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An Introduction to the Study of the Ecology and Life History of *Valvata tricarinata*

Blossom Gershten
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This problem was undertaken as a summer study which would possibly serve as an introduction to a more complete and thorough investigation in the future.

The species under consideration, *Valvata tricarinata*, is a small univalve Gastropod belonging to the subclass Streptoneura, Order Ctenobranchiata, suborder Platypoda, superfamily Taenioglossa, family Valvatidae. There is only one genus in the family.*

Aside from general descriptions of external shell characters in most reference books, and a more specific description of the internal anatomy, shell characters, Wisconsin records of the species and subspecies in F. C. Baker's *Freshwater Mollusca of Wisconsin*, very little appears in the literature, and not much work has been done on the species.

This report will review the work done during the summer in locating the snail in its natural habitat, and studying its morphology and behavior and making general observations.

Because the species is supposed to be very general and numerous in distribution, it was thought that not much difficulty would be encountered in locating and collecting individuals for study. However, the areas investigated during the summer indicated a complete absence of living specimens in most of these places, a paucity in Douglas Lake, and a moderate number in Lancaster Lake.

Areas examined for *Valvata tricarinata*

Collections were made from late June through early August. A semi-circular dip net with a long handle, and a sieve were used for collecting.

Douglas Lake was studied for the presence of *Valvata* than any other

*Classification according to F.C. Baker

body of water in the region.

From June 23 to July 1, trips were taken almost every day by foot and boat along the Pine Point and Grapevine Point shores of Douglas Lake in depths of water up to six feet. Dead shells, but no living specimens were found. On July 2, some living Valvata were located along the cove near Grapevine Point about six feet from shore in water from 1.5-2 feet deep. The bottom was sandy, interspersed with small stones and without rooted vegetation. The water was calm, the air temperature about 68°F., and the wind slight. On July 4, more collecting was done in the same area under the same weather conditions. Specimens were present, but in very small numbers. On July 11, no living individuals were found in this same region which had previously yielded a small number. Some of the shells appeared to be from animals which had recently died, but even these were not numerous. Two subsequent trips to the same place in late July and early August indicated an absence of living Valvata.

On July 5, the opportunity to examine Lancaster Lake with the Invertebrate Zoology Class arose. Here, the first moderately numerous sampling of V. tricarinata was made. The east shore south of the Redman Cottage was surveyed. The morning temperature was about 80°F. and the sky was clear. The afternoon sky was overcast, terminating in rain, and the wind was high. Two types of habitat situations were present. In one, the bottom was composed mostly of small rocks and large rocks covered with marl, and some clay and mud. A sharp slope in the basin occurred about 4 feet from shore. The vegetation was abundant, particularly in Scirpus, Chara, Nuphea and Potamogeton. The temperature of the water was quite warm. In the other area, the slope occurred about 10-15 feet from shore, the bottom was sandy, and the vegetation not so abundant. The water was cooler than that of above. Collecting was better in the first area. Some specimens were found on the vegetation, but most of them were in the bottom material.

On July 12 and 26, the same area yielded a fair number of specimens.

On August 2, a different part of the same shore, this time north of the cottage, was examined, covering three types of habitats. The first had a gritty, stony bottom with a plentiful growth of Scirpus, and Equisetum. Here, the population seemed to be the same as other collecting areas had been. The second type was a circular area about six feet in diameter about two feet from shore in the midst of a bulrush growth. Its bottom was a mass of dead snells, and it contained no vegetation. No live species were present. The third region had very little rooted vegetation. The bottom was an algal, marly, stony, detritic mass. The vegetation consisted of Potamogeton, Anacharis and Chara. There seemed to be more V. tricarinata here than any other molluscan species.

The shore along Pine Point which is sandy and has some grass and bulrushes yielded no specimens, nor did the shore between Hook and Sedge Points where the bottom is silty and stony and the vegetation growth heavy. Much evidence of dead shells, some freshly dead, appeared in this area.

On July 16, trips were made to the east shore of North Fishtail Bay, the Sedge, Beek, Hook Point Area again, and a beach pool. Some dead snells were found in the point area, but none in the bay area.

Oqueoc River at the bridge on Highway M68, having a bottom composed of large and small stones, Oqueoc Falls with a limestone bottom, interspersed with sandy and silty areas, and Oqueoc Lake were visited on July 19. The lake shore was in some places sandy with sparse vegetation, and at other parts, the bottom was soft and mucky, and the vegetation dense. No living specimens were found in any of these places, but some dead shells were picked up in the lake.

The east shore of Vincent Lake was investigated on July 25. Some parts of the shore were sandy with no vegetation, and other areas were soft and oozy with abundant growth. Again, there were no living Valvata.

A summary of the foregoing data will be found on Table I.

Laboratory observations

Description of snail

Size: The snail is small, its shell measurements indicating a variation in diameter of 1.6mm.-4.6mm., and in height from 0.8mm.-3.5mm. The smaller snails are probably baby snails, and should not be considered as part of the range in size of the adult population.

Measurements were made by placing each shell on a ruler under the binocular microscope (dissecting type) in the manner shown in the sketch below.

The technique is poor, but serves as a n indication of variations in size within a collection.

Graph I shows the numbers of snails in each size group both for diameter and height. The curves are strikingly similar. Since the 107 specimens here represented are only from one collection trip, no conclusions can be drawn, but it is an indication of the correlation between the two dimensions. The curves also indicate for this group a peak in number among the 3.1-3.5mm., 2.0-2.5mm. group with a sharp drop towards the smaller size and a less sharp drop towards the larger size. This may indicate that most of the young have grown to almost maximum size, and that some of the parent snails are still alive.

Table II gives the data for these measurements.

Shell and operculum:

The shell color is generally deep buff with some specimens having a greenish appearance. Dark mottlings occur which are not present in the dead shells indicat-

ing that the spots are probably on the soft parts and showing through the shell. The spire is elevated, but the first two whorls are flattened so that they lie in one plane, these widening out to form the third whorl above which the first two are elevated. (Plate I fig. 2) The number of whorls is $2\frac{1}{2}$-3 2/3 with the greatest number falling between $3\frac{1}{4}$-$3\frac{1}{2}$. There are three carinae, the outer two being distinct and the middle one varying from indistinct through very distinct. In many cases where the middle carina is indistinct, it becomes more so toward the end of the last whorl than it it is near the apex. They are unmarked and light in color. On a number of shells, a distinct growth line which represents last year's growth can be seen. The umbilicus is deep, and the aperture is round and complete, the carinae forming little projections, as shown in the accompanying sketch.

The sutures of the whorls of the operculum are very distinct in the living specimen, more so near the nucleus, but in the mounted specimen the whorls become difficult to distinguish. Here the outer whorls are more easily noted than those surrounding the nucleus. From what could be observed, there were 10-11 whorls in the operculum.

Exposed soft parts: The only anatomy of the soft parts studied where those visible when the snail was normally extended. The foot is a short, wide, fleshy mass, bifurcated at the anterior end and rounded at the posterior end. The upper surface is darker than the lower surface, and a granular appearance is much more evident in the upper surface. The operculum is attached by only a small part of its area to the upper, posterior surface of the foot, the end of the foot extending a little beyond the operculum.

The cephalic region separates from the base of the foot just a little posterior to the beginning of the bifurcation. At the point of separation, it is a long tube-like structure widening out into two side pouch-like areas, one

on each side just back of the eyes. The protruberances seem to have an opening on the under side. The eyes are anteriorly located at the base, and dorsal to the tentacles. The tentacles are long and slender with a clear region along the outer edge and a granular region along the center. A long extrudible rostrum projects out from between and a little below the eyes. It has a segmented appearance, and ends in a little flap-like margin anteriorly. The color is lighter than the rest of the head which is generally dark above. (Plate I fig. 3) A buccal mass can be seen in the interior. This opens into a lengthwise slit at the end of the rostrum. (Plate I fig. 6) Two gills extend out from under the upper surface of the aperture, and are usually partially relected back over the shell. The left gill sometimes appears arborous with a narrow, filamentous shaft and thin branches. At other times, it appears as a wide filiform structure with an internal pattern. (Plate I fig 5) It seems to be attached to a membrane along the dorsal side of the shell, a short distance from the orifice. (Plate I fig 4) The right gill is rudimentary, looking much like a tentacle, but its internal structure is different. It has a diffused granular appearance, except for a few spots that variously dot the length of it.

The body of the snail when pulled from the shell follows the line of the whorls. A large green mass is obvious in the mid-section of the body. The most distal end becomes black in color. The spots on the body are probably those which show through the shell.

Movement and locomotion

The snail may be quiescent for long periods of time, or is very active. When the foot first appears as the snail expands, it is folded along its mid-transverse line, the two halves of the under surface opposing each other. As the head begins to appear, the foot is completely unfolded and flattened. The snail either smoothly crawls along on it, or slowly folds and unfolds it. The two

front lobes are frequently used as feelers. They were once observed in use as as bracers, where the snail pushed itself back and forth in the same spot by bracing itself against the sand. Usually this jerky movement is not noted, its movement generally being smooth.

The tentacles are constantly used to investigate the surrounding area. The rostrum is almost always used in examining the environment, and the rudimentary gill seems to be utilized as a feeler too. Once it was seen in an undulated position instead ~~insteed~~ of the ordinarily curved or straight position.

The snail expands just as readily when lying on its back as in its normal position. Generally, it quickly rolls over, and continues on its way. One snail was observed to make no effort to turn over, but constantly moved around while on its back

Most generally, the entire head is not extended, and only the tentacles, part of the rostrum , and gills can be seen.

The snails seem to be just as happy on the under surface of the water as on the bottom sand, and lie quietly suspended with the foot in an uppermost position, or crawl around in this manner.

Locomotion in and around vegetation is often seen.

General behavior

When many snails are kept in a finger bowl, they seem to be evenly distributed along the bottom sand, on the sides of the bowl, on the under surface of the water and on the vegetation. When kept in a stender dish, a snail generally migrates to the side of the dish, and up to the surface of the water.

The snails are usually quite sensitive to disturbances such as sudden movement of the water, and being touched with an instrument or finger. They contract rapidly, and if in an active condition, they very quickly expand again. If in a more sluggish condition, they may be much slower in coming out .

When at the height of its activity, the snails movements are quite extensive. The buccal mass is in constant, rapid motion foward and back along the rostrum. Each foward thrust is accompanied by an opening and widening of the slit (mouth) at the end of the rostrum. The sides of the dish, the surface of the water, the vegetation, the surface of the sand, and the interstices between the sand particles are explored with the rostrum this way. The movement is very rapid, and the radula becomes very evident with each forward push of the organs. The individual teeth can very clearly be seen.

One snail was observed as it approached a piece of lettuce a number of times, and retreated from it. Finally, as it neared the lettuce leaf, the movement of the buccal mass became more violent and the radula was thrust clear out through the orifice, the teeth spreading apart and actively scraping the lettuce surface. Finally, parts of a very small piece of lettuce were drawn into the mouth by use of the radula. The snail was on the under surface of the water during all this time.

Anything will be used for attachment when the snail is not on the bottom of the bowl, or floating on the under surface of the water.

On one occasion, a snail was seen submerged just under the water surface, with the lower surface of the foot uppermost, and the blunt end of the proboscis on the same plane with the foot. As it moved along, constantly working its mouth parts, it encountered a floating mosquito. After a while, the snail grasped at parts of the insect, particularly the legs, and swallowed them. At times, it was difficult to determine whether the snail was grasping at the appendage and releasing it again, or whether it was really being consumed.

Food

The only things seen eaten in the laboratory were lettuce and some

unidentified material which at first looked like excrement, but might have been some decaying, filamintous plant material which no longer had any chlorophyll. The mosquito mentioned above may have been utilized as food.

Waste is excreted by the snail in a tube-like mass which seems to have little sand grains in its construction. Small pieces of waste are also thrown off into the water at times.

Parasites, commensals, and associated organisms

Some of the snails in one bowl were heavily parasitized by Chaetogaster. They were seen on the rostrum, antennae, and gills. One snail seemed to lack an antenna, but Dr. Eggleton observed that it was completely contracted with a Chaetogaster at its base.

An annelid was found in the umbilicus of one of the snails being measured.

Algae frequently grow on the backs of snails.

Anomaly observed

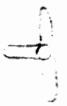
One snail was distinguished from all the rest by having one bifurcated antenna, and one normal filiform antenna. From the internal structure, it seemed to be an anomaly rather than the result of an accident or injury. The type of bifurcation is shown in Plate II. The snail's behavior was normal in all respects. It was isolated on July 5, and is still living. Perhaps attempts can be made to breed it in the future.

Eggs

Some egg masses were found on August 9 in the bowl containing specimens from Lancaster Lake, August 2, 1948. It has not been determined what species the eggs belong to, but attempts will be made to hatch them. Some of the masses were free and others attached to the sides of the bowl, with one mass attached to a snail's back. There are three to five round, green eggs in a round,

gelatinous capsule. The size of the eggs or capsule was not determined. Some of the eggs seemed to have two polar nipple-like projections with three or four striations. Two eggs had hooks (one hook on an egg).

On August 10, in another dish, single eggs in an unusually shaped capsule were observed stuck to the sides of the dish. Below are sketches of both types.



The source of these eggs may be many, such as the snails living in the dish, insect eggs laid in the bowl, or eggs brought in with the lake water.

Baker describes the eggs of Valvata as being a green mass of round eggs, from 10-30 in a mass. This hints that one of these two groups of eggs may be of the species.

Attempts will be made to hatch them.

Mating activity

On July 29, at 12:55A.M., two snails were noted in a position that may have been the copulating position. One snail crawled along the back of the other until their soft parts were in apposition, and their head parts crossing each other as shown in the sketch below. They remained almost quiescent until at

1:30A.M., one of the snails rapidly pulled in its head, possibly on being disturbed. The other snail remained attached for a while, and the two finally parted.

The two snails were isolated, and their dishes watched for the presence of eggs. None have been found to this date.

Reaction to adverse conditions

Valvata tricarinata does not seem to withstand abnormal conditions very well. Heat and crowding are fatal as proved by the death of a collection of snails which through circumstance were forced to remain in a hot automobile for an afternoon. Without frequent changes of water, the snails do not thrive too well in comparison to Amnicola which remains alive for weeks without any attention. Could this possibly be one reason why Amnicola is so abundant where Valvata is scarce?

Snails which were brought back with the algal mass in which they were found, and kept in that medium, seemed much more active and thrived better than snails from the same day's collection kept in plain sand.

Note

The snails in the laboratory were kept in finger bowls with sand on the bottom, those of each collection trip kept separate in one bowl or more depending on the size of the collection. The water was changed every day or two using lake water from the aquarium. Some vegetation from the natural habitat, and lettuce leaves were added. The bowls were not covered. If isolation of a snail was necessary, a 2-inch stender dish was used.

The snails were sometimes transferred to a 6-inch petri dishes for microscope study.

Slide preparation

Radula

Many attempts were made to mount radula with no success. The greatest difficulty was keeping the radula in sight in the course of dehydration. Generally, it was lost somewhere in the process, and in one case, it was lost in the balsam after being dehydrated, and transferred to a slide. Certain techniques were picked up, however, which in the future will be an aid in

mounting. Use of a depression slide and capillary tube for dehydration, and a camel's hair brush for transferring from dish to slide or slide to slide are helpful in the work.

The entire soft parts were soaked for 24 hours in 10% KOH, and washed in distilled water, as described in Guyer. The dehydrating alcohols were 50%, 70%, 95%, then dioxan, and mounting in balsam. The specimen was kept in each on for at least ten minutes.

One radula was mounted, and was reasonably clear after mounting, but turned black with time.

Operculum

The method suggested by Dr. Eggleton was used, namely putting the operculum through 50% and 70% alcohol, dioxan, and mounting. In case of lack of time, the specimen was kept in 70% alcohol.

Since not much could be distinguished, staining was attempted. Borax-carmine was used as described in Guyer, p. 246. The only difference in the stainedd specimen was perhaps a darker color of the crystals in the operculum.

Treatment of soft parts

Fixation of the entire living snail in hot Bouin's solution attempted according to Dr. Eggleton's directions. It was hoped that the shell would disintigrate leaving fairly well fixed the soft parts that could later be sectioned for internal anatomy study. The few that were done did not give good results. More work on this will have to be done.

Conclusion

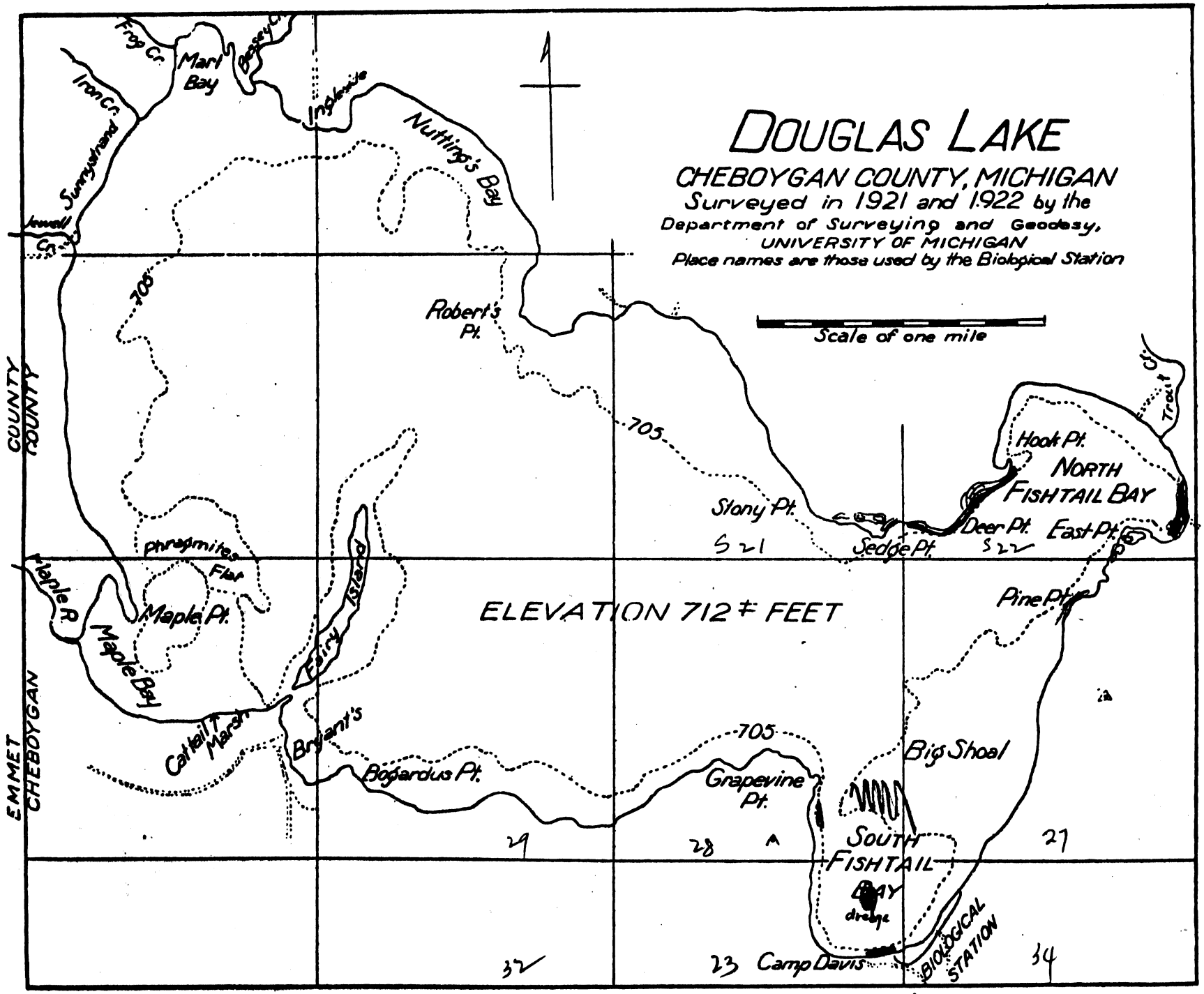
Since the summer was spent in becoming acquainted and generally observing the species, no specific experimental work was done. It is hoped that with the general knowledge gained, future work will be done which will add to the little

known on the ecology and life cycle of Valvata tricarinata.

Table I

Areas Investigated for the Presence of *Valvata tricarinata* (1948)

Date	Area	Locus Key	Description of Area	No. found Living	Hours Collected
6/22 - 7/1	Pine Point and Grapevine Point shores	T37N/R3W/S23, 28, 34	Sandy bottom; rooted vegetation in some places, but none in others	0	—
7/2	Cove near Grapevine Point	T37N/R3W/S28	sandy bottom, small stones, no rooted vegetation	13	2
7/4	Same	Same	Same	17	2 1/2
7/11, 8/2, 8/6	Same	Same	Same	0	—
7/5	Lancaster Lake near Redman Cottage (S. of Cottage)	T37N/R3W/S8	1. large and small rocks, marl, clay, mud, abundant vegetation	42	4 1/2
			2. more sandy, less vegetation		
7/12	Same	Same	Same as 2. above	56	2
7/26	Same	Same	Same	about 60	2 1/2
8/2	Lancaster Lake East shore (N. of Cott.)	Same	1. gritty, stony bottom; Scirpus, Equisetum	47	2
			2. Shell bottom; no vegetation	0	—
			3. algal, marly, stony, bottom mass; Potomogeton, Brachanis, Chara	41	1 1/2
7/10	Pine Point	T37N/R3W/S27	sandy shoal; little vegetation	0	—
	Sedge-Hook Pts.	T37N/R3W/S21,22	silty, stony; heavy vegetation	0	—
7/16	N. Fishtail Bay (E shore)	T37N/R3W/S22	Sandy; no vegetation	0	—
	Sedge, Deer, Hook Pts.	S3M5	marly, silty, mucky, Bulrushes	0	—
	Beach pool	S3M5	typical filling-in vegetation; many dead shells	0	—
7/19	Ocqueoc River at bridge on M68	T35N/R3E/S27	large and small stones	0	—
	Ocqueoc Falls	T35N/R3E/S22	limestone bottom; few silty or sandy areas	0	—
	Ocqueoc Lake	T35N/R3E/S30	mucky, heavy vegetation; sandy	0	—
7/24	Vincent Lake East Shore	T37N/R3W/S17	Some parts sandy; no vegetation. Other parts soft and mucky; much vegetation	0	—
7/23	S. Fishtail Depression with Dredge			0	



PLACES INVESTIGATED IN DOUGLAS LAKE (red)

Table II

Measurement of Snails
Number of Whorls and Type of Carinae (where done)

Lancaster Lake-August 2, 1948 (Habitat 1.)

Diameter mm.	Height mm.	Carinae	No. of Whorls	Diameter mm.	Height mm.	Carinae	No. of Whorls
3.0	1.5			3.2	2.0	3d	
3.3	1.8			2.7	1.8	2d 1s	
2.8	1.3			3.2	2.2	2d 1s	
3.0	1.1			3.1	1.9	2d 1i	
3.3	1.9			3.0	1.7	2d 1s	
3.5	2.5			2.5	1.3	2d 1s	
3.5	2.2			1.6	0.8	2d 1s	
3.7	2.5			3.2	3.0	2d 1s	
3.0	2.1			3.2	2.9	2d 1i	
3.5	2.5			3.0	2.1	2d 1i	
3.1	1.9			3.5	2.7	2d 1s	
4.0	2.3			2.9	2.0	2d 1i	
3.1	2.1			3.7	2.0	2d 1i	
3.7	2.5			2.5	1.5	2d 1i	
3.4	2.3			4.0	2.8	2d 1i	
3.8	2.4			2.3	1.5	2d 1i	
3.3	2.1			3.7	2.5	2d 1s	
3.8	2.9			2.5	2.0	2d 1s	
3.2	2.3			3.2	2.3	3d	
3.4	1.9			2.5	1.5	3d	
3.8	2.8			2.7	1.3	2d 1i	3
4.0	2.3			2.7	1.3	2d 1i	3
3.8	2.1	3d		3.1	2.2	2d 1i	3
3.3	2.3	3d					
			Habitat 2.				
3.9	2.7	3d	3	4.0	2.8	2d 1s	3
2.7	2.2	3d 1s	3	2.4	1.5	2d 1s	2 1/4
4.3	3.0	2d1 1s	3 1/2	3.5	2.3	2d 1i	3 1/4
4.0	3.0	2d 1i	3 1/4	4.0	2.5	3d	3 1/4
4.0	3.0	3d	3 1/4	4.2	3.3	2d 1s	3 1/4
3.5	2.4	2d 1s		3.5	2.3	2d 1s	3 1/4
4.5	3.0	3d	3 1/4	3.3	2.7	3d	3 1/2
4.1	3.0	3d	3 2/3	2.5	1.3	3d	3
3.9	3.0	3d	3 1/2	4.0	2.6	3d	
3.7	2.6	3d	3	4.1	3.0	2d 1s	3 1/4
4.0	3.0	3d	3 1/2	2.9	2.0	3d	3
3.2	2.1	3d	2 3/4	4.0	3.2	2d 1s	3 1/2
3.7	2.7	3d	3	3.5	2.3	3d	3 1/4
4.1	2.7	2d 1s	3	3.3	2.2	3d	3 1/2
3.5	3.0	3d	3	2.1	1.3	2d 1s	3 1/4
4.5	3.0	2d 1i	3	3.5	2.7	3d	3 1/2
4.0	3.0	2d 1s	3 1/4	3.9	2.5	2d 1s	3 1/4
3.6	2.5	3d	3 1/4	3.7	2.7	3d	
3.2	2.7	3d	3	3.3	2.0	2d 1i	3 1/2
3.8	2.5	3d	3	2.9	1.9	2d 1s	3
4.0	3.5	2d 1s	3 1/4	3.2	2.2	2d 1s	3
4.0	3.0	2d 1s	3 1/4	3.2	2.3	2d 1i	3

Table II (concluded)

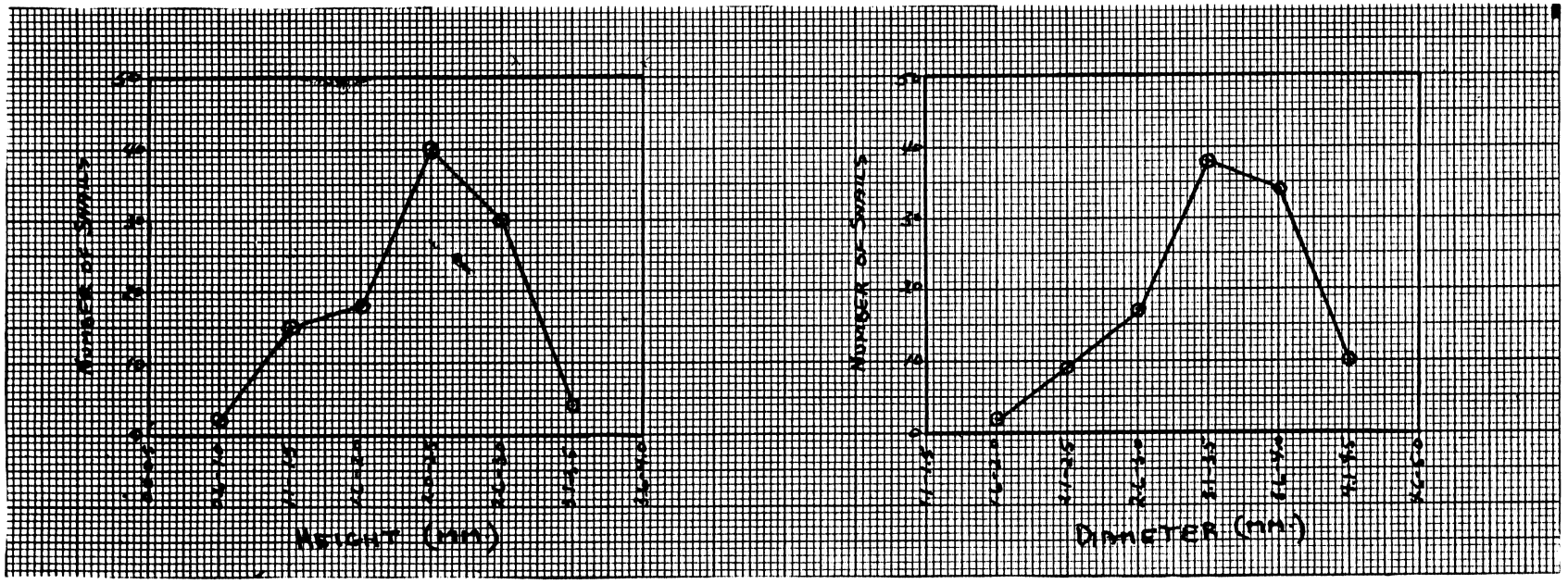
Diameter mm.	Height mm.	Carinae	No. of Whorls	Diameter mm.	Height mm.	Carinae	No. of Whorls
4.0	2.8	2d 1s	3¾	4.0	2.5	2d 1i	3½
3.5	2.4	2d 1i	3¾	2.6	1.7	2d 1s	2 3/4
3.4	2.2	2d 1i	3¾	3.2	2.7	2d 1s	3¾
4.6	3.0	3d	3¾	3.0	2.4	3d	3¾
2.6	1.3	2d 1i	2 3/4	3.3	2.0	2d 1s	3¾
4.0	3.2	2d 1s	3¾	2.2	1.2	2d 1s	2 3/4
3.5	2.0	2d 1s	3	3.8	2.5	2d 1s	3½
3.3	2.1	2d 1i	3½	2.0	1.1	2d 1i	2½
2.7	1.6	2d 1i	2½				

Summary

Diameter mm.	No. of Snails
1.5-2.0	2
2.1-2.5	9
2.6-3.0	18
3.1-3.5	39
3.6-4.0	34
4.1-4.5	5
	107

Height mm.	No. of Snails
0.5-1.0	1
1.1-1.5	15
1.6-2.0	17
2.1-2.5	40
2.6-3.0	30
3.1-3.5	4
	107

GRAPH I



COMPARISON OF HEIGHT DIAMETER CURVES TO SHOW
RELATIONSHIP OF ONE TO THE OTHER
INDICATION OF DISTRIBUTION OF SIZE GROUPS

Explanation of Plate I

Fig. 1.....Shell of *V. tricarinata*
Fig. 2.....Shell with gills and tentacles exposed
Fig. 3.....Head of snail
Fig. 4.....Aperture showing origin of gills
Fig. 5.....Differences in appearance of plumose gill
Fig. 6.....Internal buccal mass and mouth (outline)

PLATE I

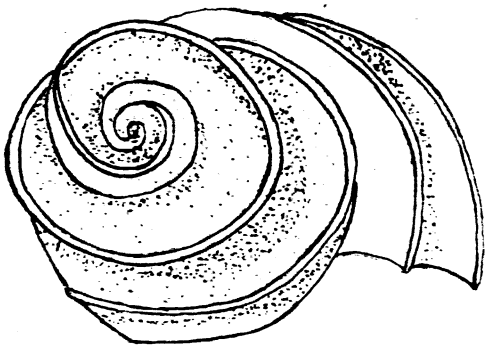


Fig. 1.

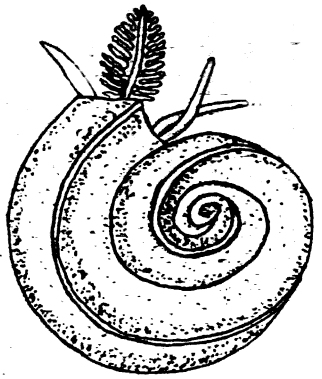


Fig. 2

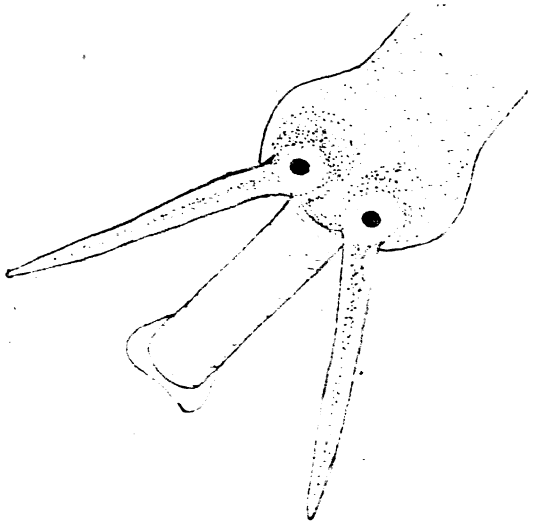


Fig 3

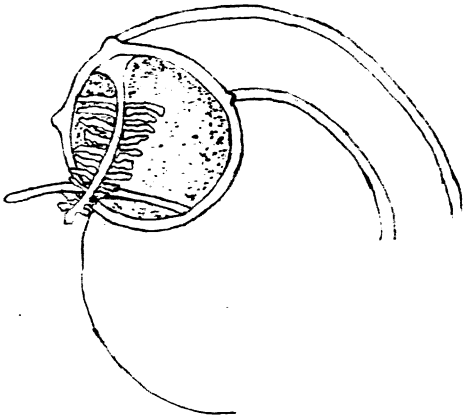


Fig 4.

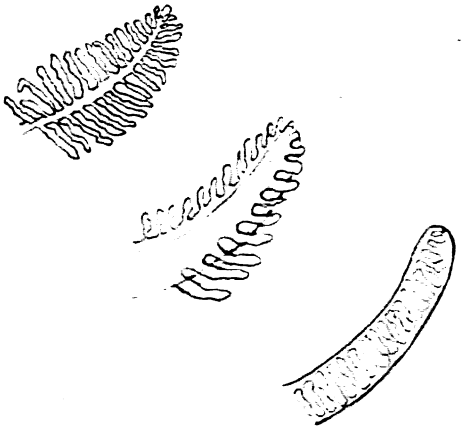


Fig 5

Fig. 6

PLATE II

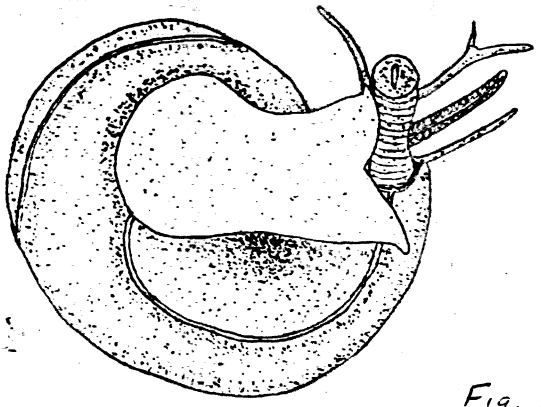


Fig. 1

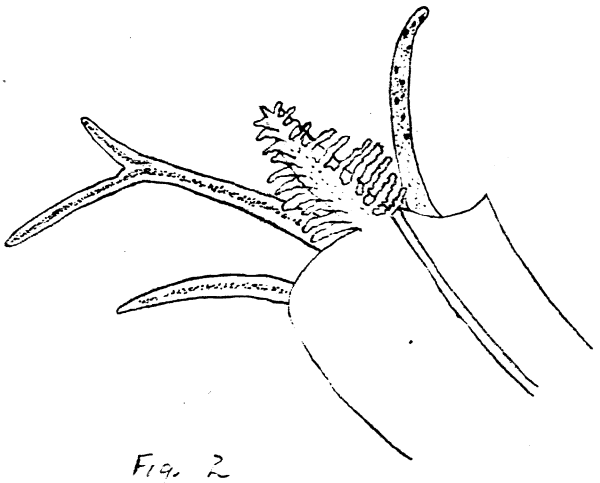


Fig. 2

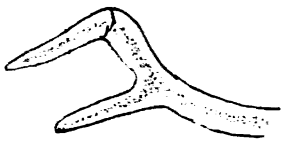


Fig. 3

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