head length	11.5	8.5	8	6.5
Head width	7	5	5	4.5
Forelimb	10	8.5	6	6.5
Hind limb	12	9.5	9	7.5
Axilla to groin	30	21.5	17	17
Axilla to snout	16	11.5	10	9

SEXUAL DIMORPHISM. According to Bishop (2, p. 280-1), the sexes may be distinguished by the vent, which in the female has the sides thrown into narrow oblique folds, while in the male the sides are bordered by a depressed flange-like ridge broken by a few narrow cross lines and produced behind into narrow flaps.

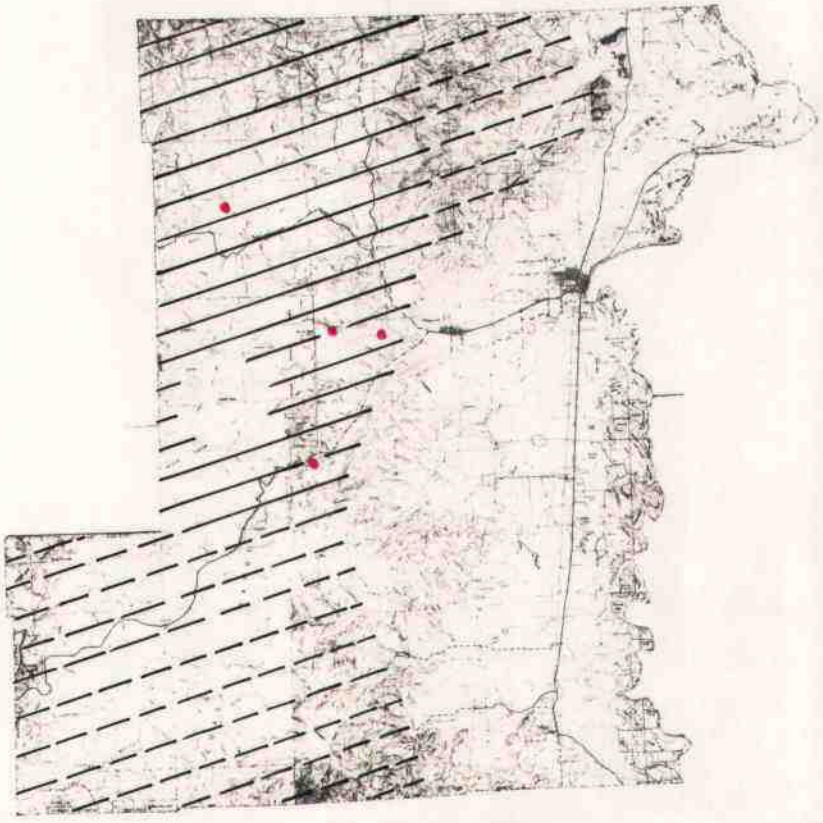
DISTRIBUTION IN OREGON. This species is confined to northwestern Oregon. According to available records, it has not been collected further south than Newport in Lincoln County, Well's Creek in Benton County, and Fernwood Camp in the Cascades of Linn County. Graf, Jewett, and Gordon (20, p. 102) have the following to say of this species:

> "It is one of the commonest salamanders in the humid coniferous forests of the northwest and may be found anywhere that these forests are found. It has, so far as is known, never been taken in the valley, and is apparently confined to the west slope of the Cascades Mountains and to the Coast Range Mountains of northwestern Oregon."

I can add nothing to this summary. (Map 7, p. 111)

DISTRIBUTION IN BENTON COUNTY. The following occurrence data are taken from specimens in the OSC collection and from personal observations (RMS). It is felt that Plethodons with definitely red backs can always be correctly called vehiculum, so that such sight records are admissible. Next to Mary's River, about 2.5 miles above Blodgett (OSC 205); Wood's Creek, 5.7 miles from U.S. route 20 (RMS); area 2.5 miles west of Philomath (RMS); Well's Creek area (OSC Nos 182, 199-205).

Since this form was collected near Fall Creek in Lincoln County (20, p. 102), its range probably includes all of the fir-forested Coast Mountain sections of Benton



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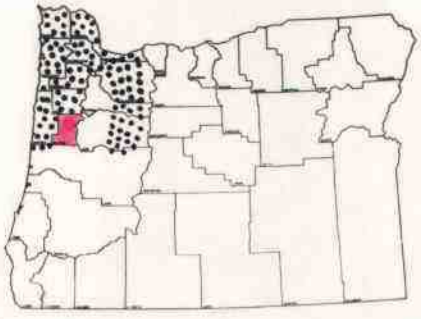


Distribution of Plethodon vehiculum

County, at least north of a line drawn east and west through the Well's Creek section. That the red-backed salamander ranges further south within the county is highly probable, since it seems to be present in substantial numbers in the Well's Creek area.

HABITAT. Graf (19, p. 39) states: "In almost every case Plethodon dunni has been collected from the same identical localities where Plethodon vehiculus were taken, often the two species were found under the same shelter." This is true to a large extent in my own experience, the location near Well's Creek, described in the preceding account, being an excellent example. Of 37 Plethodon collected in or adjacent to that rock outcrop, 21 were Plethodon dunni and 16 were Plethodon vehiculum. If any difference in habitat preferences was apparent, it was that the red-backed salamanders preferred the rock outcrop, whereas the other species was more apt to be found beneath rocks near the stream. A red-backed salamander collected north of Blodgett on May 17, 1947 was at least 10 inches below the surface of a shaded sandstone bank, about 6 feet from the edge of the Mary's River. On April 13, 1946, an adult P. vehiculum was found beneath leaf mold in an open second growth fir forest. The specimen was at least 400 yards from the nearest stream. Considerably more collecting records will be necessary before the habitat preferences of

this form can be stated accurately. At present, I feel that its preferences are much the same as those of dunni, but that it is possibly able to withstand somewhat higher temperatures than is dunni.

REPRODUCTION. Nothing is known of the mating habits or egg-laying of this animal. A female, marked "Portland, Ore." in the OSC collection contains 11 ovarian eggs up to 4 mm. in diameter. I have collected no individuals less than 50 mm. in total length, although it seems likely that the recently-hatched young are considerably smaller than this. A unicolored or melanistic individual (OSC 217) measures 32 mm. in total length, which arouses the possibility in my mind that red-backed salamanders are born dark, and acquire the dorsal band later. This seems unlikely, however, since OSC No. 208 is likewise all dark, but measures 90 mm. in total length.

GENERAL HABITS. It is quite likely that this species, like Plethodon dunni, spends the dry summer months in moist situations near water, moving out into the forest floor as the more moist weather of fall and winter allow it. Graf, in personal communication, stated that during his study he found many specimens of Plethodon by searching carefully beneath leaf mold, moss, and litter on the forest floor. In the fall of 1947, Mr. Charles Cutress brought in and showed me several Plethodon vehiculum which he had

collected on November 8 in a forest of mixed alder, cedar, and white fir in Clackamas County. Kellogg Creek runs through this forest. The salamanders were found under small pieces of wood on the ground, within 150 yards of the creek.

Like P. dunni, this form will survive captivity at room temperatures if kept moist. Experiments on the exact temperature tolerances of each species would be of interest, and should have applications to natural distribution.

PROBLEMS. Statements made under this category for Plethodon dunni apply equally well to this form. An additional local problem of interest is to determine more exactly the definite southern limits of the red-backed salamander in western Oregon.

ENSATINA ESCHSCHOLTZII ESCHSCHOLTZII GRAY

RED SALAMANDER OR OREGON SALAMANDER

DESCRIPTION. This form can be confused with no other salamander in the area. Once established as a plethodont, it is set apart from the other three by its reddish brown to yellowish coloration, which in many specimens is so light as to give them a translucent appearance. The tail is basally constricted by a definite broad circular constriction in the area of the anus, and behind this the tail appears somewhat heavy and swollen. The intensity of coloration is extremely variable in Benton County specimens. An individual collected April 6, 1946 from within a very rotted, moist section of fir log was extremely pale in its overall coloration, the general impression being one of pale flesh color. Others have been found that are almost black dorsally. A single specimen collected February 8, 1948 showed a definite mottling on the dorsal and upper lateral aspects of the trunk and tail, resembling somewhat the specimen of Ensatina eschscholtzii picta pictured by Bishop (2, p. 301). A constant feature of coloration in Ensatina is the occurrence of a clear patch of various degrees of yellow or yellow-orange on the proximal dorsal surface of each limb.

Bishop (2, p. 298) states that the adults reach an

extreme length of 5-5/16 inches (135 mm.), but the longest specimen I have measured totaled 4 inches (1o2 mm.), and the majority of specimens seen were well under this figure. Adult Ensatina in Benton County usually run between 3 and 3-3/4 inches in total length. The smallest individual measured has a total length of 31 mm. (OSC 63), but is accompanied by no collection data. Measurements are given below on three specimens. No. 1 (OSC 118) was collected about 4 miles north of Bellfountain. Nos. 2 and 3 (OSC Nos. 119 & 122) were collected about 4 miles southeast of Corvallis in Linn County.

	1	2	3
Sex	M	M	F
Head and body	45	46	51
Tail	37	36	32
Head length	12.5	13	14
Head width	8	8.5	9
Forelimb	13.5	15	14
Hind limb	15	16	15.5
Axilla to groin	20	22	26
Axilla to snout	17	18	18

SEXUAL DIMORPHISM. Bishop (2, p. 300) states that in the adult male,

> "the tail is comparatively slender and comprises about 50 per cent of the total length, while in the female the tail is swollen at the basal third and comprises about 40 percent of the length. The vent of the male is larger, longer, and more strongly protuberant, and the snout more abruptly truncated and swollen at the nasolabial region."

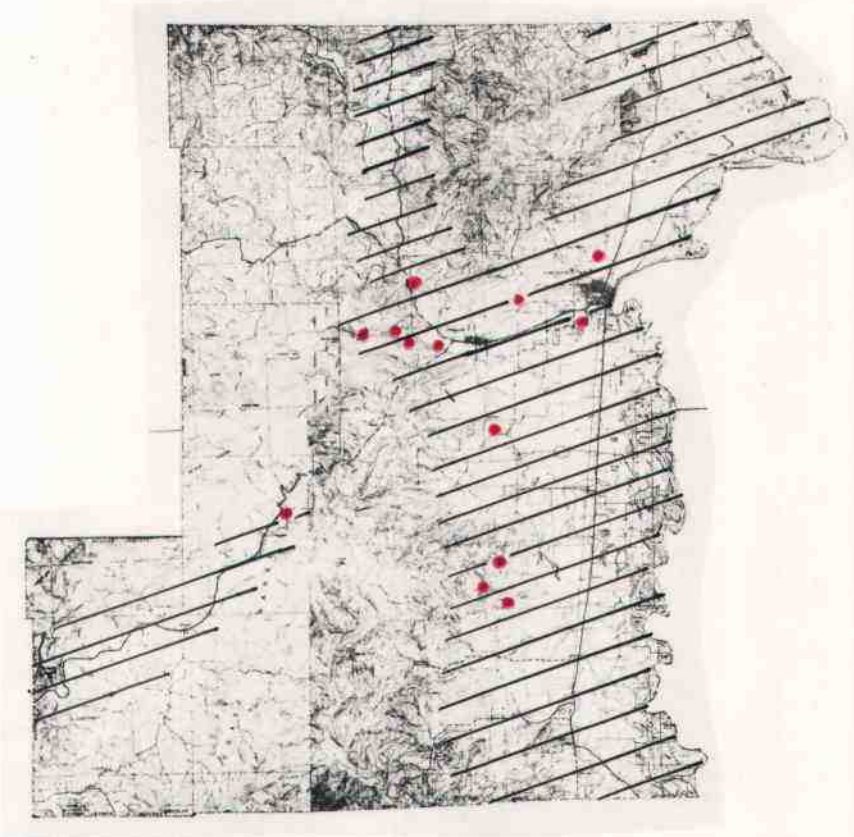
DISTRIBUTION IN OREGON. Confined to areas west of the Cascade Mountains, this form does not extend upward in these

mountains much beyond the limits of areas of deciduous forest growth (Quercus). Likewise, it is apparently absent from higher areas in the Coast Mountains. In extreme southwestern Oregon, it is replaced by the sub-species Ensatina eschscholtzii picta (Map 8, p. 118).

DISTRIBUTION IN BENTON COUNTY. The following records are largely taken from sight identifications by Mr. Fred Evenden (FGE) and myself (RMS): One mile N of Corvallis (RMS); 2 miles NW of Wren (RMS); 2½ miles W of Corvallis (FGE); 1.5 miles SW of Corvallis (RMS); in Blair Creek and Wood's Creek areas, 1, 2, 3, and 4 miles W of Philomath (RMS); near Bull Run Creek, 3½ miles S of Philomath (RMS); 3 and 4 miles N of Bellfountain (RMS); 3 miles W of Bruce Station (FGE); one mile below confluence of Spencer Creek and Yew Creek (RMS).

Ensatina has not been found in dense fir forest areas, nor has it been taken in the flat treeless areas of the main valley. Its distribution centers in the areas of mixed oak and conifers, and in areas of oak scrub interspersed with open areas. From these preferred spots, it extends somewhat into the true oak belt and into cut-over fir areas (Map 8, p. 118).

HABITAT. The habitat preferences of this form have been broadly delimited in the preceding section. It is able to withstand considerably drier and warmer situations



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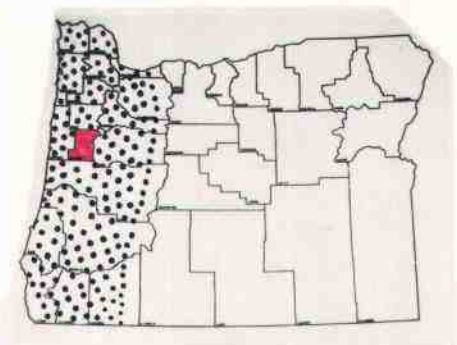


Distribution of Ensatina eschscholtzii eschscholtzii

than members of the genus Plethodon, but is more susceptible to warmth than Aneides. Thirty-one specimens were found in the following situations: Fifteen were within the wood of moist rotting stumps, some being as much as 18-20 inches beneath the surface; six were just under the bark of decaying logs; seven were on the surface of the ground under objects varying in size from small pieces of bark to logs; two were beneath well-imbedded timbers or logs; and one was well within a large log, which was dried and rotted to a powder-like consistency. It is noteable that this species is the only salamander encountered in this study that can be expected in rotting oak logs. As pointed out in the Aneides account, that species, when found in logs, occurs exclusively in fir logs.

Graf (19, p. 41) states that during the moist part of the year, Ensatina can be found under the mats of maple and alder leaves in mixed woodland. That the animals wander widely during the damp season is attested to by the fact that I have found them in January and November under small pieces of bark or wood, where they have apparently taken refuge for the day, since they are a nocturnal animal.

As the dry aestival season approaches, the salamanders become more difficult to find. As intimated above, I believe they are very sensitive to warmth and must seek cooler haunts. Storer (49, p. 110) states that several have been

found in rodent burrows during the summer in California. In addition to utilizing this refuge, I believe that many work their way into the inner parts of rotting logs, lying in less exposed situations. Whatever their retreat, it is well-hidden, for I have no records of specimens found during the summer, whereas other Plethodontidae are easily found in certain habitats.

REPRODUCTION. The season and manner of mating are unknown. Deposited eggs were found during April, June and July in California (49, p. 111-112), but no eggs of this species were found in the course of this study. A female collected February 14, 1942 contained 13 eggs, averaging 4 mm. in diameter. Eggs were apparent through the abdominal wall of a specimen collected on April 5, 1946. Likewise, ovarian eggs could be seen through the abdominal wall of specimens collected November 8, 1947 and January 6, 1948. Attempts were made to get the females to deposit eggs in the laboratory, but in all cases they died, apparently due to too high temperatures. Apparently the eggs are slow to develop within the female, so that one can expect that they are probably deposited in late spring or early summer. Storer (49, p. 111-112) states that in California, eggs were found under a decayed log and in the tunnel of a mountain beaver. These measured 5.5 to 5.75 mm. after preservation, and with their outer jelly coat

5.9 to 7.5 mm. The eggs are attended by the female.

Regarding the growth of this form, the following paragraph from Storer (49, p. 113) will probably be found applicable to this area:

> "The growth of eschscholtzii is indicated by the following. The smallest individuals taken between March and September measure 44.5 to 57 millimeters in length; a second group includes two each measuring 77, 83 and 92 millimeters, respectively. Above the latter are single individuals, 99, 105, 110, 114, 117 and 135 millimeters in total length. These suggest that three years are required to attain a length of about 100 millimeters and exceptional individuals (four or more ? years of age) reach a size of 135 millimeters."

FOOD AND FEEDING. Graf (19, p. 42) examined several specimens and concluded that they fed on a great variety of small insects. Those taken in February by him showed remains of small sowbugs, thrips, and numerous small flies and gnats which were present in the leaf mold on the ground at this season.

GENERAL HABITS. Ensatina is capable of autotomously casting off its tail. Graf (19, p. 41-2) states that several of his specimens which died in captivity were observed to have cast their tails before dying. He states that when uncomfortable, the animals were observed to go into a sort of fit in which the tail was lashed from side to side. Although he never witnessed the process, he believed that the animals behaved in a similar manner just

before dying and that the tails were cast at this time. Whether this casting of the tail occurs as a means of defense in nature is not definitely known.

A further behaviorism of the animal can be witnessed to some degree in all animals captured, and consists of the exuding of a whitish fluid from glands on the upper surface of the tail. However, a more complex behavior has been noted. A female, about 4 inches long, taken from beneath the bark of a log, showed the following response to being roughly scratched on the back. Standing high on her legs, she raised her tail to about a 45° angle, then waved it vigorously from side to side, the meanwhile exuding the milky secretion. Experiments were conducted by M. E. Hubbard (49, p. 113-114) to determine how poisonous this secretion was to snakes feeding upon them, but Storer felt that these were inconclusive.

PROBLEMS. Perhaps the outstanding problems in connection with this form deal with various details of its life history. Field studies can probably be supplemented by observations on captive animals, since I believe the form will do well in captivity if the temperature is not allowed to go over 70° F.

ANEIDES FERREUS COPE

CLOUDED OR RUSTY SALAMANDER

DESCRIPTION. This is the most easily found of the plethodont salamanders, and occurs in relatively large numbers within restricted areas of the proper habitat. The species is usually easily recognizable by its combination of a dark coloration, variously flecked or mottled with brassy, and the fact that the ends of the toes are transversely widened and truncated at the tip. In addition, the large premaxillary teeth of the animal protrude sufficiently so that they can be felt by rubbing a fingertip over the most anterior part of the closed lips.

In the great majority of Benton County specimens, the ground color above is a very deep brown, almost black, fading to a dirty gray ventrally. The dorsal ground color continues somewhat lighter onto the dorsal surface of the limbs, but the feet and toes lighten abruptly on their dorsal surfaces to a somewhat grayish brown. The dorsolateral area is more or less liberally sprinkled with brassy flecks which are more concentrated in two patches anterior to the eyes on the dorsal surface of the rostrum, in two crescent-like patches over the shoulder areas, and in a narrow band on the dorsal surface of the tail. The flecks on the dorsal surfaces of the limbs are larger and less numerous.

The number and intensity of these brassy flecks and areas vary considerably between different individuals, and their conspicuousness decreases as the animals get older. In many specimens of approximately 4 inches and over, the brassy flecks are almost or entirely lacking, so that the dorsal surface is a uniform dark brownish-black. Of at least 200 specimens of Aneides ferreus that I have seen in the course of this study, only three approached in intensity and amount of brassy coloration the specimen shown by Bishop in picture No. 2, Fig. 97 (2, p. 335). These were likewise the only three ever found in a shale outcrop (see also below under habitat).

In these individuals, in life the dorsal ground color was dark brown, but almost half of this on the dorsal and lateral aspects of the trunk was overlaid by blotches of closely-set brassy flecks. The blotches were irregular in shape and position, some having a diameter of as much as 5 - 6 mm. These continued onto the tail where they became smaller and brighter. The upper surfaces of the limbs were sprinkled with brassy blotches similar to those on the tail. A large bright area was present above the junction of the forelimb with the body, and a long crescent-like blotch above this. Top of head mottled with brassy and dark brown, brassy predominating. Six to seven very large bright blotches covering the sides of the head behind the eyes.

The general impression these animals gave in life was a startling pattern of brassy and dark brown, with the head predominantly brassy.

The largest specimen of Aneides measured had a total length (unpreserved) of 4-13/16 inches (122 mm.), and it would appear that 5-inch Aneides are unusual in this area. The smallest Aneides (a recently-hatched young) measured 1 inch (25 mm.) in total length. The following measurements are those of four adults, collected with two egg clusters on July 7, 1946. Numbers 1 - 4 are Nos. 127-130 respectively in the OSC collection.

	1	2	3	4
Sex.....	M	F	M	F
Head and body.....	69	63	56	59
Tail.....	52	44	40	43
Head length.....	15.5	13	13	13
Head width.....	12	9	9	8.5
Forelimb.....	16	15	13	13
Hind limb.....	19	17.5	15.5	15
Axilla to groin.....	36	36	29	33
Axilla to snout.....	22	18	17	17

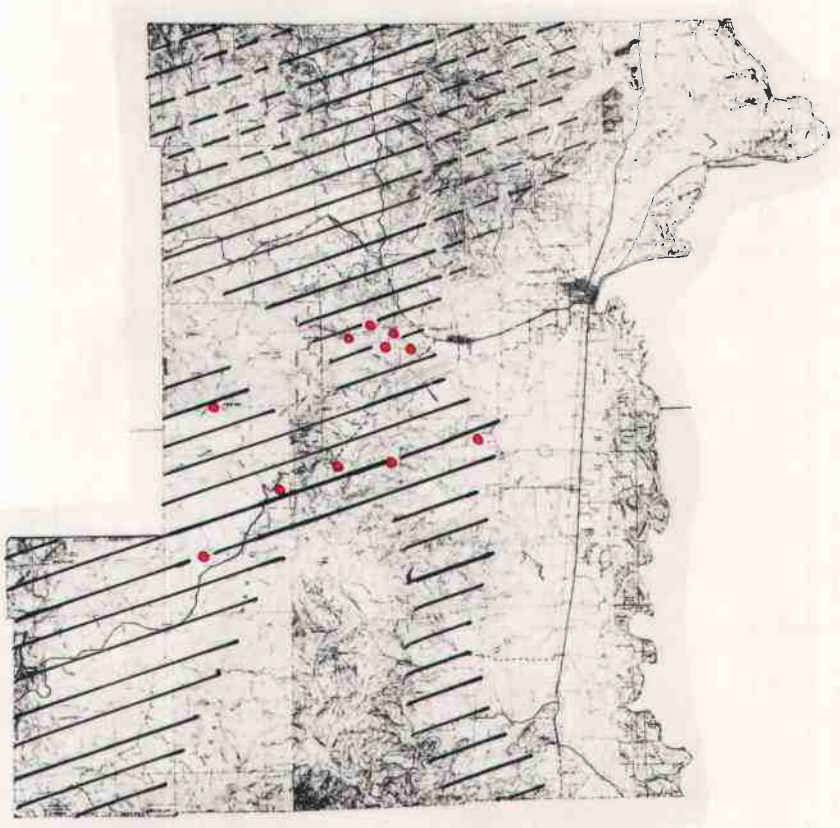
DESCRIPTION OF YOUNG. Young Aneides, within one week of hatching have the following appearance. Dorsal ground color is deep chocolate-brown. A brass-colored dorsal stripe, formed by close-set flecks begins back of the head and extends along the mid-dorsal area of the back with a width of about 1.5 mm. On the tail, this band narrows and intensifies in color, extending to the tip. The sides of the trunk show approximately 20 small irregular white

flecks on a chocolate-brown ground color. There are solid areas of brassy coloration on the dorsal aspect of the limbs, adjacent to the body. Top of the head dark brown with minute metallic yellow flecks, except for a brass-colored triangle with blunt apices at eyes and snout. Ventrally, grayish-black, sparsely flecked with minute white specks. The viscera show through the abdominal wall.

Aneides young are hatched in late summer. By the following spring, the dorsal band is invaded by a sprinkling of very small, rounded black pigment spots, which coalesce in some areas. The snout patch has become divided by black spots, and the bright crescents are apparent over the shoulder areas.

DISTRIBUTION IN OREGON. Since this species occurs in southwestern British Columbia and northwestern Washington, it may be expected to occur in most of western Oregon. However, there seem to be no records for several of the northwestern counties. Jewett (23, p. 71) collected the species in and around Portland, so that perhaps gaps to the westward will be filled in. Aneides ferreus does not extend very high into the Cascades and appears to be entirely absent from the southern portions of these, as well as lower areas immediately to the west. (Map 9, p. 127)

DISTRIBUTION IN BENTON COUNTY. Although a



(– – – occurrence uncertain)

Distribution of Aneides ferreus

comparatively large number of this species were found in the course of this study, they tended to be concentrated in small areas, and the following locality records cover very little of the county. Records followed by (RMS)are from personal observations by the author. Several localities from 1.5 to 5 miles W of Philomath (RMS) and (OSC Nos. 127-130, 135-138); 3.5 miles S of Philomath, at Bull Run Creek (RMS and OSC No. 131); Well's Creek area, about 7 miles SW of Philomath (RMS and OSC Nos. 133 & 134); slope Mary's Peak at about 3500 feet (RMS); 1 mile above confluence of Spencer and Yew Creeks (RMS); fish hatchery, 3 miles NW of Alsea (OSC 132).

It is somewhat difficult to plot a county range from these records. Ordinarily, Aneides is restricted to a very definite habitat, and patches of this habitat occur rather extensively throughout the fir-forest areas of the county. Nevertheless, although very easily found in some areas, Aneides seems to be completely lacking in what appear to be almost identical situations in other parts of the county. Based on my observations, this form should be expected in any parts of the county where the following combination of factors occur: open grass or bracken areas within or at the edge of fir forest, containing fire-charred or partly decayed fir logs and/or fir stumps. (Map 9, p. 127)

HABITAT. Of 156 specimens of Aneides ferreus, on which

accurate habitat notes were made, only 10 or about 7% were found in other than open areas of the type mentioned in the last paragraph of the preceding section. In these open areas, 83, or 57% were found within large decaying fir logs, either just beneath the bark or surface layer, or well within the log in cracks or burrows; 38, or 26% were found within decaying fir stumps, either under the surface layers or within the wood; and 25, or 17% were found under objects on the ground, varying in size from small pieces of bark to logs. These statistics take no account of the time of year at which observations were made. Actually, they represent collections in all seasons, including seven different months. It should be noted that the majority of individuals found under bark or wood fragments on the ground were collected during the rainy season from early November into April.

The best way to present a proper picture of the preferred habitat of this species is by a rather detailed description of areas in which the majority of them have been found. The most productive spot by far is located to the north of the Wood's Creek Road, at a point 3 miles from U. S. route 20. The land here slopes rather gently towards Wood's Creek, thus having a southern exposure. The vegetation is largely grasses, kept fairly short by pasturing livestock. Northward, the land slopes upward to

oak-covered ridges, at least ½ mile distant. This entire slope is quite open, being spotted with a few scattered oak groves toward the top, and fir groves toward the bottom. Evidence is at hand that the area adjacent to the road was originally forested, for there are present a few large decaying logs about 3 feet in diameter, one large fir stump, and a number of smaller stumps 15 -24 inches in diameter. The large logs and the large stump are fire-charred on the exterior, whereas the smaller stumps are not, but are the remnants of lumbering operations. The age of this set of conditions is not known, but the large logs are much older than the lumbered stumps. The fire-charred exterior of these logs apparently plays a large part in maintaining a certain ideal condition within the log. This exterior is very hard, and sheds most of the rain falling upon it, but on the other hand keeps down evaporation and drying during the summer months. Furthermore, this surface is quite resistant to insect workings and its rigidity helps to hold the softer inner wood in position. The net result is a habitat that is moist but not soggy or wet in the winter and one that remains moist, at least inwardly, during the summer.

When one tears into such a log, the heart wood is found to be decayed to the point where it can be torn out easily with the proper instrument, but yet is firm enough

to retain its shape without crumbling. This inner wood will be found to be riddled with cracks and tunnels, and will support a tremendously varied invertebrate fauna. It is supposed that certain of the invertebrates produce the tunnels in the wood, but there is some evidence (see under food habits) that the Aneides may at least enlarge these. Whatever animal produces them, these tunnels are utilized by the salamanders to reach even the innermost sections of the logs. From one of these logs, on March 19, 1942, at least 25 Aneides of all sizes were collected in less than an hour. This log measured approximately 4 feet in diameter by 12 feet in length, and only a small proportion of it was torn away. In another log (approximately 4 feet by 28 feet), in this same locality, 21 Aneides and 2 clusters of the eggs of this species were taken on July 7, 1946. To collect these, only about 10 feet of the length of the log was torn into along its southern exposure.

The large stump has not been so productive. The wood has remained harder, being suitably decayed only just beneath the hardened exterior. Specimens are usually found by pulling off slabs of this hard outer layer. The smaller stumps are much more subject to decay, and are probably less suited to semi-permanent habitation by the salamanders. Many of them become bone dry in the summer, and tend to be quite soggy in the winter. However, a number of

individuals have been taken from these stumps, both just below the outer bark, and well within the dacaying wood. It should be noted, however, that I have never collected Aneides from soppy-wet logs or stumps.

Another favorable area for collecting Aneides, although not nearly so productive as the above, is an open pasture area approximately 1.5 miles southwest of Philomath. This opening comprises 3 to 4 acres, and lies at the brow of a steep north-facing slope, which is forested with mixed deciduous and coniferous trees. The clearing itself slopes gently to the east, and is liberally sprinkled with wild rose bushes, and a few other small shrubs. It is bounded on the west by a dense second-growth of young (20-25 years) fir, on the east by a thick oak growth, and on the south by mingled oak and firs, which soon give way to the mixed open grassland-oak-conifer belt typical of the eastern foothills of the Coast Range. Several fir logs (up to about 2 feet in diameter) and stumps (mostly of a similar diameter; one or two larger) are scattered about this clearing. Eighteen Aneides have been collected in this area, mainly from just beneath the bark of stumps and logs, but several from within the wood of these. Seasonal variations in habitat preference are evident here, and will be discussed at greater length under seasonal movements.

Finally in duscussing these typical habitats, it is of

interest to note that the single Aneides found near the summit of Mary's Peak was taken from beneath the bark of a decaying fir log on a relatively open west slope, littered with charred stumps and down logs.

A paragraph must be devoted to the 10 aberrant individuals mentioned in the beginning of this section. These were found beside a small tributary of Well's Creek, which at this point flows through typical old second-growth fir. The bottom of the canyon in which this stream is located is thickly grown to alder, salmonberry, and other stream vegetation, so that the area is certainly not of an open nature. It is, however, less than one mile from a typical open log-strewn area, in which many Aneides have been found. In the space of about 200 square feet, 10 salamanders of this species were collected on April 27, 1947, in company with many Plethodon vehiculum and Plethodon dunni. Of these, four were under the bark of a down fir log, which had not started to decay and three were next to the ground under the planks of an old logging road. The remaining three were beneath loose slabs of shale on a small shale outcrop. Two of these were under the same slab, some 7 feet up the steeply sloping surface of the outcrop. Previous mention has been made of the atypical coloration of these shale-inhabiting individuals. I am at a loss to explain this rather outstanding exception to the typical habitat.

It is of interest that Graf (19, p. 42) collected but one specimen of Aneides during his study, and this one was under a loose sheet of stone in a moist limestone ledge in the Cascades of Linn County.

In summary, the center of Aneides abundance is located approximately at the boundary of the true fir forest and the lower deciduous zone. Here is found that unique combination of fir logs and fir stumps, produced by fires and lumbering, and scattered open areas, which is preferred by this species. I consider their occurrence in other areas as peripheral - a continual pushing into new possible habitats.

REPRODUCTION. The mating of Aneides ferreus has never been observed. A female collected on February 2 contained 14 ovarian eggs, averaging 3 millimeters in diameter. In addition, it was found that live sperm were present within her cloaca, which indicates mating prior to this time. However, since sperm can be stored within the spermatheca of the female for considerable periods, there is no indication of how long before this, copulation occurred. A male, 105 mm. long, also collected on February 2, showed no evidences of sexual activity, whereas males collected on July 7 and August 30 possessed enlarged testes. Mating may occur during the summer, almost a full year before the eggs are deposited, but retention of viable sperms over so

long a period seems highly unlikely. The solution of this problem seems well within the grasp of one who will concentrate on solving it, for the species are easy to collect and technical difficulties do not appear insurmountable.

Prior to this study, the eggs of Aneides ferreus had been found only once (6, p. 52). These were found on August 16 in Del Norte County, California. The nine eggs were found accompanied by a female under the bark of a Douglas fir log. At that time, they were approximately 6 mm. in diameter, and contained 15 mm. embryos.

During the course of this study, 3 egg clusters of this species were found in the field, and a fourth set was deposited by a laboratory specimen in a terrarium (50, p. 60-62). Two recently deposited clusters were found well within a large fir log in the area near Wood's Creek. A cluster of 17 eggs was found in a small cavity six inches below the outer surface of the log. These were accompanied by a male, 125 mm. long and a female 110 mm. in length. The second cluster, containing 9 eggs, was likewise found in a cavity well within the log, this set being accompanied by a male 99 mm. in length, and a female 104 mm. in length.

The yolk of the eggs measures approximately 5 mm. in diameter, and each egg is covered by a milky yellowish

gelatinous covering, which continues from one end in a strand about 3/4 inch long. The strands from all eggs twist about and adhere to one another toward the point of attachment. The eggs are light cream-colored at the end of attachment, with a slight brownish-orange bloom toward the free end, probably due to wood-dust particles.

A female collected May 23, 1946 and placed in a small terrarium with a considerable amount of sphagnum moss, deposited 13 eggs in a gourd-shaped hollow which she constructed in the moss on either July 6 or 7. These eggs were not in a cluster, but were attached singly or in groups of two or three to strands of moss.

It can be assumed then that the eggs are deposited by this species during early July. The female, at least, remains near the eggs until their hatching. It was found that if the eggs are removed from the adult and allowed to incubate away from her, they soon mold, so that her presence is necessary to prevent this. Perhaps secretions from skin glands destroy the mold spores, or it is conceivable that the female licks off the eggs from time to time, although this was never observed in captivity. Of the 13 eggs deposited by the captive female, only two remained unmolded, following a disturbance of the nest set-up for photographic purposes. These two eggs continued to develop and were supplemented by five of a group of eight eggs, collected on

August 20 in the same log as were found those of July 7. No adult was seen near these eggs when they were first exposed, but a specimen of adult size was seen briefly in a near-by tunnel, from which it escaped into deeper crevices. These eggs contained developing embryos, apparent through the translucent membranes of the egg and having a total length of 19.5 mm.

The captive female remained near these 7 eggs until they hatched. Hatching occurred over a period extending from September 8 to September 14, five of the eggs hatching within the first 3 days. It is not known which eggs were the original two from the captive female, but it is of interest to note that the time of development was so nearly coordinated in captive eggs and in those that had remained in their natural environment for well over half of their development. It can be concluded that egg development covers a period of approximately two months in this species.

Soon after hatching, the young averaged 25 mm. in total length. Mother and young remained in the nest area for approximately 3 days following hatching, at which time the adult left. The young stayed together for a day or two longer, then began to wander singly about the terrarium. At this time, they would attempt to feed on small termites placed in the container.

Sufficient measurements were made on individuals of

this species to give some idea of the growth rate and age groups existing. By November of the same year they are hatched, the young average close to 31 mm. in total length. By February and March of the following year, their average length is approximately 40 mm., and by the time they are a year old, they average somewhat over 50 mm. At that time, they vary in length from about 42 mm. to as much as 59 mm. In November of the same year, they average close to 60 mm. In the following year, their growth is not quite so rapid, so that by July of their second year, the Aneides average 73 mm. in total length, varying from 69 to 81 mm. During the latter part of the second year (late summer and fall), the young attain sexual maturity at lengths somewhere close to 70 - 85 mm. Consequently, breeding probably occurs at slightly over two years of age, the females depositing eggs for the first time when they are a little less than three years old. By the third summer, the average length of the adults is approximately 103 mm., and there is a variation from 95 to 110 mm. Adults of 120 - 130 mm. collected during the summer are probably ending their fourth year, and since larger specimens are thought to occur, some individuals must live for five years.

FOOD AND FEEDING. A preliminary study of the feeding habits of this species was made in co-operation with Mr. A. R. Aller (51, p. 59-60). Sixty-three stomachs of

Aneides ferreus were examined, the specimens varying in total length from 1-3/8 inches (35 mm.) to 4-3/4 inches (121 mm.); the food was found to be a general sampling of the smaller invertebrates present in the Aneides habitat. Ants seemed to be the favored food, having been found in 57% of the stomachs examined. A computation was made of the number of organisms consumed per inch of salamander, separating the salamanders collected into spring, summer and winter groups. These figures are as follows: 3.56 for the spring group, 1.03 for the summer group, and 2.8 for the winter group (7 specimens). The small number of stomachs examined in the winter group tend to make this figure unreliable. However, the difference between the numbers 3.56 and 1.03 must indicate less feeding activity in the summer months. This is borne out by the fact that the salamanders appear to move around less during the dry summer months.

The capacity of one stomach is indicated by the contents of the stomach of a 4-5/8 inch (117 mm.) specimen, collected May 3, which contained 50 ants averaging 3.5 mm. in length. A number of stomachs contained varying amounts of wood particles. Whether these are taken in with the food, or are the product of a certain amount of excavating by the animals is not known.

GENERAL HABITS. Aneides ferreus is apparently nocturnal in its activities - at least in those activities carried on outside of their sheltering logs or stumps. No specimens have ever been seen abroad during the day, although several have been collected from beneath small sheltering objects on the ground. The fact that they spend the majority of their lives in the inner recesses of logs and stumps indicates an excellent adaptation to living in the dark. No information is available on the cycle of activities within these logs, where something other than light must be a controlling factor. What proportions of time are spent in logs and outside of them is not known. There is some evidence to indicate that the young are most active beyond the limits of the logs and stumps, for the majority of specimens I have collected under small objects on the ground have been immature imdividuals. In all probability, the young scatter out to seek new living quarters, and perhaps they move into these permanently.

As intimated in preceding sections, during the moist season of the year, individuals may be found under small objects on the ground, indicating a wandering in the "out-of-doors" at this time of year. As the weather becomes warmer and drier, a great many specimens can be found just beneath bark or surface layers of logs or stumps. I collected on April 6, 1946 in the small clearing 1.5 miles

west of Philomath. Near the center of this opening is a down fir log some 2 feet in diameter by 50 feet long, which at that time had remnants of bark on its surface. Five individuals of Aneides ferreus were collected under this bark, of which three were over 4 inches long, the remaining two being approximately 2 inches in length. It is a usual occurrence to find fully matured specimens in such a habitat at this time of the year. Whether such large individuals are moving into the log after a winter of wandering or whether they have moved out of the log to enjoy the warmth after the rain and chill of winter is not known.

During the hot, very dry days of the summer, Aneides is found well within large logs or stumps, and I have collected a few below the ground level among the large decaying roots of smaller stumps.

I have noted that Aneides, when sufficiently aroused by efforts at capture, will wriggle violently and very rapidly from side to side. These rapid motions make them difficult to seize and furthermore tend to work them into whatever cracks and crevices may be present in the substratum. The usual procedure, however, is to move with astonishing rapidity into the nearest dark retreat.

This species is remarkably hardy in captivity, so long as they are kept moist. They withstand heat which kills any other captive Plethodontidae of the area, and will

survive long periods without food. Specimens have been kept for at least 6 months without giving them nourishment. They will, however, feed very readily on termites, ants, and other small crawling invertebrates.

PROBLEMS. A number of problems have been indicated in the body of this account. The almost spectacular differences in coloration found between log- and shale-inhabiting individuals present an interesting study in physiology, if not in genetics. The distribution of Aneides ferreus in northwestern Oregon is entirely unknown, and the fact that Dr. W. A. Hilton has recently found what he believes to be a variety of Aneides flavipunctatus in the northern Cascades of Oregon indicates the tremendous gap in distributional knowledge of this genus in Oregon (22, p. 117-119). The finding of specimens in the atypical habitat in the Well's Creek area throws some doubt on supposed habitat preferences of this animal, and this exception should be more fully investigated. In a form such as this, where captivity is no great problem, the possibility for a careful observer to watch mating procedures is greatly increased. This species has been the most abundant plethodont encountered in the Benton County area, and the ease with which large numbers can be collected should greatly facilitate studies in breeding, growth rates, correlations of location and season, etc.

ASCAPHUS TRUEI STEJNEGER

BELL TOAD OR RIBBED TOAD

DESCRIPTION. During the course of this study, one adult was collected on Mary's Peak, this constituting the first and only record for adults of this species in Benton County.

The single specimen collected is a male (OSC 222), with a head and body length, exclusive of the tail, of 39 mm. The tail itself is 7 mm. long. Other measurements are as follows: hind leg to tip of longest toe - 65 mm.; hind foot - 31 mm.

In life, the dorsal area of this specimen was mainly various shades of a bright, somewhat reddish-brown. A short mid-dorsal streak opposite the forelimbs creamy gray; a somewhat crescent-shaped bar of this same color across the top of the head in front of the eyes, this edged with dark brown posteriorly. The general effect in bright light was a rich variety of browns. In dimmer light, the toad appeared more gray dorsally.

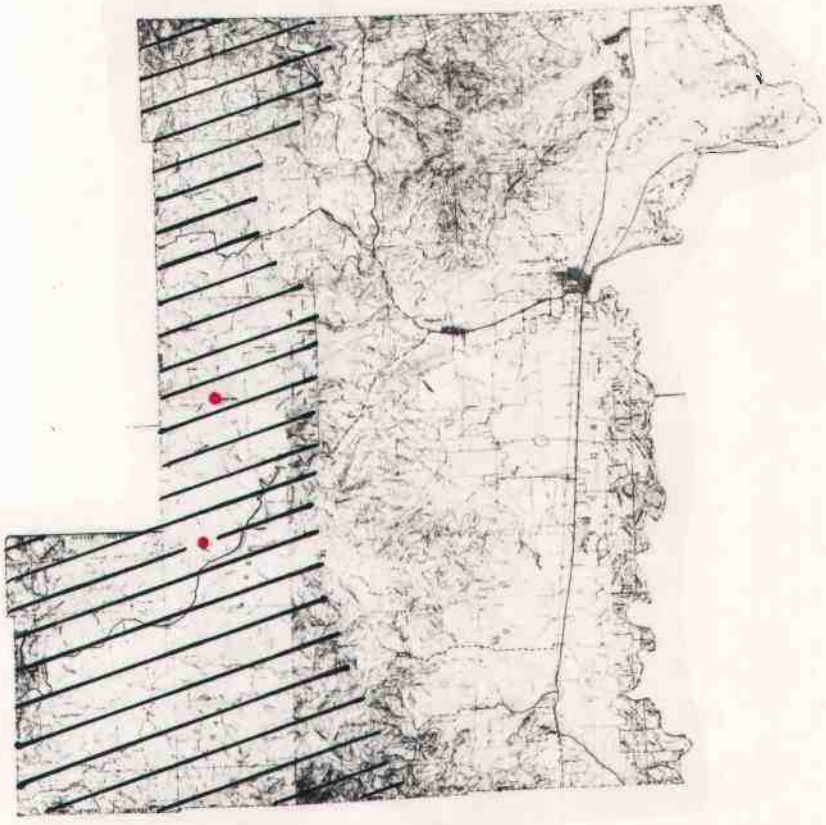
Ventrally, the trunk area was faintly mottled with cream and flesh-color; this mottling coarser and more apparent on chin and throat; ventral side of the snout dark brown on each side, with a narrow light line running dorsoventrally between these dark areas; forelimbs suffused with pinkish ventrally, and with dark areas on anterior surfaces;

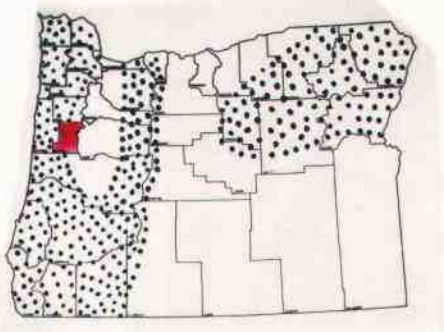
hind limbs faintly orange or pinkish ventrally, overlaid by a faint dark suffusion.

DESCRIPTION OF LARVAE. During May of 1947, two tadpoles of this species were brought in by Mr. Webb of the Alsea Fish Hatchery, who stated that he had taken them from one of the hatchery pools. These were kept alive in a refrigerator for several weeks and when killed, measured 46 and 48 mm. respectively. The corresponding tail lengths were 27 and 30 mm. Both measured 10.5 mm. in greatest width. In life, these larvae were deep chestnut-brown, finely mottled with a darker color dorsally, fading somewhat to grayish brown ventrally. They can be easily identified by the large sucker-like mouth, in which the tooth ridges are conspicuous with their long rows of black teeth.

DISTRIBUTION IN OREGON. There are several scattered records for this form in the Cascades (mainly west flank), in the Siskiyous, and in the Coast Range of western Oregon. In northeastern Oregon, the species was collected near Lick Creek Ranger Station. It probably occurs throughout the mountainous areas of northeastern Oregon and throughout the Coast Range, western Cascades, and Siskiyous of western Oregon, with the exception of the more southern Cascades in Jackson and Klamath Counties. (Map 10, p. 145)

DISTRIBUTION IN BENTON COUNTY. Only 2 records are available: headwaters of Parker Creek on Mary's Peak





Distribution of Ascaphus truei

(OSC 222); Alsea Fish Hatchery (OSC 223 & 224). In addition, Graf, Jewett, and Gordon (20, p. 102) record three larvae "from a small stream on Mary's Peak, Benton County." Due to the dependence by Ascaphus upon permanent, cold, swift-flowing mountain streams, it is certainly confined to the Coast Range sections of Benton County. I feel, however, that it is not limited to the Mary's Peak section but will eventually be found in the upper reaches of all the larger permanent streams, as, for example, the Yaquina River, Mary's River, Tum Tum Creek, Spencer Creek, and the south fork of the Alsea River. (Map 10, p. 145)

HABITAT. The single adult collected was found beneath a rotting branch about five feet from the edge of Parker Creek, which at this point is a small swift-flowing creek not more than 4 or 5 feet in average width. On the date of collection, May 10, the forest was still quite moist from recent rains. Dicamptodon ensatus larvae were likewise found in riffles of this stream.

Information obtained by Ricker and Logier (37, p. 46) in British Columbia should largely apply equally well in western Oregon. They stated that the streams in which specimens of A. truei were collected lie between 50 and 250 meters elevation. In the more southerly latitude of Oregon, such low altitudes may be too warm during the summer. However, they make the general statement that these streams

> "are of medium or mostly small size, permanent, and comparatively cold. For one of them, Smith Creek, a daily record of maximum and minimum temperatures is available. The summer ranges (June 5 to Sept. 12) in 1934 were: Minima, 10° - 12° C. (50° - 54° F.), Maxima, 11° - 14° C. (52° - 58° F.)"

They added that the general character of the country where these specimens were found is fir-hemlock rain forest, the same sort of forest that covers large areas of the Coast Range in western Oregon.

The occurrence of larvae in a rearing pool of the fish hatchery is difficult to explain, and it may well be that the larvae were not actually collected in the pool, but in the adjacent Alsea River.

REPRODUCTION. No local observations are available on this aspect of the life history. Wright and Wright (59, p. 45) believe that the period of development is probably over winter, transformation occurring in July and August when the tadpoles are 42 - 55 mm. in length. If this be true, the tadpoles collected in May at the Alsea Hatchery were nearing the end of their first year and approaching transformation.

FOOD AND FEEDING. Fitch (12, p. 639) records the following as found in the stomachs of 2 adult male Ascaphus collected May 21, 11 miles above the mouth of the Rogue River:

> "The stomach of one contained fragments of a small brown beetle; the other a geometrid larva 16 mm. in length and three small sowbug-like isopods of a kind extremely abundant under rocks along the creek."

GENERAL HABITS. Although remaining in or near streams most of the time, Ascaphus may leave the immediate vicinity of the stream following rains. Slevin (44, p. 82) mentions the finding of a young toad, which had not yet begun to absorb its tail, over 100 feet from water. The forest was extremely wet at this time. During dry spells, Ascaphus apparently burrow deeply into the gravel of the stream bottom. Graf (19, p. 47) reports finding them in gravel some eight inches below the normal stream bed. Graf's account (19, pp. 46-47) of collecting this species in a small tributary of Fall Creek should be of value to future collectors in this area.

It is not known to what extent this form hibernates during the winter.

Larvae of this species were kept alive for over a month, by keeping them in a refrigerator. The heat incident to photographing them under lights was sufficient to kill them.

PROBLEMS. The primary problem in this area is the determination of the distribution of Ascaphus, both as to area and habitat. The form has not yet been found in sufficient numbers locally to make other problems feasible.

HYLA REGILLA BAIRD AND GIRARD

PACIFIC TREE FROG

DESCRIPTION. No other salientian in Benton County can be confused with this species. It is the only tree frog in western Oregon, and as such always possesses small adhesive disks at the ends of the toes. There is great variation in the color, but a black line through each eye is a consistent characteristic, and most individuals exhibit a dark triangle between the eyes on the dorsal surface of the head.

There is a tendency for the frogs to assume a color in harmony with that of their background, so that frogs found on leaves or in grass are usually bright green with the pattern either not evident or showing very faintly. On the other hand, a dark pattern on a lighter background is usually apparent in individuals found in breeding pools, where there is a certain amount of dead vegetation. This rule is certainly not infallible, for several more or less unmarked individuals have been taken from pools. On April 12, 1946, a bright green-backed specimen was found on the side of a Douglas fir stump, where it stood out sharply against the grey-black bark.

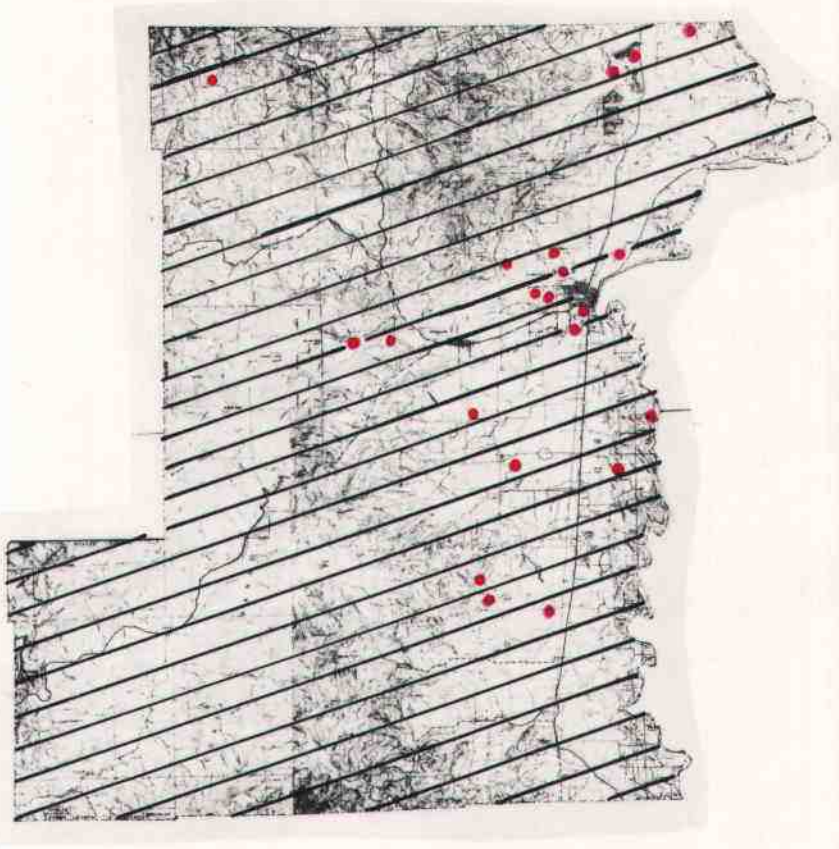
In the adult frogs, the throat of the male is dark green or black in color. In two instances of amplectation

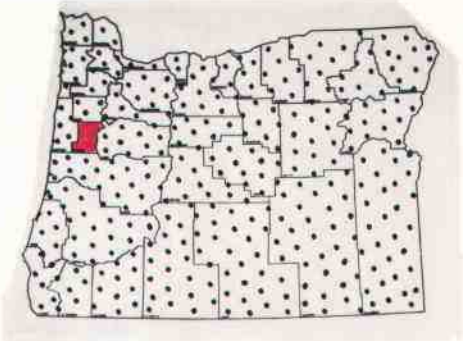
recorded by Mr. Fred Evenden (personal notes), the female was noticeably larger than the male.

DESCRIPTION OF LARVAE. Larger larvae, over 10 mm. in total length are the only salientian larvae in this area showing the following combination of characteristics: dextral anus, opening above lower margin of tail fin; eyes lateral, visible from ventral as well as from dorsal aspect of body. Since identification of frog larvae is often quite difficult, the reader is referred to Storer's detailed description of the larva of Hyla regilla (49, p. 217), where all details of structure and coloration can be checked.

DISTRIBUTION IN OREGON. This is the most widely occurring amphibian in Oregon, and can be found almost anywhere in the state, where sufficient water is present in the spring for egg-laying and the transformation of the tadpoles. I have found it near the ocean in Lincoln County and in lakes of the high Cascades. It has been collected in all three of the dry southeastern counties of Oregon. (Map 11, p. 151)

DISTRIBUTION IN BENTON COUNTY. The location records below are based entirely on sight records, identification of this form being sufficiently simple to allow of this. Locations followed by (FGE) are from Mr. Fred Evenden's notes; those marked (RMS) are from my notes. Oleman Creek,





Distribution of Hyla regilla

3½ miles N of Summit (RMS); N edge of Benton County on Independence road (RMS); S edge of Coffin Butte, about 8 miles N of Corvallis (RMS); Stewart Lake, 1.5 miles NE of Corvallis (FGE); Dixon Creek, 1.5 miles NW of Corvallis (FGE); oak hills, 3 miles NW of Corvallis (FGE); various areas up to 3 miles W of Corvallis (RMS); several areas within 2 miles of S edge of Corvallis (RMS and FGE); Kiger Island (RMS); Peoria Ferry road, 7 miles S of Corvallis (RMS); oak hills, 2½ and 4½ miles W of Philomath (RMS); oak hills, 2½ miles S of Philomath (FGE); oak hills 2 and 3 miles N of Bellfountain (RMS); swampy area, 12 miles S of Corvallis (FGE).

These records indicate a widespread occurrence of the form in the county, but unfortunately leave out certain areas of the Coast Range section. The species' occurrence in higher sections of the Coast Range is doubtful. This is not due to the cooler temperatures, but rather to the lack of ponds or quiet stream portions where breeding can take place. It can be stated with some certainty that Hyla will be found wherever small shallow pools persist from winter into May and early June.

In summary, Hyla regilla probably occurs throughout Benton County, except on the upper slopes of the Coast Range, where breeding water is lacking. (Map 11, p. 151)

HABITAT. Hyla apparently ranges throughout valley

areas and lower mountain slopes, irrespective of cover. I do not have sufficient data to deduce any preferences in this species. They were found as commonly in a small pool adjacent to Wood's Creek, which flows between fir-covered hills, as they were in a small pond located in an open pasture area west of Corvallis. Their distribution over the state is sufficient to indicate a considerable disregard for plant cover, so long as pools and quiet water can be found to breed in.

The amount of water necessary to induce egg-laying need not be very large. On May 30, 1946 larvae of this form were present in considerable numbers in what appeared to be a rain puddle, situated in the unused entrance road to an abandoned ranch. This puddle was not over 2 - 3 inches deep, and averaged about 10 feet in diameter. Its bottom was largely bare mud. It is, of course, quite possible that this water area was more extensive at the time eggs were deposited.

Well-used breeding ponds near Corvallis are often thickly grown with thick mats of a green alga, but a popular small pool west of Corvallis supports almost no vegetation, except two or three patches of water buttercup. In summary, it is not yet possible, if indeed it ever will be, to confine this amphibian to any particular habitat or group of habitats. It can only be stated that

they do not appear to breed in moderately running water, so that pools, ponds, and quiet stream edges are apparently necessary.

REPRODUCTION. Hyla do not normally enter the breeding pools in numbers before the first part of February. However, I believe that exceptionally warm weather in January would probably induce congregating and egg-laying. In 1948, chorusing first occurred as nearly as could be determined about February 15. That day did not seem very much warmer than the preceding days, but the following two days were the first markedly warmer days of the year. I received oral reports from various friends, indicating a considerable movement of frogs toward ponds on the evenings of February 15 and 16. One reporter stated that an acquaintance of his had seen "hundreds" of frogs crossing the roads on the night of the sixteenth. What percentage of these were Rana and what were Hyla will never be known.

Amplectation is axillary in this species. On February 20, 1943, Mr. Fred Evenden collected a breeding pair in a pond west of Corvallis. His notes state that "the male clasps the female tightly just below and behind the forelegs. His forefeet, used for clasping, are doubled up like a fist." This pair was placed in a glass jar in Mr. Evenden's quarters, and retained the amplectic position for at least 31 hours after being brought in. Observations were

interrupted at that time, but 10 hours later, the pair had separated and the female had deposited 30-40 eggs in the bottom of the jar.

The eggs are usually deposited in small clumps up to about 2 inches in diameter, these being attached to vegetation at or somewhat below the surface of the water. The jelly is very soft so that the clump often sags apart when lifted from the water. Several small clumps, containing 10-15 eggs and averaging 15 to 20 mm. in diameter have been found lying on the bottom in shallow water. When brought in and hatched, these always produced Hyla tadpoles. Water temperatures, taken in pools where freshly laid eggs have been found have been as low as 8° C., but I have made no attempt to correlate water temperature with breeding activity.

Hyla eggs apparently hatch in somewhat under two weeks, the length of time depending on the temperature. Thirty-seven newly-hatched larvae (hatched in laboratory) varied in length from 7.7 to 9.1 mm., with an average length of 8.7 mm. A tadpole 29 mm. in total length has the rear legs developed to a length of about 2 mm. This specimen was about one month old when measured.

In 1947, a considerable amount of Hyla breeding occurred in the period between February 10 and 20. Eggs deposited in this period were probably hatched by close to

the first of March. On May 9 of that year, no transformed Hyla were to be found in or adjacent to a small pond, one mile west of Corvallis. At that time the pond appeared to be drying up, but still contained about a foot of water through a reduced area. Countless amphibian larvae were present, of which the greatest proportion were Hyla. On May 15, conditions were about the same in this pool, and no transformed Hyla could be found. One week later, however, on May 22, dozens of transformed Hyla were present around this pool. At this time, the water had become very low and there is no doubt but what the tadpoles' transformation was hastened by the lowering and consequent higher temperature of the water. A larval period of close to three months is indicated by these observations.

On May 26 of the same year, I dug into cracks around this pool, searching for recently transformed Ambystoma macrodactylum (see under account of that species). During this digging process, a few young Hyla were encountered in the cracks, and a few others were seen in the nearby grass, but these were not nearly so numerous as on the preceding visit. It is probable that many of these young frogs find their way into rodent tunnels, where they may largely remain until the more moist weather of the following fall and winter.

Three recently transformed young from the above pool

measured 15, 15, and 14 mm. respectively, in total length. Sufficient material is not available for remarks on growth. However, I believe that two Hyla (OSC 325 & 326) collected February 8, 1948 from beneath logs, are frogs of the preceding spring. These measured 21 and 22 mm. respectively. It seems probable that the Hyla breed in the second spring after their hatching, or at a little less than two years of age.

GENERAL HABITS. Hyla is largely terrestrial during the non-breeding season. Storer (49, p. 220) states that the species, in California, remains "close to, on, or under the surface of the ground." In the Benton County area, there is abundant evidence that it spends much time in trees or shrubs. Livezy (28, p. 33) states that it was not uncommon during the winter months to hear numerous Hyla croaking from very near the tops of oaks. Evenden's personal notes contain several references to the frog's being well above the ground level: e.g., on August 30,

> "this afternoon I found a copper-backed tree frog on a leaf of a Wigelea shrub near our house. Upon inspection I found 8 others....All were on the top side of leaves of this bush."

on September 29,

> "calling from upper branches of oak"

on November 30,

> "one or two calling from big-leaf maples along the river."

I have heard several croaking during the early winter, the sound seeming to come from well up in the trees.

It is probable that tree frogs are largely nocturnal in activities during the summer, remaining quiet during the day to avoid excessive loss of moisture. The following observation by Mr. Evenden may be indicative of the frogs' summer schedule, although it occurred in April. At 7:45 A.M., a medium-sized but very fat-appearing frog was seen as it hopped through the ground vegetation and up onto the trunk of a small oak tree. When picked up, it immediately released about a tablespoonful of a clear water-like fluid. Following this, the frog appeared much thinner. Mr. Evenden suggested that perhaps the frogs store up water during the night, in order to survive the day's heat. The ability of Hyla regilla to resist dessication is well known, and accounts in large measure for its successful distribution through so much of far western United States.

It seems apparent in this area that Hyla is active the year around. It is heard throughout the winter, although it probably becomes inactive through periods of sub-freezing weather. It has been collected at various times through the summer, and although often found in sheltered spots, it is always active when handled.

The larvae are undoubtedly preyed upon by individuals

of the red-spotted garter snake in this area, for these snakes are often encountered in or near pools in which there are large numbers of larvae. It is probable that the snakes likewise feed upon the adults. An unusual record in Mr. Evenden's notes demonstrates another enemy of this small frog. On August 26, 1946, he watched a robin catch and carry to its young a small Hyla.

PROBLEMS. With the possible exception of Triturus, this is the most abundant amphibian in Benton County. Nevertheless, its exact distribution is not yet known. It would be of interest to determine its upper limits in the Coast Range, and if it is found to occur to the summit, to find its breeding areas. Problems in the effects of temperature on egg and larval development, the temperature tolerances of the adult, the moisture requirements in the adult, etc. could be worked out on this easily available form.

RANA AURORA AURORA (BAIRD AND GIRARD)

RED-LEGGED FROG

DESCRIPTION. The largest specimen collected had a head and body length, when freshly killed, of 72 mm. At that time, its hind leg measured 132 mm., and the length of the entire foot was 60 mm. This individual is No. 231 in the OSC collection, and is a female. The following description was made from a recently killed frog, collected April 3, 1948 from a slough, about 4 miles southeast of Corvallis, in Linn County.

Dorsal ground color of trunk and of head behind eyes reddish-brown; this becomes more olive-brown on the upper eyelids, between the eye protuberances, and on the rostrum. Dorsal surfaces of forelimbs similar to dorsal rostrum; dorsal surface of hind limbs more like dorsal trunk area, but not so reddish. The dorsal surface of the head including eyelids, and body contains numerous inky black spots, ranging in size from minute to about 1 mm. across. In another fresh specimen from the same area, the spots fewer and larger (c. 4 mm.) on the trunk, and some contain a lighter spot within them. The forelimbs show a few small black spots dorsally; hind limbs crossed by about ten faint dark bands, composed of irregular black spots. The dorsolateral folds are moderately prominent and their

lateral edges give the appearance of forming a dark line, although actually this is made up of numerous irregular black markings. The canthus rostralis is marked by a black line, and a black line curves slightly downward from back of the eye to above the base of the forelimb. The upper lip is mottled with brownish black on a light creamy-brown ground color. This ground color shades into a clear cream-colored line, which runs from just below the middle of the eye to above the base of the forelimb, where it meets the black line from the eye, mentioned above. The tympanum is largely black, with golden flecks. A dark line runs distally and slightly ventrally from the antero-posterior base of the forelimb, being confined to the proximal 2/3 of the upper arm. The sides of the trunk, for about the anterior ½ are finely streaked with light cream and brown, over which appears to be a mottling of larger dark areas. Through this area appear fine streakings and mottlings of red. The posterior lateral ½ of the trunk (groin region) is faint clear yellow boldly marked with an irregular pattern of black. Ventrally, the frog is largely a creamy white, slightly iridescent. The lower lip is mottled with gray and cream; chin and throat very faintly mottled with gray; abdomen with numerous small gray spots, which are not conspicuous. The normally concealed under sides of the fore- and hind limbs are mainly a clear

orange-red. Small light-colored papillae are scattered over the postero-ventral surface of the femoral region, and there are a few faint gray spots beneath these. On the hind limbs, the reddish color is faintest proximally and becomes most intense in the tarsal area. The posterior surfaces of the thighs are black with small yellowish-green flecks. Bottoms of hands and feet dark gray.

In summary, the following structural and color characteristics seem typical of Rana aurora in this area: a somewhat interrupted black line extending from nostril to posterior end of trunk, running along canthus rostralis, posterior edge of vitta, and lateral edge of dorsolateral fold; light line from eye to shoulder; anterior part of side suffused with red, posterior part contrastingly mottled with black and light yellow; hidden surfaces of legs, deep orange-red, most intense distally; two phalanges of fourth toe free of web.

The following measurements are from preserved specimens. Nos. 1-6 are equivalent to OSC Nos. 231-236 respectively.

	1	2	3	4	5	6
Sex	F	F	M	M	F	F(imm.)
Head and body	69	69	57	55	52	39
Length of head	24	22	20	19	18	15
Width of head	26	25	21	20	18	14
Forearm	17	17	15	15	13	10
Hand	22	20	19	17	16	13
Femur	38	39	30	30	29	22
Tibia	42	40	34	32	31	24
Tarsus	23	21	19	18	16	13
Whole foot	59	57	50	47	46	35

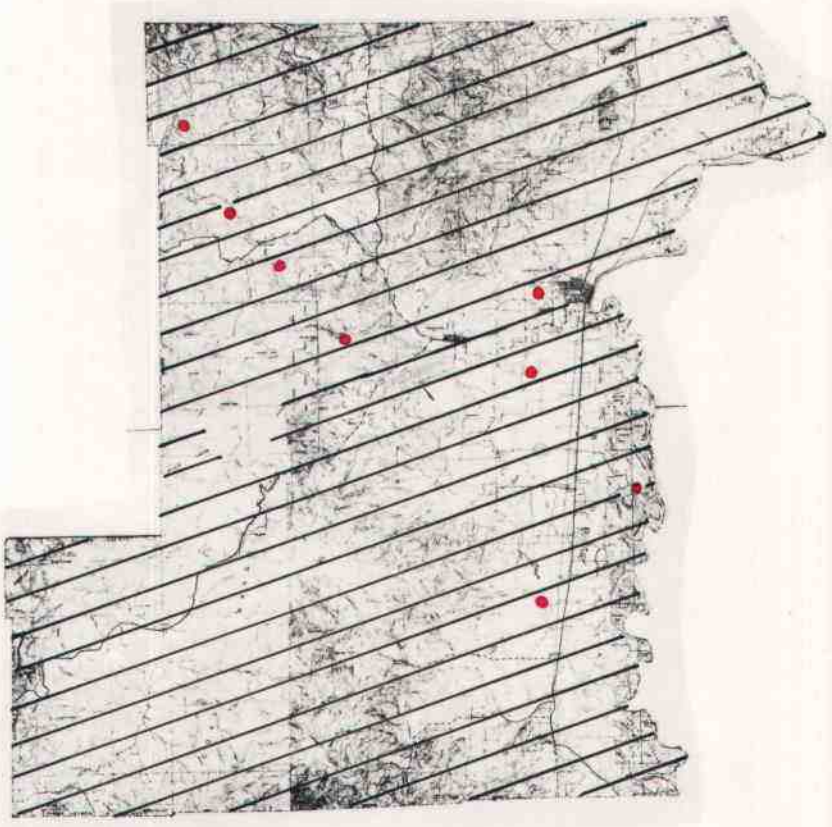
SEXUAL DIMORPHISM. In adult frogs, the upper arm appears proportionately heavier in males. Sufficient material is not available for a more detailed analysis of this difference. According to the Wrights (59, p. 174-175), the "webs (are) very well developed, greater in males than females; some males with inconspicuous groove across middle of thumb tubercle."

DESCRIPTION OF LARVAE. The tadpoles of Rana aurora can be confused with those of Hyla regilla and of Rana catesbeiana. They are easily distinguished from Hyla larvae by the fact that the eyes appear close together on top of the head, whereas those of Hyla are distinctly toward the sides of the head. In addition, the vent of R. aurora opens at the edge of the tail fin, whereas that of Hyla opens midway between the body of the tail and the fin's lower edge. Tadpoles of R. aurora differ in color from those of R. catesbeiana. The former are quite uniformly dark (appearing black) above, and purplish iridescent below. Tadpoles of the bullfrog are greenish above, with small black spots, and are yellowish below, without iridescence. The labial teeth appear to be somewhat variable in R. aurora, but whereas bullfrog tadpoles possess one long row and two very short rows above the mouth, tadpoles of aurora usually exhibit one continuous row and a second row, narrowly interrupted in the middle.

In view of the possibility that Rana pretiosa may be present in the county, it is felt that caution should be exercised in immediately assigning all tadpoles, which are neither Hyla nor Rana catesbeiana to the present species. Tadpoles, of which some later transformed into what appear to be Rana aurora, are uniformly black above and light purplish iridescent below. The tail is lighter in color with scattered dark blotches. The fin is faintly mottled with gray-brown. In one of these, possessing hind legs 5 mm. in length, the greatest length of head and body is 21 mm., and the greatest length of the tail is 36 mm. The greatest depth of the tail (over fins) is 11 mm., or over 3 times in its own length.

DISTRIBUTION IN OREGON. A considerable amount of careful collecting remains to be done before the range of this frog in Oregon can be accurately delimited, At present, it seems safe to say that it occurs throughout the forested areas of western Oregon, with the possible exception of Josephine and Jackson Counties. How far it extends up into the Cascades has not been definitely determined. Specimens in the O. S. C. collection, marked Rana pretiosa, and collected in the sub-alpine region of the Cascades, appear to be typical of Rana aurora. (Map 12, p. 165)

DISTRIBUTION IN BENTON COUNTY. The following location records are based on specimens in the O.S.C. collection,



Distribution of Rana aurora aurora

and on the field observations of Mr. Fred Evenden and myself where personal notes include a sufficient description: about 2½ miles N of Summit (OSC Nos. 236-238); on Mary's River 3 miles above Blodgett (OSC Nos. 231 & 233-235); on Mary's River 1 mile SE of Blodgett; 5 miles up Wood's Creek from U. S. route 20 (OSC 232); 1 mile W of Corvallis (RMS and FGE); near Muddy Creek 3.5 miles SSW of Corvallis (OSC 240); on old Peoria Ferry Road about 7 miles S of Corvallis (RMS); Bruce Station marsh 12 miles S of Corvallis (FGE).

Numerous other localities could be cited, at which eggs, tadpoles, or frogs of either Rana aurora or Rana pretiosa have been seen, but until considerable collecting has definitely shown the absence or presence of Rana pretiosa in this area, I will consider these records as doubtful. The above records indicate a distribution in the main valley and up smaller valleys running into hills to the westward. In the light of present knowledge, Rana aurora may be considered as not occurring in the upper reaches of the Coast Range, due probably to a lack of suitable breeding areas. (Map 12, p. 165)

HABITAT. Gordon (18, p. 62) states that this frog is "usually found in the ferns and vegetation of the woods or in nearby wet areas." Although a number of specimens taken in the course of this study were found in or near typical

river bottom growth, a sufficient number were also collected in comparatively open areas to indicate that this frog is by no means confined to heavily forested areas. On November 11, 1947, I visited an area about 3 miles south of Corvallis, along the shores of Muddy Creek. This area is mainly grown to oak scrub, with many grassy clearings up to 2 or 3 acres in extent. Rains had formed many shallow pools in these clearings, and a total of six young frogs of this species were seen "sunning" in the shallow water at sun-bathed edges of these pools. Such an area seems quite different from locations on Wood's Creek and on Mary's River, where fir approaches the streams, and is interrupted by the deciduous stream growth. On the other hand, trees are present quite abundantly in both areas, but it seems probable that other factors than forest growth limit the spread of this frog.

The most unusual habitat, assuming this species to be a wood frog, is presented by the pool, one mile west of Corvallis, mentioned as a favorite breeding pool of Hyla regilla. It should be emphasized here that this pond is in an open pasture area, with no trees of any sort directly around the water. Oak Creek is only a few yards to the west, but its course is comparatively scantily marked by riparian growth, due to the encroachments of agriculture. The nearest continuous woodland is probably ½ mile distant,

and consists of the oak-covered foothills of the Coast Range. Nevertheless, red-legged frogs deposit many clumps of eggs in this pond every spring. There is reason to believe that the frogs may travel for some distance to reach the pool, since I have never been able to capture adults in or near the pool, and the recently transformed young disappear from the vicinity almost immediately after leaving the water.

Evidence of the above sort leads one to believe that suitable breeding pools are a main limiting factor. With this in mind, the following apparent requisites for breeding water are set forth. The pool or pond must have at least a few feet of shallow water along its edges, but must retain water until at least the middle of May. The shallow areas should be well-grown with aquatic vegetation, or should contain stems and stalks of more mesophytic plants, which made their growth following the drying of the pond in the preceding year. Ponds with shrubbery and trees partly shading them are preferred, but this growth is not always necessary.

Eggs of what are probably this species have been found most abundantly in the marsh at Bruce Station, 12 miles south of Corvallis. Here the eggs are laid in water 1-2 feet deep, near the road crossing the marsh. This is thickly grown with various species of submerged vegetation,

and is shaded to some extent by growths of a small shrub.

In summary, adult Rana aurora prefer to spend the non-breeding period in wooded areas, but these may be the heavy growth near lower Coast Range streams or the more scattered woodland type near the lowland streams. Breeding pools must be semi-permanent or permanent, sloping-bottomed, and weed-grown. They need not be surrounded by shrubs or trees, but this seems preferable.

REPRODUCTION. These frogs appear to deposit most of their eggs at about the time the tree frogs begin their breeding season. In 1947, eggs were deposited on February 7 or 8, in the little pond one mile west of Corvallis. On February 8, Mr. Fred Evenden found the water temperature in that pond to be 45.2° F. (8.3° C.). In 1948, February 15 and 16 were the first days of perceptibly warmer weather. No Rana eggs were found until February 24, when one mass was found, with embryos in the neural groove stage, indicating that these eggs were probably deposited near February 20. On February 28, several egg masses were seen in the pond, of which one appeared to have been deposited the previous evening. The water was slightly above 8° C. Two night trips were made to this pond on the evenings of February 23 and 24, but no breeding Rana could be found. There is a small amount of evidence to indicate that 8° C. is a critical temperature among these frogs, which agrees

with Noble's statement that a "lowering of temperature below 8° C. was found to induce laboratory frogs to seek a retreat under objects in the bottom of the tank." (32, p. 418). However, the temperature of the water can have nothing to do with temperatures inciting the frogs to move to water from nearby (?) terrestrial situations. No information was gathered on the effect of air temperatures on the onset of mating. It is further not known whether or not these frogs actually hibernate. I have no records of any Rana aurora seen or collected in December or January. If hibernation occurs, it is probable that emergence from this state coincides with the beginning of movement toward the breeding areas.

The eggs are deposited in roundish masses at or just below the surface of the water, and are usually fastened around a dead stem or under water plant. They gather debris easily, and are somewhat difficult to detect in murky water. Livezy and Wright (29, p. 201) state that the eggs number 750 to 1300. Their further description is as follows:

> "All gelatinous envelopes indistinct, particularly the middle. Outer envelope 10.0-14.0 mm. Middle envelope 6.25-7.93 mm., average 6.80 mm. Inner envelope 4.0-6.68 mm., average 5.70 mm. Vitellus 2.31-3.56 mm., average 3.04 mm.; black above and creamy-white below.....eggs in flat masses 6-10 inches across. Vitelli 3/4 inch apart. Jelly of mass loose and viscid with a bluish cast. Individual eggs 1.2 cc. in volume.

Masses deposited at surface of water attached to vegetation."

Time of hatching is dependent on temperatures, but average times appear to be between one and two weeks. Freshly laid eggs brought in by Mr. Fred Evenden (personal notes) and kept at temperatures ranging from 47° F. to 64° F. developed tadpoles which broke out of their capsules in about 10 days. The average length of 10 recently hatched larvae was 11.55 mm., the lengths varying between 11.0 and 12.3 mm. At that time, gills can be seen protruding from both sides of the posterior head region, and two small ventral suckers are evident. The distal end of the tail vertebrae is slanted downward. The body is quite uniformly dark in color.

Growth of the tadpoles is fairly rapid, and their transformation in the spring of 1947, occurred almost simultaneously with that of Hyla regilla tadpoles, although observations were made in a drying pond, which may have hastened the change of both. Six tadpoles collected from this pool (1 mile west of Corvallis) on May 9, 1947 measured as follows:

1. total length - 59 mm., hind legs - 6 mm.;
2. total length - 37 mm., hind legs - mere buds;
3. total length - 38 mm., hind legs - 2 mm.;
4. total length - 56 mm., hind legs - 2 mm.;
5. total length - 43 mm., hind legs - 14 mm.;
6. total length - 32 mm., hind legs - 2 mm.

These figures indicate a lack of correlation between total

length and hind limb growth, and it is possible that receding waters brought about this disproportion.

On May 22, 1947, sweeps in this pool yielded two almost transformed Rana aurora. These possessed all four limbs but the tails were only about half gone. On May 26, no transformed Rana were found, but the pool - very low by now - contained numbers of large tadpoles.

A red-legged frog, which had just completed transformation in a laboratory aquarium measured 21 mm. in head and body length, 27 mm. in hind leg length. In life, this specimen was grayish-green dorsally with black dots or markings; interrupted black line along dorsolateral area; sides lighter, mottled or spotted with black; black line at edge of canthus rostralis and back of eye continuous with dorsolateral line; light line on upper lip evident as in adult; dark diagonal bar across upper limb on anterior side; hind legs mottled and barred with dark; throat obscurely mottled with dark on gray background; belly yellowish-white; underside of hind legs pale flesh color.

Age or size groups could not be estimated on the basis of the few specimens collected. Many frogs are found with body lengths of 30-40 mm., which are probably in their second year. A number of these tend to show reddish-brown dorsolateral lines, but no study has been made of the extent or significance of this variation. Sexual maturity is

probably not attained until the third spring after hatching.

GENERAL HABITS. Individuals of this species up to 60 mm. in head and body length have been collected quite commonly under well imbedded logs at the edge of a slough in western Linn County. Known collection dates are February 8 and April 3. Both of these days were chilly, and it is possible that the frogs seek such sheltered spots during cool weather. In no instance have frogs been found hibernating in such terrestrial situations, and I believe it entirely possible that in this area, they do not truly hibernate, but merely become inactive in protected locations during cold spells.

I have encountered several references in the literature, stating that this frog is stupid and easily caught. I find that, on the contrary, the majority of the frogs seen in this area have been quite wary, although one or two were captured rather easily. Air temperature greatly affects the ability of a frog to move rapidly, and it seems probable that a reputation for slow-wittedness may have developed on the basis of frogs taken in chilly surroundings.

The tadpoles are probably preyed upon by red-spotted garter snakes and certain aquatic insects. Young frogs along the edges of ponds and sloughs undoubtedly provide food for herons, raccoons, etc. The adult frogs must

likewise fall prey to various snakes, birds and mammals.

I have never heard the voice of this frog, although other observers state that it gives voice during the breeding season. No descriptions can be found in the literature. The voice of frogs is usually significant in calling individuals to the breeding pools, so that one can expect a far-reaching note in this form which in some cases must travel considerable distances to the pools.

PROBLEMS. Perhaps the outstanding problem in connection with this frog is an accurate determination of its distribution and geographic variations in western Oregon. I am inclined to believe that many Rana aurora have been falsely called Rana pretiosa, leading to a confused estimate of the status of these two forms. Details of life history, food habits, etc. are poorly known, or, more often, unknown.

RANA CATESBEIANA SHAW

BULLFROG

The bullfrog has become well established in the main valley section of Benton County, having been introduced at numerous locations. It is not known as to when the frog was first brought into this area. Numerous aspects of this species' biology have been adequately discussed in the literature, although natural history accounts refer largely to the species in its original eastern range. In view of this, I will shorten this account to some extent, attempting to bring out only those features of the bullfrog, which may be unique to this area.

IDENTIFICATION. Full grown bullfrogs can be confused with no other local species. Their very large size (nearly 8 inches in head and body length) is far above that of native forms. Smaller individuals may at first glance be mistaken for other frogs, but can be identified by the combination of very smooth skin, complete lack of dorsolateral folds, a tympanic membrane as large as, or larger than the eye, and complete lack of red in the ventral coloration. Recently transformed young most nearly resemble certain Rana aurora. However, these lack dorsolateral folds, they lack the light line on the upper lip, have no canthus rostralis line nor vitta, and show no red underneath. In addition, their entire dorsal surface is dotted

with small rounded black dots and the web of the hind foot extends completely to the end of the fourth toe.

IDENTIFICATION OF LARVAE. Differentiation from larvae of Rana aurora has been treated under that species. Larger larvae can be confused with no other species, being the only tadpoles attaining to that size. Upper limits of larval length are not known for this area, but many have been seen that were at least 4 inches long.

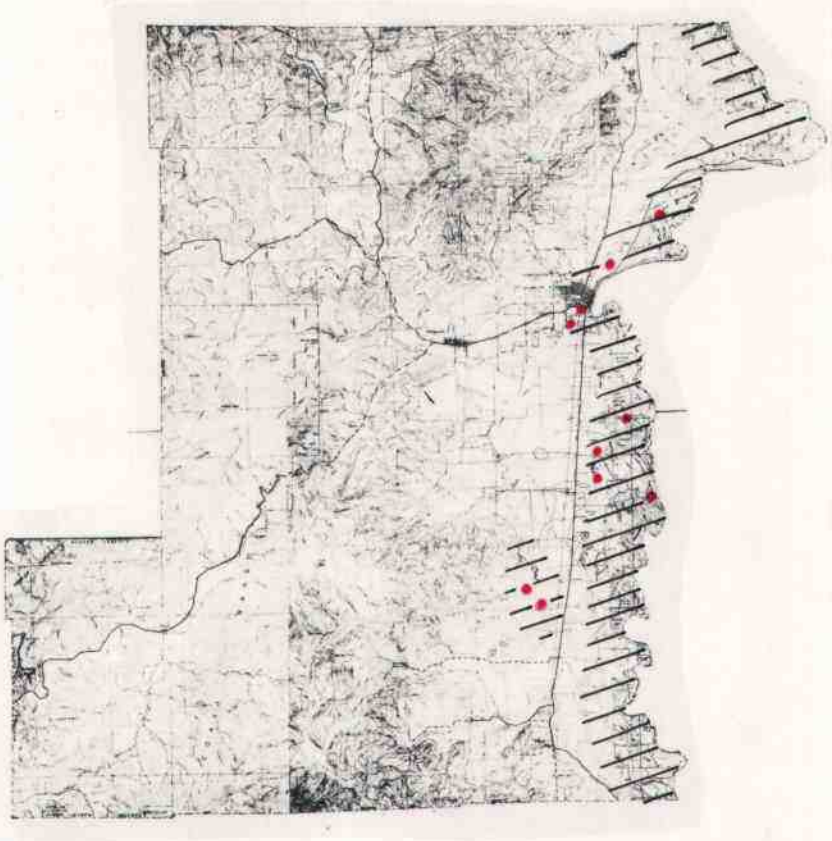
DISTRIBUTION IN BENTON COUNTY. The following records are based on observations by reliable observers, it being possible to identify the large tadpoles and large adults of this form quite accurately. The voice of this frog is sufficiently different to allow of its being used as an indication of the frog's presence in an area.

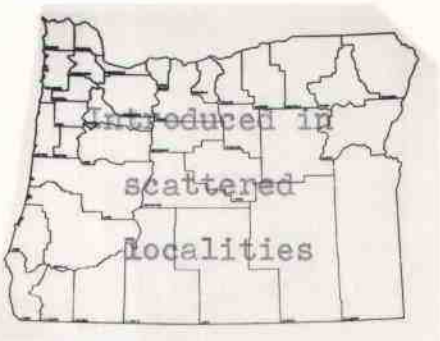
Slough behind Children's Farm Home, 3 miles NE of Corvallis; Stewart Lake, one mile NW of Corvallis; pond at railroad bridge over Mary's River, S edge of Corvallis; small pond at end of Brook Lane, 1.5 miles SW of Corvallis; slough on Kiger Island; McBee Lake, 6 miles S of Corvallis; gravel pit pond on Peoria Ferry road, c. 6.5 miles S of Corvallis; marsh at Bruce Station, 12 miles S of Corvallis; swampy area 1.5 miles NW of preceding location.

These by no means indicate all of the areas where the bullfrog may be found in Benton County, but they are sufficient to indicate that its distribution remains fairly

close to the course of the Willamette River. The last locality cited is the most distant from the Willamette, being approximately 4½ miles west of the river. I have not been able to determine the most potent limiting factor, preventing the frogs from spreading to the westward, but believe that two factors combined may be largely instrumental. One is the reluctance of the species to go far from water, which tends to keep them near areas where introduced, or allows their spread along watercourses which are practically continuous. The latter situation is existent along the Willamette, where particularly during the high waters of winter, many tadpoles must be carried into new areas by flood waters. The second factor is the dependence of the frog on permanent standing water, due to the 2 or 3 year larval period. This would account for their abundance in the permanent sloughs and marshes near the river. An apparent exception to this dependency was noted at the Bruce Station location. It will be discussed in the following section. (Map 13, p. 178)

HABITAT. Bullfrogs appear to favor deep ponds or slow water courses, in which there is abundant aquatic vegetation. The sizes of favored areas vary greatly. The small pond, south of Corvallis on Brook Lane is not over 100 yards long, averages perhaps 30-40 feet in width, and has an average depth of 2-3 feet. This pond supports a





Distribution of Rana catesbeiana

flourishing bullfrog population. On the other hand, sloughs along the Willamette may be a mile or more in length, two or three hundred feet wide, and often 15-20 feet deep. Nevertheless, if shallower portions support a good growth of aquatic plants, particularly water lilies, bullfrogs will probably be present.

The largest concentration of bullfrogs I have seen in Benton County is present in a comparatively small marsh, about 1½ miles northwest of the main Bruce Station marsh. At this point a large beaver dam has backed up a pond, which is possibly 3 to 4 acres in extent, and which is almost solidly filled with underwater plants. I visited this area on May 13, 1947, and as I waded through the water, the large tadpoles were everywhere, shaking the vegetation quite perceptibly as they moved away. Many recently transformed young were seen, and adults were heard giving voice from time to time. I doubt if this pond is anywhere over five feet deep and most of it seems much shallower.

The larger marsh at Bruce Station likewise supports a large bullfrog population. The comparatively shallow depth of this marsh was evident in the summer of 1946, when on August 27 the entire area was devoid of water except for 2 pools, one under each bridge. The larger of these measured perhaps 40 by 150 feet, but the smaller was

only 10 by 20 feet. Three small adults and numerous tadpoles of the year were seen in the larger pool, and the smaller pool was quite crowded with larger larvae. It seemed inconceivable that the entire bullfrog population survived in these limited areas, but large adults were very common in the following spring. It is probable that the adults either moved into the waters of Muddy Creek, which flows at the west edge of the marsh, or that they may survive dry periods by burrowing into the mud.

REPRODUCTION. Wright (59, p. 191) states that in the northeast, bullfrogs do not breed until the water has warmed to 70° F. In 1947, eggs were first deposited in the Bruce Station marsh about May 13, when 3 masses were found in shallow water near the road. At this time, many large adults could be seen at the surface of the water, but no mating activity was noted.

Tadpoles in this area apparently spend two winters as larvae, transforming in the following spring. Tadpoles collected August 27, 1946 range in length from 75 to 100 mm., and probably represent 2nd year larvae. Larvae larger than this, seen in the spring, usually possess hind limbs and are in the process of transforming. These are then almost two years old.

HIBERNATION. Both adults and overwintering larvae hibernate in this area, although the larvae remain active

longer in the fall and emerge earlier in the spring. Larvae apparently become active during February, but the adults are not usually seen before the middle of April. In the fall, adults usually disappear by mid-October, but active larvae can be found well into November.

PROBLEMS. Complete studies on the life history of this frog in western Oregon would be useful for comparison with the results of similar studies in the eastern United States.

SCELOPORUS OCCIDENTALIS OCCIDENTALIS (BAIRD AND GIRARD)

PACIFIC FENCE LIZARD

DESCRIPTION. Easily the most abundant lizard in this area, the fence lizard can be confused with no other form. It is the only lizard in the area possessing large, spiny scales. Furthermore, its predominantly gray to almost black dorsal coloration, combined with bright blue ventral patches are distinctive. The dorsal coloration varies greatly, appearing dark gray-black in many individuals, and varying through lighter shades to a grayish brown ground color, upon which the dorsal pattern of dark and colored spots stands out clearly. No attempt has been made in this study to correlate color with internal or external factors, although it has been noted that early spring specimens are darkest, whereas summer specimens appear the lightest. Smith (45, p. 41) cites Atsatt in stating that low temperature causes darkening in iguanids,but he lists 8 general factors which may act to control the color of lizards, so that the phenomenon is probably due to interaction of certain of these.

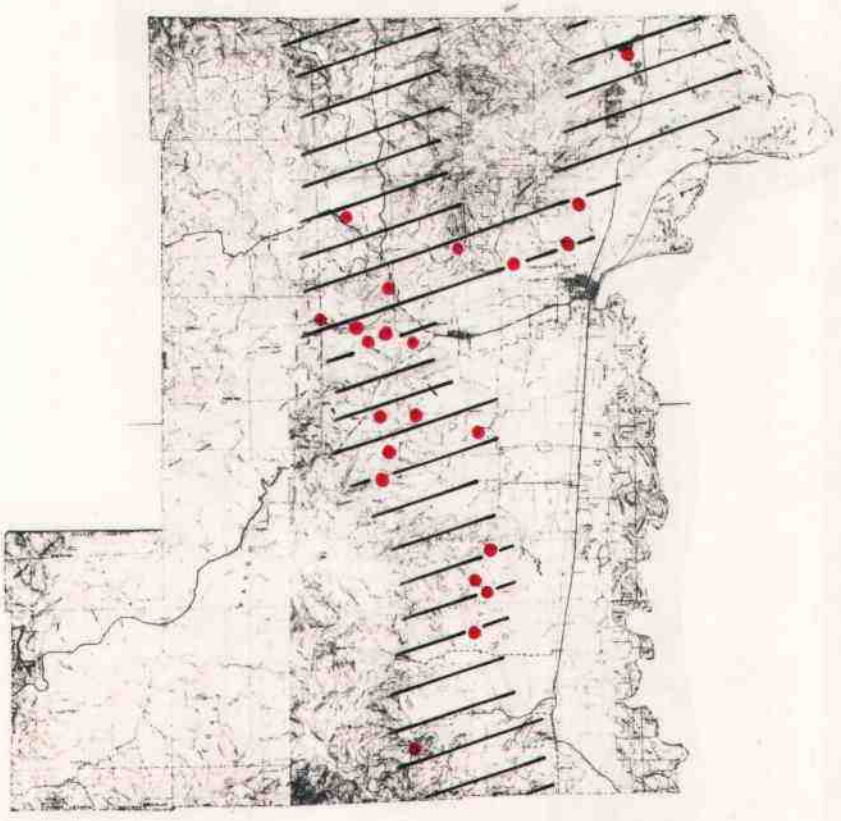
The following statistics are offered as being typical of adult Sceloporus in the area. Nos. 1, 2 and 3 represent OSC Nos. 242, 243, and 244 respectively.

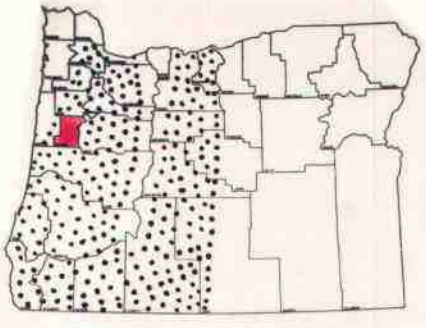
	1	2	3
Sex	F	M	F
Head and body	70	74	79
Tail	87	imperfect	85
Head length	14.5	15	17
Head width	14	14	16
Forelimb	27	30	29
Hind limb	40	44	44
Number of dorsal scales	38	37	41
Number of femoral pores	15-15	14-15	15-15

SEXUAL DIMORPHISM. Fitch (16, p. 155-156) states that sex can be distinguished when the individuals are less than ¼ grown, or in the spring after their first hibernation. The males have deeper blue ventral patches, and in specimens with a head and body length of over 40 mm., bluish or greenish dorsal flecks are present in the male, but lacking in the female. Van Denburgh (56, p. 300) states that the entire mid-ventral portion of the abdomen and almost the entire throat of many adult males are black.

DISTRIBUTION IN OREGON. Sceloporus occurs in valleys and adjacent areas of the western part of the state, probably being absent from the upper Cascades north of Crater Lake and from much of extreme northwestern Oregon. In eastern Oregon, it extends eastward as far as The Dalles and Prineville, and probably at least through Klamath County. (Map 14, p. 184)

DISTRIBUTION IN BENTON COUNTY. The following occurrence records are taken entirely from field observations, the identification of this lizard being sufficiently simple





Distribution of Sceloporus occidentalis occidentalis

to allow of this. All observations are my own, except that followed by FGE, which was taken from Mr. Evenden's personal notes.

Coffin Butte, one mile S of Polk County line and one mile W of Highway 99-W; 3½ miles N of Corvallis; Dixon Creek area, 1½ miles NW of Corvallis; summit of road between upper Oak Creek and Wren, about 5 miles NW of Corvallis; 2 miles NW of Wren; foothills W of Corvallis; 3 miles W of Philomath; various spots from 2-5 miles straight W of Philomath (Wood's Creek road and Pioneer Butte road); foothill areas 3½-6 miles SW of Philomath; Bull Run Creek area, 3½ miles S of Philomath; 1-4 miles N of Bellfountain; drained mill pond at Glenbrook. (FGE)

These records seem sufficient to show a distribution which avoids the low flat areas of the Willamette Valley proper and the forested higher portions of the Coast Range. Sceloporus distribution seems to be centered in the oak foothills, spreading westward into cutover, burned, or otherwise opened up fir land. The species seems very mobile, and is able to move quickly into newly available areas of the proper habitat. I was unable to find a clear-cut example that would indicate that lizards had crossed any area of typical Coast Range fir forest, to gain access to more open areas. (Map 14, p. 184)

HABITAT. Fitch states (16, p. 154) that the newly

hatched young

> "lack the strong predilection for climbing that is characteristic of adults or partly grown young, and they are nearly always to be found on the ground or near it on fallen logs or on rails. An adult usually centers its activity about a bush, stump, tree, or rock outcropping, or some similar place offering adequate concealment,....."

This indicates a preference for a habitat in which can be found these objects suitable for climbing. In the present study, lizards were found to be most common in open areas of scattered fir stumps. These apparently provide the necessary elevation for climbing and in addition furnish excellent cover into which the animal can retreat. I have never secured hibernating lizards, but it seems quite plausible that they can find their way to the necessary depth by following the decaying roots of these stumps.

Another apparent reason for occupying areas in which elevated positions occur is the phenomenon of territorial behavior evidenced by Sceloporus. Particularly in the spring, each male occupies an elevated site within his territory, attempting to drive off other adult males that may come into his vicinity. (16, p. 162)

A reasonably open cover is required, because the lizards seem to require a certain amount of direct sunlight. However, it was found in this study that the amount of cover may be extremely variable. Lizards have often been found on or in stumps on open hillsides, where there

were few or no trees and shrubs. On the other hand, several have been collected or seen in open second growth fir, or at the edge of rather heavy fir in relatively open areas adjacent to a road. This seems further evidence of the facility with which they extend into newly opened areas, no matter how limited these may be.

The absence of Sceloporus from flat areas of the valley, seems to be due to more than one factor. Probably foremost is the lack of any extensive areas of scattered open growth, containing elevated rocks, stumps, etc. A further factor may well be the saturated condition of the valley floor during the winter. The lizard hibernates largely underground, and could not survive the moisture.

As intimated above, typical dense fir forest may serve as a barrier to this form, even though its width be small. However, the lizards have been found commonly in clearings, almost surrounded by heavy fir growth; they are often seen at the very edge between fir and open areas, and they have been seen quite frequently in open second-growth fir.

In summary, the primary habitats of Sceloporus are the stump-strewn hillsides of the lower Coast Range and the oak and brush-covered hillsides of the foothills.

REPRODUCTION. During this study, no special attempt was made to study mating habits or other aspects of

reproductive activity. Fitch's study of the fence lizard (16, p. 151-172) has contributed a great deal to our knowledge of this behavior.

A pair of lizards were collected on April 19, 1947 from beneath the same small piece of bark. It may be assumed that these were close together for the purpose of mating. Male lizards captured during April possess enlarged active testes, and females contain easily visible eggs about 3 mm. in diameter.

No eggs were found in the course of this study. These are apparently deposited in the ground. Fitch (16, p. 161) found several females digging burrows for their eggs in the moist soil of a nearly dry creek bed. He states that the burrows were made beneath flat rocks on damp soil. This observation was made in Lane County, Oregon, on June 5, 1928.

Wood's figures on the dimensions of Sceloporus eggs at the time of laying may be useful in determining the approximate time at which eggs taken from pregnant females would have been deposited. He states (58, p. 70) that of thirty-eight fertile eggs laid in the laboratory by three lizards, the average size was 11.5 mm. long by 7.0 mm. wide.

Young of the year were seen during this study as early as September 9, but appeared to be at least several days old at that time.

GENERAL HABITS. Although Sceloporus hibernates in

this area, it is apparently able to remain active at lower temperatures than other lizards. Disappearance from above the ground in fall is quite dependent upon weather conditions, but usually occurs during October. The earliest available record for emergence in the spring is February 25, 1947.

Sceloporus are probably almost entirely diurnal in their activity, but an observation by Ned W. Stone (48, p. 129) indicates that they may be abroad at night. He states that in northern California, he several times saw these lizards moving about at night. On one occasion, he witnessed a male pursuing a female, at a time shortly after midnight.

Concerning enemies of the form, Fitch states (16, p. 169-170) that the yellow-bellied racer (Coluber constrictor mormon) is one of the most destructive enemies. He added that these snakes were so quick as to often seize running lizards. He mentions in addition that rattlesnakes, king snakes, garter snakes, bull snakes, and the sparrow hawk were also seen to prey upon these lizards.

PROBLEMS. This lizard because of its availability is particularly useful for experiments involving the marking of populations. Fitch's excellent study (16, p. 151-172) serves as a model, but much can yet be learned. Other local problems are the manner and sites of hibernation, the

time and sites of oviposition, and the precise habitat limitations.

GERRHONOTUS COERULEUS PRINCIPIS (BAIRD AND GIRARD)

NORTHERN ALLIGATOR LIZARD

DESCRIPTION. Although practically limited in Benton County to the areas west of the Coast Range summit, the northern alligator lizard may at certain points overlap the range of the Oregon alligator lizard (Gerrhonotus multi-carinatus scincicauda). This is the only lizard of the area with which it can be confused. From that form, coeruleus is distinguished by its smaller size (head and body length never over 100 mm.), the presence of a dark post-ocular stripe, lack of white-tipped black scales on the sides of the trunk, the presence of faint dark lines running between the scale rows on the ventral side of the trunk, and the presence of 14 rows of full-sized dorsal scales. In addition, individuals of the species coeruleus tend to be generally darker than individuals of the species multi-carinatus, but this is only of value in comparing two specimens side by side.

The following measurements and counts represent Benton County specimens in the OSC collection. Nos 1-6 represent OSC nos. 245-248, and nos. 253 & 254.)

	1	2	3	4	5	6
Sex	F	F	M	M	M	F
Head and body	62	60	80	64	81	83
Tail (if perfect)	-	-	-	121	-	-
Head length	13	13	17	15.5	18	17
Head width	9.5	9	13	10	12.5	11

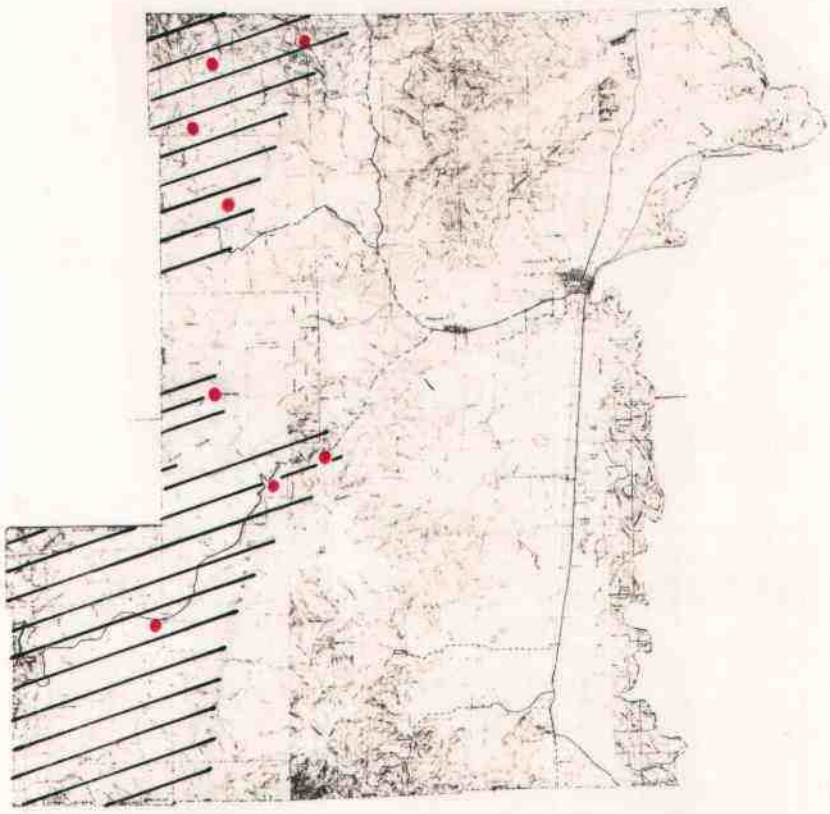
	1	2	3	4	5	6
Length of forelimb...	16	14.5	20	17	21	18
Length of hind limb..	20	16	23.5	21	25	22
No. of dorsal scales.	48	44	47	47	49	46

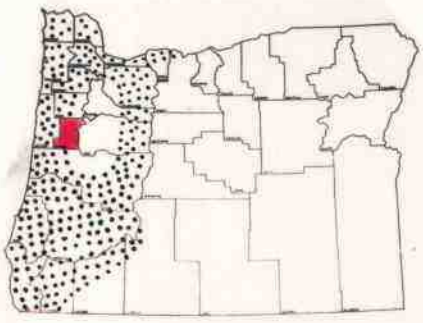
SEXUAL DIMORPHISM. In the available preserved material, no consistent sexual differences can be noted. Measurements seem to indicate, however, that males have proportionately longer and wider heads, and proportionately longer limbs.

IDENTIFICATION OF YOUNG. Young alligator lizards of this species tend to be of a lighter general coloration than the adults. The most noticeable feature of these small (c. 3 inches) individuals is the presence of a light bronze-colored band extending from the head down the dorsal part of the trunk.

DISTRIBUTION IN OREGON. Probably occurs throughout western Oregon in areas of suitable habitat, with the following exceptions. It is apparently absent from the lowland portions of the Willamette Valley, at least south of Washington County. It is also absent from southern Jackson County, where it is replaced by the Shasta alligator lizard (Gerrhonotus coeruleus shastensis). It probably extends for some distance up the Columbia River, since it occurs throughout eastern Washington. (Map 15, p. 193)

DISTRIBUTION IN BENTON COUNTY. The following locality records are based largely on specimens in the OSC





Distribution of Gerrhonotus coeruleus principis

collection, but a few are taken from reliable field observations, and are marked thus (RMS): 3 miles NW of Hoskins (RMS); 4 miles N of Summit (RMS); 2 miles N of Summit (OSC 247); 2.5 miles NW of Blodgett (OSC 249); summit of Mary's Peak (OSC 248); Well's Creek area, 7 miles SW of Philomath (OSC 253 & 254); Spencer Creek area about 5 miles NE of Alsea (OSC Nos. 245, 246, 251, 252); 1 mile SW of Alsea (RMS).

Except for the Hoskins and Well's Creek records, the above localities are westward from the upper reaches of the Coast Range. The northern alligator lizard probably occurs throughout suitable habitat west of these mountains. Its distribution in the higher portions of the mountains, and in the areas of the county to the west is more difficult to delimit. Its presence at the summit of Mary's Peak may indicate a surprising ability to cross wide areas of comparatively dense fir forest. On the other hand, much of the west slope of the Peak has been lumbered and burned, so that relatively open areas are almost continuous down the west side. It seems more probable that the lizards have penetrated upward into these, eventually reaching the summit.

The records east of the mountains seem to me to be due to two different reasons, depending onwhether they are more northern as the Hoskins location, or more southern, as the

Well's Creek record. I believe that the lizards to the north are at the southern periphery of a continuous tranmontane (Coast Range) distribution to the north. Lizards occurring in the Well's Creek area, on the other hand have probably penetrated the mountains, via the relatively low, cut-over pass area to the west. In this region, east and west bases of the main mass of the hills are only separated by a straight line distance of about 3 miles.

In summary, Gerrhonotus coeruleus principis is mainly confined to the part of Benton County west of the Coast Range. They occur east of these mountains in the northern part of the county, this being the southern extension of a wider distribution into the Willamette Valley to the north. In more southern parts of the county, they have been able to penetrate through the mountains where lumbering has provided a more suitable habitat. (Map 15, p. 193)

HABITAT. Due to the development of ovoviviparity, lizards of this species are able to occupy cooler and damper habitats than can the Oregon alligator lizard. Fitch (11, p.23) states that areas of dense vegetation are most favorable as habitat for this species, but this is not strictly true. In all cases in which I have collected coeruleus in Benton County, they have been found in open areas, in or near vegetation which varied in density from a hillside with scattered shrubs and trees to fairly heavy

second growth forest.

On May 30, 1946, we collected 2 miles north of Summit. A single alligator lizard of this species was found under a log, on a hillside covered with several old logs and large charred stumps, with some shrubby growth, but with few trees.

The specimen collected on Mary's Peak was found on the open south slope, just below the summit lookout, Vegetation here is almost entirely grasses. Two lizards were taken in the Well's Creek area. These were both beneath a small log at the edge of an old logging road running up the floor of a narrow valley. Vegetation here varies from fairly old fir to brushy burned over areas, but there are a number of small open banks, created when the road was put through.

In summary, although coeruleus is more adapted to heavier vegetation and higher altitudes (from a vegetation standpoint) than multi-carinatus, it nevertheless requires open areas, containing logs, stumps, or rocks in and under which it can find refuge. It is probably entirely absent from unbroken fir forests, but will be found in their open edges.

REPRODUCTION. As mentioned above, this species is ovoviviparous. No young individuals were seen in Benton County, and consequently no observations could be made on

the time of birth in this area. A female, collected April 27, 1947 contained 4 eggs up to 5 mm. in diameter. This female was accompanied by a mature male, and mating activities may have been interrupted, although there was nothing to indicate this. A second female, collected May 17, 1947 contained eggs measuring 8 by 13 mm.

Observations by Lewis (27, p. 155-157) in Washington may be applicable to this area. These are based on captive specimens. He observed vigorous mating activity among caged individuals from April 26 to 28. The average air temperature was 27.5° C. On August 15, six young were born to one female. These were cinnamon brown above, with fine white speckling laterally. The ventral surface was light gull gray. A second brood was born to another female on August 22. These were similar in color to the above, but possessed in addition a mid-dorsal spotting of black. A third brood of five was born on August 29, and a fourth brood of four on September 5. The average length of all 22 of the young was 76 mm.

GENERAL HABITS. Nothing is known of the hibernating habits of the northern alligator lizard in this area. It is quite probable that it does hibernate, but the length of the hibernating period and the places of hibernation are unknown.

An interesting ability of this lizard is swimming.

Mr. Fred Evenden (personal notes) reports seeing a small individual (c. 3.5 inches) jump into and swim rapidly across a small mountain stream in the Cascades. It moved with sinuous motions in the manner of a swimming snake.

PROBLEMS. Knowledge of the exact distribution in the Coast Range would be useful. It would be of interest to note whether or not this form ever occurs in the same habitats with the following lizard (G. multicarinatus scincicauda). Much can yet be learned of reproduction habits and dates. Places and manner of hibernation are practically unknown.

GERRHONOTUS MULTICARINATUS SCINCICAUDA (SKILTON)

OREGON ALLIGATOR LIZARD

DESCRIPTION. This is the largest of the lizards in this area, and adults are markedly larger than the adults of coeruleus. A large female (OSC No. 266) has a head and body length of 145 mm. Unfortunately, her tail is imperfect, but perfect tails may be more than twice as long as the head and body. General color comparisons with adults of Gerrhonotus coeruleus principis were discussed under that species. It can be repeated for emphasis that the present species possesses white-tipped black scales on the sides, and usually shows faint broad lines extending down the middle of the ventral scale rows. The head and body length of adults is more than 100 mm.

The following measurements and counts are based on specimens in the OSC collection, nos. 1-4 representing OSC nos. 260, 263, 265 and 266 respectively:

	1	2	3	4
Sex	G	M	M	F
Head and body	140	112	143	145
Tail (if perfect)	-	206	-	-
Head length	27	24	29	25
Head width	19.5	16.5	23	18
Length of forelimb	32	28	33	32
Length of hind limb	37	33	41	36
No. of dorsal scales	48	50	46	48

SEXUAL DIMORPHISM. Adult males usually possess longer and wider heads in proportion to their length than do

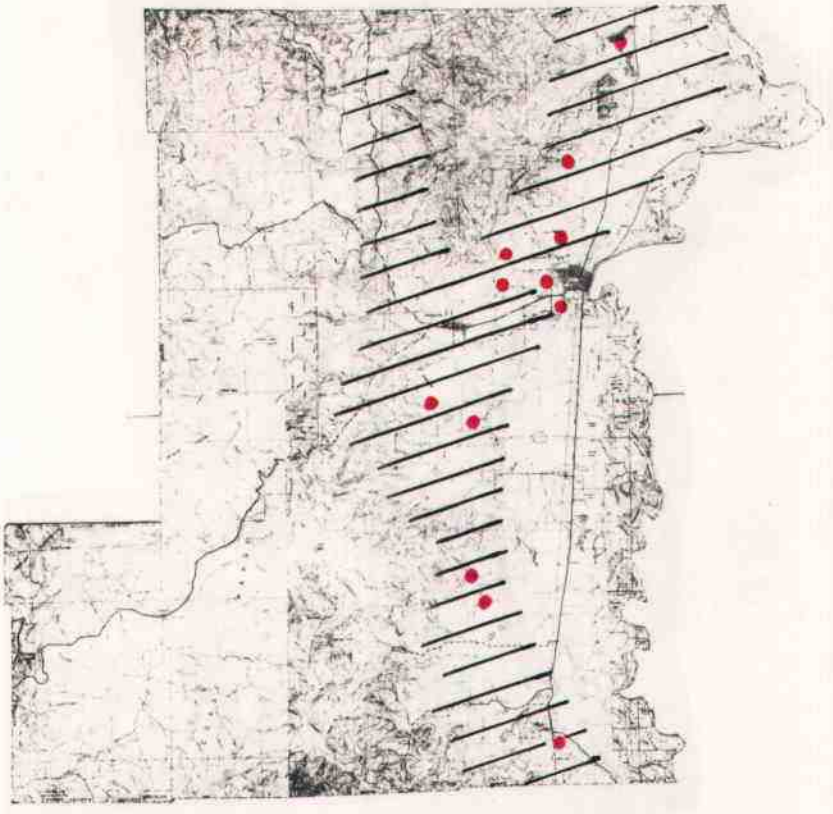
adult females. The males exhibit large temporal swellings, due to heavier musculature beneath.

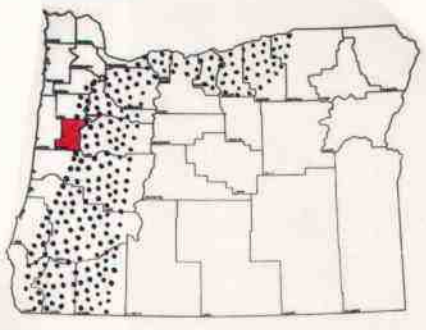
DISTRIBUTION IN OREGON. In western Oregon, this form is apparently confined to areas between the Cascades and Coast Range. It is probably absent from the lower Willamette Valley around Portland, but extends eastward up the Columbia River, spreading somewhat southward east of the Cascades, at least as far as southeastern Gilliam County. (Map 16, p. 201)

DISTIBUTION IN BENTON COUNTY. The following location records are based on specimens in the OSC collection, and on reliable field observations. Observations followed by (FGE) are from Mr. Fred Evenden's personal notes; those followed by (RMS) are from my notes. Near Coffin Butte, 10 miles N of Corvallis (RMS); 4 miles N of Corvallis (RMS and FGE); 2 miles NW of Corvallis (FGE); one mile N of Corvallis (RMS); 3½ miles W of Corvallis (OSC Nos. 260 & 265); ½ mile W of Corvallis (OSC No. 263); 1½ miles SW of Corvallis (RMS and FGE); on Evergreen Road 3½ miles SW of Philomath (OSC No. 266); Bull Run Creek 4 miles S of Philomath (RMS); various areas 2 to 4 miles N of Bellfountain (RMS and FGE); ½ mile SE of Monroe (RMS).

These indicate a distribution quite similar to that of Sceloporus. However, the present form is not found as far westward as is Sceloporus, and there are certain small

Map 16





Distribution of Gerrhonotus multicarinatus scincicauda

habitat differences, which will be mentioned in the next section. The range of multicarinatus is practically complementary to that of coeruleus. Being oviparous, the Oregon alligator lizard cannot survive in the cooler, damper areas where coeruleus is usually found.

In summary, the Oregon alligator lizard centers its distribution in the oak-covered foothills of the Coast Range, but has spread out from these to some extent into old ranch clearings in the edge of fir forest, and onto the valley floor at its western edge. (Map 16, p. 201)

HABITAT. Fitch (11, p.7) states that this subspecies is a characteristic inhabitant of the Garry oak belt. This is true in Benton County, although the form is often found at some distance from oak. It does not require elevated situations as does Sceloporus, and has been seen more frequently in flat open areas at the edge of the main valley floor. An area well populated with these lizards occurs about 3 miles west of Corvallis at the site of a burned sawmill. Several acres to the west of this support the dead and dying trees of an old orchard. The ground under these is littered with boards, pieces of bark, and slabs of wood, which remain from mill activity. During the spring and summer, alligator lizards occur rather commonly under these various pieces of wood. This area is almost devoid of woody vegetation except for the orchard trees,

and the nearest oaks are probably some 200-300 yards distant.

On May 13, 1946, I found a large adult of this form beneath a small piece of bark in the central part of an open pasture 2 to 3 acres in extent. This pasture is situated about a mile north of Corvallis, and lies at the foot of a north slope of mixed fir, oak, and other deciduous growth.

On June 25, 1947, I collected in an old ranch clearing about 3½ miles southwest of Philomath on the Evergreen Road. This clearing is surrounded on three sides by second growth fir, and slopes downward through open land to more distant oak-covered hills on the fourth side. The clearing contains an old orchard, a few blackberry thickets and a small stream lined with willows and other streamside growth. A large female (OSC No. 266) was found beneath a large plank, in an open area of closely-cropped grass.

A more typical area, where many Gerrhonotus have been seen is located about 1½ miles southwest of Corvallis, on a small hill, known as Country Club Heights. This hill is covered with a heavy growth of oak brush and poison oak (Rhus), with many larger oaks scattered through this. The lizards are usually found under or near large oak logs in the area.

These examples indicate that although the Oregon

alligator lizard may center its activities in oak growth, it is able to extend its range into more treeless areas nearby, and even moves into openings close to dense fir forests, provided these openings are continuous with oak areas. This lizard has never been found on open hillsides covered with fir stumps and logs, nor has it been found in small openings along roads, well within the limits of fir forest. It will be recalled that Sceloporus occurs commonly in both of these situations.

REPRODUCTION. A mating pair of this species was observed on May 15, 1947. The two were in long grass near a large timber. The male had seized the head of the female and appeared to be dragging her through the grass. My field companion at the time was unaware of the significance of these actions, and frightened the lizards so that they separated before complete observations could be made. The male was captured (OSC No. 265), and its testes were found to measure 8 x 5 mm.

Apparently, deposition of eggs by this subspecies in nature has not been observed. Fitch (11, p. 13) believes that the eggs are deposited underground in rodent burrows. I collected a female on June 25, 1947, with a head and body length of 145 mm., containing 17 eggs averaging 13 x 10 mm. Eggs are probably deposited in July or early August in this region.

GENERAL HABITS. Smith (45, p. 459) states that hibernation is complete and lasts through November until late March. Apparently the lizards spend this time well below the surface of the ground. An interesting observation indicates that this winter rest is not always undisturbed. On January 6, 1948, we found an alligator lizard, about 6½ inches long, on top of the ground under a board. It had been raining steadily for several days and the ground in this area was saturated. The lizard had apparently been "drowned out". This could well be a limiting factor in keeping the form in or very close to the foothills, since drainage there would be considerably better than on the valley floor.

PROBLEMS. As with many of our forms, the exact distribution of this subspecies in the county is unknown. Knowledge of this distribution combined with more detailed information on habitat preferences would be of much interest, for comparison with the preceding lizard. Studies on reproduction, food habits in nature, and hibernation would yield much new information.

CHARINA BOTTAE BOTTAE (BLAINVILLE)

PACIFIC RUBBER SNAKE

DESCRIPTION. This snake is easily identified by the combination of small eyes, with vertical pupils; blunt, rounded tail tip; and undivided urosteges. The color above is a uniform medium to rather dark brown, the ventral color light yellow. The scales are very small and smooth. The measurements and counts below are based on specimens in the OSC collection. Nos. 1-4 represent OSC Nos. 272-275. Measurements given here were made on the freshly killed snakes. (No. 275 is not a Benton County specimen, but was collected in the lower Cascades of Linn County.)

	1	2	3	4
Sex.....	young	M	young	F
Head and body length....	230	562	205	508
Tail length.....	38	73	27	70
No. of scale rows.....	47	37	43	43

No. 2 is the largest specimen measured during this study, although several have been handled which must have been near 18 - 22 inches (450-550 mm.) in total length.

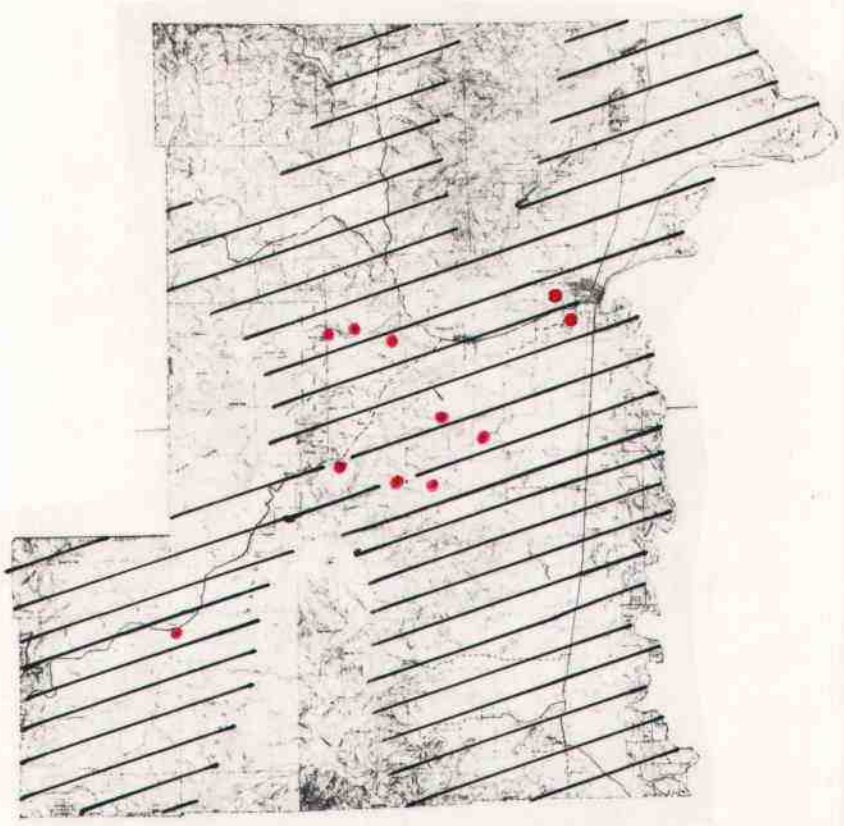
DESCRIPTION OF YOUNG. Young up to at least 10 inches in total length are quite similar in structure to the adults, but are somewhat differently colored. In these, the upper parts are a uniform light pinkish brown, and the ventral portions are a rather light brownish yellow, becoming pale flesh color on the urosteges. The general

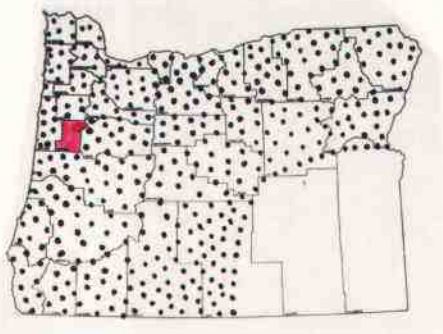
aspect of one of these small snakes is of delicate coloration, with a somewhat translucent quality.

DISTRIBUTION IN OREGON. According to Klauber (25, p. 85-86), the subspecies bottae is found only west of the Cascades in Oregon. In these mountains, it intergrades with the subspecies of eastern Oregon, C. bottae utahensis. Sufficient material was not collected in this study to test the validity of Klauber's statistics on scalation, but it is probably a reliable division. A more accurate definition of ranges in Oregon must await further studies. (Map 17, p. 208)

DISTRIBUTION IN BENTON COUNTY. The following locality records are based on specimens in the OSC collection and on reliable sight records of this easily identified snake: ½ mile W of Corvallis (RMS); Country Club Heights, 1½ miles SW of Corvallis (RMS); areas 2½, 4 and 5 miles W of Philomath (OSC 272) & (RMS); on Evergreen Road, 3 miles S and 1½ miles W of Philomath (RMS); Bull Run Creek, 3½ miles S of Philomath (RMS); areas from 6-7 miles SW of Philomath (RMS); entrance of Well's Creek road, about 7 miles SW of Philomath (OSC 274); Alsea (OSC 273).

These records tend to be concentrated west and somewhat southwest of Corvallis. However, they give a good picture of the main habitat preferences of the snake, and it seems probable that the snake occurs throughout the





Distribution of Charina bottae bottae

county in similar habitats. The boa is found with fair regularity around lots in the outskirts of Corvallis, and I have recorded it at least 3 times in low country adjacent to sloughs, east of the Willamette River. In summary, the rubber boa probably occurs on the main valley floor near streams, on isolated, forested hills or buttes and in the eastern foothills of the Coast Range. It ranges westward into more open fir areas and up into relatively open valleys, but is probably absent from the dense fir areas of the higher mountains. West of the Coast Range summit, it is to be found in open clearings and in the relatively open valleys of streams and rivers. (Map 17, p. 208)

HABITAT. Although considered typically a snake of moist coniferous forests (18, p. 71; 19, p. 67; 35, p. 40; 56, p. 642; evidence accumulated during this study seems to indicate that it prefers considerably drier habitats than usually afforded by typical coniferous forest. Probably its true habitat requirements are more nearly indicated by Lewis (27, p. 158-159), who states that in Washington, it has been found to inhabit dry, well-drained terrain, and that its habitat demands are rather exacting in this respect. I have noticed that younger snakes seem to require more moisture than the older individuals. Young snakes have often been taken from well within moist

rotting stumps or logs, although they were usually located in relatively open areas, or within the edge of open tree-growth.

On July 7, 1946, I collected in an area approximately 5 miles up the Wood's Creek Road, west of Philomath. Here the valley becomes quite narrow between forested slopes. The north slope supports fairly dense second growth fir, whereas the south slope is more open and of mixed fir and deciduous growth. Between the road and the creek at this point are well-imbedded, rotting railroad ties. Two medium-sized and one large Charina were found by tearing up these ties. The interior of these ties was slightly moist, but must have been quite hot since they lay in the full sun. A fourth boa of medium size was found beneath the thin bark on the root extension of a large fir stump near the foot of the south slope.

On June 25, 1947, I visited an old ranch clearing on the Evergreen Road southwest of Philomath. This is in the lower edge of the fir zone. Two Charina about 11 inches long were found together resting on bare ground beneath an old plank. This plank lay in full sunlight and the ground appeared quite dry beneath it. This seems to indicate a much higher tolerance of heat and dryness than has usually be attributed to this snake.

In summary, Charina apparently finds its most

favorable habitats in relatively open areas, but near trees. Young snakes are more often found in moist logs, stumps, etc., whereas older snakes exhibit greater tolerance to, and even a preference for, drier and warmer situations. It should be pointed out that Charina ranges farther into the Coast Range valleys than does Gerrhonotus multicarinatus, and that it also goes down onto the main valley floor, which neither Gerrhonotus nor Sceloporus do.

REPRODUCTION. I can find no record of the mating behavior of this snake, and do not know when mating may occur.

A female collected on May 24, 1947 in the lower Cascades of Linn County (OSC 275), and killed on June 24, one month later, contained 5 eggs, averaging 20 x 35 mm. Embryonic development appeared to be just beginning in these eggs. Mr. Donald Darling, who has collected many Charina on the east side of the Willamette Valley, has given me the following information (personal correspondence):

A gravid female, collected on August 30, 1946 was killed on September 3. She contained four well-developed young that appeared ready for parturition. These measured 231, 232, 235 and 236 mm. in total length, and had respective diameters of 8, 9, 9, and 9 mm. This observation indicates that the young are born alive in September, an

assumption more or less born out by Svihla in Washington (53, p. 128). A female collected near Cle Ellum on September 15, 1941 gave birth to four young on September 21 or 22. On September 24, these measured 215, 222, 220 and 225 mm. respectively. The dorsal surface was the color of an earthworm, while the underside was a more intense pink. A remnant of the yolk stalk was still present on the ventral side, somewhat posterior to the center of the body. These would only feed by force, but by the second week of the following March, they had increased in length by 50-100 mm.

FOOD AND FEEDING. The preferred food of the adults is probably mice. Very young snakes must rely to a large extent on invertebrate food, although I have no data on this. Lewis (27, p. 159) states that captive adults fed eagerly on Mus musculus and Peromyscus, alive or dead. Small specimens ate nestling mice, but invertebrates, salamanders and frogs were refused. Ross (38, p. 8) found young mice a very satisfactory food, and stated that the rubber snakes often responded more quickly to food than captive rattlers or gopher snakes.

Van Denburgh (56, p. 642) gives two instances in which individuals of Charina had fed on Sceloporus.

GENERAL HABITS. Observations by Ross (38, p. 7-8) in California may be applicable to the species locally.

He found that the snakes were never active at temperatures below 50° F. Caged individuals were active in the early morning until about 8:00 A.M. They became active again about 5:00 P.M., except on cloudy days when they were out earlier. They usually retired near 8:00 P.M., when the temperature fell below 50°. At night, they retired below the surface of the soil, but not more than 2-3 inches deep.

Ross also offers interesting observations on the climbing ability of this snake. He saw one climb 12 feet up a slightly leaning trunk to a chipmunk nest. In experiments, he found that this snake could climb a rough trunk by zigzagging from side to side. It never twined about smooth poles to climb, but utilized twigs in this way. He cites a Charina that he found on the ridgepole of a two-story frame house, which was under construction.

No information is available on the hibernation habits of this snake. On October 4, 1941, a companion and I came upon a large fir stump in an old ranch clearing 6-7miles southwest of Philomath. In and around this stump were seen 3 Charina, about 10 inches long, 4 Diadophis, one small Coluber, and one small Pituophis. It was felt at that time that these snakes were preparing to hibernate in and below this stump.

PROBLEMS. Further careful collecting should be done to determine more exactly the distribution and habitat preferences of this snake. The breeding habits are poorly known, and almost nothing is known of their daily activity cycle, their feeding habits in nature, or their hibernation.

COLUBER CONSTRICTOR MORMON (BAIRD AND GIRARD)

WESTERN YELLOW-BELLIED RACER

IDENTIFICATION OF ADULTS AND YOUNG. Adults of this form are easily identified by their slender build and consistent coloration of brownish dorsal area, pale blue on the lower sides, and pale yellow or bluish-white venters. They are a relatively large snake in this area, growing to a maximum size of near 40 inches. Very little material from Benton County is available for measurements or scale counts, and these are omitted for this species. Ortenburger (34, p. 215-225) discusses coloration and scalation of this snake at length. No attempt was made to compare local specimens with his statistics.

The young up to a length of about 300 mm. are colored quite differently from the adult. These possess 70-85 dark gray or brown saddle-like blotches on a light gray or gray-brown ground color (34, p. 216). They can only be confused with small individuals of Pituophis. From these they differ in certain definite color variations, and also by the fact that the present species has smooth scales and a divided anal plate. In Pituophis, the scales are keeled and the anal plate is undivided.

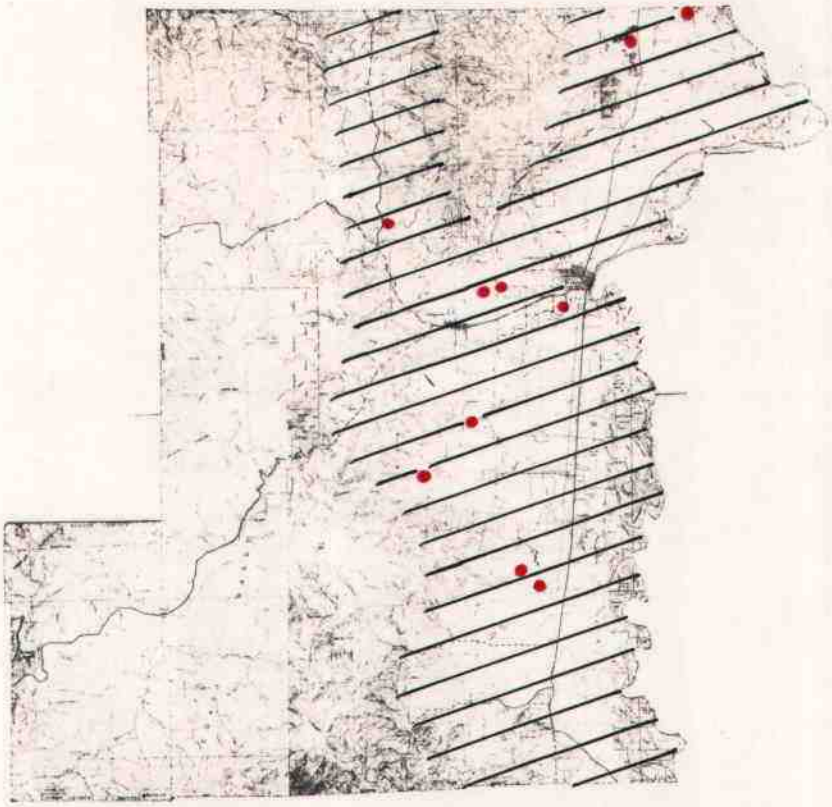
DISTRIBUTION IN OREGON. Probably, this species occurs throughout Oregon in suitable habitats. Fitch

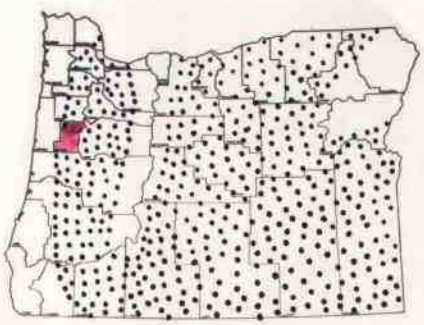
(12, p. 644) found the snake most abundant in the Upper Sonoran life zone, but also common in Transition life zone, except in thick coniferous forests. The snake is probably absent from most of the Cascades and higher Blue Mountains, and there do not appear to be any records of its occurrence west of the Coast Range. (Map 18, p. 217)

DISTRIBUTION IN BENTON COUNTY. The following locality records are taken entirely from reliable observation records by Mr. Fred G. Evenden, Jr. and by myself: northern county line, on Independence road (RMS); Coffin Butte, about 10 miles N of Corvallis (RMS); 3½ miles W of Corvallis (RMS); Country Club Heights, 1½ miles SW of Corvallis (RMS); one mile N of Wren (FGE); above Bull Run Creek, 3½ miles S of Philomath (RMS); about 6 miles SW of Philomath (RMS); swamp area at Bruce Station, 12 miles S of Corvallis (FGE); one mile NW of Bruce Station swamp (RMS).

These indicate a distribution entirely east of the Coast Range within the county, which seem compatible with habitat requirements discussed below. The snake is apparently distributed throughout the floor of the valley, and extends into the eastern foothills of the Coast Range only to the approximate edge of the fir. Its extent of range in the foothills seems to be quite similar to that of Gerrhonotus multicarinatus. (Map 18, p. 217)

HABITAT. Fitch (12, p. 644) states that in the Rogue





Distribution of Coluber constrictor mormon

River Valley, Coluber constrictor "is common in open woods of Garry Oak and poison oak, on grassy slopes, in chapparal, and in grain or hay fields." This statement applies well to the present area, although a further type, consisting of over-pastured areas grown to scattered shrubs, might well be added. I have never collected the snake in valleys running into the Coast Range, but have taken it in large ranch clearings, which were almost surrounded by fir, provided these were at the extreme lower edge of the fir zone.

The presence of the snake on the valley floor must involve some method of enduring the very wet condition of the ground during the winter. It seems quite possible that this fast-moving, far-ranging snake may move into higher areas for winter hibernation. Whether or not this is true could probably be worked out in the Willamette Valley, since there are extensive areas east of the river where higher areas are several miles distant. Lack of the snake in such areas would indicate a dependency on higher ground for hibernation.

REPRODUCTION. This is an oviparous form, but no data are available on the time of egg deposition, the number of eggs, or the time of hatching.

FOOD AND FEEDING. Ortenburger (34, p. 218) states that the food consists mostly of insects, lizards and

snakes. Fitch (12, p. 644) found one racer attempting to swallow an adult meadow mouse, and states that captive snakes ate fence lizards and were able to catch these animals on the run. No local observations were made on this activity.

GENERAL HABITS. These snakes are mainly terrestrial, but are reputed to have a considerable ability to climb into bushes (56, p. 644). I have seen only one above the ground level, and this individual was twined through the twigs of a 3 foot shrub, apparently resting in the sun.

The racer is almost invariably of a very bad disposition, and makes every attempt to bite when captured. This temperament is usually exhibited by even the very young snakes.

The time of hibernation is approximately from early or mid-October to April. The place of hibernation is not known, but as speculated above, is probably in more elevated situations as hills and buttes. Mr. Fred Evenden's personal notes refer to a snake of this species collected near Country Club Heights on November 23. Considerable rain had fallen in the area, so that the valley was somewhat flooded. It seems probable that this snake had chosen too low a hibernating site and had "drowned out".

PROBLEMS. A more complete knowledge of this snake's distribution in the Willamette Valley is needed, in order

to determine to a certainty whether or not it is penetrating to the west side of the Coast Range. Breeding habits, hibernation, daily and seasonal wanderings, and the economic significance of their food habits present problems of which little is yet known.

PITUOPHIS CATENIFER CATENIFER (BLAINVILLE)

PACIFIC GOPHER SNAKE

DESCRIPTION AND IDENTIFICATION. This is the largest of the Benton County snakes, although I have measured no specimens over four feet in length. Stull (52, p. 143) states that the longest specimen she examined during her study measured 1630 mm. (about 5 feet 4 inches). Klauber (26, p. 16) mentions a specimen 1854 mm. (6 feet 1 inch) in length. I have seen a few individuals that appeared to be between 4 and 5 feet in length, but the majority were under 4 feet. On May 30, 1946, I talked with a rancher's son, living about 3 miles north of Summit. He stated that on the preceding day, a "blow snake" had been caught near Blodgett, which measured 52 inches alive.

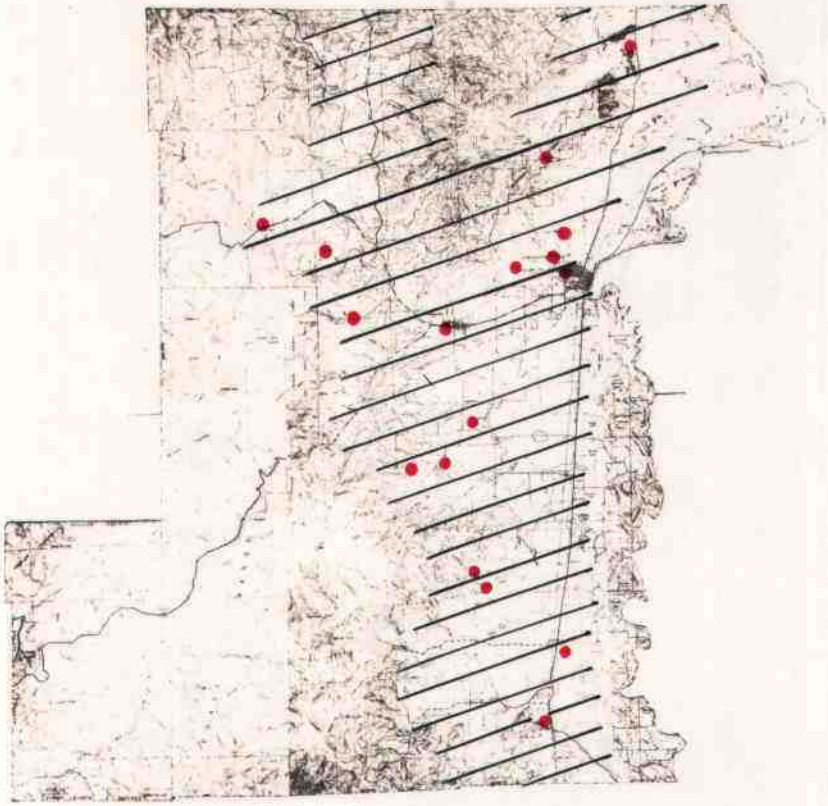
The snake can be easily identified by its pattern of dark brown, black-edged dorsal blotches on a yellowish-brown ground color. In this area, there is a considerable gray-brown suffusion in the ground color, so that in some individuals, the ground color of the dorsal regions is almost as dark as the dorsal blotches. Young individuals usually exhibit a more contrasting light ground color. Measurements and counts are given below on four Benton County specimens. Nos. 1-3 represent OSC Nos. 276-278; No. 4 is OSC No. 280. Measurements were all made on freshly killed specimens.

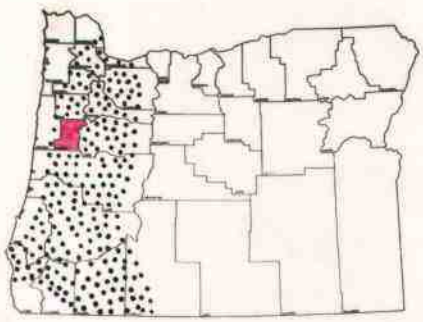
	1	2	3	4
Sex	M	M	M(?)	M
Head and body length	990	870	766	962
Tail length	204	184	136	206
No. of gastrosteges	212	208	210	205
No. of urosteges	71	70	60	71
No. of dorsal blotches	77	60	66	61

SEXUAL DIMORPHISM. Klauber (26, p. 16-17) states that the "ratio of the length of the tail to the length over-all averages about .157 in adult males and..143 in the females,....." In Nos. 1, 2 and 4, above, this ratio is .171, in No. 3, it is .150. No. 3 is tentatively identified as a male according to its gonads, but the examination gave uncertain results.

DISTRIBUTION IN OREGON. This subspecies is probably largely confined to the region west of the Cascades. Stull (52, p. 152) states that it ranges east to Summer Lake in Lake County and Heppner in Morrow County. Klauber, on the other hand, considers trans-Cascade Pituophis as belonging in the subspecies deserticola (26, p. 35). Klauber's viewpoint seems more sensible in regarding the presence of the Cascades as a barrier between mixing of eastern and western populations. In western Oregon, the gopher snake is rare in the northern part of the Willamette Valley, and there are no records of its occurrence in northwestern Oregon. Its presence in the northern 2/3 of the Coast Range area is problematical. (Map 19, p. 223)

DISTRIBUTION IN BENTON COUNTY. The following locations





Distribution of Pituophis catenifer catenifer

are based on specimens (OSC) and reliable observations (FGE and RMS): near Coffin Butte 10 miles N of Corvallis (RMS); in Macdonald Forest 4 miles N of Corvallis (FGE); in Dixon Creek area one mile N of Corvallis (OSC Nos. 278 & 279); ½ mile NW of Corvallis (OSC 277 and RMS); NW part of Corvallis, within city limits (OSC 281 and FGE); Oak Creek Road, 2 miles W of Corvallis (RMS); main highway in Philomath (FGE); 2½ miles W of Wren (RMS); near Blodgett (RMS); 2.1 miles up Wood's Creek road from U.S. route 20 (RMS); above Bull Run Creek, 3½ miles S of Philomath (RMS); near Beaver Creek, 5½ miles S of Philomath (RMS); about 7 miles SW of Philomath (RMS); 2½ and 3 miles N of Bellfountain (FGE and RMS); near Long Tom River, 3 miles N of Monroe (OSC 278); ¼ mile NW of Monroe (RMS).

These records indicate a distribution centered in the eastern foothills of the Coast Range. The gopher snake extends its range into the flat valley lands adjacent to the foothills, but I have only one record of its occurrence well out in the valley. The specimen taken near the Long Tom River was probably 2 to 2½ miles from the nearest foothills. It seems probable that in the present species, we are again dealing with a snake which is unable to hibernate in the wet flat areas of the main valley floor. Pituophis has been taken in clearings within the eastern edge of the fir zone, and has been found up the eastern

valleys of the Coast Range as far as agriculture and lumbering have opened these up. Its occurrence near Blodgett is the most westerly record that I have.

In summary, Pituophis ranges throughout the oak covered foothills and butte areas of the county, and spreads from these into at least the western parts of the main valley floor. It extends westward into the more open areas of the side valleys in the Coast Range. It probably does not occur west of the Coast Range summit. (Map 19,p.223)

HABITAT. Fitch (12, p. 645) states that he found individuals of this species in dense Douglas fir forest and in pasture land near the coast, but that it was most common in the cultivated areas of the valley (Rogue River) and in brushland in the foothills. Klauber (26, p.19) states that this is a snake which prefers the Lower Sonoran and Upper Sonoran life zones, and is not plentiful in the Transition Zone. In the present study, gopher snakes have been found most often in oak-grown or shrub-grown (Rosa, Rhus, Cytisus, etc.) areas, usually near streams. A further requirement appears to be adequate shelter, in the form of large decaying stumps, objects on the ground (large boards, pieces of tin, etc.), and rodent burrows. A favorite refuge of these snakes is within the decaying lateral root extensions of large fir stumps.

It seems probable that during the non-hibernating

season, individuals of Pituophis range far into agricultural areas in search of food. Here they find temporary shelter in rodent burrows, and very often beneath large pieces of metal or board. It is evident from Mr. Fred Evenden's and my own personal notes that the gopher snake also enters small towns (Philomath) and the edges of larger towns (Corvallis). This indicates a wide-ranging habit, and likewise little fear of man. Mr. Evenden found a snake 5 feet above the ground, coiled around the limb of a tree in the northwestern part of Corvallis.

REPRODUCTION. Fitch (12, p. 646) records several matings by captive gopher snakes, but gives no dates. In preparing to mate, the male grasps the body of the female in his jaws.

Pituophis is oviparous, but no eggs were found during the course of this study. Van Denburgh (56, p. 712) records 19 eggs laid by a captive California specimen on July 14 and 15. I believe that in this area, Pituophis eggs are deposited in rodent burrows or other underground cavities. A position near the surface of the ground must be necessary in order to obtain sufficient heat for hatching.

Klauber (26, p. 57-58) states that Pituophis (sp.?) are hatched between mid-September and early October, and gives an over-all length for the newly-born snakes of

about 370 mm.

FOOD AND FEEDING. Numerous references in the literature refer to the beneficial feeding habits of this snake. It feeds largely on small mammals, and in this area mice and pocket gophers probably make up much of its fare. Nestling birds may be eaten when found, but I do not know to what extent the snake will actively search for nests in bushes and low trees.

GENERAL HABITS. The gopher snake is primarily diurnal in activity, but has exhibited the ability, in California, to become crepuscular, and even nocturnal during the warm summer months (26, p. 52). It may undergo a similar seasonal change in habits in this area. During the spring, gopher snakes can often be seen in midday, crossing roads or sunning in exposed spots. In the summer months, the snakes are seen during midday only if the weather is overcast. On sunny days, they are encountered crossing roads in the late afternoon very near sunset. Whether this summer activity continues after nightfall is not known.

Little information is available on hibernation in this species. It probably occurs in better-drained hilly areas, beneath large stumps or in underground burrows. The period of hibernation is approximately from mid-October to mid-March.

Although it has been mentioned often in other accounts,

this snake's habit of resting on gravel roads and highways is so prevalent as to merit some discussion. Whatever the cause, it would seem that Pituophis can seldom resist the urge to stop for a period of several minutes when crossing a road. They seem to derive sensual pleasure from this experience, probably due to the encountering of an extensive warm surface after traveling over cool earth. I have encountered many snakes in such a position, and invariably they must be closely approached or even handled before being stimulated to move away into roadside grass or brush. When encountered in other, more normal situations, the snake is quick to move out of sight. This habit probably leads to a higher destruction of this snake than by any other cause. All too many individuals believe that by running their automobiles over snakes, particularly big snakes, they do great service to fellow men.

PROBLEMS. This largest of our local snakes is rather poorly known. Its distribution throughout the county and the Willamette Valley needs clarification. All phases of its life history are at best but little known.

CONTIA TENUIS (BAIRD AND GIRARD)

SHARP-TAILED SNAKE

DESCRIPTION AND IDENTIFICATION. This is the smallest of the local snakes, adults seldom attaining more than 12 inches in total length. Van Denburgh (56, p.772) gives a total length of 413 mm. (16.3 inches) for one specimen, but this seems exceptionally large. On May 4, 1947, Mr. Donald Darling collected 23 snakes of this species under boards on Country Club Heights, southwest of Corvallis. The largest of these measured 300 mm. in total length, the smallest 164 mm. The average length for the 23 specimens was 231.3 mm. This series seems representative of the sizes of this snake in this area.

The dorsal color of these snakes is a somewhat yellowish-brown, which is minutely sprinkled or reticulated with black, giving the area a darker cast. A reddish-brown line runs down the 5th scale row on each side, and there is a small black dot at the anterior end of each scale for 2 or 3 rows below this. The ventral scales are light gray, each one crossed anteriorly by a narrow black band, this producing a striking alternation of light gray and black. The last $\frac{1}{2}$ to 1 inch of the tail is a dull red in color dorsally. The end of the tail is tipped with a hard, very sharp-pointed scale.

The following data are based on freshly-killed

specimens. Nos. 1-6 represent OSC nos. 285-290.

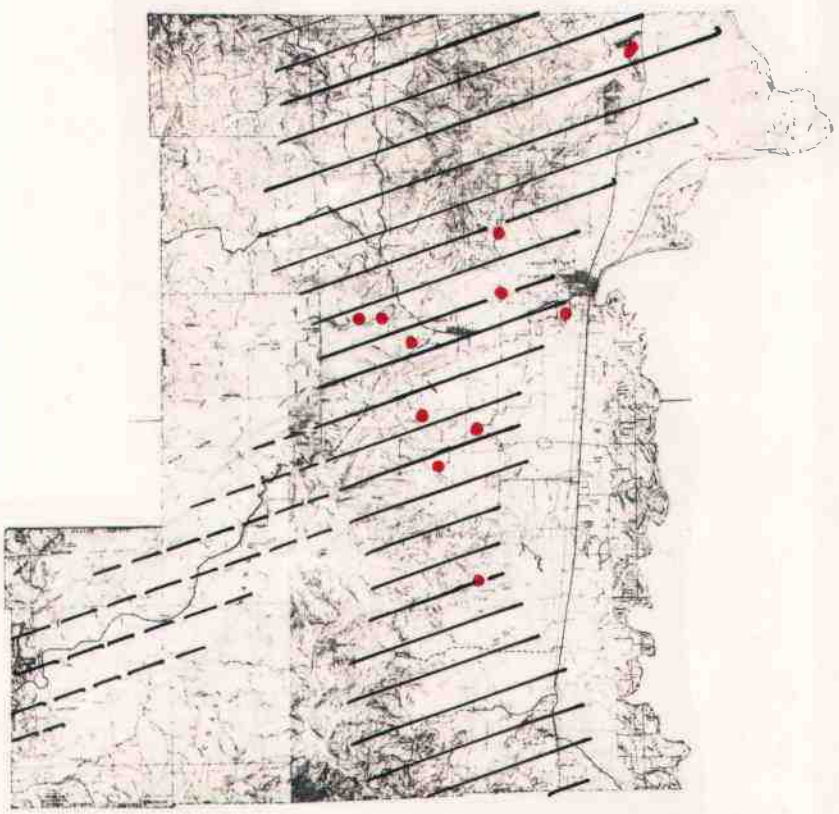
	1	2	3	4	5	6
Sex.....	F	M	M	M	F	F
Total length	277	221	173	208	248	188
Tail length.	38	35	26	34	30	25

SEXUAL DIMORPHISM. Although based on very few measurements, there is evidence that the tail of the female is proportionately shorter. The ratios of tail length to total length in 3 females are .121, .133, and .137, whereas the same ratios in 3 males are .150, .158, and .163.

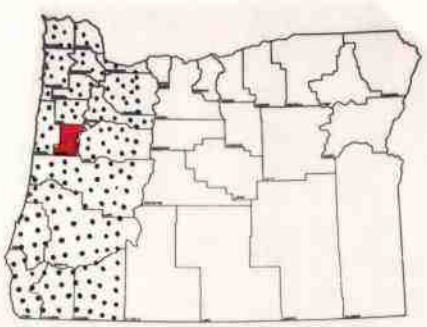
DISTRIBUTION IN OREGON. Very few collection records are available for Oregon. The snake occurs in both western Washington and western California, so that it probably occurs throughout western Oregon in suitable habitats. The nature of its habitat requirements may keep it confined in general to the large valleys west of the Cascades. (Map 20, p. 231)

DISTRIBUTION IN BENTON COUNTY. Contia tenuis has been seen or collected in the following localities in Benton County: Coffin Butte, 10 miles N of Corvallis (RMS); near Oak Creek road, 3 miles NW of Corvallis (RMS); S slope of Bald Hill, 2½ miles W of Corvallis (FGE); Country Club Heights, 1½ miles SW of Corvallis (RMS); Pioneer Butte road, 2 miles W of Philomath (OSC Nos. 285 & 286); Wood's Creek road 2 and 2½ miles W of Philomath (RMS and OSC 287); Evergreen road, 3 miles SW of Philomath (OSC 289); Bull Run

Map 20



(- - - Occurrence uncertain)



Distribution of Contia tenuis

Creek, 3½ miles S of Philomath (OSC Nos. 288 & 290); near Beaver Creek school, 5 miles S of Philomath (Kenneth L. Gordon); 3½ miles N of Bellfountain (RMS).

These records are sufficient to indicate that this snake is confined pretty well to the oak foothill regions of the county. Although not so obvious from the location records, it has been noted in field work that the majority of the snakes have been found rather close to the fir zone. The occurrence of Contia on Country Club Heights seems somewhat unusual, in view of this hill's isolated position with respect to Coast Range foothills. Coffin Butte is likewise isolated by at least ½ mile from foothill habitats. It is apparent that either the snakes are able to traverse the low areas in between, or that they remain as isolated populations from an earlier continuous prehistoric range. The former possibility seems the more likely, and future intensive collecting should demonstrate the snake's presence in intervening areas.

In summary, the sharp-tailed snake centers its distribution in the eastern foothills of the Coast Range. It has not been found on the main valley floor, but its presence on isolated hills makes probable its occurrence in the area between. It is probably not found west of the Coast Range summit. (Map 20, p. 231)

HABITAT. The sharp-tailed snake has been found in

numbers of more than 30 in two localities in the county. The first of these is the Country Club Heights area, about 1½ miles southwest of Corvallis. This hill has an elevation of approximately 450 feet. Most of its lower slopes are given over to agriculture, city lots, a cemetery, and a golf links. The summit, however, is densely grown to Garry oak, poison oak, wild rose, and other shrubby growth. A small stand of second-growth fir occurs on the northeast slope of the hill. Most of the snakes have been found in more open oak on the northeast part of the summit, and a series of 23 was collected beneath boards along a fence between the golf links and an open pasture. This particular area is just north of dense oak and underbrush growth.

The second favorable area is a south slope just above Bull Run Creek, 3½ miles south of Philomath. Here, there are several acres of open closely pastured ground, littered with old fir stumps. Second-growth fir encroaches on the upper edge of this slope, but it gives way to scattered oaks to the east. Snakes collected here were usually found in the decaying wood of the fir stumps.

If the Country Club Heights area is left out of consideration, it can be stated that almost every Contia collected has been within 100 yards of fir forest, and they have usually been considerably closer. However, I have

never collected them within continuous fir growth. It is of interest to point out that a few acres of fir occur on Country Club Heights, but there is nothing here to indicate that this is controlling.

In summary, I have tentatively concluded that like the salamander, Aneides ferreus, Contia is in the unusual position of preferring more open, drier situations, but requiring logs and stumps in which to find shelter. Such logs and stumps occur most commonly near fir forests. Unlike Aneides, this snake is more able to utilize boards and pieces of wood on the ground, and this may now account for its presence more distant from fir forests, where man has left old buildings to supply boards for shelter.

REPRODUCTION. Nothing is definitely known about the breeding habits of this form. An adult female was collected on July 30 from within a crack in a decayed fir stump. She was accompanied by an adult male. The female contained ovarian eggs up to 4.5 by 1.75 mm., which seemed much too small to develop the same year. It was assumed that she had deposited eggs or young prior to that date.

FOOD AND FEEDING. The series of 23 snakes, collected on Country Club Heights by Darling were analyzed for their stomach contents. He states (4, p. 28) that six of these contained slugs of an unidentified species. From one to five slugs were found in each of the six stomachs, and

these varied in length from 4 to 8 mm.

Contia tenuis is largely nocturnal. Fitch (12, p. 647) states that a captive specimen was secretive and seldom showed itself during the day, but became active and crawled about the cage at night. I have noticed a similar behavior in specimens kept in the laboratory for a few days.

GENERAL HABITS. On the basis of my collection records, this snake is most likely to be found under boards and other objects on the surface of the ground in the spring, before temperatures become high and the dry period begins. During the summer and early fall, they move into logs or stumps where they can burrow to cool, moist areas within.

No definite information is available on hibernation. A snake collected on November 8, 1947 was well within a small stump on an open south slope, This snake was sluggish at first, but became active in less than a minute of being held in my hand. Whether this snake was already hibernating or had not yet started could not be determined. The snakes usually appear under boards, bark, etc. in late March or early April.

When picked up and handled, snakes of this species often make weak striking motions with the tail, or they push the spine on the tail against the flesh of one's hand. Their strength is not sufficient to cause any pain at all, and one wonders what possible use this feeble gesture can

have. It may serve in some way in helping to capture certain food forms.

PROBLEMS. This is the least known of the snakes in this area, and as such offers numerous possibilities for investigation. Nothing is known of its breeding habits. A much more extensive knowledge of the snake's precise habitat requirements and food habits would be useful. Little or nothing is known of daily and seasonal wanderings, hibernation, or relative abundance of this interesting little snake.

THAMNOPHIS ORDINOIDES ORDINOIDES (BAIRD AND GIRARD)

PUGET SOUND GARTER SNAKE

DESCRIPTION AND IDENTIFICATION. Garter snakes of the species ordinoides have been treated at length by Fitch (15, p. 1-150), and it only seems necessary in this account to co-ordinate or compare certain of my own observations with those of Fitch. Fitch's discussion of the subspecies ordinoides (15, p. 97-110) is of particular usefulness in this area, since he collected at several localities in the Willamette Valley, including Benton County.

This snake exhibits a great variation in coloration, within the area studied, which is consistent with Fitch's statements on coloration (15, p. 97). In general, the dorsal line may be distinct, faint, present for only a short distance behind the head, or absent altogether. When present, it covers the median row of scales and half of each adjacent row. The dorsal stripe when distinct, is usually a pale yellow, but is often variously flecked with brick-red. I have seen specimens in which the stripe was dull orange or various shades of pale green. Lateral stripes are usually lacking, but when present, occur on scale rows 2 and 3 and are usually grayish or olive-gray in color.

The dorsal ground color varies in different individuals through such shades as olive-gray, reddish-brown,

deeper shades of brown, and black. In individuals of lighter coloration, 2 series of alternating black spots are present between the dorsal line and the 2nd and 3rd scale rows. Johnson (24, p. 165 and personal communication) has emphasized the fact that the lower row of spots is more prominent, the upper row being faint or absent.

Ventrally, snakes of the present subspecies usually show a considerable black suffusion, particularly on the posterior 3/4 of the body. In many individuals, the entire underside is black, whereas others exhibit a considerable amount of green or red coloration flecked through with black. A few specimens have been seen that were a clear bluish-white or bluish-yellow ventrally.

Although no statistics have been kept on the matter, there is some indication that snakes of the main valley floor tend toward a black or dark brown ground color, and possess a distinct dorsal stripe, whereas snakes of the small Coast Range valleys are more apt to possess olive or grayish ground colors, and lack the dorsal stripe.

Johnson (24, p. 165) found evidence that these many variations in color are produced in later life upon a standard pattern that is present at birth. His evidence, although based on broods of Washington specimens, may be applicable in the present area. He gives the basic pattern as follows: the ground color is brown; a light yellow

dorsal line may be absent or present in part; lateral stripes are indefinite. Just above the lateral stripe there is a series of dark spots, alternating with a more dorsal series of spots. This more dorsal series is minimal and may be absent. Ventrally the color is light yellow to olive becoming darker posteriorly. Johnson (24, p. 164) believes that changes in coloration with age occur by extension of the melanistic elements of the color pattern or by development of latent color potentialities through influences of environment.

Scalation in this subspecies is less variable. Of eighteen specimens examined, seventeen possessed 14 supralabials, and only one showed 16; nine had 16 infralabials, four had 17, and five had 18; of pre-oculars, fifteen had 2, and three individuals had 3. Gastrosteges varied in number in seven males from 149 to 157, with an average of 153; in nine females, these varied in number from 146 to 155, with an average of 150. Urosteges varied in seven males from 61 to 74, averaging 67; in eight females from 52 to 64, averaging 59. There are never more than 19 scale rows, counted 2 inches behind the head, and there are usually only 17. When 19 are present, the 4th row on each side disappears before mid-body. In some specimens with 17 scale rows anteriorly, a short extra row may be present near mid-body, making the total here 19. The number of

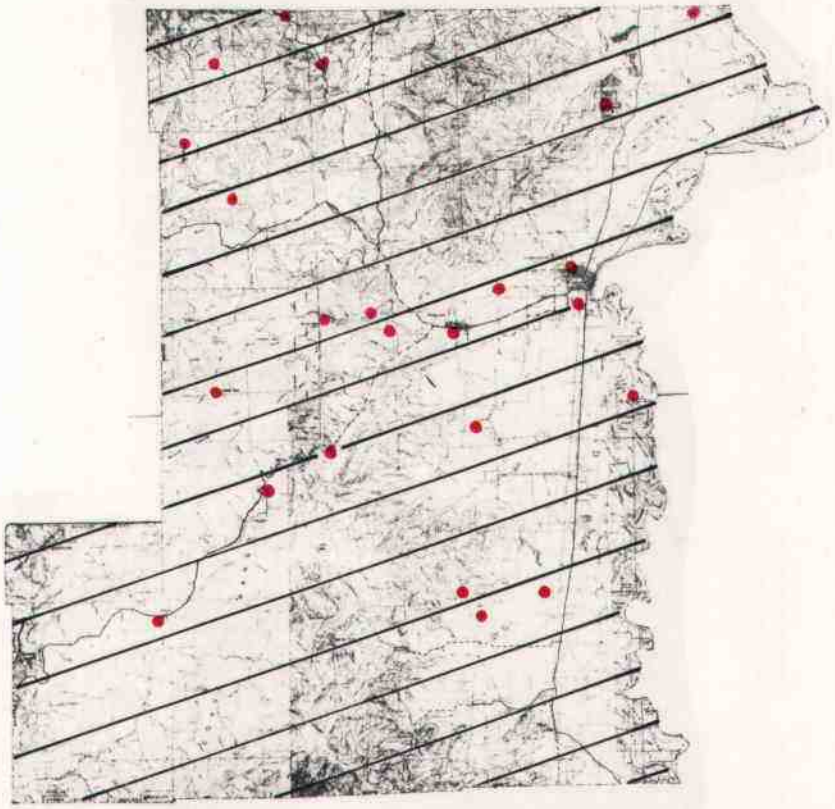
scale rows 2 inches in front of the anus is invariably 15 in adult specimens.

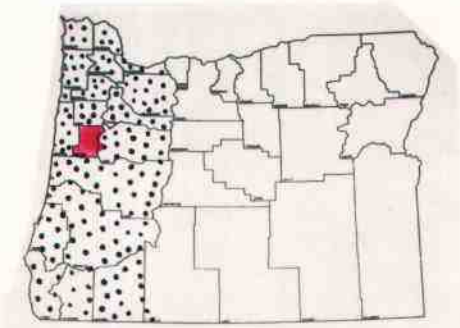
Thamnophis ordinoides ordinoides is a comparatively small snake. The largest individual measured is a female (OSC No. 292), with a head and body length of 524 mm. This is probably near the maximum for this subspecies. The average head and body length of fourteen Benton County adults is 395 mm. (15.5 inches).

SEXUAL DIMORPHISM. Females average fewer gastrosteges and urosteges than males. Snakes with more than 155 gastrosteges are usually males; those with less than 150 are usually females. There is less overlap in numbers of pairs of urosteges. Males usually have more than 64, females less than this. The tails of females are proportionately shorter, the ratio of tail length to total length varying from .225 to .258 in five males, and from .157 to .232 in seven females. Respective averages are .241 and .210.

DISTRIBUTION IN OREGON. Thamnophis ordinoides ordinoides occurs throughout western Oregon, going to an altitude of at least 4000 feet in west Cascades. (Map 21,p.241)

DISTRIBUTION IN BENTON COUNTY. This is probably the most common snake of Benton County. The following locality records are based on museum records and on reliable identifications by Evenden (FGE) and myself (RMS); Benton County line, on Independence Road (OSC 297); Arboretum Pond in





Distribution of Thamnophis ordinoides ordinoides

Macdonald Forest (FGE); on Oleman Creek, 4 miles N of Summit (OSC 292); one mile N of Summit (RMS); near Luckiamute River, 2 and 5 miles above Hoskins (RMS and OSC 304); near Mary's River, 2½ miles above Blodgett (OSC Nos. 311-314); within Corvallis city limits (OSC Nos. 299 & 302); Avery Park, ½ mile S of Corvallis (OSC Nos. 307-308); Bald Hill, 3 miles W of Corvallis (RMS); Philomath (15, p. 104); Pioneer Butte road, 2 miles W of Philomath (RMS); Wood's Creek road, 3½ and 5 miles W of Philomath (RMS and OSC Nos. 301 & 318); summit of Mary's Peak (OSC Nos. 294-296); Well's Creek area, 7 miles SW of Philomath (OSC Nos. 293 & 309); near Bull Run Creek, 3½ miles S of Philomath (RMS); Kiger Island (RMS); marsh at Bruce Station, 12 miles S of Corvallis (FGE); 2 and 3 miles N of Bellfountain (FGE); near confluence of Yew and Spencer Creeks (RMS); Alsea River, near Alsea (15, p. 104)

These and other localities not shown indicate a distribution throughout the county. This garter snake is probably absent from tracts of dense fir forest, and avoids the more open areas of the floor of the main valley, but can be expected in almost any other part, particularly within a few hundred yards of running water. (Map 21, p. 241)

HABITAT. Fitch (15, p. 102) states that of 108 individuals, for which he had habitat data, all were found in the vicinity of dense forests, but mainly in meadows or

clearings, rather than on the forest floor. He adds that specimens were usually found away from water. The following statement by Fitch (15, p. 102) is of interest:

> "An ecologic necessity to this form is the presence of dense ground cover of vegetation offering concealment. None was found in an exposed situation, such as an open gravelly beach, even when the beach was adjacent to a habitat in which the snakes were extremely abundant."

The above remarks were born out in the present study. The majority of the snakes found were in grassy meadows or clearings, usually not very far from adjacent forest or deciduous stream growth. In many instances, the snakes were found beneath the bark or hard outer surface layer of decaying stumps or logs. This snake has also been seen to rest on gravel roads, apparently deriving an agreeable sensation from this. Often, when found resting in such an exposed situation, these usually shy snakes seem very unconcerned. In one instance, I had to nudge the snake sharply with my foot before it would move away.

T. o. ordinoides is often found in the vicinity of running water, but the reason for this relationship is the presence of relatively dense sheltering vegetation adjacent to the streams. I have never seen any of this subspecies in the water, and Fitch (15, p. 101) has pointed out that the snakes are very reluctant to enter water, even when it is the only method of escape.

In summary, the Puget Sound garter snake occurs in

this area, wherever there are grassy or brushy areas adjacent to fairly dense vegetation. Riparian growths appear to offer the best sources of cover.

REPRODUCTION. I have never witnessed copulation in this form, and have no precise information on dates of its occurrence. Fitch (15, p. 112) states that apparently all races of the species normally breed during a short period in the spring, and that young are born alive in July, August and September. A female collected on May 30, 1946 (OSC 292) contained 14 eggs which averaged approximately 10 x 22 mm. Embryonic development had hardly started in these. A female collected June 1, 1946 (OSC 294) contained 6 eggs averaging 10 x 21 mm., and in a very early development stage. An adult female collected on July 24, 1946 (OSC 302) contained only very small ova, which indicates the possibility that the young may be born during June or July in this area.

FOOD AND FEEDING. Ordinoides forages during the day, and is usually only active on warm sunny days. Fitch (15, p. 103) states that the period of activity of the snake tends to coincide with the inactive peiod of the secretive animals they usually prey upon. Thus the garter snake searches for its food at a time when this is quiescent and hiding. This is born out by the food eaten. The food preferences are summarized by Fitch (15, p. 104):

> "The animals eaten by ordinoides were almost all forms incapable either of rapid escape or of vigorous self-defense when attacked. It is evident that ordinoides preys mainly on slugs, though it also frequently eats earthworms and plethodont salamanders. All the animals eaten were of terrestrial kinds, and with one exception were forms of inactive and secretive habits that are seldom found in the open in the daytime."

GENERAL HABITS. This snake hibernates in this area from early October until late March, and is somewhat less hardy in this respect than the red-spotted garter snake (Thamnophis sirtalis concinnus). The sites of hibernating are not known, but are probably large logs and stumps in lowland areas, with an additional utilization of burrows in the ground in better-drained localities.

Compared with other garter snakes, this subspecies is fairly docile, seldom attempting to bite when captured, or doing so only weakly and ineffectually. This is in line with its secretive way of life and its reliance upon weak and slow-moving food forms.

PROBLEMS. In a form with the many color variations of this one, it would be of interest to establish whether or not these are correlated with factors of geography, microclimate, habitat, etc. More can be learned of the time and manner of breeding, development time of the young, growth rates, etc. In certain areas, the snake occurs very abundantly and is thus well adapted to population studies involving the marking of individuals.

THAMNOPHIS SIRTALIS CONCINNUS (HALLOWELL)

PACIFIC RED-SPOTTED GARTER SNAKE

DESCRIPTION. This snake presents a fairly stable color pattern, and the following description applies to the majority of individuals found in this area. The dorsal ground color is dark brown to jet black, and a single series of red lateral blotches contrast strongly with the ground color. There is a narrow dorsal stripe, covering the mid-dorsal row of scales and half of each adjacent row, and set off sharply from the ground color. This stripe is usually pale yellow, but may be white, pale green or blue-gray. Lateral stripes are often absent, but when present are usually gray or very pale yellow, with irregular borders. The top and sides of the head and face are predominantly a bright coppery red. Ventrally, these snakes are heavily marked with dark blue-gray or black, which often entirely fills in the ventral surface of body and tail. Chin and throat are white or pale yellow.

This typical coloration is most strongly developed in the Willamette Valley proper. Snakes from more western areas of the county usually exhibit a brownish or dusky suffusion in the red on the sides of the head.

The scalation shows little variation. Supralabials usually number 7 on each side, but may number 8 on one side and 7 on the other, or 8 on both sides. Of twelve

specimens examined, eight possessed 14 supralabials, two possessed 15, and two had 16. Of eleven specimens examined, one had 19 infralabials, eight had 20, and two had 22. Scale rows are uniformly 19 in number on the anterior 2/3 of the body. Posterior to this, the 5th row drops out leaving 17 rows. Fitch (17, p. 574) states that for the entire species, gastrosteges vary in number at least from 146 to 177, and that males average five more gastrosteges than females. He also states that urosteges vary at least from 70 to 94. In the present study, gastrosteges varied in number from 158 to 172, and urosteges from 73 to 93.

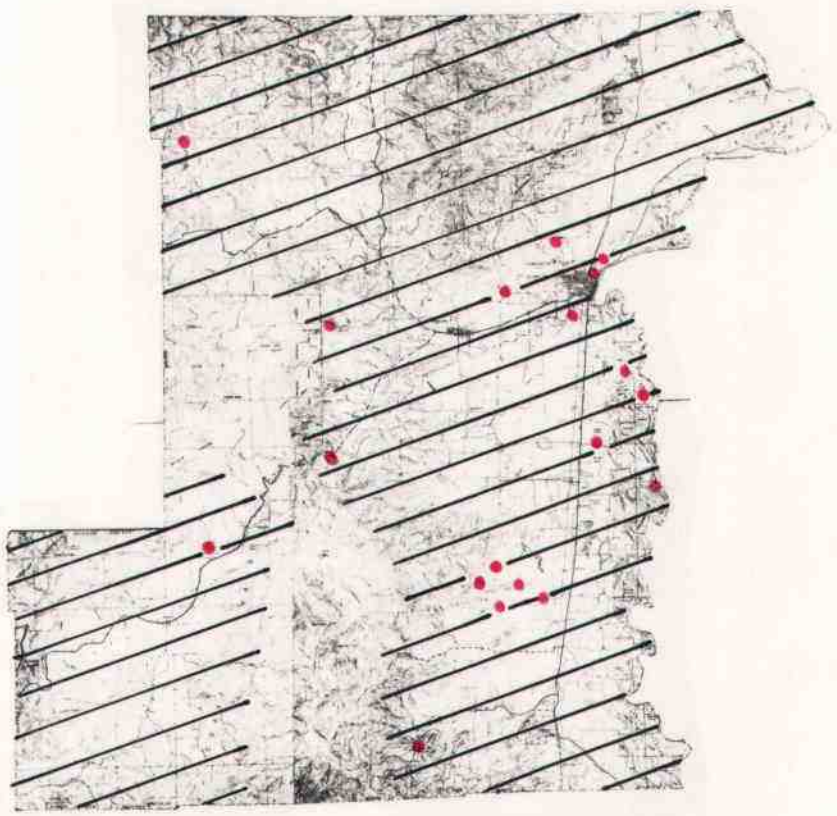
Individuals of the red-spotted garter snake attain a larger size than do those of Thamnophis ordinoides ordinoides. The three largest specimens measured had head and body lengths of 570 mm. (OSC 319), 595 mm. (OSC 324), and 611 mm. (OSC 329). The average total length of nine adults is 603 mm. or approximately 24 inches. Many individuals have been seen that were obviously longer than this.

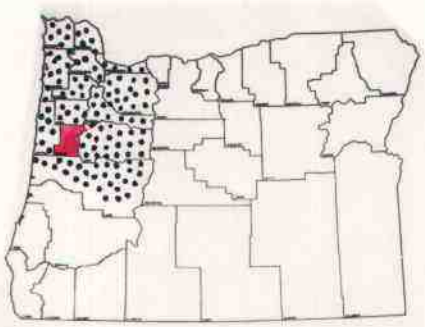
SEXUAL DIMORPHISM. Males possess a greater number of gastrosteges, and a proportionately longer tail. In five males examined, urosteges numbered from 84 to 93; in five females, from 73 to 76. In four males, the ratio of tail length to total length was from .256 to .285, with an average of .268. In four females, a similar ratio varied from

.230 to .239, with an average of .234. Fitch (17, p.574) says that adult females are markedly larger than males in average and maximum size.

DISTRIBUTION IN OREGON. Fitch (17, p. 578) gives the following range for this subspecies: "Drainage basin of Willamette River, and coastal region of northern half of Oregon." He believes (17, p. 579) that the low Umpqua-Willamette divide acts as a barrier in separating the concinnus population from tetrataenia to the south. I have collected specimens of the species sirtalis in the high Cascades that appeared to be intergrades between sirtalis and tetrataenia. (Map 22, p. 249)

DISTRIBUTION IN BENTON COUNTY. The following locality records are based on specimens in the OSC collection, and on reliable identifications by Mr. Fred G. Evenden, Jr. (FGE) and myself (RMS): near Benton-Polk line on Independence road (RMS); 1½ miles N of Summit (RMS); Dixon Creek area, 1 mile N of Corvallis (FGE); Stewart Lake, 2 miles NE of Corvallis (FGE); northeastern edge of Corvallis, near Dixon Creek (RMS); Brook Lane, 1½ miles S of Corvallis (RMS) near Oak Creek, one mile W of Corvallis (RMS); Bald Hill area, 3 miles W of Corvallis (RMS); Wood's Creek road, about 5 miles W of Philomath (RMS); Bull Run Creek, 3½ miles S of Philomath (RMS); Well's Creek, c. 7 miles SW of Philomath (OSC 325); Kiger Island (RMS); gravel pit pond, 6 miles S





Distribution of Thamnophis sirtalis concinnus

and 1 mile E of Corvallis (OSC 324); Peoria Ferry (RMS); Bruce Station marsh, 12 miles S of Corvallis (RMS & FGE); 1½ miles NW of Bruce Station (OSC Nos. 319-323); oak foothills, 2-4 miles N of Bellfountain (RMS & FGE); Glenbrook mill pond (RMS); fish hatchery, 3 miles NW of Alsea (FGE).

These records are sufficient to indicate a distribution over most of the county, so that the range appears to be as extensive as that of Thamnophis ordinoides. Actually, however, sirtalis is considerably more dependent upon bodies of water, and its greatest concentration occurs on the floor of the main valley, where streams, rivers, ponds, sloughs, etc. are most abundant. (Map 22, p. 249)

HABITAT. The red-spotted garter snake is more nearly like typical members of the genus in being semi-aquatic. The majority of specimens seen will be in or at the edge of water, or in riparian growth. Fitch has this to say of habitat requirements of the species (15, p. 115-116):

> "...; its habitat requirements necessitate the presence of water in slow-moving streams or stagnant pools, and damp meadowland, swampy ground, or thickets of riparian growth in bottomland."

In my own experience, individuals of the subspecies concinnus have adhered closely to such habitats. One of the largest concentrations of this form to be found is adjacent to the marsh at Bruce Station. Here, numerous individuals

can be seen during the apring, summer and fall feeding in shallow water, sunning on rocks, logs or the gravel road, or foraging through the heavy grass and thickets of adjacent fields.

REPRODUCTION. Mating probably occurs in early spring, soon after the snakes emerge from hibernation. On March 1, 1946, Mr. Fred Evenden observed 6 of these snakes in a rather compact mass at a location in Marion County. They were writhing about one another, but it could not be established whether or not they were actually mating.

The snake is ovoviviparous, but no information is available on the length of development time or time of hatching. A female collected on May 7, 1947 contained 16 eggs, averaging approximately 14 x 20 mm. in size. Embryonic development was not apparent. It can be expected that the young hatch during July, August or September. A snake of this species, collected on August 29, measured approximately 9 inches in total length and must have been recently born.

FOOD AND FEEDING. The food of the subspecies consists in the main of aquatic forms, salamander larvae, tadpoles, and adult frogs probably making up the bulk of their diet. They have been observed many times in shallow ponds or edges of ponds, feeding on tadpoles and larvae that swarmed therein. The fact that many salamander and

frog breedingpools dry up totally or in part is utilized fully by this snake. The drying pools concentrate the food forms so much that it is relatively simple to find food.

GENERAL HABITS. Thamnophis sirtalis concinnus appears to be hardier in respect to seasonal climatic changes than is ordinoides. If a few warm sunny days occur during early February, red-spotted garter snakes can usually be found sunning in sheltered locations. Specimens have been seen in the field as late as the middle of November, so that in some years, this form hibernates less than three months.

The exact locations of hibernation are poorly known. During the summer of 1946, a number of shed skins of this form were found near a very large fir stump on a relatively dry south slope just above the Wood's Creek road. It was assumed that the snakes had hibernated in or beneath this stump, during the preceding winter. Numbers of the snakes have been seen around the Bruce Station marsh in early February, making it appear as though they had hibernated quite near this low, wet area. It is quite possible here that they take shelter in the cracks and crevices of rocks used to bulwark a road crossing the marsh.

During the spring and summer, they are frequently found beneath boards or other objects on the ground, or

beneath the bark of decaying stumps. It is probable that they take shelter in such temporary locations on cool days, or when retiring after feeding. It is further possible that they search for food in decaying stumps.

PROBLEMS. Most of what was said under this heading for ordinoides applies equally well to this form. A study of its variations in coloration and scalation throughout its restricted range would be of interest. Exact areas of intergradation with other subspecies should be worked out. Many phases of its life history are poorly known, and nothing is well known. As with ordinoides, this snake is so abundant in certain areas as to be particularly useful for marking studies.

CLEMMYS MARMORATA MARMORATA (BAIRD AND GIRARD)

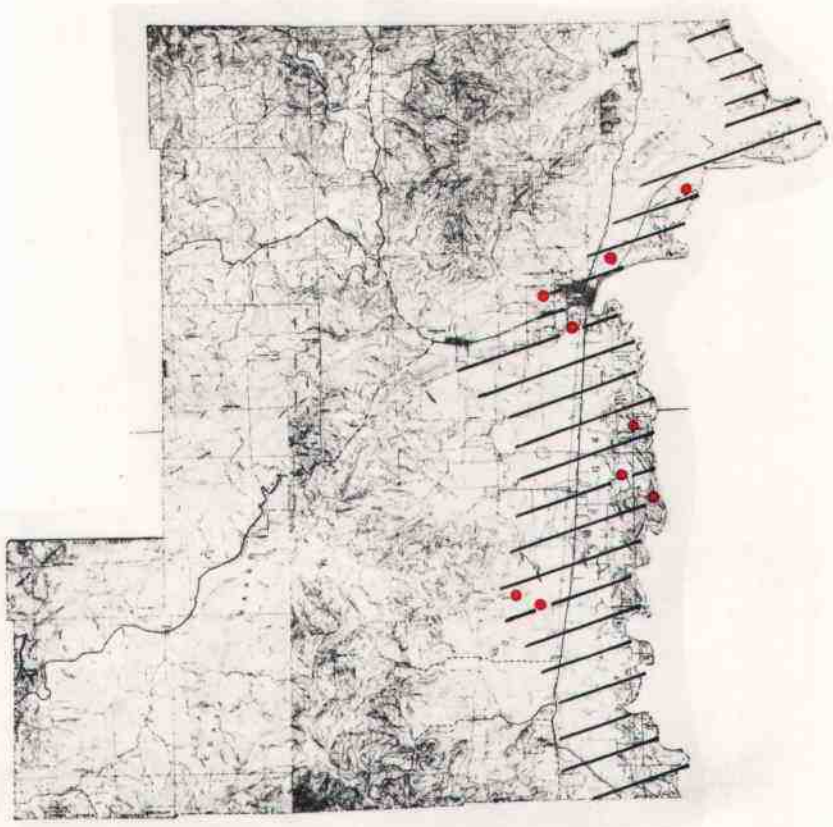
PACIFIC POND TURTLE

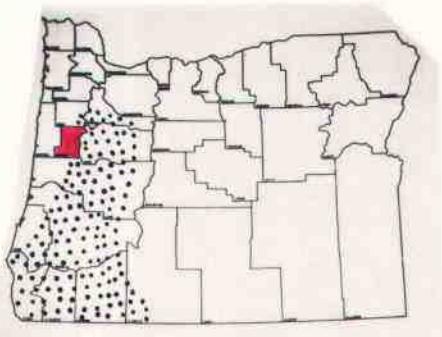
DESCRIPTION. This is the only species of turtle present within the borders of Benton County. Although seen many times during this study, only one pond turtle was collected in the county, so that there is insufficient material for any color or structural analysis of the form as it occurs here. In general, it can be said that the carapace is rather uniformly olive- or dark brown, with a tendency for each shield to be marked with a fan-shaped pattern of fine black lines. The plastron is brownish yellow in color, often possessing brown blotches on each shield. The head is yellowish brown, finely patterned with black lines.

The size probably reaches a maximum in a total carapace length of between 7 and 8 inches, but the majority of specimens seen appear to run between 5 and 7 inches.

DISTRIBUTION IN OREGON. A paper by Evenden summarizes the distribution of Oregon turtles (8, unpublished manuscript). His paper in combination with other literature indicates that Clemmys occurs in the Klammath Lake region of eastern Oregon, and in the Rogue, Umpqua, and southern Willamette Valleys. Evenden has established that the turtle does not extend much north of Salem in the Willamette Valley. (Map 23, p. 255)

Map 23





Distribution of Clemmys marmorata marmorata

DISTRIBUTION IN BENTON COUNTY. The following locality records are based on one specimen collected, a nd on observations by Mr. Fred Evenden (FGE) and myself (RMS): lower Kiger Island, 5 miles NE of Corvallis (RMS); Stewart Lake, 2 miles NE of Corvallis (RMS); pond on west campus, Oregon State College, ½ mile west of Corvallis (RMS); pond at end of Brook Lane, one mile S of Corvallis (FGE); Mary's River at Avery Park, S edge of Corvallis (FGE); slough near Willamette River, on Kiger Island (RMS); gravel pit pond, 6 miles S and 2 miles E of Corvallis (OSC 333) near Peoria Ferry (RMS); marsh at Bruce Station, 12 miles S of Corvallis (RMS); marsh on Fehling estate, 2 miles NW of Bruce Station (FGE).

Graf (19, p. 82) found the turtle common in all the sloughs along the Willamette River, and likewise found it in sluggish streams like Muddy Creek and Mary's River. The pond turtle appears to center its distribution in the sloughs near the Willamette. From these, it has extended its range into slow-moving streams and rivers, and to ponds adjacent to these. The turtle does not move up these side streams beyond a point where the current reaches a certain speed. It seems probable that the limiting factor is the presence of bottom mud, which is dependent on current plus the nature of the sub-stratum. (Map 23, p. 255)

HABITAT. These turtles are found in greatest numbers

in the comparatively deep, quiet, mud-bottomed sloughs, which are so common in bottomlands near the Willamette. The muddy bottom seems to be a necessity for temporary shelter and for hibernation. It is probable that the presence of floating logs upon which the turtles can sun is likewise necessary for their presence in numbers. In the absence of logs, tree stumps at the water's edge or beaver lodges (Evenden, personal notes) are at least two of the substitutes utilized. Stewart Lake, northeast of Corvallis, is well populated with these turtles. This is a small lake, perhaps 2 or 3 acres in extent, and is at least ½ mile from the Willamette. It is deep and permanent, surrounded by a narrow fringe of willows, alder, etc. Several large oak logs extend from the bank out into the water, and Mr. Evenden tells me that he has seen as many as 17 turtles on one of these logs.

That the turtle may wander overland into new areas is evidenced by the following: On April 11, 1947, I came upon a medium-sized Clemmys sunning on a small log in a pool about 200 yards from Oak Creek, on the west campus of Oregon State College. This pool was no more than 20 feet across at any point, and may have been 4 feet deep in spots toward the center. A large clump of willows grew in one side of it, and the turtle took refuge in the roots of these. This turtle had probably worked up Oak Creek from the Mary's

River, then followed moist seepage areas to this pond. Its sojourn there was probably temporary, since the pool was quite dry when I returned in late June.

REPRODUCTION. Graf (19, p. 83) found a turtle that had just deposited eggs in the first week of June. Her nest was in a clover field, about 100 yards from water. Graf noted that the nesthole had been dug to a depth of some 4 inches in soil that was almost brick-like in its hardness. Pope (36, p. 102) states that females usually deposit from 5 to 11 eggs. According to Van Denburgh (56, p. 977), the eggs are elliptical and measure about 34 x 21 mm. The young are probably close to 30 mm. in carapace length when first hatched.

FOOD AND FEEDING. Graf (19, p. 84-85) found crayfish and one small fish in several stomachs examined. He reports talking with a man who witnessed the capture of a young duck by one of these turtles. Evenden (personal notes) observed a turtle of this species feeding on a dead mallard duck in the water. It is probable that they feed on any invertebrates or small vertebrates that they can capture, and also upon carrion in the water. I have seen them tear at fish which had been placed on a stringer at the side of my boat.

GENERAL HABITS. Clemmys marmorata is a markedly aquatic turtle, seldom leaving the water except for sunning or

egg-laying. In this area, they seem uniformly shy, and dive off of logs into the water while the observer is still quite distant. Whether this is a natural tendency or the result of persecution is not known. They often float near the surface with only eyes and nose protruding, but even in this more sheltered position are quick to submerge if the observer moves noticeably.

Clemmys hibernates in the bottom mud, usually entering into hibernation during October, and emerging during early March. The earliest spring record available is February 28, 1948.

This turtle is of no economic import in this area, although it has been trapped and used for food in other areas. (36, p. 102-103)

PROBLEMS. Although extemely common in the lowlands of the Willamette Valley, very little is actually known of this shy turtle. By patient observations and trapping and marking, much could be learned of its reproductive habits, growth rates, daily and seasonal wanderings, and general behavior.

Plate I

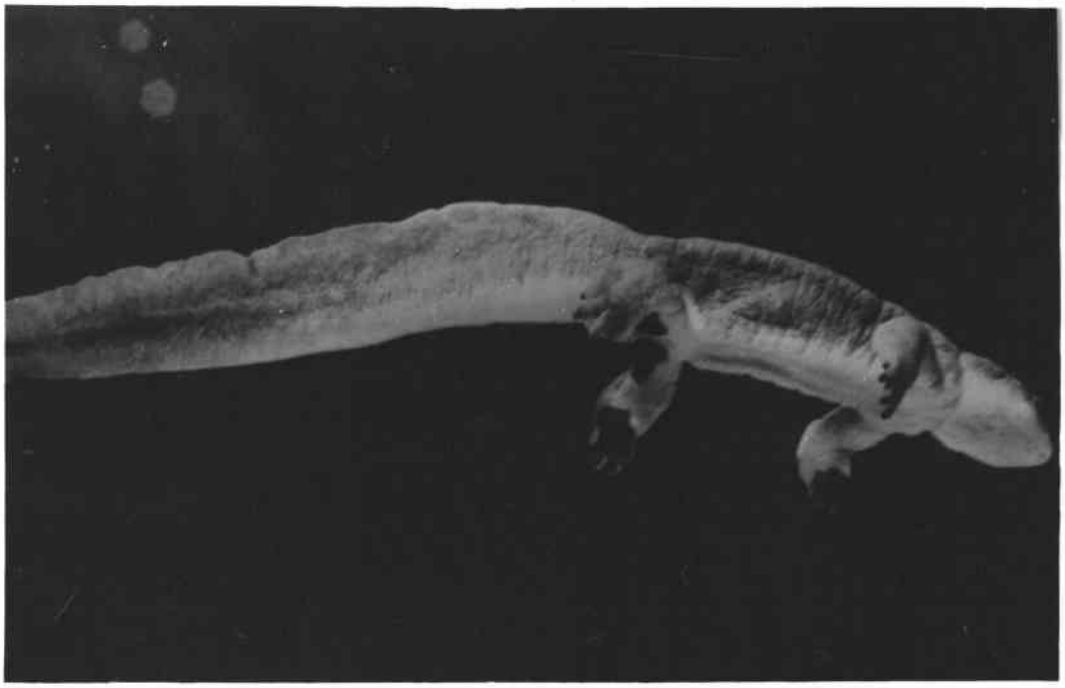


Fig. 1. Triturus granulosus granulosus, adult male in aquatic breeding phase. x2/3

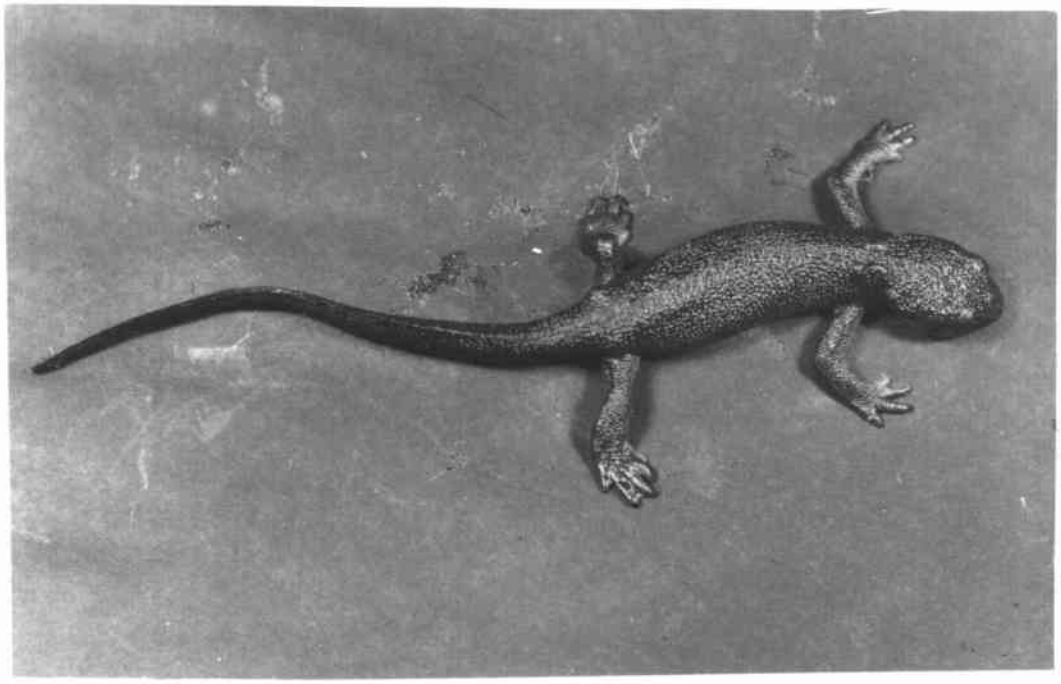


Fig. 2. Triturus granulosus granulosus, adult in terrestrial non-breeding phase. x1

Plate II

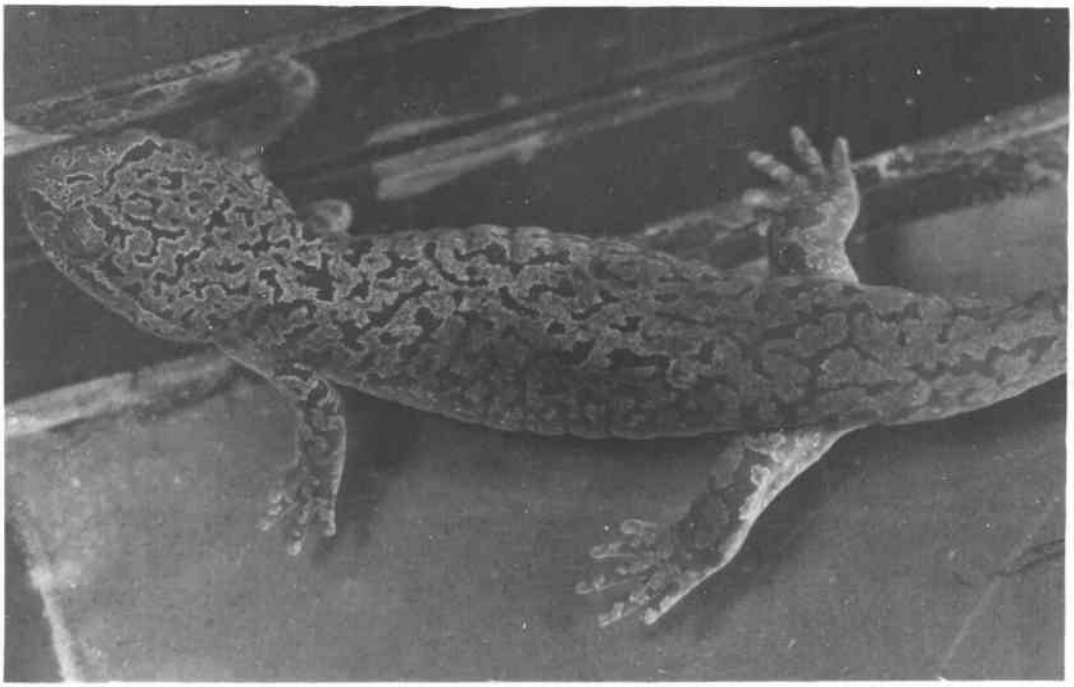


Fig. 3. Dicamptodon ensatus, showing marbled dorsal pattern. x1

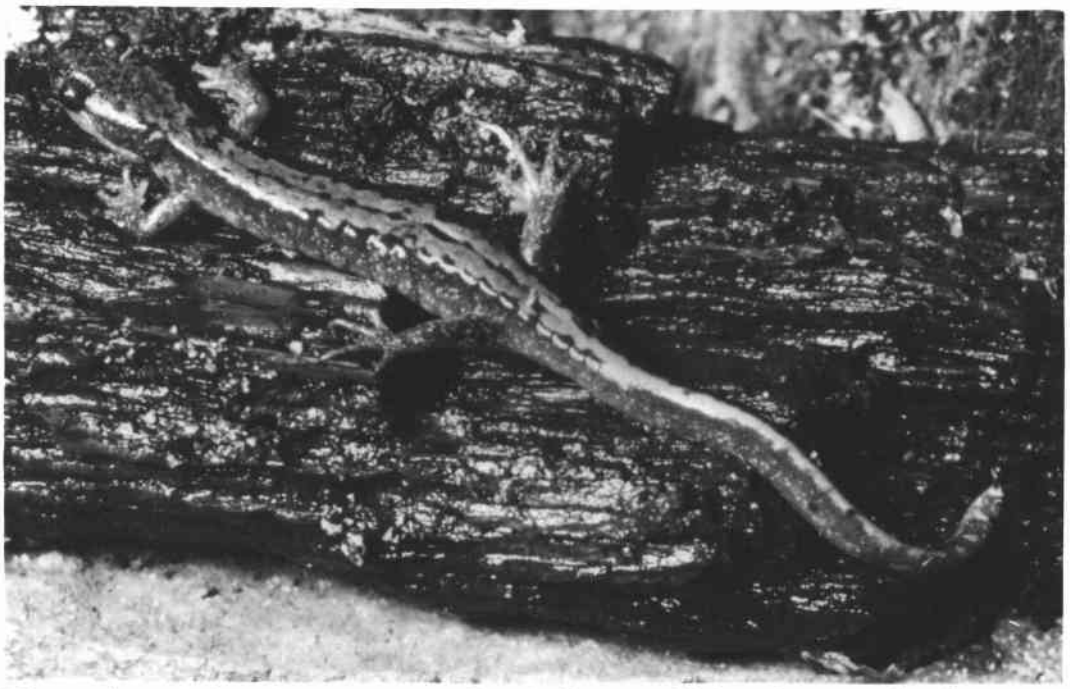


Fig. 4. Ambystoma macrodactylum. Note irregularly-edged dorsal band and long slender toes. x1¼

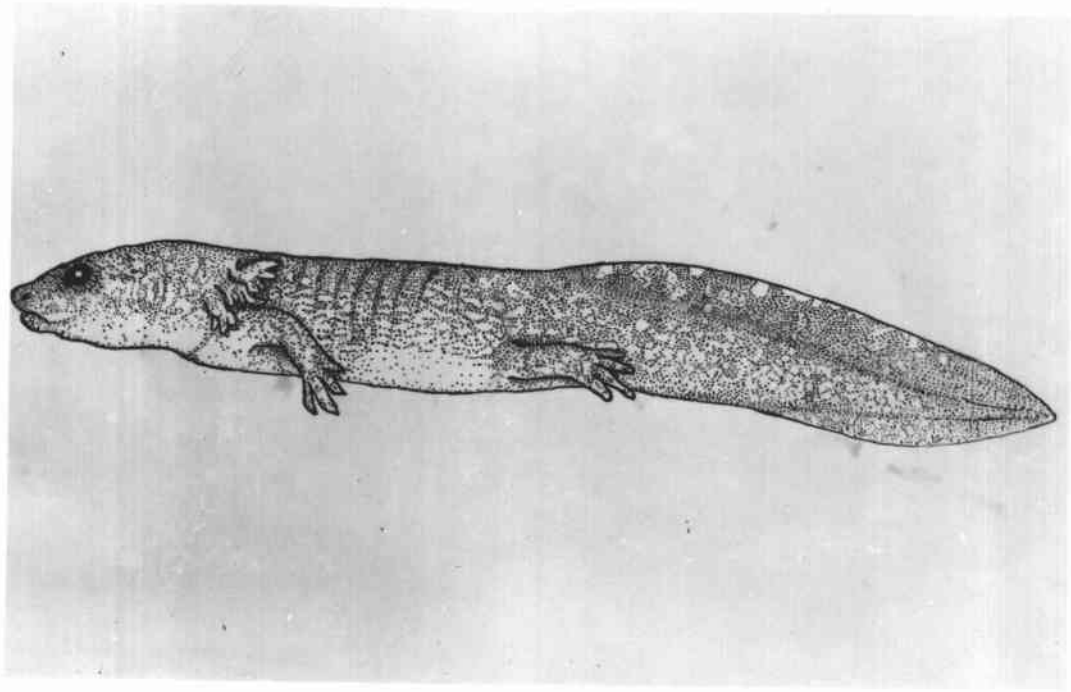


Fig. 5. Larva of Dicamptodon ensatus. x3

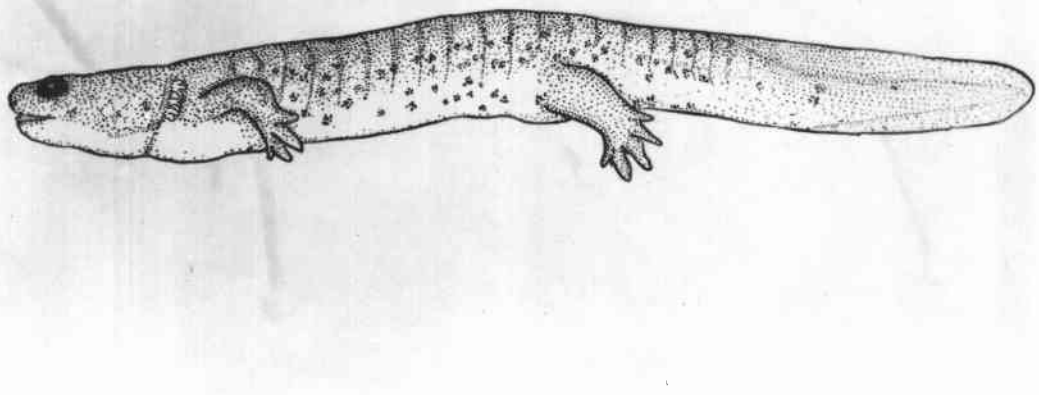


Fig. 6. Larva of Rhyacotriton olympicus. x3

Plate IV

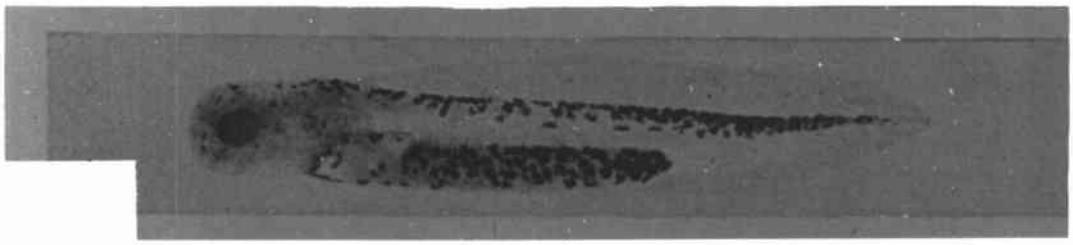


Fig. 7. Recently hatched larva of Triturus g. granulosus. x7½. Photographed from Twitty (55, p. 72)

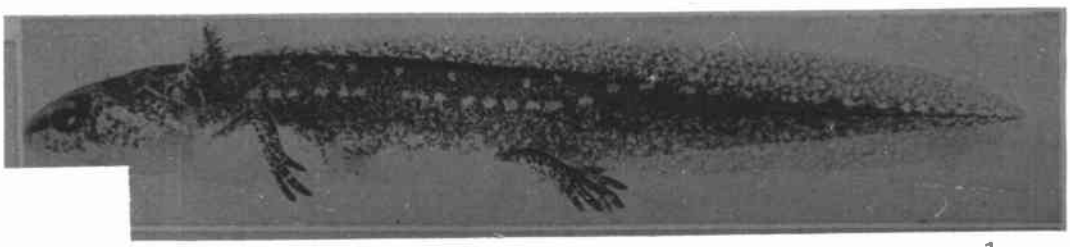


Fig. 8. Older larva of Triturus g. granulosus. x2½. Photographed from Twitty. (55, p. 72)

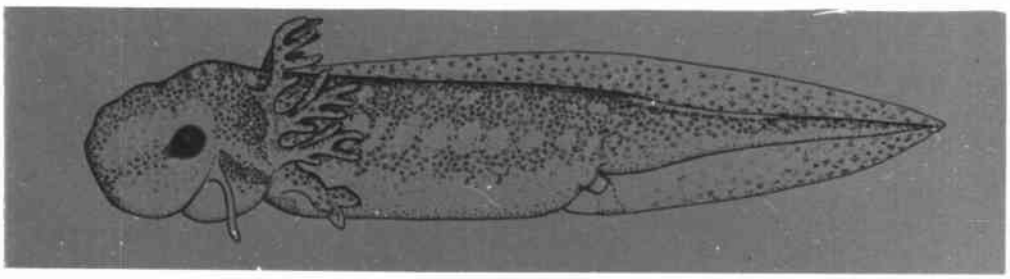


Fig. 9. Recently hatched larva of Ambystoma gracile. x7. Drawn from life by Mr. Charles Cutress.

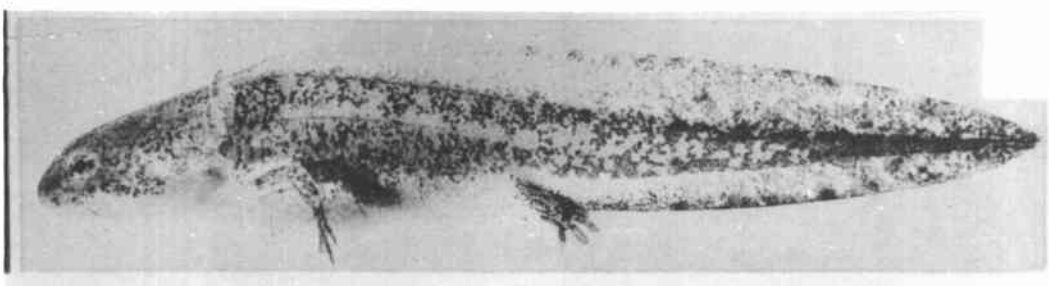


Fig. 10. Older larva of Ambystoma gracile. x2½. Photographed from Henry and Twitty. (21, p. 248)

Plate V

Fig. 11. Plethodon dunni. Note faint mottling to edge of dorsal stripe, and ending of dorsal stripe proximal to tail-tip. x1-1/3

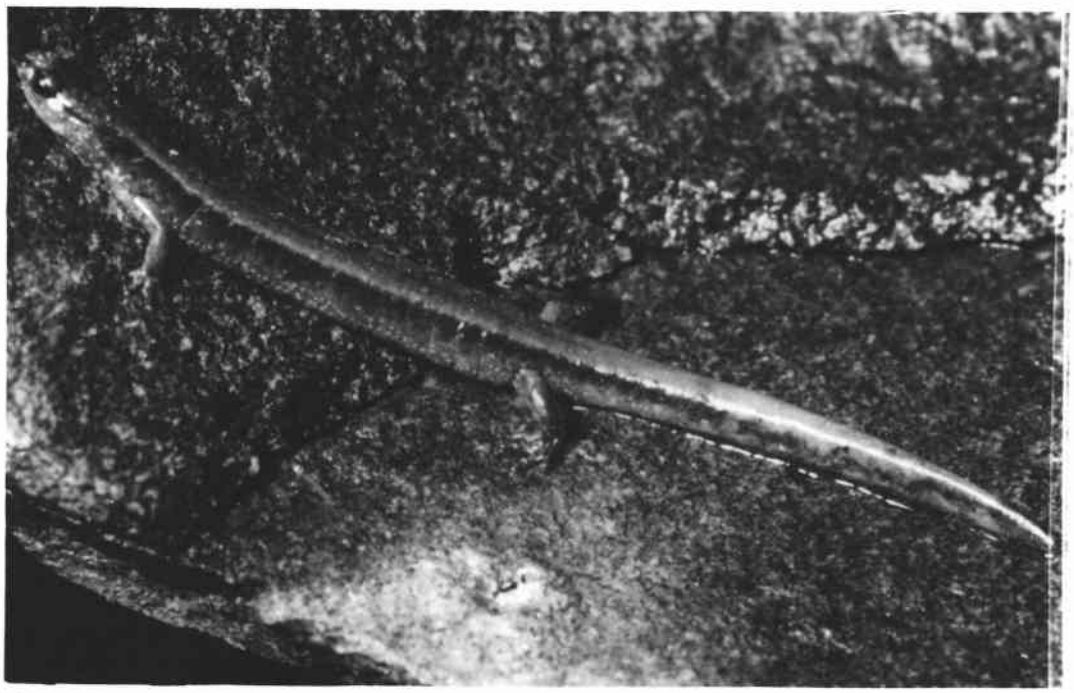


Fig. 12. Plethodon vehiculum. Note solid dark area adjacent to dorsal stripe, and dorsal stripe running to tail-tip. x2.

Plate VI

Fig. 13. Ascaphus truei, male. x2

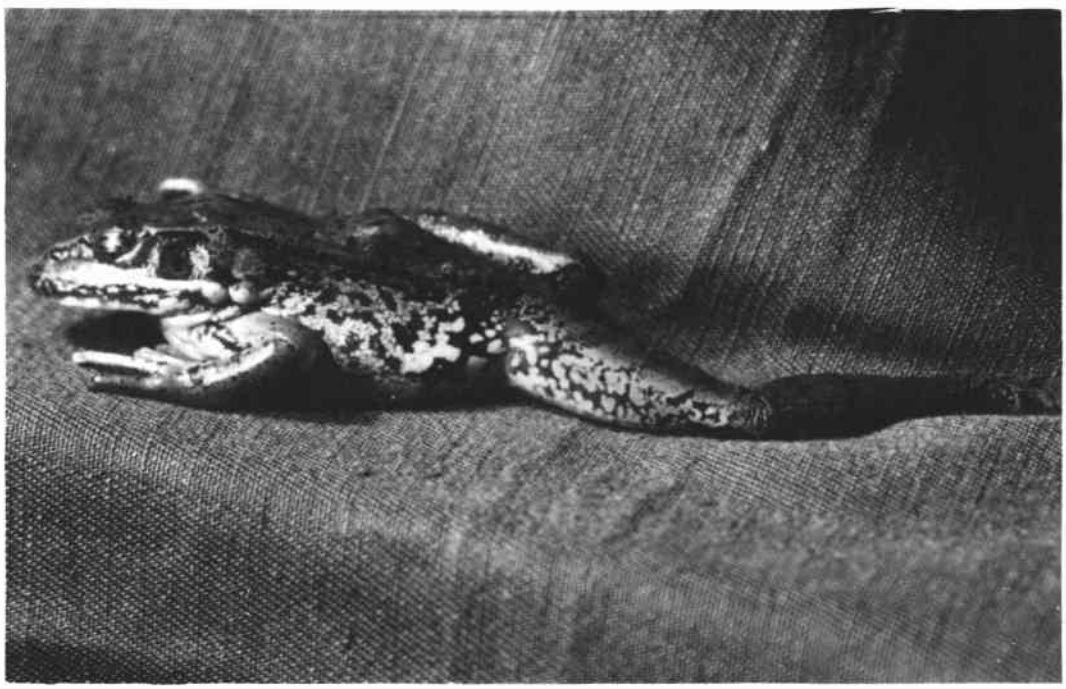


Fig. 14. Rana a. aurora. Note dark line on canthus rostralis, vitta, and dorsolateral fold; light upper lip; mottled groin. xl

Plate VII

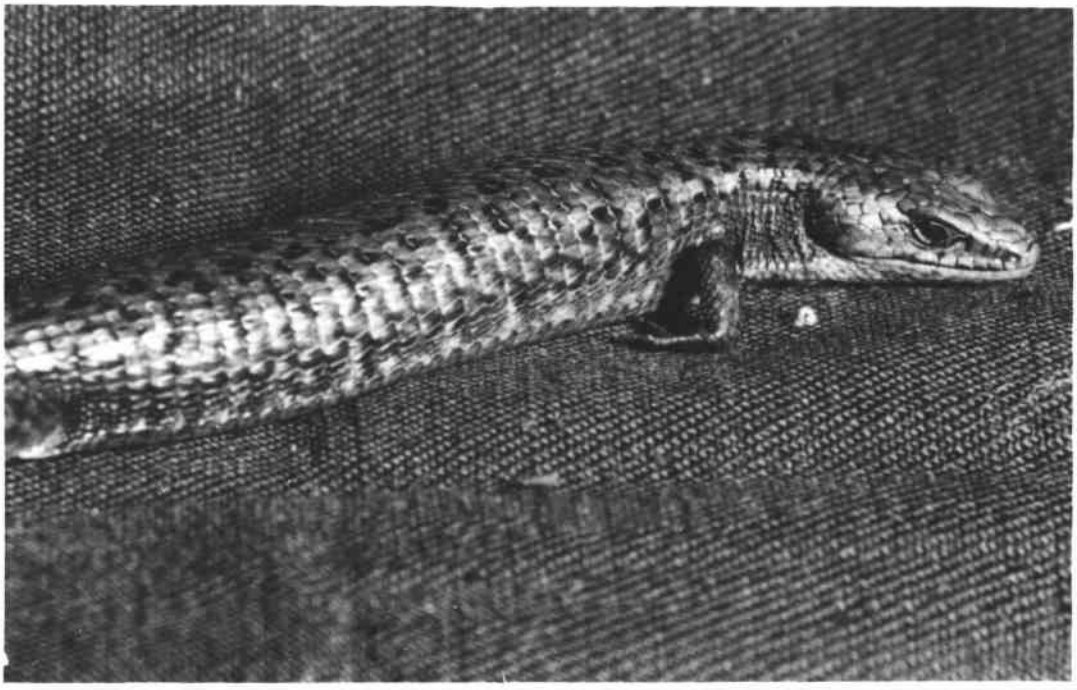


Fig. 15. Gerrhonotus coeruleus principis. Note dark spots on back, no white-tipped lateral scales. x1½

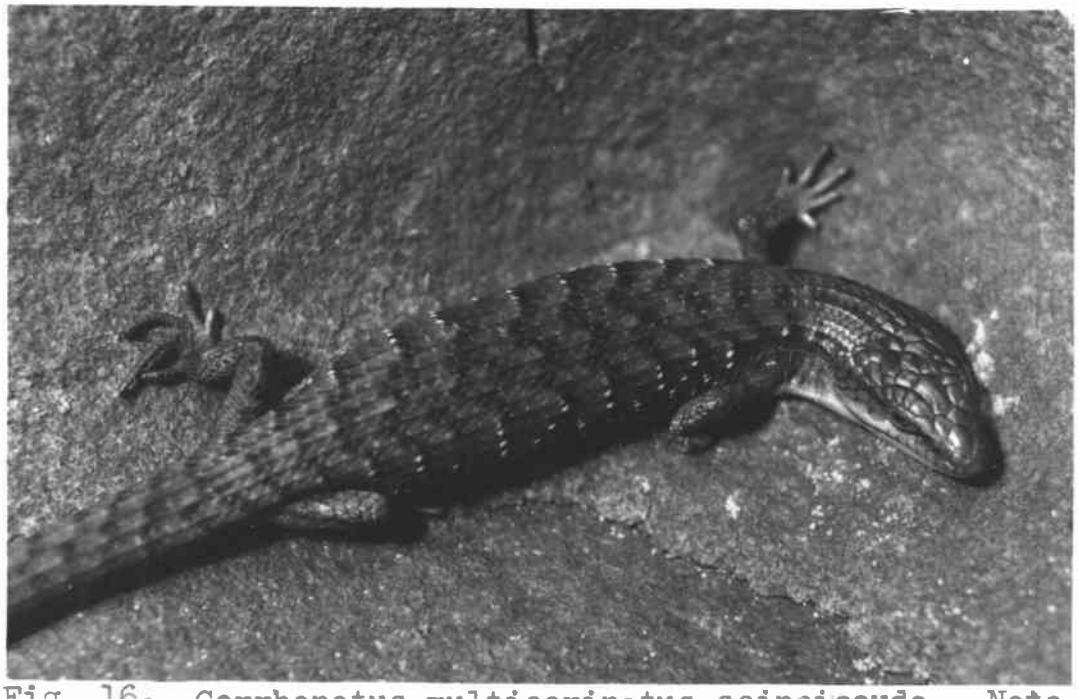


Fig. 16. Gerrhonotus multicarinatus scincicauda. Note dark dorsal bands, white-tipped lateral scales. x1

Plate VIII

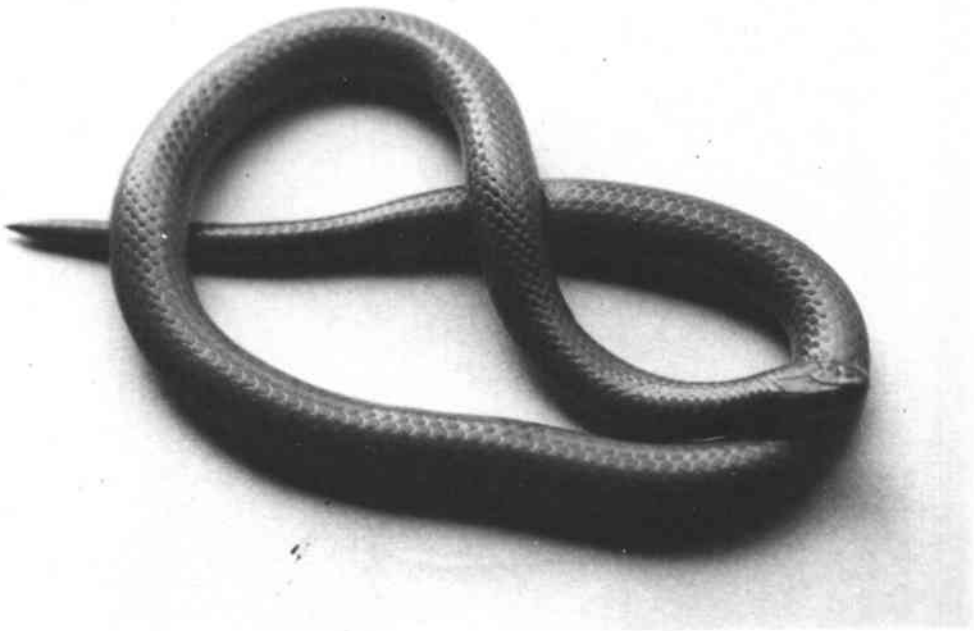


Fig. 17. Contia tenuis, dorsal view. xl-1/3

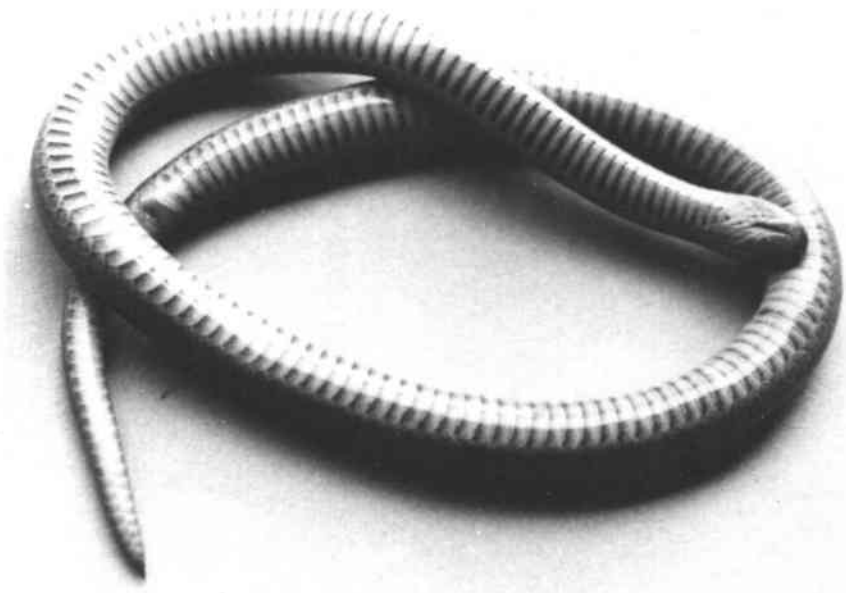


Fig. 18. Contia tenuis, ventral view. Note sharp tail-tip, dark and light ventral bands. xl-1/3

Plate IX

Fig. 19. Looking southeastward across Willamette Valley. Note isolated hill, trees along stream courses.

Fig. 20. Looking across Willamette Valley to distant Cascades. Note very flat nature of valley floor.

Plate X

Fig. 21. Marsh at Bruce Station. Rana catesbeiana and Clemmys occur here.

Fig. 22. Breeding pond, one mile west of Corvallis. Utilized by Triturus, Ambystoma macrodactylum, Hyla, Rana aurora.

Plate XI

Fig. 23. Old sawmill area near Bald Hill, 3 miles west of Corvallis. Scattered debris shelters such forms as Ambystoma macrodactylum, G. multicarinatus, Coluber.

Fig. 24. Coffin Butte, an isolated hill, 10 miles north of Corvallis. Note bare slope and oak to the right (south slope), fir to the north.

Plate XII

Fig. 25. Oak-covered foothills, west of Corvallis; typical of eastern foothills throughout Benton County.

Fig. 26. Foothill area northwest of Corvallis. Preferred habitat of Pituophis, Coluber.

Plate XIII

Fig. 27. Brushy pasture area, north of Bellfountain. Ensatina, G. multicarinatus, Coluber, Pituophis occur here; Contia near firs in background.

Fig. 28. Area near Well's Creek, 7 miles southwest of Philomath. Aneides, Sceloporus, both Thamnophis species occur here. Note stream vegetation in background.

Plate XIV

Fig. 29. Bull Run Creek area, 3½ miles south of Philomath. Aneides, Contia, Sceloporus found in these stumps.

Fig. 30. Bull Run Creek. Note riparian growth. Taricha, Charina, Coluber, Pituophis, Contia, both Thamnophis species found in stumps or under objects on ground near this stream.

Plate XV

Fig. 31. Area on Pioneer Butte Road, 3 miles west of Philomath. Favored habitat of Aneides, Sceloporus.

Fig. 32. Area on Pioneer Butte Road. Fire-charred fir logs very frequently utilized by Aneides. Ensatina occurs on wooded slopes here.

Plate XVI

Fig. 33. Rock outcrop and old logging road in Well's Creek area. Small stream flows through debris at right. Plethodon dunni and P. vehiculum common here.

Fig. 34. Well's Creek, flowing through old second-growth fir. Dicamptodon in and along this stream; Plethodon and Rana aurora adjacent to it.

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