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A study of the hydra of Salem pond

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A STUDY OF THE HYDRA

OF

SALEM POND

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Signed:

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INTRODUCTION

The site of investigation for this work was Salem Pond, Salem (formerly known as Pond Town), Utah. It was settled in 1851 by David Crockett and David Fairbanks. Colonization began in 1856 when a fort of adobe and lumber houses was built near the pond, and later, several industries located there, benefited by the water wheels constructed by the pioneers (Huff, 1947).

The purpose of this study was to investigate the hydra of Salem Pond from the following aspects: 1) the ecological niche; 2) seasonal variation of the natural population; 3) behavior, and sexual and asexual reproduction in cultured Chlorohydra viridissima (Pallas, 1766). Notes are also included on the brown hydra which were not definitely identified.

These observations covered a period from January to May, 1956. During this period the pond was visited each week at which time several hours were spent making collections and observations.

ACKNOWLEDGMENTS

The completing of such a study necessitates the assistance of experienced and accomplished individuals who can aid the student in various ways. The writer wishes to acknowledge with sincere thanks, the valuable suggestions, the numerous aids and the encouragement given by

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ECOLOGICAL NICHE

The word "niche" is interpreted at this time to mean "where the organism is" rather than "what it is doing in the community."

This pond seldom freezes, and is fed by underground springs and run-off water from the nearby mountains. Its reaction, from top to bottom, varies from pH 7.5 to pH 8.5. There are abundant plankton, littoral and benthic organisms, and at the water's edge there are numerous willows, cat-tails, grasses and smaller plants.

Hydra were found throughout the pond, and at the southern end, the least disturbed area, they were abundant at certain times of the year. During January, Hydra were most plentiful at Station #1 (Plate 7, fig. 1). During the last of March and the first of April, they were most plentiful at Station #8 (Plate 7, fig. 1). The amount of floating material during March and April was negligible, and the surface of the muddy bottom when examined for adult hydra was found to be negative. Adult hydra that were present during most of April were found floating freely in the lower water.

On windy days, the hydra were found below the water's surface. On calm sunny days they were found at the surface on floating plants and debris. Hydra were found attached to several kinds of floating material. None were found attached to small stones at the water's edge. H. littoralis has been found on the stones at the shore of Lake Michigan (Hyman, 1931).

METHOD OF COLLECTING, CULTURING AND MAINTAINING CULTURES

After determining the best collecting area by previous examination of floating debris, the actual site was not disturbed until close visual examination revealed extended or contracted hydra, for when hydra were removed from the water they appeared only as small jelly-like masses flattened against the debris to which they were attached.

Material with attached hydra was brought to the laboratory in clean glass bottles filled with pond water. As soon as the collecting bottles arrived, small amounts of their contents were transferred to other bottles containing large amounts of pond water taken at the same time of the collection.

Approximately two hours after collecting, hydra in undisturbed bottles were seen in their extended position with tentacles out-stretched. Three full quart bottles have been found to contain 100 to 350 hydra.

Specimens were removed from the collection with a small metal spatula made from a dissecting needle. Green hydra were easily encouraged to release themselves, float, and be lifted from one culture to another. Brown hydra were not so easily handled, and were not successfully cultured for any length of time. Therefore, detailed studies of the brown hydra were not carried out at this time.

The culture medium was always pond water taken at the time of

the collections. It was stored in the refrigerator at 6° C and 5 cc. of cold pond water was added to each small culture after the daily observations. This immensely reduced casualties.

It has been pointed out by Chang (1952), that one cause of depression in H. oligactis was crowded cultures. This same inactive and gradually degenerating state was also demonstrated by Chlorohydra viridissima in crowded or unattended cultures.

Four to seven hydra, Chlorohydra viridissima, were kept in a 1.5 inch culture dish with 20 cc. of pond water. If a small amount of green plant material was added to each culture these hydra lived longer. Cultures of green hydra maintained for three months without plant material resulted in thin, light green, inactive specimens and during this time they attached themselves to the glass container. However, they immediately moved to green plants when these were added to the culture and became darker green and more active within three days.

The cultures were not placed in direct sunlight, nor were they covered at any time. When the cultures of Chlorohydra viridissima were placed in the direct sunlight they expired in a few days. The laboratory culture temperatures varied from 19 to 24°C.

Cultures of inactive hydra were placed in a 6°C refrigerator for 15 to 20 minutes and when removed a 40 watt bulb was placed over them to rapidly raise the temperature of the culture. If they became active with this treatment they could survive for many months.

The majority of casualties resulted from: 1) leaving specimens

in collecting bottles too long; 2) leaving specimens in confined areas; 3) leaving specimens in bottles containing a great amount of decaying material; 4) too much evaporation; 5) cultures not changed soon enough; 6) too many specimens per culture dish; 7) presence of predators.

REPRODUCTION AND HABITS

The following information was taken from the daily observations on Chlorohydra viridissima under the culture conditions previously described.

Budding

The beginning bud was recognized by the simultaneous evagination of what appeared to be the epidermis and the gastrodermis (Plate 4, fig. 1 A or B). This evagination did not represent the point at which a bud had just released itself, for the adult hydra column was uniform in appearance immediately after the bud was released (Plate 4, fig. 1G). After the bud protruded to 0.25 mm., it widened at the distal and showed a ridge or crown in the area where the tentacles began to form (Plate 4, fig. 1 D). At 1.5 mm. the tentacle or tentacles began to appear. These were minute protrusions in the crown area and did not always form directly opposite each other.

In the green hydra at least five tentacles were formed before the release of the bud; there was one exception in which a bud was released with only four tentacles. The tentacles were not always uniform in length at the time the bud was released. The bud grew to 2.0 to 2.4 mm. in length and a slight constriction at the proximal end began (Plate 4, fig. 1F). Also at this time the bud was active (Table III), (the tentacles were the last

to become active before the release of the bud). When the bud was 2.0 to 2.4 mm. in length it was contracting and expanding, and bending down and away from the adult (Plate 4, fig. 2 A to D).

There was more and more constriction at the proximal end of the bud, and more tentacles might form and become active. A definite hypostome was not noticeable until the last stages of an attached bud. When the hypostome did appear the bud was ready for release. The bud adhered to the substratum by the hypostome and continued to contract and expand, finally pulling itself from the adult. Buds were on an average of 3.9 to 4.5 mm. in length at the time of their release (Table IV).

Simultaneous beginning of bud formation was not seen, but two or more buds were often present at the same time in different stages of development on a single individual. Some of the adults had one, two or three testes present at the oral end; sometimes formed before and sometimes after budding began.

When the animals were brought into the laboratory they produced one or two buds per day for a week and then the rate of bud formation decreased.

Sexual Forms

Testes

Testes of the green hydra formed at the oral end from a smooth, round evagination of what appeared to be the epidermis. Upon maturing the inner area became white until the whole testes was filled with a whitish

mass and an opening was formed through which its contents were extruded. Under 100 X magnification, the whitish mass containing the sperm could be seen circulating within the testes; and as the animal was bending the inner material could be seen to move out of the testes.

Testes matured to a nipple-like form in 3 to 6 days and at this time an opening for the release of the contents was formed (Plate 3, fig.1). The number of testes varied from one to four (Table II), and generally they formed and matured at different intervals. According to information available in the literature, testes are not located directly opposite each other. However this arrangement was noted by this writer in one instance.

Eggs

Eggs of the green hydra were produced at the aboral end on an average of 20 to 30 days, (Table I). An area of the column in what appeared to be the epidermis began to protrude. This area was 1 to 1. 5 mm. lengthwise and circled 3/4ths around the lower portion of the column. This area became increasingly white, with striations at its base. When the egg itself began to develop, it appeared as a spherical, yellow mass and its maximum size was reached in 4 to 7 days. The egg was not released at this time but remained in a concave theca for several days. The theca persisted on the stalk of the adult for 4 to 6 days after the release of the egg. A maturing egg is seen in the microphotograph (Plate 3, fig. 2). There was a great amount of colorless material which stayed attached to the egg at all times, but which cannot be seen in the microphotograph.

Tentacles

Tentacle Formation and Variation

The bud was 0.5 to 0.75 mm. in length when the tentacles appeared as small knobs at its oral end. By the time the bud was 1.5 mm. these small knobs began to appear as tentacles. The tentacles did not always form simultaneously. The majority of specimens of the green hydra developed 6 to 8 tentacles, and only one animal developed 5 (Table V). The number of tentacles formed at the time of release of the bud remained the same throughout life (Plate 5, fig. 1A to E).

There were several types of branching seen in this hydra (Plate 5, fig. 1 F to I). This branching generally persisted throughout the life of the individual. There were three specimens taken in the field which showed tentacles below the hypostome (Table V). Plate 5, fig. 1 J shows a tentacle below the hypostome and the other tentacles shown are in a contracted state.

Tentacle Degeneration and Regeneration

When the culture was left for three weeks without changing, the specimens became inactive and sometimes they were found unattached and floating freely in the culture dish. At the oral end the length and the motility of the tentacles decreased and then the tentacles disappeared. Some of the individuals lost all their tentacles and upon changing the culture the tentacles began to appear in three days as small knobs resembling those found on buds still attached to the adult (Plate 5, fig. 2 A to E). Again

they were not formed simultaneously, and there was a decrease in the number of tentacles formed. When the tentacles again formed, the hydra returned to a state of normality.

Specimens which underwent tentacle degeneration and regeneration showed no loss of testes during this process, but the opening once present on the testes was absent, and the animals seemed to have lost the capacity to eject sperm.

Ingestion of Food

Several green hydra were seen ingesting Cyclops (Plate 6, fig. 1 A to F). Before Cyclops were put into the culture, other organisms were tried as food. Ostracods, because they were plentiful, were freshly killed and put into the area of the tentacles. The hydra would ingest the Ostracod but would eject it within an hour. The same treatment of Annelida was also observed.

The Cyclops when caught struggled for 15 minutes to an hour. The hydra directed the Cyclops to the hypostome (Plate 6, fig. 1 A to F), by means of the tentacles after which they released the specimen and hung down to the side of the column while the hypostome did the ingesting. This inactivity of the tentacles in the ingestion process has been described by Mereschowsky (1878). Downing (1902) has described the ingestion of an 8 mm. carp by a brown hydra, and the ingestion of a worm is pictured by Buchsbaum (1935).

The hydra sometimes placed the hypostome over Spirogyra and

the tentacles directed the filaments to the hypostome and into the enteron where the Spirogyra could be seen to give a sharp zig-zag appearance to the hydra.

Attachment and translocation

The adults with buds usually adhered to the bottom of the culture dish, while the young released buds and some of the single forms moved to the side of the dish and attached themselves there in a position parallel to the bottom, much like the position in which they were once attached to the adult. Unhealthy specimens did not contract quickly and were very easily removed from their place of attachment.

Doubling and Fission

Plate 6, fig. 2 A to F shows an example of one common column whose oral end divided into two individuals. While they were on this common column, the specimens in Plate 6, fig. 2 A contracted and expanded simultaneously. In the stage represented in Plate 6, fig. 2 D, they were acting independently. Those specimens were found in a month old collecting bottle. A similar case has been noted in H. oligactis and cited by Chang (1952).

DISCUSSION

From observations made on the collections of hydra from Salem Pond, there is a possibility of three species being present.

There were two different brown hydra seen. The only published record of the brown hydra of Salem, Utah was described and named Hydra utahensis by Hyman (1931). This hydra was collected in August 31, 1930 by L. A. Giddings and sent to Dr. Hyman in December, 1930. This hydra is not differentiated into a stalk and body region. It is small with tentacles 1.5 times the length of the animal. It is pale brown to pinkish-brown. The other hydra seen in the collections was well differentiated into a stalk and body region. The tentacles were at least 1.5 times the length of the body, and it was a definite brown color. The culture of the brown hydra could not be maintained for long, therefore the exact species could not be identified.

The third hydra seen was Chlorohydra viridissima, and in correspondence with Dr. Hyman she informs me that this species is most probably the same throughout the world. Dr. Hyman mentioned that Dr. Charles Hadley of Montclair, New Jersey is working on the question as to whether or not this is true.

The green hydra, abundant from January to March, were maintained in laboratory culture in which the temperature varied from 19 to 24°C.

Sexual and asexual forms were seen; also, the releasing of buds, ingestion of Spirogyra, and fission were observed. The asexual forms collected in the field showed signs of sexuality in two to three weeks after culturing. The bud constricted at the proximal end and pulled itself from the adult. The Spirogyra was taken into the enteron by the use of the tentacles and the hypostome; the ingested filaments gave the hydra body a zig-zag appearance. In the first stages of fission there is simultaneous movement of the separated parts which will become two individuals. Upon further separation the parts begin to move independently.

Many of the early workers did not mention in their reports the exact species with which they worked. More recent literature refers the scientific name of the hydra being studied. There are several different names given to this animal. The common name is "green hydra". Scientific workers have referred to it as Chlorohydra viridissima, Pallas, 1766 (Hyman, 1930), Hydra viridissima (H. viridis L.) 1766, (Ward and Whipple 1918), H. viridis (Needham and Lloyd, 1937 and also Huxley, 1892), H. viridis L. (Bullough, 1954).

Aristotle used the term Cnidae and Leuckart (1847) suggested Coelenterata. After multiple studies were made by Hatschek, of comparative anatomy fame, he again recognized Aristotle and suggested the name Cnidaria (1888). Many people even now refer to the Phylum Coelenterata instead of Cnidaria. The "L" at the end of some of the scientific names used in connection with the green hydra refers to Linnaeus who in 1767 chose to add his name to an already described species previously

named by Pallas in 1766.

Merschkowsky (1878) remarks about the appearance of two tentacles simultaneously in H. vulgaris and H. oligactis. This was the exception rather than the rule in Chlorohydra viridissima cultured by this worker. There seemed to be no set pattern for this process.

The green and brown hydra mentioned in this work were taken from the same habitat, a pond in which the pH varied from 7.5 to 8.5. As the air and water temperature rose there was a marked decrease in the number of adult hydra on floating debris to which they were attached in January. These hydra were found in different places; at the surface, one to two feet below the surface or floating freely. Properties of the habitat have not been mentioned, nor has there been mentioned that different hydra live in the same natural environment.

In the literature there was no mention of the ingestion of Spirogyra which was observed in the laboratory cultures maintained by this worker.

Much of the literature reports on temperature experiments, taxonomic characteristics, and biological properties. There seems to be no literature containing notes on the physical properties of the natural environment or physical features of the natural habitat other than to mention their geographical area and the kind of material to which they were attached. Measurements of buds being produced or just released were not found and therefore no comparisons from this aspect could be made with data obtained in this study.

SUMMARY

This study of green hydra was done weekly from January to May at Salem Pond, Salem, Utah. Notes were taken on the pH, air and water temperature, and seasonal variation of the hydra population. Hydra attached to floating debris were brought to the laboratory and cultured in pond water varying from 19 to 24°C. Much of this work deals with observations on the behavior, sexual and asexual reproduction, and comparison of generations in green hydra. Because of the difficulty in culturing, the brown hydra were not completely studied.

In studying the ecological niche of the hydra, it was found that collection of floating plants and debris at the water's edge contained the most specimens. Collections throughout the pond revealed the greatest number of hydra to be at the southern end which was the least disturbed area. Other observations were: 1) There is now established another area in Utah for Chlorohydra viridissima. 2) This area contains sufficient hydra to supply the general Zoology classes of Brigham Young University with live specimens for laboratory examination. 3) There are also brown hydra in this pond which can later be observed and compared. 4) The habitat of Chlorohydra viridissima can vary from a pH of 7.5 to pH 8.5.

The collections are seen to vary monthly and seasonally. (Plate 1, fig. 1) During January, February and March the hydra were

plentiful, and in April and May when the temperature rose, the population of adult hydra on floating debris decreased. The animals apparently moved to different habitats for some were found floating freely in deeper water. These unattached animals were still in an asexual state.

In measuring with a millimeter rule placed under the culture dish, the attached buds which had just become active were found to be an average of 2.1 to 2.5 mm. in length. When the bud constricts at the proximal end and pulls itself from the adult its column is usually 3.9 to 4.5 mm. in length. The adult's column varied from 5.5 to 9.0 mm. in length at the time of budding. The first generation from the adult produced buds when they were 5.0 to 7.0 mm. in length.

The third generation began to develop testes on an average of 1.5 days after their existence, compared to 4.5 days and 10.6 days for the first and second generations respectively. These animals apparently became well-adjusted to and even accelerated by the culture conditions.

The adults began to develop eggs on an average of 21.5 days after the field collection and establishment of the culture. The first generation from these adults began to develop eggs on an average of 33.4 days after their existence. The culture conditions were not so favorable to the producing of eggs as they were to the formation of testes.

Three specimens brought in from the field showed one or two tentacles below the hypostome; none of the laboratory-cultured animals produced tentacles below the hypostome, but branching of the tentacles was seen. The occurrence of tentacles below the hypostome was reported as

early as 1878 by Sydney J. Hickson, a student of Professor Lankester. This variation of tentacle position in Chlorohydra viridissima can possibly be found on animals in their natural habitat and also under laboratory conditions. The branching of tentacles is common to hydra in laboratory cultures. This branching was seen to continue throughout the life of the animals spoken of in this work, but others report that H. oligactis produces and then absorbs branched tentacles.

From the laboratory culture maintained at temperatures varying from 19 to 24° C, the writer made the following observations: 1) Chlorohydra viridissima from field collections placed in crowded culture conditions showed depression similar to that observed in H. oligactis by Chang (1952). Depression resulted in degeneration of tentacles, inactive individuals, and ceasing of sperm output. Regeneration of tentacles resulted in a decrease in number compared to the original. The number of tentacles not regenerated was less than the number regenerated. Apparently absorbtion at this time was more important than tentacle formation. 2) These hydra took freshly killed Ostracods and Spirogyra into the enteron for short periods of time after which they were ejected. Cyclops were seen to be ingested by specimens in the field as well as by animals in the laboratory.

These hydra under these laboratory conditions produced fewer tentacles with each generation. The column and tentacle length did not vary as much as the actual number of tentacles produced. Therefore, the buds were not necessarily released before they were fully developed

and perhaps had not had time to develop the usual number of tentacles. The conditions could have caused the animals to conserve the majority of cells for structures concerned with reproduction, and preservation of the general body form. Reproduction in individuals without tentacles and with two basal discs has been described by Brien (1952).

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ABSTRACT

The laboratory cultures of Chlorohydra viridissima (Pallas, 1766), taken from Salem Pond, Salem, Utah were maintained at a temperature varying from 19 to 24°C, and observed for behavior, sexual and asexual reproduction, and comparison of generations. The two species of brown hydra also found in the pond could not be cultured for a sufficient length of time to permit classification.

Under crowded laboratory conditions and in unattended cultures, the green hydra underwent depression similar to H. oligactis as described by Chang (1952). This depression resulted in inactive individuals with degenerating tentacles, and when tentacle regeneration occurred a decrease in the original number was seen.

The bud became active on an average of 2.1 to 2.5 mm. in length and released itself on an average of 3.9 to 4.5 mm. in length. The first generation began to develop testes on an average of 4.5 days, and eggs on an average of 33.4 days. The second generation produced testes on an average of 10.6 days; no eggs were produced. The third generation began to develop testes on an average of 1.5 days; no eggs were produced.

The hydra attached to floating plants and debris were most plentiful from January to March. As the temperature rose the hydra

TABLE I. Egg Development in Cultures of Temperatures Varying From 19 - 24° C.

Adult	# Days[1]	# Eggs	1st Generation Bud #	# Days[2]	# Eggs	2nd and 3rd generations did not produce eggs.
4	-	-	1	38	1	
5	32	1	1	30	1	
			2	34	1	
			3	39	1	
			4	39	1	
			5	39	1	
11	11	1	1	15	1	
12	9	1				
14	34	1				
Average	21.5	1		33.4	1	

[1] Number of days between culturing and beginning of egg.

[2] Number of days from first existence and beginning of egg.

TABLE II. Testes Formation in Cultures of Temperatures Varying From 19 - 24°C.

			1st Generation			2nd Generation		
Adult	# Days[1]	# Testes	Bud#	# Days[2]	# Testes	Bud#	#Days	# Testes
4	-	-	1	8	2			
			2	8	2			
			3	10	3			
5	9	3	1	11	3			
			2	10	2			
			3	10	3			
			4	10	3			
			5	12	1			
			6	16	2			
6	9	3	1	9	2			
			2	10	2			
			3	16	2			
7	8	4	1	9	3			
			2	15	3	3-1	10	1
8	8	2	1	2	3	1-1	4	1
			2	1	1			
9	9	2	2	24	2			
10	7	4	1	5	2			
11	8	3	1	8	2			
			2	8	2			
			3	5	2			
12	7	3	1	8	2	1-2	1	2
13	12	1	1	10	2	1-1	3	4
			2	10	2			
			3	7	3	(3rd Generation)		
			4	7	1	1-A	2	2
						1-B	1	2
14	8	4	1	8	2			
			2	5	1			
15	9	4	2	13	2			
			3	22	1			
Average	8.5	3		10.6	2.0	2nd gen.	4.5	2
						3rd gen.	1.5	2

[1] Number of days between culturing and beginning testes.

[2] Number of days between first existence and beginning testes.

TABLE III. Length of Attached Buds at the Beginning of Their Activity. Culture Temperature 19 - 24°C. Measurements in millimeters.

	1st Generation			2nd Generation		
Culture #	Bud #	Column	longest tentacle	Bud #	Column	longest tentacle
2	1	2.0	-			
	3	3.0	-			
3	1	3.0	2.0			
	2	2.0	1.0			
	4	3.0	1.5			
4	1	2.5	1.5	1-2	3.5	-
	2	2.5	1.5			
	3	-	-	3-1	2.5	-
				3-2	2.5	-
	4	1.25	-			
		1.5	-			
5	1	2.5	1.0			
	2	2.5	1.0			
	4	3.0	1.5			
	6	3.0	1.25			
6	-	-	-	1-1	2.5	1.75
7	2	1.5	-			
8	2	2.5	1.0	1-1	1.5	0.5
9	1	1.5	1.0			
	2	2.5	-			
	4	3.0	-			
10	1	1.25	-			
11	1	1.5	1.0			
12	1	1.5	1.25	1-1	1.5	-
				1-2	3.0	1.75
	2	0.75	-	(3rd Generation)		
13	1	2.0	1.5	1-D	2.5	0.75
14	1	3.5	2.5			
	2	1.5	-			
15	1	1.25	-			
Average		2.14	1.3	2nd gen.	2.4	1.5
				3rd gen.	2.5	0.75

TABLE IV. Length of Bud at the Time of Release. Culture Temperature 19 - 24°C. Measurements in Millimeters

	1st Generation			2nd Generation		
Culture #	Bud #	Column	longest tentacle	Bud #	Column	longest tentacle
2	2	4.0	-			
	3	3.5	-			
3	1	4.5	2.5			
	4	5.0	-			
4	1	4.0	2.0	1-1	3.0	-
				1-2	4.0	-
				3-1	4.0	1.5
				3-2	3.5	-
5	1	3.5	2.0			
6	-	-	-	1-1	5.0	-
8	4	4.5	1.5			
9	1	3.0	1.5			
10	1	3.0	1.25			
12	-	-	-	1-2	4.0	1.25
13	5	4.0	-	1-1	3.75	1.5
Average		4.5	1.8		3.9	1.4

TABLE V. Number of Tentacles on Adult, 1st, 2nd, and 3rd Generations. Culture temperature 19 - 24° C.

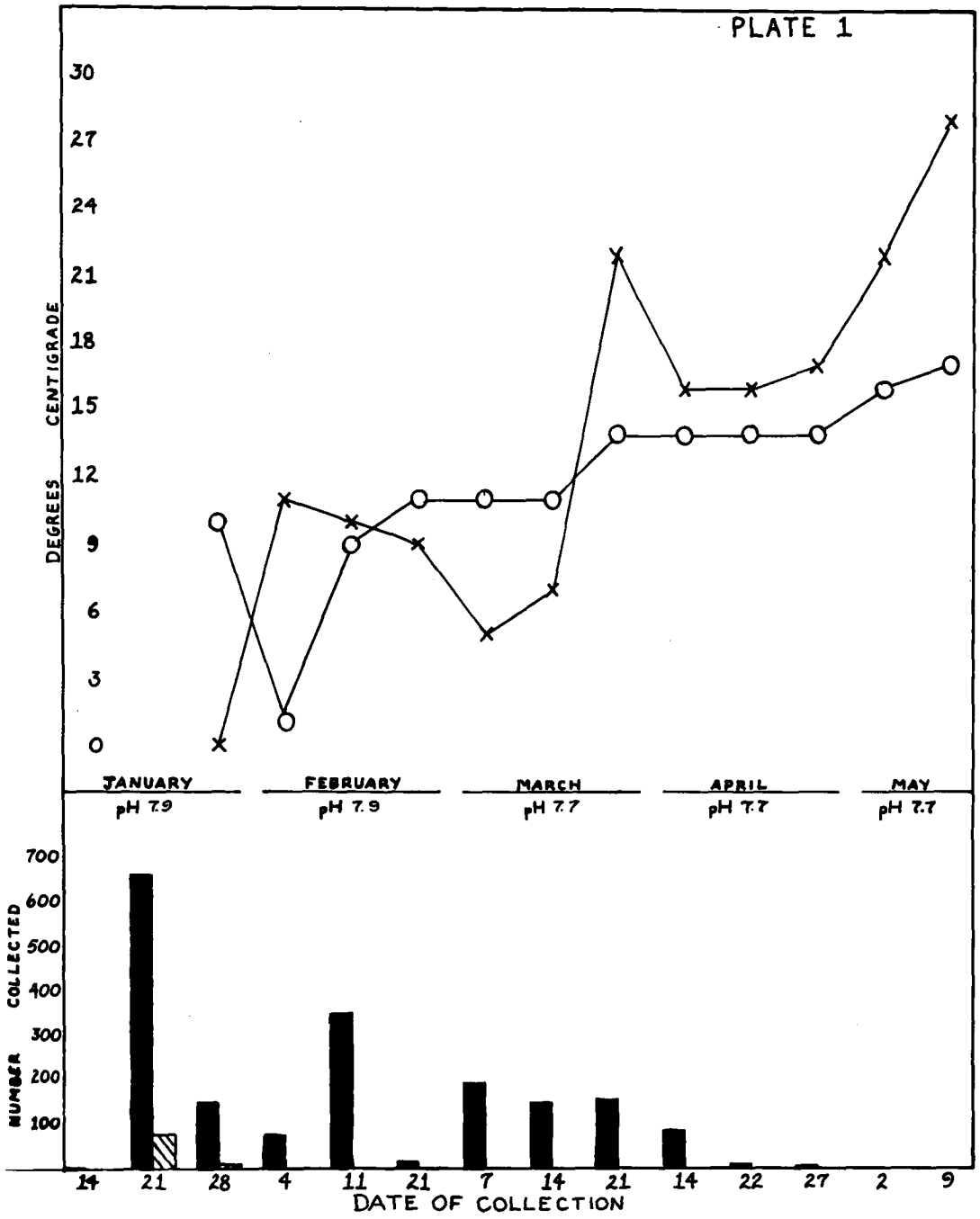
Adult Culture #	# Tent.	1st Generation Bud #	# Tent.	2nd Generation Bud #	# Tent.	3rd Generation Bud #	# Tent.
1	7	1	8				
		2	8				
2	10	1	9 (one branched)				
		2	9				
		3	7				
		4	8				
3	7	1	7	1-1	7		
		2	9				
		3	8				
		4	7				
		5	7				
4	7	1	7	1-1	7		
				1-2	7		
		2	8				
		3	7	3-1	7		
				3-2	7		
		4	8				
		5	6				
5	8	1	7				
		2	8				
		3	7	3-1	7		
		4	7				
		5	7				
		6	7				
6	8 (one below hypostome)						
		1	8	1-1	6		
		2	8				
		3	6				
7	7	1	7				
		2	6				
		3	7	3-1	6		
8	7	1	8	1-1	6		
		2	7				
		3	7				
		4	6				

TABLE V (continued)

Adult Culture #	# Tent.	1st Generation Bud #	# Tent.	2nd Generation Bud #	# Tent.	3rd Generation Bud #	# Tent.
9	8	1	8				
		2	5				
		3	6				
		4	6				
10	7	1	7				
11	8	1	8				
		2	8				
		3	6				
12	8 (one below hypostome)						
		1	9	1-1	6		
				1-2	7		
		2	8				
13	7 (one below hypostome)						
		1	8	1-1	7	1-A	6
						1-B	6
						1-C	6
						1-D	6
		2	8				
		3	7				
		4	6 (one branched)				
		5	7				
14	8	1	9				
		2	7				
15	8	1	7				
		2	7				
		3	6				
		4	6				
Average	7.6		7.2		6.6		6.0

Plate 1

Fig. 1 Collection of hydra of Salem Pond. All hydra collected were single individuals or animals with one or two buds.



CORRELATION OF pH, AIR AND WATER TEMPERATURE, AND POPULATION OF GREEN HYDRA OF SALEM POND, SALEM, UTAH

O—O WATER TEMPERATURE
X—X AIR TEMPERATURE
GREEN HYDRA
OTHER HYDRA

FIG. 1

Plate 2

Fig. 1 Green Hydra
A) Evagination of what appeared to be the ectodermis.
D) Mature testes
E to H) Testes arrangement at the oral end.

Fig. 2 Green Hydra
A) Evagination of what appeared to be the ectodermis.
B to G) Developing egg.
H) Mature released egg with outside granular layer. (Egg, yellowish; granular layer, colorless).

PLATE 2

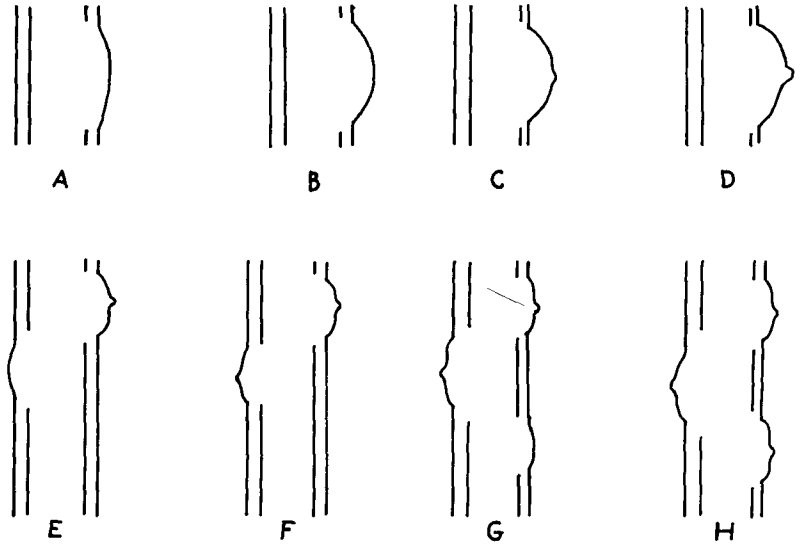


FIG. 1

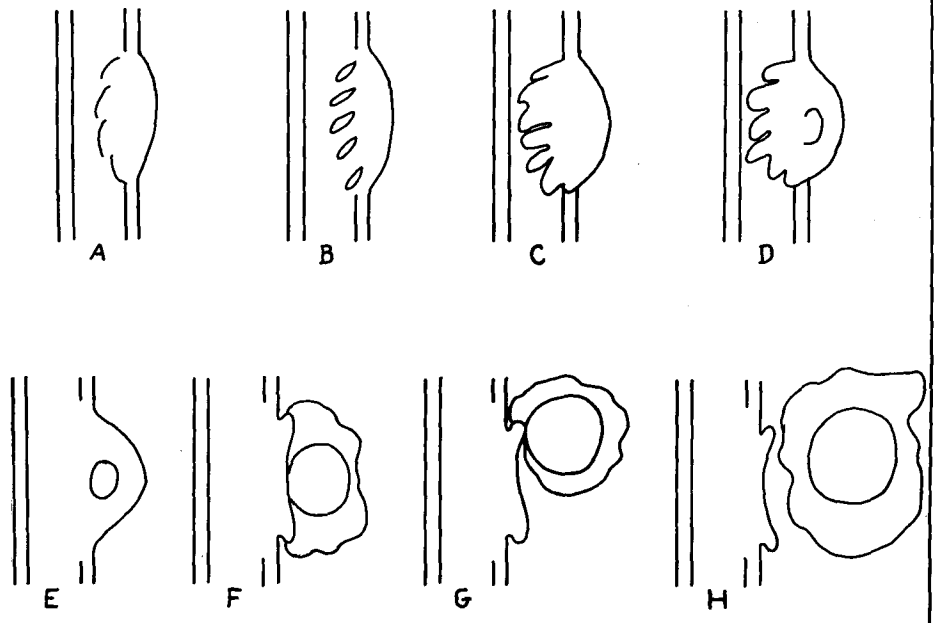


FIG. 2

Plate 3

Fig. 1. Green Hydra
Microphotograph of mature testes; the inner portion was a visible circulating white mass, and upon bending and twisting portions of the white mass were ejected.

Fig. 2. Green Hydra
Microphotograph of maturing egg in theca. The colorless granular layer which surrounds the egg is not seen in the photograph.

Pictures were taken with a Lietz camera on a compound microscope with 10 X eyepiece and a 10 X objective. Exposure 0.5 sec. Magnified approximately 600 times.

(The straight, black, narrow line to the right of each organ is a pointer.)

PLATE 3

Fig. 1

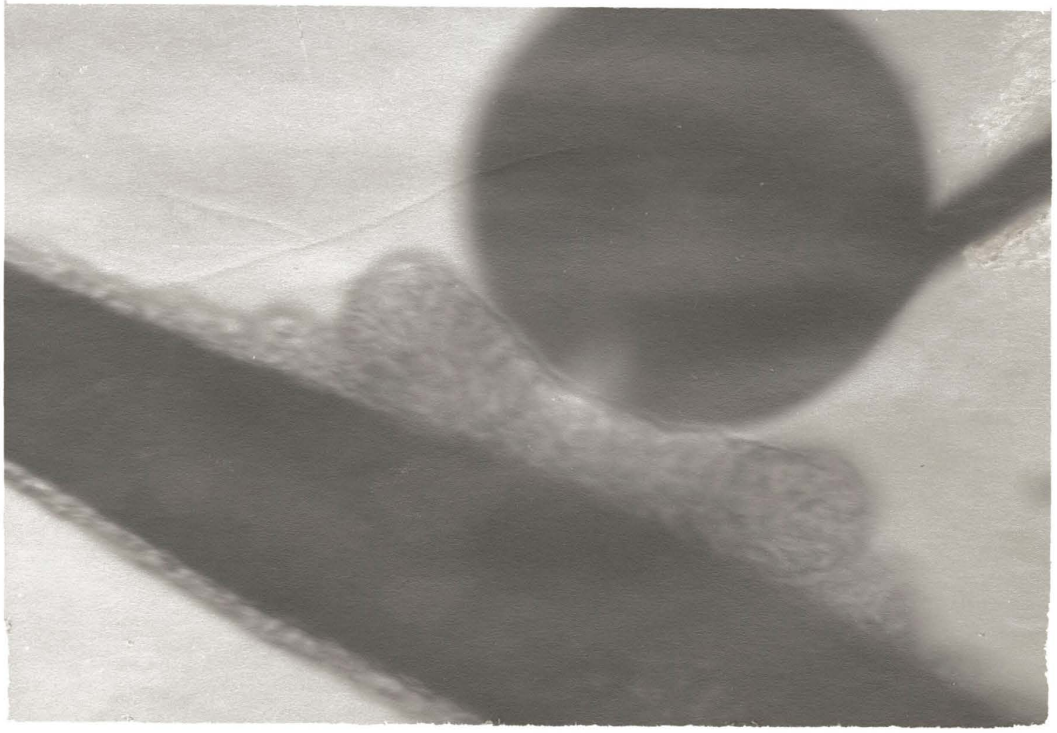


Fig. 2

Plate 4

Fig. 1. Budding Green Hydra A to H

A) Evagination of what appeared to be endoderm and ectoderm.
B) Variation in evagination.
D) Appearance of Bud with widened distal and where tentacles will appear.
F) Constricting at proximal end of bud.
G) Uniform adult column after release of bud.
H) Released bud.

Fig. 2. Bud Release

A to C) Both adult and bud are twisting and turning, bud is also contracting and expanding.
D) Bud pulling itself from adult with the help of the hypostome.
E to G) Young active bud immediately after release.

PLATE 4

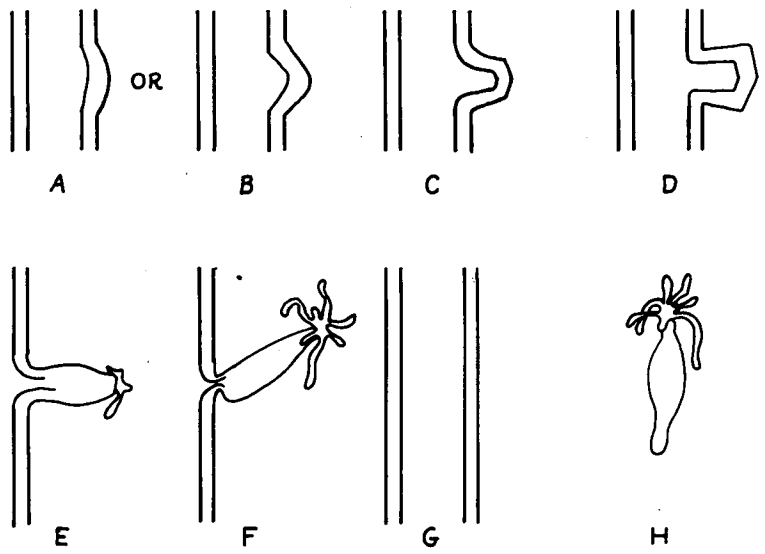


FIG. 1

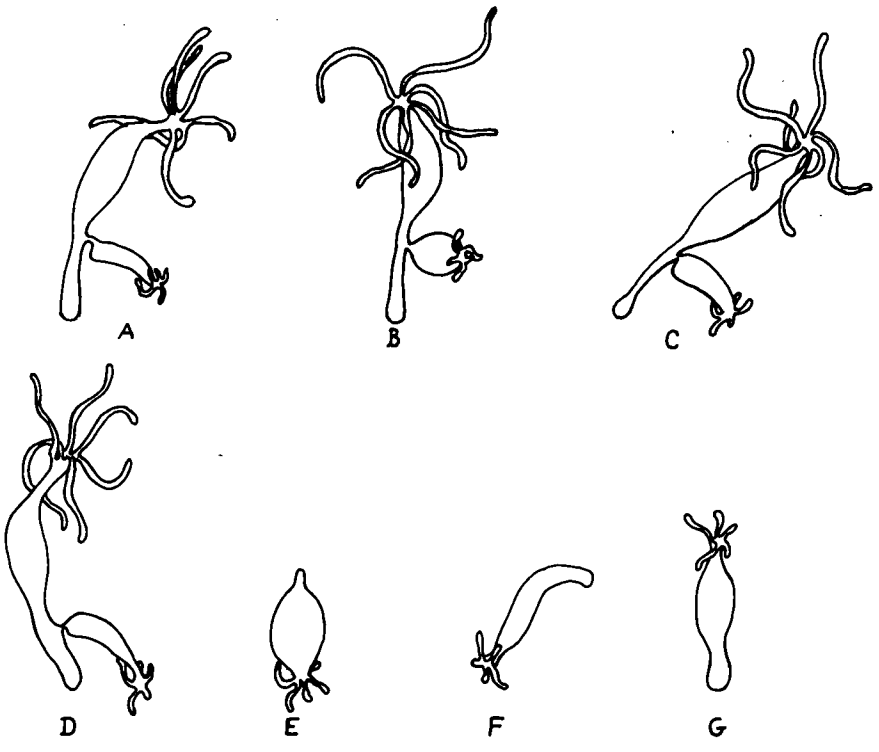


FIG. 2

Plate 5

Fig. 1 Tentacle formation and variation in Green Hydra

A to E) Points at which the tentacles form.
F) Tentacles were also seen to form opposite each other simultaneously.
G to I) Variation in branching; dotted lines refer to the position of the other tentacles.
J) a. Tentacle below the hypostome seen on a specimen from the field. There were also seen specimens with two tentacles below the hypostome; sometimes these various tentacles were active, sometimes short and inactive.
b. Other tentacles shown are in a contracted state.

Fig. 2 Degeneration and Regeneration of Tentacles of Green Hydra left in an unattended culture.
A and B) Degeneration.
C to E) Regeneration after transfer to new culture.

PLATE 5

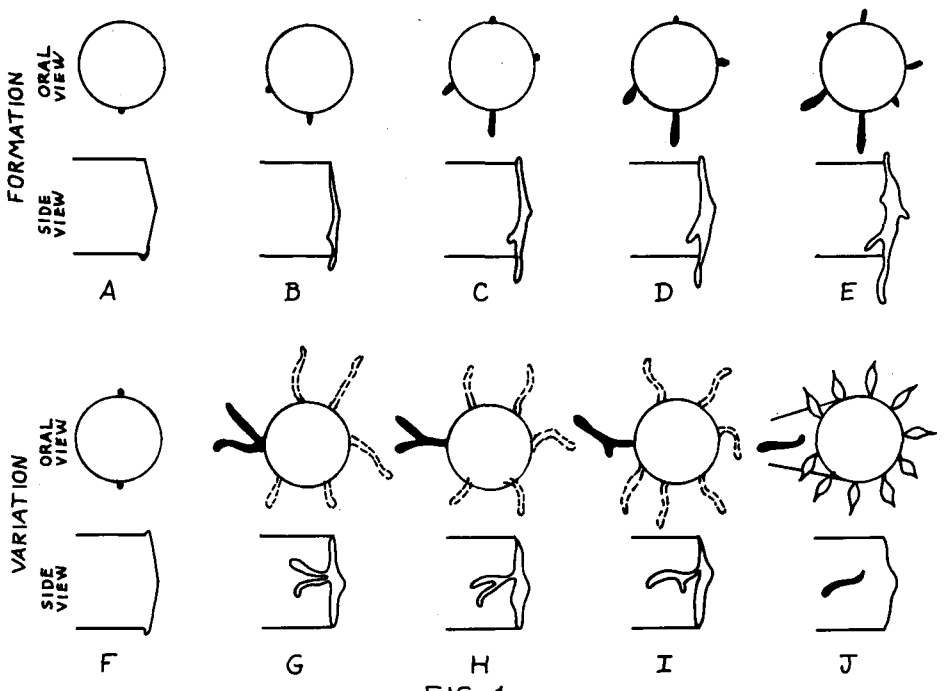


FIG. 1

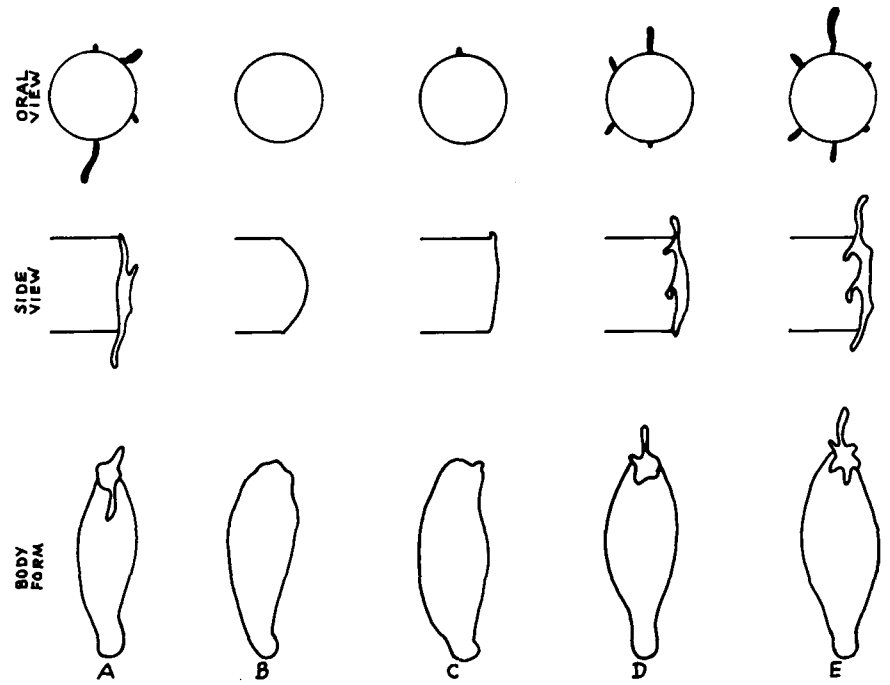


FIG. 2

Plate 6

Fig. 1 A to F) Ingestion of Cyclops by green Hydra. After 20 minutes the outline of the Cyclops was only slightly visible.

Fig. 2 Doubling in green Hydra.
A to C) Both specimens with one testes each; they contracted and otherwise moved simultaneously.
D) Specimens splitting and having developed more testes; individuals now move independently.
E and F) Two separated individuals.

Fission took 26 days.

PLATE 6

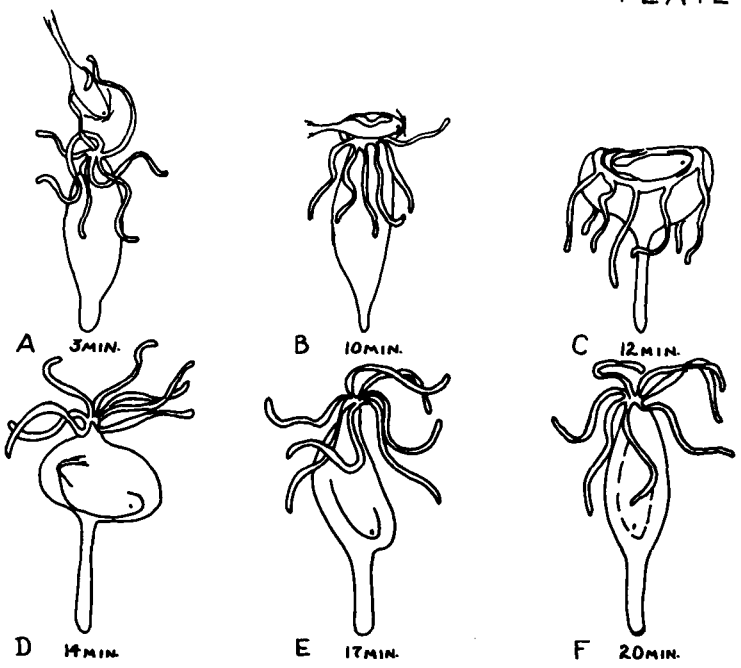


FIG. 1

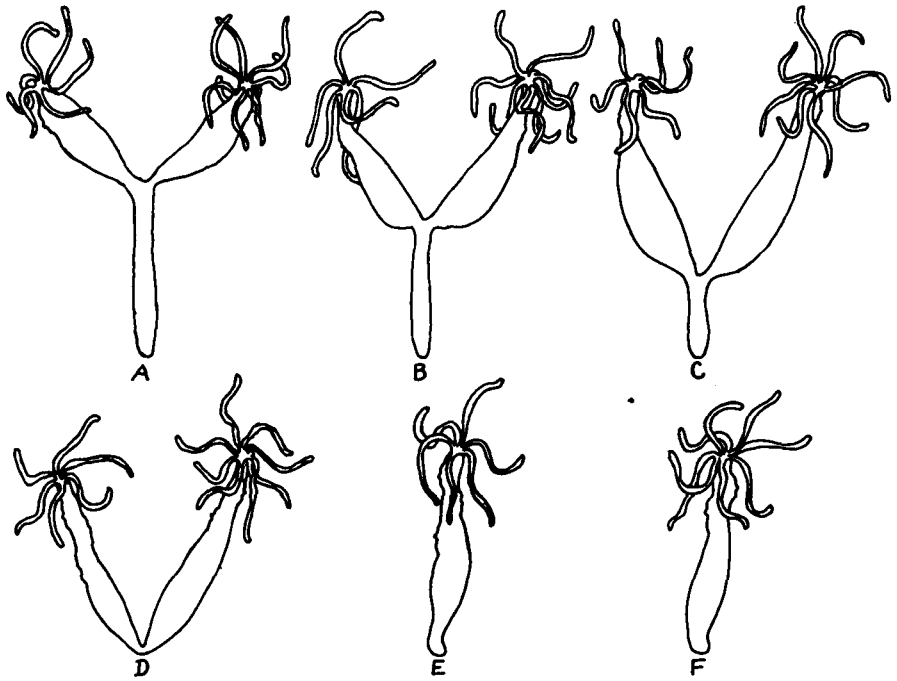
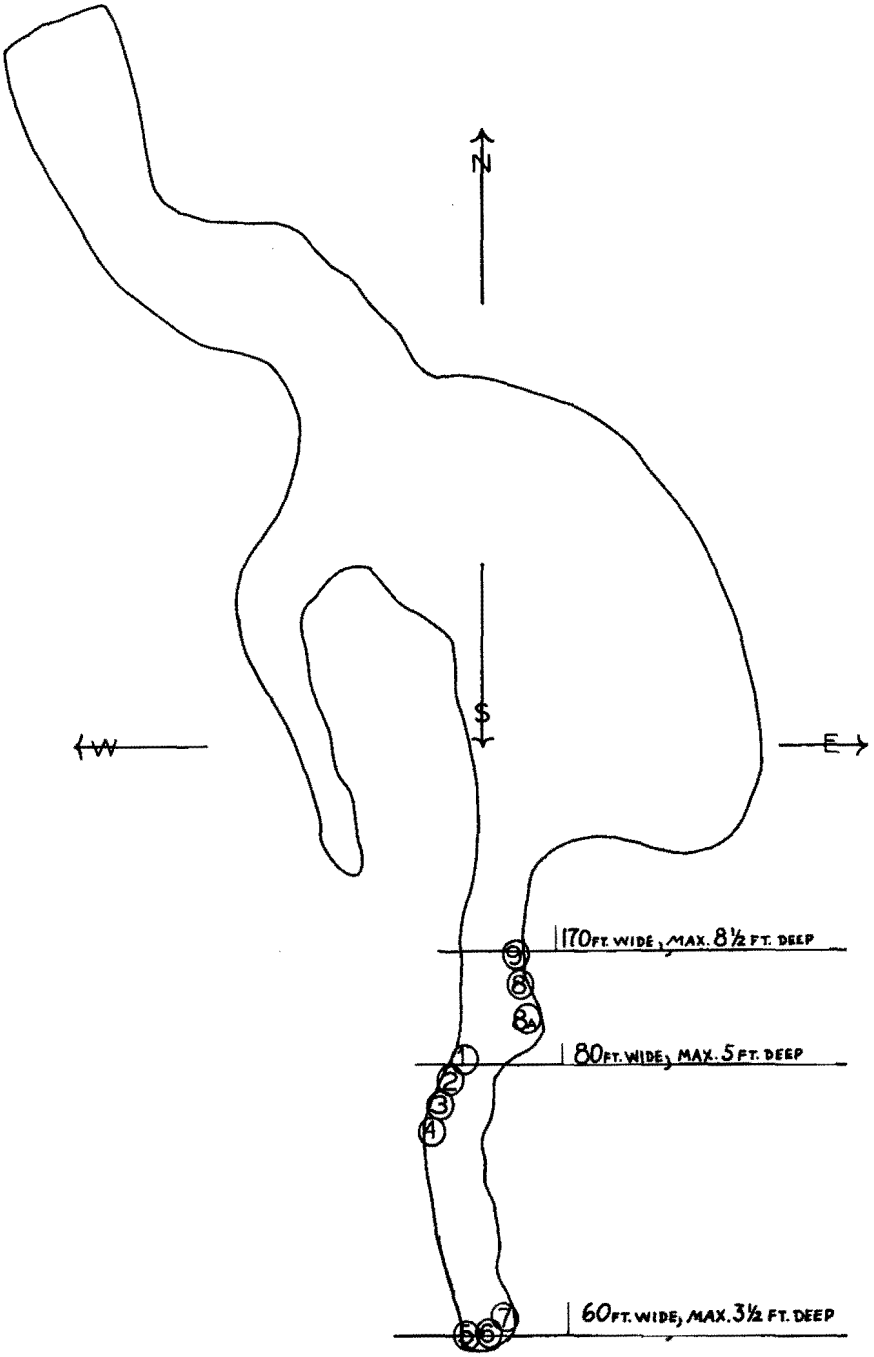


FIG. 2

Plate 7

Fig. 1 Collecting areas in Salem Pond, Salem, Utah

PLATE 7



COLLECTION AREAS
SALEM POND, SALEM, UTAH
ELEVATION 4600 FT.

FIG. 1