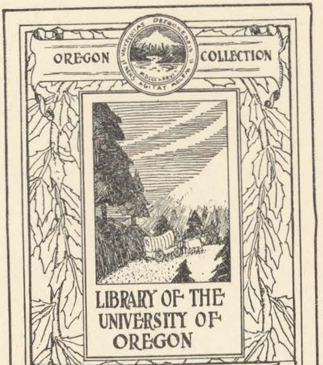
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A PRELIMINARY ECOLOGICAL SURVEY OF A TEMPORARY POND IN A DOUGLAS FIR FOREST ASSOCIATION WITH EMPHASIS ON THE FOOD AND FEEDING HABITS OF THE OREGON NEWT, TRITURUS GRANULOSUS GRANULOSUS

by

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A THESIS

Presented to the Department of Biology
and the Graduate School of the University of Oregon
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of the requirements for the degree of
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APPROVED:

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(Adviser for the Thesis)

(For the Committee)

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ACKNOWLEDGEMENT

I am greatly indebted to Mr. A. S. Lockley for his most considerate and sincere aid throughout the work necessary for the completion of this problem.

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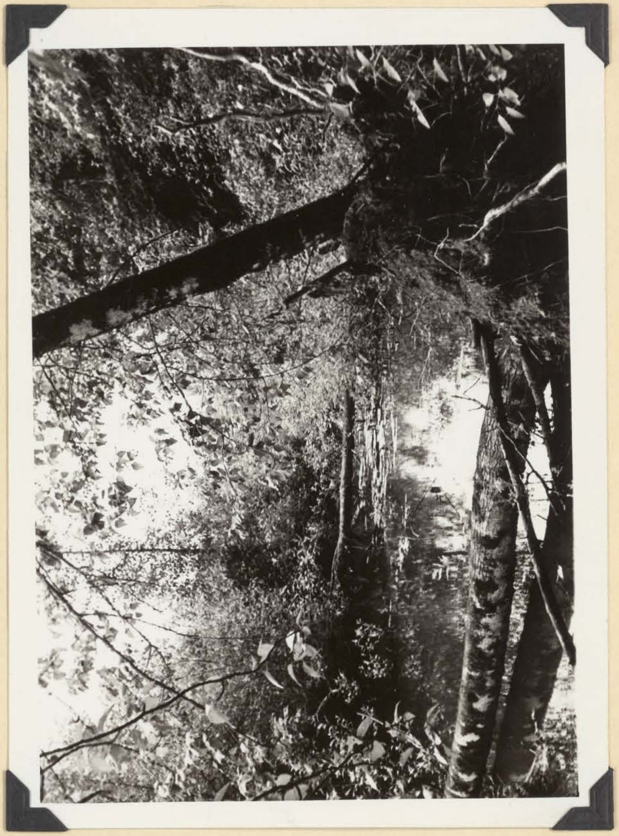


CHAPTER I

INTRODUCTION

This work has been done as a preliminary ecological survey of an aquatic habitat in a Douglas fir forest association. Since this is a preliminary study it is not expected to be complete in all details affecting the associations within a community. Little work of this type has been conducted previously, and much more work should be done along these lines in order to have a more complete understanding of the ecology of this, or a similar area. Perhaps this work will be of less value in itself than the assistance it may afford others who are beginning similar undertakings.

The area chosen for this work appears to be typical of the temporary fresh-water habitat in association with the forest. The area is relatively unaffected by human influences, although it is readily ascessible by road and railroad. It is seldom visited by humans or domestic animals, and there is no evidence present that the pond has been disturbed recently. There are areas resembling this one throughout the Willamette Valley, and it is believed that this area will prove typical of the others.

In this work an attempt has been made to point out many of the physical factors which have an influence on, or directly affect the community, e.g., the size of the pond, the location, depth, etc. A descriptive account will be given of the flora and fauna, and an attempt has been made to present the interrelations between the organisms and their environment.

It would be impossible to do a complete survey on every species of animal in the area, in a relatively short space of time, and hence, one has been chosen upon which, to my knowledge, limited work of this type has been conducted. The animal chosen for this work is the Oregon newt, Triturus granulosus granulosus. This animal is relatively abundant in other areas and is prevalent throughout this region, i.e., Pacific Northwest, west of the Cascade Range. (Bishop, 1947) Therefore this animal does play an important role in the community and a more detailed study of its life and habits seems desirable. It is hoped that this study does not appear unbalanced, since so much emphasis has been placed on this one form, therefore leading to the neglect of other organisms. Elton (1947) suggested that in an ecological study one form in particular should be carefully studied; that suggestion has been followed.

CHAPTER II

PHYSICAL CHARACTERISTICS

The area selected for this research problem is located approximately ten miles northeast of Eugene, in Lane County, Oregon.

The area is bounded by a heavily wooded hill on the western side, the eastern part is bounded by a railroad embankment. The north and south boundaries of the pond are distinguished mainly by the trees and shrubs which grow in abundance at both ends.

This work has been done in a lotic habitat, which will be termed a pond. Although there is some disagreement as to the difference between a lake and a pond, a pond appears to be distinguished from a lake mainly by its area and depth. (Welch, 1935)

The pond in question has a rather dubious parentage, since the general succession is from lake to pond, from pond to swamp, and from swamp to dry land, (Welch, 1935). This pond has not descended from a lake in recent history, and its succession will prove to be more of the following type, although this is uncertain. The pond was probably initially a pond, formed from both natural and artificial causes, and with the usual succession from bare bottom and a minimal biota to the bottom covered with vegetation and an increasing biota, then the swamp and finally dry land again.

This pond from all appearances, seems to be comparatively young. This is apparent from several view points. The flora is not one of an old aquatic community since there are few higher aquatic plants, even of the kind one would expect in a transition from swamp to dry land. The trees which are growing in the pond do not appear to be dying as yet.

The western boundary of the pond has a definite line of demarcation between the land and the water. The margin being steep since the hill runs to the waters edge. The eastern shore also has a sharp line of demarcation, due to unknown causes. The margins at both the north and south ends are very indistinct however, and at the northern end there is a natural spill-way which aids in keeping the water level constant in-so-far as a high water mark is concerned.

From the above descriptions and the photographs of the area, it can be seen that the area is in a sheltered position. The westerly winds are greatly attenuated by the vegetation and the hill. The air temperature above the water is usually considerably warmer than in a less protected position.

The temperature of the pond would be expected to follow that of the atmosphere rather closely, since the comparatively small depth would heat rapidly. However, there is a diminutive thermal stratification. The surface layer of water is usually considerably warmer than that of the bottom. This could be expected, however, since the days are warm, but the nights cool.

Since this pond does have a relatively small area, there is very little water movement. This is due in part from its sheltered position, with few winds, and no noticeable currents. The algae mats and other flora at the surface further impede the wind and aid in keeping the water movement at a minimum, even when there is a strong breeze.

The bottom of the pond is deeply covered with an accumulation of debris. The allochthanous organic materials from the surrounding area appear to decompose at a slower rate than they are added, and the pond is decreasing in depth at a fairly rapid rate. The autochthonous materials are relatively unimportant as compared with the allochthonous materials, although the material from the first source is present. The addition of silt, clay, and similar materials from the surrounding area adds greatly to the material deposited on the bottom.

The bottom of the pond is also covered with a great many peeled sticks which have been brought there by beaver, and there are numerous stumps and twigs protruding through the surface of the water.

It is not believed that this pond is permanent, since it does have a rather shallow depth, and there is no apparant source of water other than the run-off from the surrounding country-side and the direct source of rain. Although it is not definite as yet, it seems that a small amount of water may remain during the dry summer months in the deeper areas, but not sufficient amounts to warrant the classification of a permanent pond.

The general size and shape of the pond can be seen from the photographs. The dimensions of the pond along with the depth of the different parts are given in the chart on page nine.

The water in the pond has been consistently saturated with suspended material, and the clarity of the water has been classified according to the methods suggested by Davis (1938). The color of the water is "light brown", and the turbidity is "murky". The meaning of the term murky has been interpreted as a condition in which the turbidity is such that the bottom of the pond is indistinct at from one to four feet.

The pH of the pond ranged between 6.4 to 7.5. Since it is realized that pH alone is rarely a limiting factor, it will not be considered further.

CHAPTER III

METHODS

Before any work on the ecology of the pond could commence it was first necessary to select a number of collecting stations in the pond. The purpose of these stations is to insure the examination of representative areas in the pond, and thereby obtain information in an orderly fashion, rather than in a haphazard fashion which would be the case in an unorganized survey.

First a rough sketch was made of the pond, and collection stations were selected to insure a well balanced survey of the area. The following drawing outlines the collecting stations.

Station one:

An area with the depth ranging from one inch near the bank to twenty-four inches near the outer edge. It is thickly grown up in shrubs with a small area of algae mats. This area is covered by sunshine during most of the day.

Station two:

This station was selected to give an indication of the life in the deeper portion of the pond which ranged

PLATE II

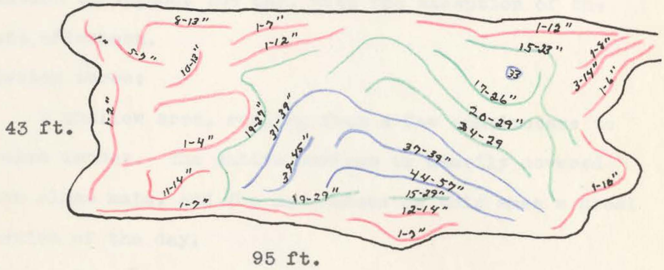


Figure 1. Topography of the pond
Contours in red - depth below 15 inches
Contours in green - depth from 15-29 inches
Contours in blue - depth greater than 30 inches

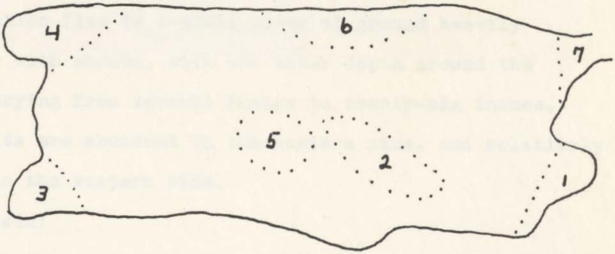


Figure 2. Location of collecting stations.

from thirty-two to fifty-seven inches. The surface was not covered with any plant growth. The sun shines on this station throughout the day, with the exception of the late afternoon.

Station three:

A shallow area, ranging from a few centimeters to twelve inches. The entire surface is heavily covered with algae mats, and the sun shines on this area a great portion of the day.

Station four:

The fourth area is also shallow, ranging from a few centimeters to ten inches. This area is shaded constantly, and there are no algae mats.

Station five:

Station five is a small piece of ground heavily grown up with shrubs, with the water depth around the edges varying from several inches to twenty-six inches. Algae mats are abundant on the eastern size, and relatively scarce on the western side.

Station six:

This is a station which varies in depth from four to twenty-three inches. The area is shaded except in the early morning.

Station seven:

The seventh station is similar to station three in that it is shallow and covered with algae mats, but the sun does not cover this area as much as it does station three.

In general the stations could be grouped into about three areas in regard to the findings. Stations one, three, and seven were similar in their faunal and floral characteristics, whereas four and six were similar. The other major area would include the outer edges of five and all of station two.

One of the most satisfactory methods found to determine the food and feeding habits of cold-blooded vertebrates is that of stomach analysis. This has proven to be an efficient method to determine the various foods the animal consumes (Lagler, 1950). This method also aids in showing the ecological relationships between organisms in such a manner that one may make a number of deductions concerning the community from the results of such an analysis. In this study it was not practical to attempt to work out in detail the feeding habits of each organism in the community. A vertebrate animal which is typical of such an area and one upon which very limited work has been done regarding the role it plays in the metabolism of this type of community was chosen. This animal, Triturus granulosus granulosus, has proven to be an important member of the community since it is relatively abundant and is of such a size as to constitute an important unit in the community metabolism.

Since Triturus g. granulosus is a comparatively large animal the method of using a stomach analysis as an index of the food it preys upon was satisfactory. From the findings of the stomach analysis, a partial basis for determining its status among various predatory or competing forms has been found. The work on the newt was done on the adult forms in all instances.

There are various methods by which a stomach analysis may be performed, differing mainly in the way the organisms in the stomach are measured. W. L. McAtee (1912) gives a number of methods for measuring the stomach contents of birds. The method of measuring the contents merely by numerical counts is not satisfactory. This method is objectionable because if one reading the report is not familiar with all the forms included there is no conception of the size of the food, and therefore the main items in the diet. Also in this method there is no standard scheme by which only parts of animals and plant foods are counted. Size can receive proper recognition only under the percentage-by-bulk system. All systems having to do with numerical counts alone are not adequate because they are not sufficiently comprehensive.

Another method is to separate the food into different components made up of various species, and then to weigh each unit on a percentage basis. This would be a satisfactory method, but the problem of size still remains.

The procedure followed in the present work is used by most authorities for the measurement of stomach contents. The stomach of the Triturus g. granulosus was first examined intact and a note taken of the relative fullness, which was later used as an aid in determining if the feeding was cyclic. The relative fullness was impossible to determine exactly due to the variance in the size of the animals, the biological variations in the stomach capacity and other factors. An effort was made to approximate the relative fullness by taking the male with the greatest stomach contents and saying it was 100 per cent full, and then classifying the others accordingly, and then duplicating the procedure on the females of the species.

The stomach contents were usually examined immediately after the collection of the animals, but if that was not practical at the time, the newts were preserved in 7 per cent formaldehyde. All of the specimens were either examined or preserved in less than one and one-half hours after collection.

The stomach was removed and the contents emptied. The organisms which had been ingested were separated into component piles of separate species, and the individual units were measured separately by the volumetric method. Although mathematical exactness was not attainable in these measurements, every possible means was taken to reduce the error to a minimum.

The contents of the stomach cannot be used to determine the preference of food unless quantitative methods are used (Hess and Rainwater, 1939). Although it is not definite, some idea of the preference will be given later, not from exact biological data, but mainly from observations and assumptions.

The collection of specimens for an examination of the stomach contents presented somewhat of a problem due to the limited numbers. It would have been desirable to collect ten specimens every hour for a twenty-four hour period and to repeat this periodically over a long period. However, due to the limited numbers in this case, the above method was impossible.

It would have been possible to collect one newt every hour for twenty-four hours. Then repeat this once or twice in order to obtain a representative section. This method would be impractical since only one specimen is taken each hour, and that one specimen might not be representative of that period.

The method used was as follows: a collection was made of ten specimens at 9:00 A.M. one week, the following week a collection of ten more newts was taken at 3:30 P.M., and one further collection was made the following week at 11:30 P.M. During and following the three week period single newts were taken throughout the day, but no important differences were noted. Approximately three months after the last major collection five specimens were taken during each of the three periods mentioned above. The only difference being a lapse of two days between collections instead of one week.

The identification of organisms in the pond was carried out through the use of keys. Collections were made by means of plankton nets, bottom scrapers, and seines. The last did not prove useable since the bottom of the pond is dotted with stumps and sticks, and the sweep of the seine could seldom be completed.

At the time of collections, notes were made of the water temperature, air temperature, and the general climatic condition of the day.

CHAPTER IV

PLANT LIFE IN THE POND

The following list of plants were found to be present in the pond and the individual organisms were classified to order or genus. It would have been possible to classify most of them to species, but this seemed unnecessary since the emphasis of this paper is directed toward the feeding habits of the newt, Triturus g. granulosus. It seems likely that numerous species of plants must occur in different areas which are inhabited by the newt; the addition of species names would add little to an understanding of their metabolism.

The pond is very limited in higher aquatic plants. This may be due in part to the fact that the pond is temporary, but there is also a lack of those which one would expect to find even in a temporary pond, e.g. duckweed. The only major higher plants in the community are trees, which have sent up numerous sprouts throughout the pond. The major aquatic plants are the algae, which are abundant.

The importance of these aquatic plants cannot be over-emphasized. They are the basic food producers and it is evident that life in this pond could not continue if they were not present.

It is realized that the list of plants in the community is not complete, but every endeavor has been made to list those which play the most important roles. The organisms which have been named were sufficiently abundant to be an important item in the food supply of the community.

The list is not intended to show the relative importance of the different groups, but merely to indicate the floral life which was present.

Bacteria have not been included in this work, but it has been assumed that the bacteria usually found in similar habitats are also present in this area.

Algae

Chlorophyceae	Desmidiaceae	Bacillariaceae
Ulothrix	Cosmarium	Frustulia
Zygnema	Staurastrum	Melosira
Spirogyra	Titmemous	
Botryoccoccus	Ctosteium	
Richteriella		
Drapranaldia		

The other plants which have been found in the area have less affect on the metabolic activities of the community than these basic ones which have been listed above. The trees which are growing around the margin are listed below. These higher plants are important in the ecology of this area since they contribute certain food materials to the community such as leaves and branches which are decomposed by bacteria. In addition to the parts of the trees which serve as food for the members of the community, the trees also have a characteristic fauna and often insects and other organisms will fall into the pond and become food for its inhabitants. The following is a list of the trees in and around the pond.

Douglas Fir - - - - - - - - Pseudotsuga taxifolia
Maple - - - - - - - - - - - Acer
Willow - - - - - - - - - - Salix
Alder - - - - - - - - - - - Alnus
Spiraea - - - - - - - - - - Spiraea

There are numerous grasses and weeds on the bank around the pond. Their inhabitants undoubtedly add to the food resources of the pond in many instances.

CHAPTER V

ANIMAL LIFE IN THE POND

A more detailed description of the animals in the pond will be given than was afforded the plants. Since almost every animal in the pond which can be eaten by the newt is used as a source of food, this list will apply more directly to the newts than the previous list of plants. The animals which are not preyed upon by Triturus g. granulosus are usually those which are too large to consume or too fast to capture. They in turn may prey upon the same food that the newt uses, and are therefore important in a consideration of the ecology of Triturus g. granulosus.

As was the case with the plants, there are undoubtedly numerous animals in the community which have escaped detection. It is believed that those listed below are the major inhabitants, and contribute most importantly to the understanding of the feeding habits of the newt. Most of the animals listed below have been classified as far down as genera, and in all cases the animals listed below have been placed under major headings.

Protozoa

Amoeba
Arcella
Difflugia
Actinophrys
Stylobryon
Phytomastigida
Euglena
Chrysopyxis
Pleodorina
Volvox
Peridinum
Ctedoctema
Stentor
Eschaneustyla
Vorticella

Amphibia

T. granulosus granulosus
Rana catesbeiana
Hyla regilla
Rana aurora aurora

Rotifera

Philodina
Diglena
Salpina
Pterodina

Hyaracarina

Hydrachnid

Tardigrada

Nematoda

Filaria

Crustaceae

Cyclops
Daphnia
Cypris
Asellus

Reptila

Thamnophis sirtalis s.s.p.
Clemmys marmorata

Insecta

(larvae and adults)

Diptera

Pedicia
Eriocea
Limnophila
Ptychaptera
Dixa
Ceratopogon
Chrysops
Strateomyia

Trichoptera

Phryganea

Hemiptera

Corixa
Buenoa
Lethocerus
Benacus
Dineutes

Odonata

Comphus
Tetragoneuria
Macromia

Coleoptera

Hydroporus
Thermonectes
Hydious

Ephemerida

Thraulus
Sipholourus

An interesting point concerning the insect larvae is that the only class which is represented by large numbers, as well as by great diversity, is the Diptera. There are members of other classes present, but due to some factor, or group of factors, which are unknown at this time, the presence of other larvae is relatively limited. It was to be expected that the Diptera would outnumber the others but the difference was much greater than anticipated.

A main group of animals which was missing completely from this community, and which are usually well represented in an aquatic habitat are the mollusca. No specimens were found in the community. Although in the analysis of a frog's stomach a terrestrial snail was found.

CHAPTER VI

HABITATS WITHIN THE COMMUNITY

This section will be devoted to a consideration of a few of the most important habitats within the community. Although the information is not complete, the observations made will indicate a few of the aspects which must be further investigated in order to attain a better knowledge of the interrelationships in this type of community.

One of the most obvious, and certainly an important habitat, is that of the algae mats. These large masses of algae which float on the surface and those which are submerged, have a characteristic, dependent fauna. One of the important characteristics of this habitat is the protection which it offers. This miniature jungle is filled with hordes of small animals. The comparatively large insect larvae which crawl and swim through the filaments, the smaller protozoans which swim about, and the others which are attached to the strands of algae, the hydrachnids, the small crustaceans, the frogs which rest on the surface, and the newts which hide from their enemies and search for food in this jungle are all included, or form a part of this habitation. To these animals the algae mats afford protection from their enemies.

Then, conversely, there are those predators which go into this mass of vegetation in search of food. The algae itself furnishes food to many forms directly, and to other forms indirectly. Many small organisms which feed directly upon algae would be expected to be present in this habitat, and since those forms are present, one would also expect to find predators there to prey upon the algae-eating forms. In the algae mats there are great numbers of diatoms and desmids, which furnish food for many of the smaller animals. Thus, in the algae mats one finds animals seeking protection and animals seeking food.

The bottom of the pond, with its specialized fauna, is a habitat within a habitat. Here are found the animals which act in the manner of scavengers, such as Asellus, and the bacteria which resynthesize the dead material. Here also numerous insect larvae and protozoans occur. This type of habitat also affords protection and food for the various species adapted to such an existence.

A case of specific parasitism will be inserted here under the title of habitat, since there is no section in this report on parasitism.

The case of parasitism which will be mentioned has to do with Triturus g. granulosus. On May 3, 1950, several specimens of the newt were captured, and upon close observation each was found to be infected with one leech of the family Glossiphonidae, in the mouth cavity. This prompted further investigation, and it was found that approximately 90 per cent of the newts were infected with one or more leeches in the mouth cavity. The usual number of parasites per animal was one, but multiple infections were noted in several cases, and one newt was infected with forty-four leeches, all in the mouth cavity. This appears to be a case of temporary parasitism, since no specimens captured previous to May 3, 1950, were infected, and after June 9, 1950, no further instances of this case of parasitism were observed.

In the section on methods, the different collecting stations were mentioned, and this section on habitats will be enlarged so as to include a discussion of the general findings in the different stations.

In station one, two large frogs of the species Rana catesbeiana were taken, along with one smaller Oregon red-legged frog, Rana aurora. This appeared to be a good habitat for the frogs since there is an abundance of shrubs which afford protection, along with the algae mats present in this area. There were numerous larvae and adult insects found here, forming an adequate food supply for frogs. This station was similar to three and seven, in that they all have many species in common. There was a great abundance of aquatic life in all three areas, due to the presence of the algae mats.

Stations two and five were the areas of greatest depth, and here the swarms of copepods and daphnia were found to be most prevalent. The daphnia were here mainly due to the colder water at the greatest depth; the copepods seemed to stay in the open mainly because of their phototropic nature, although they were occasionally found in other areas. Stations two and five, it may be recalled, have the most sunlight which appears to attract them. In this area also, when the copepods and daphnia "blooms" occurred, there could be found the majority of newts, likely attracted to the great food supply from these crustaceans.

Stations four and six are the ones on the west side, next to the hill where they are in shade most of the day. There is little aquatic vegetation in this area, and hence the number of animals in these two areas are considerably less than in the more lighted areas. Most of the specimens found in other areas were also found here but in fewer numbers.

CHAPTER VII

METABOLISM

It is obvious that food is one of the major limiting factors of a community in that it governs the size, complexity, and density of the flora and fauna. It is not possible, as yet, to make a complete analysis of the food of a community, and this will remain impossible until the complete metabolic processes are known for every species constituting a part of a community. One of the purposes of this research is to make available the information gathered as a contribution to the general knowledge of the metabolism of a community. Since the metabolic processes of a community are of such importance in an ecological study this report has attempted to emphasize that phase.

In order to present a balanced study of the food and feeding habits of a community it is first necessary to consider all of the related factors which have a direct bearing upon the community, such as light, exposure, etc. Since these factors have been treated previously it will be unnecessary to present them again at this time.

The next step in examining the metabolism of a community is to have as complete an index of the population as is possible. The various forms constituting the population of this community have been listed in a previous section.

Table number one shows the date and time the specimens were taken, the number collected, sex, length, weight, relative fullness, amount of food displacement, and temperature of the water. From this table a number of factors concerning the habits of the salamander have been taken, and the following diagrams were constructed from the information presented in this table.

Plate number three shows three diagrams, based upon percentage, of the stomach contents of Triturus g. granulosus during the three periods in which the specimens were collected. In these diagrams, and the others, wherever "miscellaneous" is used it represents the digested and/or unidentifiable remains in the stomach, or those animals which would not constitute a measurable amount. These diagrams also show that a greater variety in the diet occurred during the afternoon and evening, while the morning food consisted almost entirely of eggs. The greatest variety in diet took place in the afternoon when the percentage was not greatly overbalanced by any one item.

Plate number four, figure one, shows the amount of food qualitatively consumed during a twenty-four hour period. The eggs which were consumed by the salamander in the morning collection greatly overbalanced the food eaten during the remainder of the period. This diagram may not be accurate as far as nutritive material is concerned, since the capsule around the eggs is probably not used as food. The diagram does; however, give a true account of the diet of a typical newt during a twenty-four hour period. Although the percentages may not be exact, due to the low number of specimens, it is as accurate as conditions permitted.

Plate number four, figure two, shows the amount of food eaten quantitatively during the twenty-four hour period. Again the eggs prove to be a major component. The greatest amount of food was consumed in the morning, then the afternoon and evening respectively.

Although it is not definite, Triturus g. granulosus appears to be entirely carnivorous. Small amounts of algae found were probably ingested accidentally. The amphibian eggs which play such an important role in their diet always appear to be covered with algae, and therefore much of the algae is ingested along with the egg. Frequently small pieces of bark and other plant material have been found in their stomachs, but it seems unlikely that any nutrition is derived from this material. An examination of the feces indicated that the digestive juices did not affect the plant

TABLE 1

Date Collected	Temperature Air	Water	Sex	Size (cm) Length	Weight gms.	Relative Fullness	Food Displacement
			M	14.9 cm	14.6	88%	0.22 cc
			M	15.2	17.2	56	0.14
			M	15.8	16.0	32	0.08
			M	17.0	13.8	52	0.13
April 14			M	16.3	13.0	36	0.09
9:00 A.M.	15°c.	12°c.	F	12.6	7.4	16	0.04
			F	14.3	8.8	100	0.13
			F	13.3	8.6	26	0.04
			F	13.6	9.0	38	0.05
			F	14.3	8.1	7	0.01
			M	16.7	9.2	100	0.25
			M	17.5	17.0	26	0.065
			M	16.8	15.6	16	0.04
			M	14.7	14.1	12	0.03
April 21			M	15.6	14.3	8	0.02
3:30 P.M.	18°c.	14°c.	M	16.5	12.0	24	0.06
			F	13.7	8.3	4	0.01
			F	15.2	9.5	31	0.04
			F	12.8	7.6	23	0.03
			F	14.2	8.9	15	0.02
			M	16.3	16.9	40	0.10
			M	17.2	14.8	12	0.03
			M	14.9	15.3	20	0.05
			M	15.1	15.4	28	0.07
April 28			M	15.8	14.0	16	0.04
11:30 P.M.	7°c.	12°c.	F	14.3	9.8	38	0.05
			F	14.8	9.3	7	0.01
			F	13.7	8.7	5	0.02
			F	14.1	8.9	27	0.04
			F	15.0	10.0	23	0.03
			M	16.02	14.6	35.37	0.088
Average			F	13.98	8.78	25.71	0.037

Data on *Triturus* *g.* *granulosus* collected during April.

TABLE 2

Date Collected	Temperature Air	Temperature Water	Sex	Size (cm) Length	Weight gms.	Relative Fullness	Food Displacement
July 1 9:00 AM	28°c.	21°c.	M	16.0	15.3	40%	0.10 cc.
			M	16.5	14.9	20	0.05
			M	17.3	16.0	28	0.07
			F	14.0	8.0	62	0.08
			F	14.7	8.2	7	0.01
July 3 3:30 PM	26°c.	19°c.	M	18.2	15.5	8	0.02
			M	16.0	13.0	20	0.05
			M	16.9	14.2	16	0.04
			M	17.3	14.9	12	0.03
			F	11.9	7.4	23	0.03
July 5 11:30 PM	10°c.	17°c.	M	16.3	13.3	8	0.02
			M	17.3	15.4	4	0.01
			M	17.2	14.5	20	0.05
			F	13.7	8.5	8	0.01
			F	13.3	8.9	8	0.01
Average			M	16.9	14.7	17.6	0.044
			F	12.52	8.2	21.6	0.028

Data on Triturus g. granulosus collected during July.

PLATE III

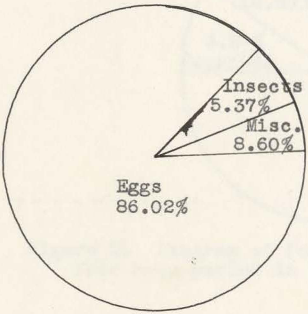


Figure 1.
9:00 A.M.

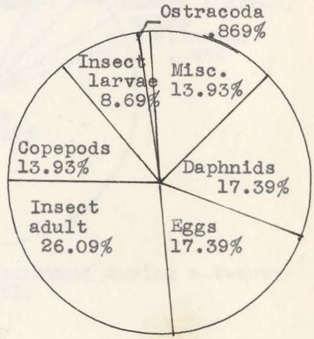


Figure 2.
3:30 P.M.

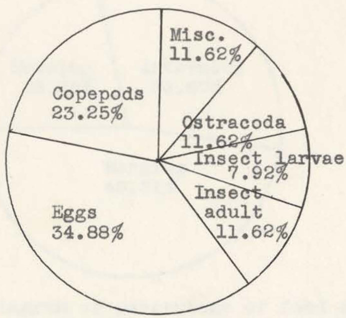


Figure 3. - 11:30 P.M.

Figures 1, 2, 3. Diagrams of food consumed by Triturus g. granulosus during three specific periods in April.

PLATE IV

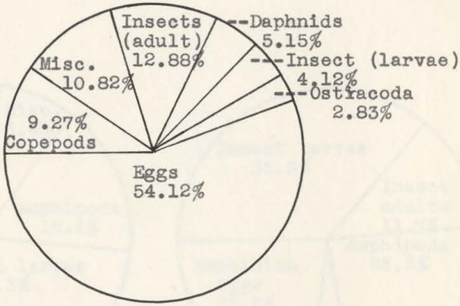


Figure 1. Diagram of food consumed during a twenty-four hour period in April.

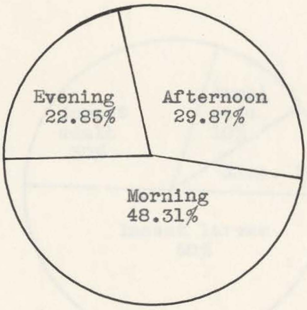


Figure 2. Diagram of percentage of food consumed by Triturus g. granulosus during each of the three periods in April.

PLATE V

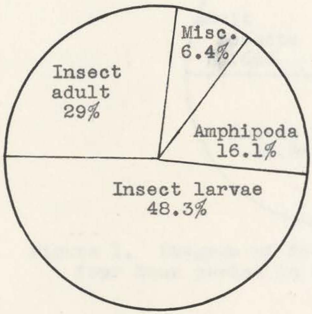


Figure 1.
9:00 A.M.

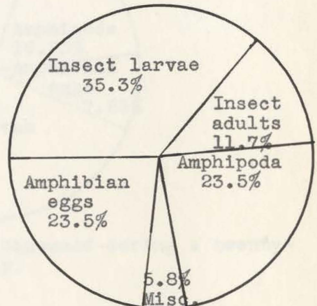


Figure 2.
3:30 P.M.

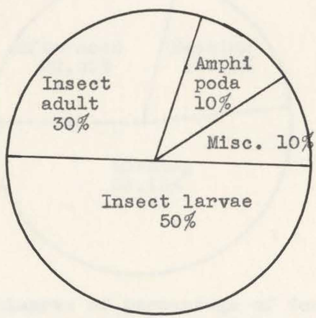


Figure 3. - 11:30 P.M.

Figures 1, 2, 3. Diagrams of food consumed by Triturus g. granulosus during three specific periods in July.

PLATE VI

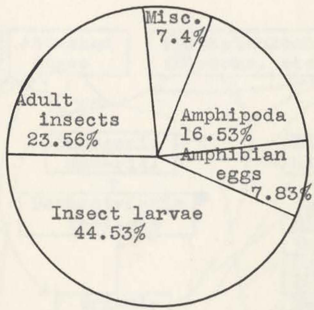


Figure 1. Diagram of food consumed during a twenty-four hour period in July.

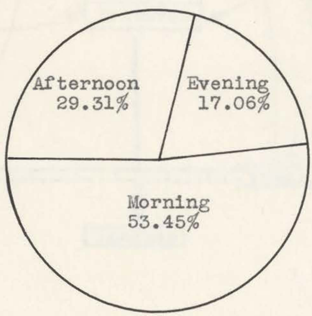
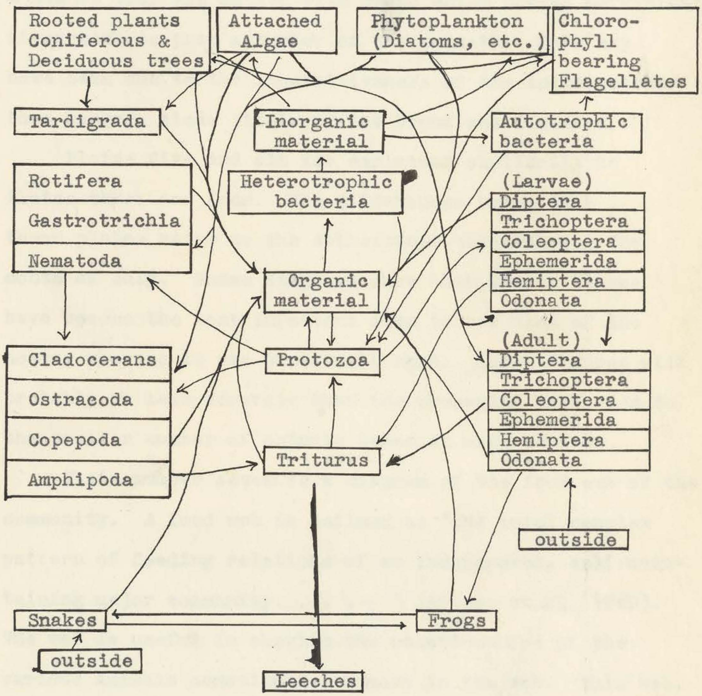


Figure 2. Diagram of percentage of food consumed by Triturus g. granulosus during each of the three periods in July.

PLATE VII



Food web interrelations of the pond community, after the method used by Elton (1947).

forms in any noticeable way. As far as animal forms are concerned the Triturus seems to eat everything available. A minnow trap was baited with bread which proved sufficiently attractive to trap a number of the animals. This may have been due to the inquisitiveness of the animal rather than hunger, since little of the bread was ingested.

Plates five and six are explained similarily to Plates three and four. The differences being that these plates refer to the collections taken during the month of July. These diagrams show that insect larvae have become the most important item in the diet of the newts, whereas it was previously eggs. These figures will probably be less accurate than the preceding ones, due to the smaller number of animals taken at each period.

Plate number seven is a diagram of the food web of the community. A food web is defined as "the total complex pattern of feeding relations of an independent, self-maintaining major community. . . . . " (Allee, et.al, 1949). The web is useful in showing the relationships of the various animals constituting a mesh in the web. This web, and the previous work on <u>Triturus</u> <u>g</u>. <u>granulosus</u> applys to two seasons, spring and summer. The web does not show what an animal will eat, but what it does normally eat.

Since a complete web would be impossible to construct with the present information, this web will be incomplete in many ways. The intention is to diagram the position of the newt in the community metabolism. Many of the relations in the web are taken from other sources (Allee, et al., 1949 and Elton, 1947), and it is logical to assume that those common relationships will apply to this area as well as to the ones in which the original research was conducted.

There is a great variation in the composition of heleoplankton from season to season, and year to year, especially of the nannoplankton (Welch, 1935). The diet of animals feeding upon the plankton can also be expected to change with the changes during the different periods. Another factor affecting the diet of the community is that certain species of plankton may one year be abundant in a certain community and be completely absent the following year.

The action of bacteria upon inorganic and organic material and the photosynthetic activity of green plants are necessary and basic factors in every community, with few exceptions (Frobisher, 1947).

The macroflora and microflora are the chief sources of carbohydrate anabolism in the community. The green plants which would be carbohydrate producers in this area are the algae, and these benefit directly from the action of the heterotrophic bacteria. Since the chart is self-explanatory in its relationships, further space will not be used to explain the clearly seen relationships.

Protozoa, which are usually parasitic in almost all comparatively large animals, have not been shown by arrows as infecting those animals, since this fact is well known, and inclusion of arrows would only serve to confuse the picture. The frog-snake relationship represents the fact that the large bull-frog, Rana catesbeiana, was found in two instances to have ingested a full grown garter snake. The garter snakes were found to eat the smaller species of frogs.

In the chart the various genera of insect larvae and adults were also omitted, since Triturus g. granulosus eats all of them it can capture.

CHAPTER VII

CONCLUSIONS AND SUMMARY

The newt, Triturus g. granulosus, has been found to be a carnivorus animal, and apparently derives no nutrition from plant material which may be ingested.

This newt was found to differ greatly in its food habits during the spring and summer. During the spring months, amphibian eggs were a basic unit in the diet. Eggs seem to play an important role in the feeding habits of other species of Triturus. Hamilton, (1932) in working on Triturus v. viridescens observed them feeding upon the eggs of Ambystoma maculatum during the latter part of March. The newts were also observed to eat the eggs of Rana sylvatica during a later period. It was shown by stomach analysis that the eggs of Ambystoma maculatum were an important food item during the period when they were abundant.

Although it is not definite as yet, the eggs ingested appear to be those of Triturus g. granulosus. From available sources Triturus g. granulosus was found to lay its eggs singly or in small groups (Bishop, 1947), but large masses of from thirty to forty-two were abundant in the pond.

These masses were hatched, and they are definitly salamander larvae, and it is believed that they are the larvae of T. granulosus granulosus.

Since the newts were found to contain more eggs during the morning, than the evening, and lastly in the afternoon, it appears likely that this may be attributed to their relative abundance. Work has been done on Triturus v. viridescens and it was found that they feed almost entirely without preference, but by the abundance of the food. It is believed, however, that in this instance there was some preference since copepods and daphnids were plentiful during the spring, and negligible amounts were eaten during the morning. Here, both were obviously abundant, and one was eaten copiously while the other was disregarded.

The newts may lay their eggs at night, since their feeding upon eggs is greatest during the morning and evening. In the afternoon the supply has probably dwindled and other sources of food must be found.

The lack of eggs in the diet of those collected in the summer is explained by the fact that those females examined had no eggs in their oviducts. This fact also lends strength to the theory that the eggs consumed are those of Triturus g. granulosus.

Since the copepods and daphnids bloomed during the spring and were absent in any considerable numbers during the summer, the Triturus were forced to substitute something in place of these crustaceans. In this instance it was insect larvae, which are more prevalent during the summer.

The average Triturus consumed more food during a twenty-four hour period in the spring than during the summer. This may be due in part to the availability of food, and also to the temperature of the water, which was slightly cooler during the spring.

During the spring and summer the most active feeding period was in the morning. Feeding during both seasons was less active at night, and the afternoon period was almost identical in both cases.

The newt, Triturus g. granulosus, is an important member of an aquatic community. They have some economical value as an aid in controlling insects, although this is probably not too great. An attempt has been made to show how it fits into the community life, although much information is still lacking.

It is hoped that the work started here will be of use to the ecologist and that what has been started here can be completed by further and more intensive research.

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