

NATURAL HISTORY OF ~~GONIABASIS~~ GONIABASIS LIVESCENS(MENKE)

(1)
1937
Report

IN DOUGLAS LAKE, MICHIGAN

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In Douglas Lake, Michigan, Goniabasis livescens(Menke) is an inhabitant of the sandy shoals in which the descent into deep water is abrupt and reasonably close to the shore. It also thrives best on those shoals which are protected from the sweep of the strong prevailing winds from the west and northwest. This species of snail belongs to the sub-class Streptoneura and family Pleurocera. It is strictly a fresh-water mollusk .

Goniabasis livescens was unknown in Douglas Lake until about twenty five years ago when it was introduced into the lake by Prof. H. B. Baker. Since that time it has thrived in the regions of the lake where it was introduced and may be gathered in quantities at any time during the period in which the University of Michigan Biological Station is in session.

Since the time of its introduction into the lake, it has been a familiar snail among the students of the Station and a subject of a considerable amount of study by the parasitological group. However, the questions of its food, ecology, life cycle, distribution, etc., has never been a matter of serious study by anybody connected with the Station. "either has any completed work been done on the detailed phases of the life cycle by anybody else as far as the writer has been able to learn. The work of Van Cleave and Jewell¹ apparently leaves the field open for further detailed study.

As a beginner's attempt in the field of research a study of the various phases of Natural History of Goniabasis livescens was begun under the direction of Dr. Frank E. Eggleton. The period during which the Biological Station was in session, June 28 to August 21, 1937 included the time of the study.

The kindly criticism and helpful suggestions of Dr. Eggleton and the assistance of the Director, Prof. G. R. LaRue in placing collecting materials at the writer's disposal, are greatly appreciated.

DISTRIBUTION

In Douglas Lake Goniabasis livescens is essentially an narrow inhabitant of the sandy shoals, and to date has not been found in any part of the lake except South Fishtail Bay, and in that Bay only from Grapevine Point southward and eastward to the old site of the Biological Station. A survey of the lake at all points at which it might occur is as yet incomplete, but none have been found in the areas near Bryant's, Fairy Island, Marl Bay, Ingleside, Sedge Point, or North Fishtail Bay. (See attached map)

DISCUSSION OF THE POINTS SURVEYED

(South Fishtail Bay not included)

Marl Bay

On July 6th this region was explored for traces of the snail in question. This is a region of loose marly encrusted sand with a wide shelf, gentle slope and well protected. Sedges, especially species of Scirpus and alder associations of high bush shrubs occupy the littoral regions. In the sub-littoral regions Scirpus

validus and plants of the Typha associations occupy a prominent place. Potamogeton beds and extensive areas of Chara fetida

are at the edge of the limnetic zone. No specimens of Gonia-basis were found at all. Mud screens, a special dip net used in snail collecting, and a glass bottom bucket were used in the sampling. Campeloma rufum, G. decium, Helisoma sp. and Sphearidae were found in abundance. The little bay at the mouth of Bessey Creek was given especially careful searching.

Ingleside Beach

During the time the Biological Station people have given any consideration it has been commonly taken for granted that Gonia-basis livescens has not spread to wider shoals of the lake because it could not support itself on the loose sands in the face of the wave action. With this point in mind, Ingleside Beach was also surveyed for traces of Goniabasis. This is a beach with a gentle slope and many small boulders ranging in size from a volume of a few cubic inches to a volume of 200 or more cubic inches. In view of ²Kreckger's findings in regard to exposure and strong wave action, this site should be well suited to the species. It is well protected and there is plenty of support for the snails. Sedges fringed the shore and beds of Chara and Potamogeton were common at the edge of the shallow water. *None were found.*

Grapevine Point (Station 6)

The name Station 6 was given to the first little bay west of Grapevine Point. The designation of areas by stations was arbitrarily adopted as a simple means of recording locations in the field notes and the avoidance of descriptive locations in the write-ups which were to follow. Station 6 is so close to

Station 4 (see maps) that Goniabasis might very easily have migrated around the point and become well established if distance alone is to be considered. Station 6 is well exposed to prevailing winds and a considerable amount of wave action. However, it is well littered with boulders at such depths that the snails could easily find support deeply enough to avoid disturbance of the equilibrium, which, according to Krecker² is a very important factor in the maintenance of the snail in rough waters. The boulders and sands of this bay are deeply encrusted with matl. No specimens of Goniabasis were to be found. Helisoma campanulata was found in abundance.

Other Situations Observed

No specific detailed survey was made of the other regions observed. However, on field trips connected with course work, a close watch was made of the shallow waters of Sedge Point, North Fishtail Bay, the waters along Pine Point, and all the region from Station 6 to Bogardus Point. No specimens of Goniabasis were found in any of the places. In view of a population introduced twenty five years ago, there has been ample time for establishment at any of the regions with the exception of the Mad Bay and Ingleside regions. All of these areas appear to be such as the snail might find suited to its needs, but for reasons as yet unknown they do not thrive there.

THE CHIEF AREAS OF ABUNDANCE AND STUDY

The areas in which Goniabasis was found most abundant at all times during the study are best shown on the enlarged sketch map of the west shore of South Fishtail Bay. This region was arbitrarily divided into Stations 1, 2, 3, 4, and 5. Station 5 is assigned

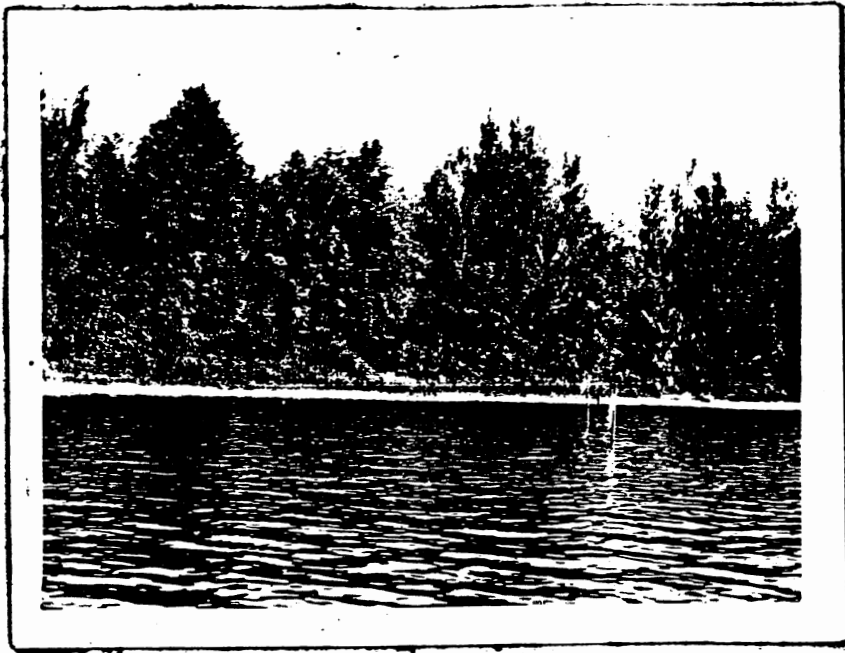


Photo of Station 4 showing the absence of boulders or any materials which might be used for oviposition as is common supposed. Also to show a general view of a well protected area in which *Goniabasis* is very common.

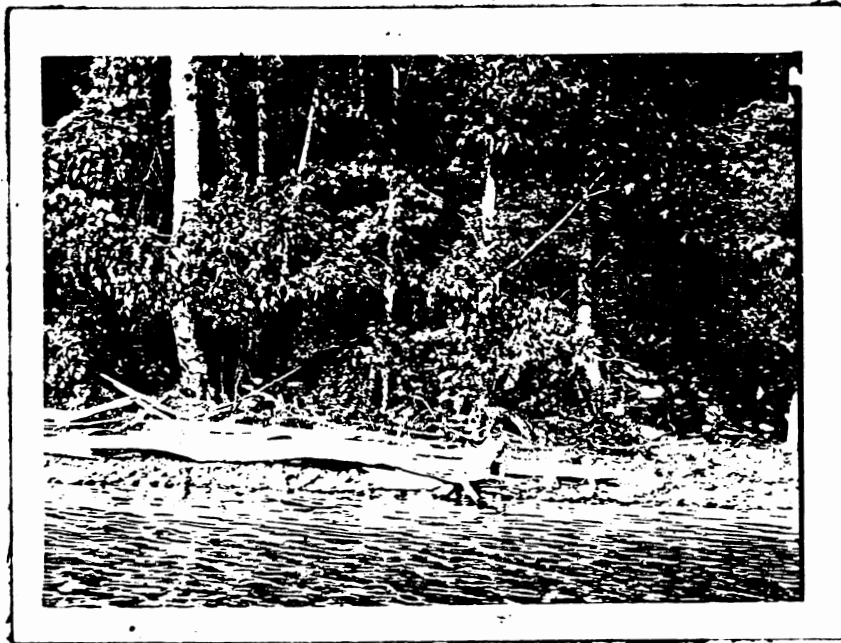


Photo of Station 5 to show the type of shoreline and the boulders where eggs are commonly supposed to be laid.

to the lengthy area occupying most of the west shore of the bay.

In these areas the snails were abundant throughout the period of the session. One exception occurred to this general statement; immediately following a three day period of heavy winds, very few snails were to be found. The cause was not determined, but, in view of later observations, one is inclined to believe that during such periods of disturbance they become quiescent and are buried slightly by the wave action.

It will be noted from the sketch map that all along this general region of the bay the shoal is narrow, in no place exceeding 100 to 125 feet in width. At Stations 1, 2, 3, and the northern fringe of Station 4, the face of the declivity is within ten to twenty feet of the shore. The outer edge of the shoal is marked by an abrupt descent into deep water, the angle of which is the angle of repose of fine sand in water. This descent begins at $1\frac{1}{2}$ to $1\frac{3}{4}$ meters.

Reference to photos #1 and #2 will disclose that there is a decided difference in the shoreline of Station 4 and Station 5. The shore lines of Stations 1, 2, and 3 are essentially the same as that of Station 4. The shoal along Stations 4 and 5, and particularly the edge of the declivity is well sprinkled with sunken timber ranging from small limbs to logs of twelve or more inches in diameter. Small boulders of 50 to 300 cubic inches in volume are also to be found along the shoal waters, but are not as numerous as those along the shore of Station 5. These for the most part are buried from one half to two thirds of their volumes. The exposed portions are heavily marl encrusted. In all the region the sand is loose but intermixed with a considerable amount of marl deposit. Very little loose debris is to be found except at the edge of the shoal in the deeper water.

STUDIES CARRIED ON

The intensive study was undertaken in several directions somewhat simultaneously, not all of which gave significant results as far as determination of the life cycle was concerned. Census counts were made in an attempt to learn why small local areas were so much better adapted to *Goniabasis* than others and to determine if possible the cause and extent of local migration. Eggs, supposedly those of *Goniabasis*, were taken with the stones to which they were attached, to the aquarium shelter for hatching. Some brief study was made in the attempt to determine possible hybridization in the twenty five years since the snail was introduced into Douglas Lake.

An attempt was made to study extent and time of migrations. A series of measurements was made to determine if there was any segregation into definite age groups, suggestive of the length of life span.

Each summer a large population of the snail appears on the wider shoals of South Fishtail Bay but is never able to maintain itself there for succeeding seasons. A series of cage experiments was undertaken to determine if there was any other factor besides lack of support entering into their failure to maintain the population for more than a few weeks.

Anything pertaining to the general biology of the snail and not pertaining to any particular part of the study was observed as far as possible.

Egg Development.

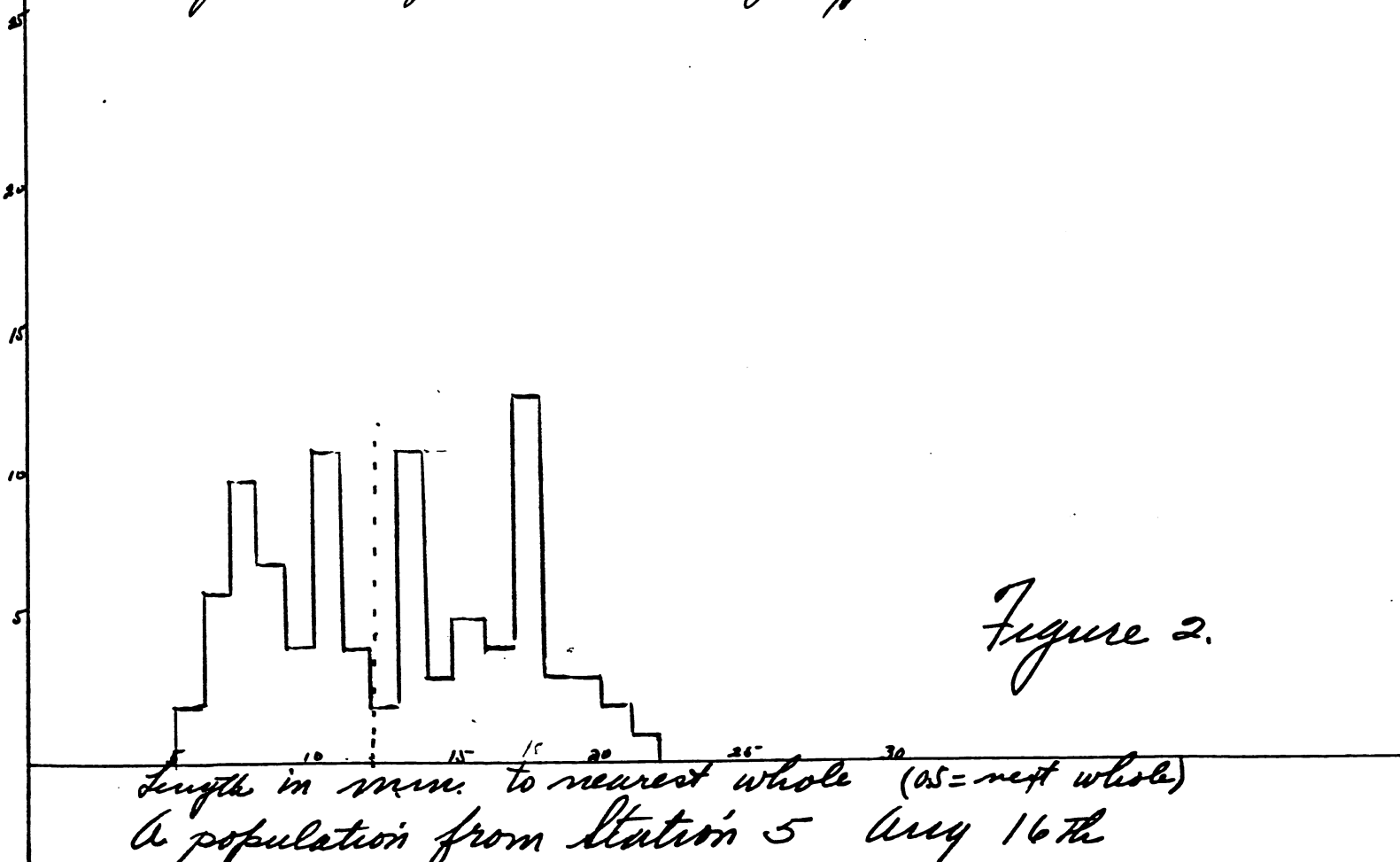
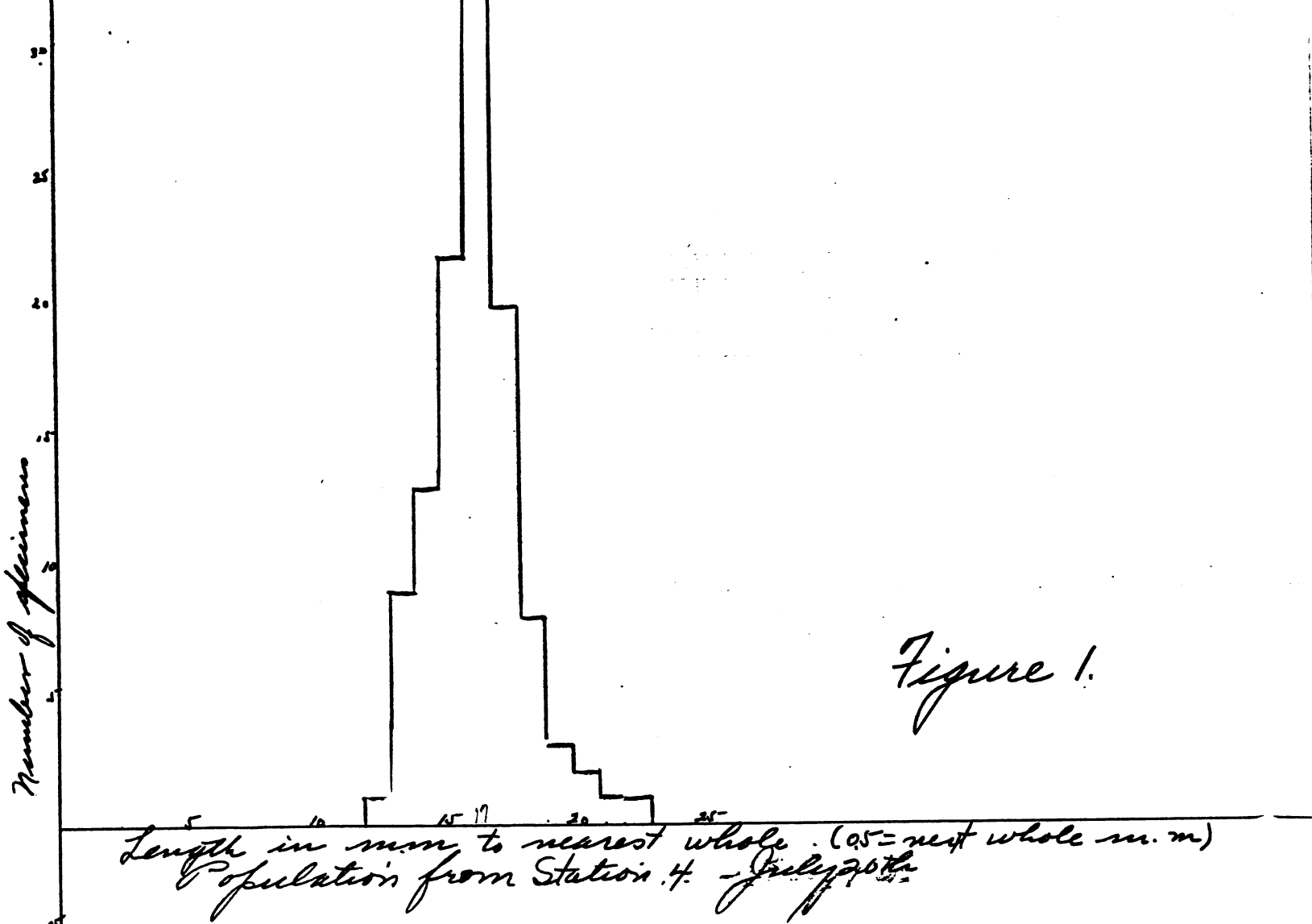
Eggs, supposedly those of *Goniabasis livescens*, were taken along with the boulders on which they occurred from Station 5 and placed in the aquarium in the the aquarium shelter. They were collected July 6th. At that time the aquarium was supplied with water from the Station well. After about ten days the eggs decomposed.

By the time the aquarium shelter was supplied with lake water no more eggs were to be found. What appeared to be eggs later on turned out to be colonial rotifers. The rearing of young from eggs will have to await another season. There is evidence that possibly two broods per year are hatched, but no eggs were found to support the evidence. In fact, a statement as to where eggs are laid would be based entirely upon presumption.

Measurement Studies

A study of measurements was undertaken to determine if possible what age groups were to be found during the months of July and August. As this was the first attempt at anything of a statistical nature, the mistake was made of undertaking to measure too many dimensions of the snail. Thus too few specimens were measured for the results to be conclusive. In addition to the measure of length, measurements for diameter (obesity) and length and width of the aperture were made. Length appears to be the chief measure on which age groupings might be made.

In measuring a vernier caliper was used. Length was considered as the measure from the apex to the further extremity of the aperture. Diameter measure did not represent greatest diameter of the body whorl, but the diameter just below the upper extremity of the aperture. Measured at this point there was less chance of error. Length of the aperture was considered as the distance from upper edge to the extremity of the lip. Width of the aperture was considered as the distance from the point of union of the columella and the body whorl to the portion of the lip directly opposite. This measure was probably subject to a greater degree of error than any of the others as the point of union of columella and body whorl is often very hard to see in dark colored specimens.



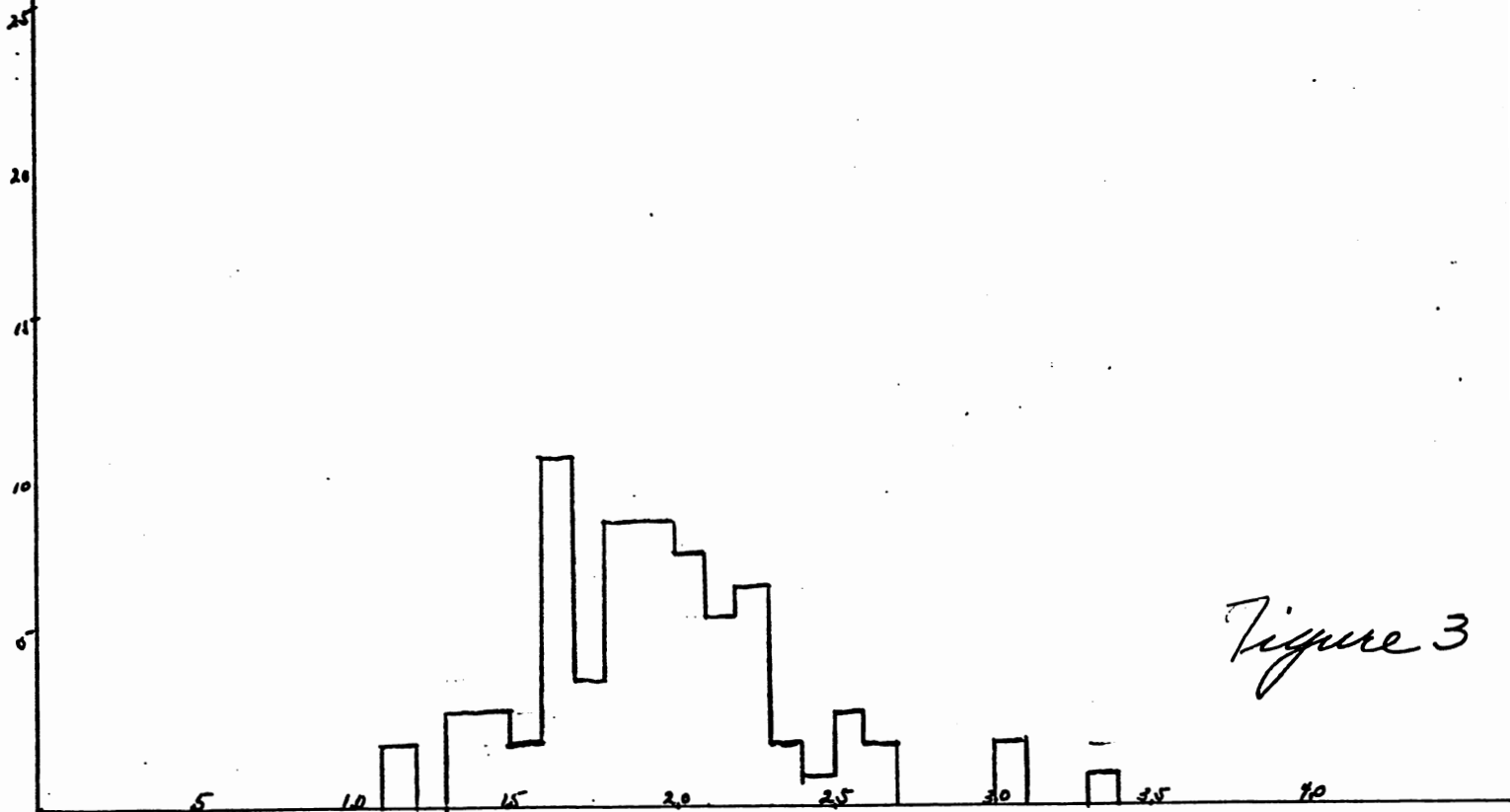


Figure 3

Lengths expressed in 0.1 mm.

75 specimens

Size-frequency chart of Minute Specimens
of *Coriabasis livescens*.

A population measured July 8th was too small to have any significance in statistical count.

Analysis of the measurement figures is shown in Figures 1, 2, and 3. A study of Figure 1 indicates that the population from Station 4, (and the largest one studied) is of one age group, presumably adults or near adults. As to the age of an adult, evidence is still lacking.

It is not to be understood that the figures indicate strictly that no other age groups were present in the area. At the date of collecting no screen had been used which was fine enough to retain minute specimens such as were found some time later. The personal error in this series of measurements lay in assuming that because no snails less than ten to twelve mm. in length were to be seen, no smaller ones were there. Later collecting showed they were probably there in quantities at the time. The fact that no eggshells suitable to ovi-positions were to be found along the shore also probably had something to do with the assumption that no small ones were to be found in Station 4. It was assumed the population there was a migrant one.

A study of Figure 2 indicated the presence of two age groups. It will be noted that there is a definite break in the graph at the thirteen mm. length. A comparison with Figure 1 in which seventeen mm. snails predominate shows that there is a group in Figure 2 corresponding closely with those of Figure 1. Figure 1 shown no specimens shorter than twelve mm. As the left hand side of Figure 2 shows a range from five to twelve mm. in length, it appears that this represents another age group altogether. It is not to be assumed that this group was not present on July 20th. Faulty sampling or the possibility that they were buried in the sand probably accounts for their not being found. The question arises as to whether they are spring hatched snails attained to a length of 5-12 mm or whether

they are juveniles of last season's hatching. The best that can be said is that improved technique in measuring, sampling, and the using of larger populations should by all means be continued.

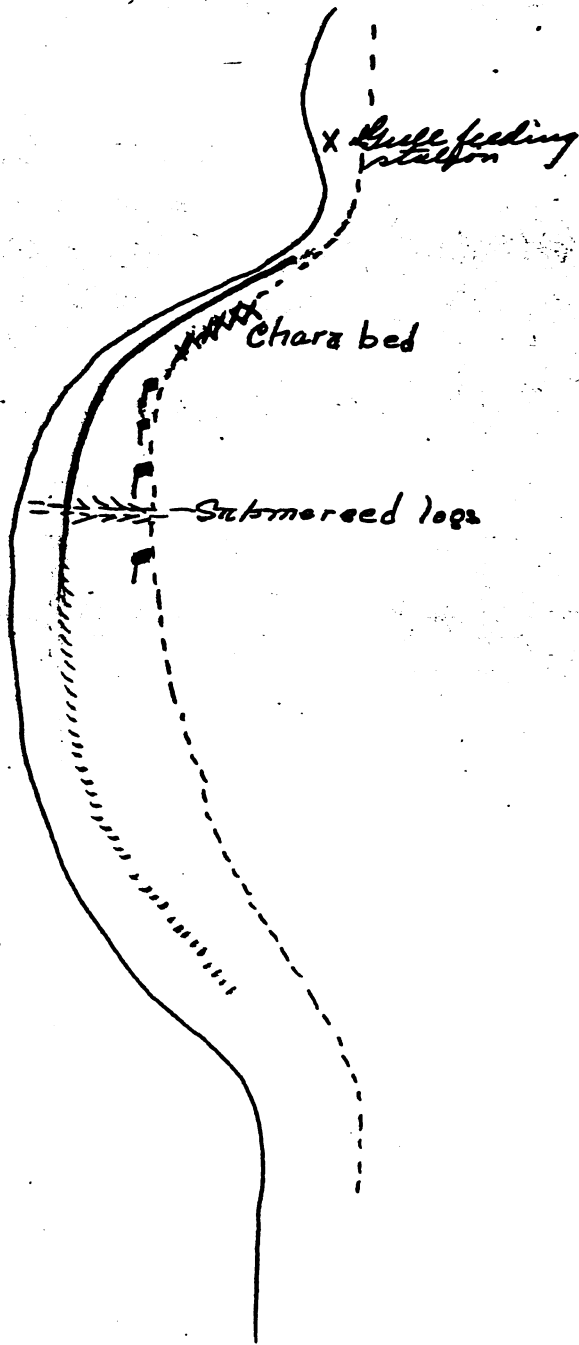
On August 4th, while attempts were being made to find eggs that might prove to be those of Goniabasis, minute specimens were found in water one third meter in depth at Station 5. They were just beyond the row of boulders and some six feet from shore. None were to be found on the boulders or in the fine sand among the boulders. Further sampling with a thirty mesh screen showed that they were inhabiting the loose sand from a depth of one third meter to a meter or more. Few were to be found near the edge of the declivity, the greater portion of the population being found at a depth not to exceed one half meter.

The belief of some workers that the young of Goniabasis liviscens inhabit a different region from that of the adults is not borne out in this case.

The presence of minute forms in this region of the lake and at that time of the year points to the possibility of their having been hatched from a second egg deposition in the middle of summer. It only reemphasizes the question: Where and when are eggs laid?

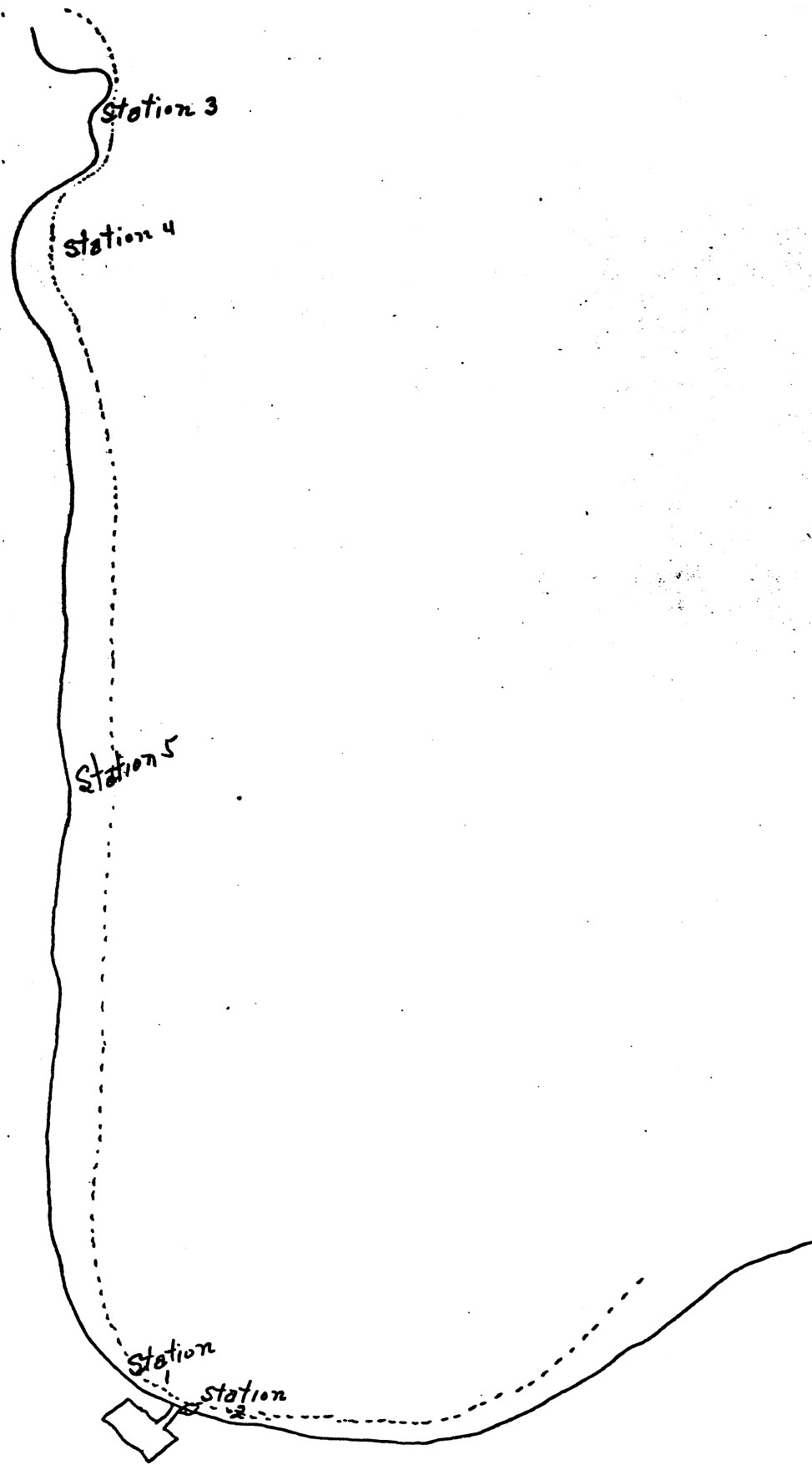
Search for minute specimens was then undertaken in Station 4. Here no boulders line the shore on which eggs might have been laid. Snails of the same sizes as those found in Station 5 were found even more plentifully, and what seemed especially ^{angular} queer, were found in that portion of Station 5 where the adult specimens had not been found in quantity at all. In the region where the adults had been plentiful all the season, they were especially numerous. No statistical counts were made as to the density of the population. They were also found near the submerged logs at the face of the declivity.

See sketch map of Station 4.



P Food-support
 cage experiments
 — area in which
 snails were plentiful
 all season.
 ||||| area of low population
 all season.
 - - - - Edge of shoal.

Enlarged sketch of Station 4
 where the greater part of
 the work was carried out.



Enlarged sketch of West Shore of South Fishtail Bay showing arbitrary station assignments for convenience of record keeping.

In the light of present knowledge no satisfactory explanation can be given of these findings. Two possibilities suggest themselves: (1) There is a possibility that, if eggs are laid on boulders, they may also be laid in the loose sand of such habitats. (2) There is the possibility that they may be laid on submerged timbers, and the young migrate shoreward into the warmer waters soon after hatching.

The graph as shown in Figure 3 shows the size range of the minute forms. Certainly they do not represent the same age group as the five to twelve mm. forms, and evidence is badly needed to indicate if ~~they two groups~~ represent snails from two different years or different broods from the same year. The failure of having some of the badly needed evidence lies in failure to segregate and hatch eggs of *Goniabasis livescens* under controlled conditions.

An attempt was made to determine the rate of growth of the smallest specimens, but time limit did not permit the securing of any significant figures. Seventy five (75) of the smallest were measured by means of the compound microscope using the sixteen mm. objective and eyepiece fitted with ocular micrometer. Calibrating was done with the stage micrometer.

The smallest specimens were ^{found} to be 1.172 mm (two of them) and the longest was 3.144 mm. The average of the seventy five was found to be 2.019 mm. or 37.88 ocular units.

The snails were then placed in an aquarium in the aquarium shelter on sand from the same region from which they were taken. Lake water trickled through the fine cloth cover of the aquarium. Twelve days later they were again measured in the same manner as before. The second measurements showed an average of 38.11

ocular units or an average gain of 0.23 ocular units. When the calibration factor was applied to the average gain it was found to be 0.012 mm. or a gain of one micron(0.001 mm) per day.

There is nothing of significance in these figures, especially in view of the personal error involved in the failure to prevent one third of the snails escaping through the cloth covering of the aquarium or around the fastening. All things considered the measurement studies only paved the way for more detailed and systematic study of growth rates and age groups. Too many personal errors were involved, and the elimination of many of these in future work should show some worthwhile statistics regarding age groups. One of the things worst needed is a group of figures which will indicate age grouping in such a manner as will give some hint as to the length of life span.

CENSUS COUNTS

Four attempts were made to arrive at some census figures which would cast some light upon the lack of a population in the portion of Station 4 where snails were so few all during the time of the study. Apparently the conditions in this part of the area were no different from those in the portion where they were plentiful. (See sketch map of Station 4) No figures of any significance were obtained except in one instance. A count was made along the shallow waters water of Station 4 ; the depth ranged from 0.1 to 0.3 meter and the sample intervals were approximately 1.5 meters. A sampler made of galvanized iron and shaped like a dust pan was used. The bottom was made of 1/4-inch sand screen with a supplementary layer of sixteen mesh galvanized window screen over that. The area was 660 sq. cm. but in practical use about 1000 sq. cm. of the surface sand were removed as the scraper was pushed gently forward at a depth of eight to ten centimeters.

While the chart shows nothing of value as a census it shows the extent of the tendency to become buried in loose sand. This tendency was noticed repeatedly throughout the time of the study.

No. samples taken	Snails visible	Snails visible invisible	Total	% visible	% invisible
64	10	21	31	33-	67plus

The low total count is accounted for in the next chart. (See below)

Examination of specimens buried in the sand and observations of their behavior when placed in a different habitat indicate that they are normal, and such burying is not due to any abnormal condition. The question arises as to the possibility of their feeding while they burrow. Possibly such is one normal manner of feeding.

The following figures are presented as an example of the sudden leaving off of a population in a region which appears to be equally favorable to their habitation at all points. By comparison of the count with the ^{sketch} map of Station 4 it will be seen that there seems to be some relation of numbers to the proximity of deep water. Later examinations showed approximately the same situation.

Samples # 1 - 20

0.145 snails per sq.m. (?)

Samples # 21 - 64

0.00454 snails per sq. (?) m.

The population in the first twenty samples where the deep water approached the shore was 34.1 times as great as in the last forty-four samples where the shall was wider.

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Although no attempts were made to get a census count on submerged logs, snails were abundant there at all times during the session. They were to be seen on logs extending lengthwise down the face of the declivity and as deep as it was possible to see with the glass bottom bucket. The snails seemed to exhibit a decided preference for coniferous logs, especially Thuja. Very few were to be found on oak logs. On the logs many specimens were so marl encrusted that they appeared to be much larger than they really were, and not to have left the log for a long time. Those in the loose sand seldom showed any encrustation, but did show the polished effects of having crawled about in the sand.

STUDY OF VARIATION

So far as is known there has been no attempt to study variations in *Goniabasis* since the time of its introduction twenty five years ago. In fact, in so far as it has been possible to learn, there is no assurance that *Pleurocera acuta* might not have also been introduced along with the population of *Goniabasis*. Close study is required to determine the differences between the two. Apparently Prof. Baker left no record of the introduction of the snails.

In the handling of many snails unusual individuals showed up from time to time. Of these the most noticeable feature was the appearance of the aperture more to the left of the median longitudinal line than was usual. This feature did not show often but frequently enough to arouse suspicion as to the possibility of there being another species or variation carried to a decided extent. Time did not permit extensive search for such specimens, but a start was made on a statistical study in connection with length and growth measurements. Some study in operculum structure was begun, but because of faulty

technique in preparing the slides and the small number of specimens studied, no committing statement can be made as to species.

Out of the lot of more than 3000 measured a few figures pointing to a considerable degree of variation were obtained.

The following chart shows the extent of variation in three dimensions in which the fourth is the same.

	Length	Diameter	L. aperture	W. aperture
1.	23.3mm	8.5 mm	8.7 mm	6.2 mm
2.	21.9 mm	8.5 mm	7.4 mm	5.0 mm
Difference	1.2mm	0.0 mm	1.3 mm	1.1 mm

General observations of the measurements and figures accompanying were that if two specimens agreed in one dimension, variation of the other three seldom exceeded more than 0.5 mm. The original figures are reserved for closer study before continuing this phase of the work.

A study of the figures was then approached from the variation in the length of the aperture. In the work of making measurements it was noted that in general the diameter and length of the aperture seldom varied more than 0.5 mm in a given specimen. However, specimens in which the length of the aperture and the diameter varied more than 0.7 mm were not uncommon. The table below shows this trend in a small degree.

Specimen	Length	Diameter	L. aperture	W. Difference
1.	17.3mm	7.3mm	6.1mm	1.2mm)
2.	23.3mm	8.5mm	7.4mm	1.1mm)
3.	18.0mm	7.2mm	8.5mm	1.3mm)
4.	19.7mm	7.5mm	8.5mm	1.0mm)
5.	16.0mm	6.3mm	7.5mm	1.3mm)

) Diam. greater than length of aper.
) L. aperture greater than diameter.

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While there is nothing particularly enlightening in the above figures or the ones just preceding, they point to the fact that a noticeable amount of variation occurs, and that closer study of opercula of unusual snails may bring forth some clearer evidence as to their true identity.

MIGRATION

Mention has been made earlier in the report of the fact that some snails of this species apparently do not migrate to any appreciable extent on the logs to which they cling. Others on the loose sand show tracks of very definite migration from day to day. This raised the questions of the extent, direction, and time of migration; also the possibility of there being a group of non-migrants among the sand dwellers, especially since numerous buried specimens were not hard to find in any sampling of the shallow waters where the species was well established in the shallow waters.

On July 12th at 4:30 P.M. three equal groups of snails totaling 225 were "planted" parallel to the face of the declivity and about two meters from it on the shoal opposite the former camp site. A line about five meters long was given each group and marked with a stake and attached flag. The water was about four fifths meter deep.

The grouping were:

I spires pointing shoreward

II spires pointing lakeward

LLL dropped without reference to spire position

During the ensuing evening hours of daylight the population, apparently in response to release from crowded conditions, began migration with the exception of fifteen specimens. Some completely reversed their positions, some headed as they were pointed, while

others crossed and recrossed each other's paths in all manner of patterns. The fifteen remained quiescent with apertures downward against the sand. Temperature conditions and water action in no way suggested cause for any unusual behavior. The snails were unmarked; hence, paths were the only means of recording direction or extent of migration.

The following morning observations were again made with no unusual weather conditions prevailing. By this time no distinction could be made among the three groups. Individual tracks were all but obliterated. The longest migration was four meters shoreward. No evidence was to be had of any individual having passed over the face of the declivity. Numerous specimens after a period of wandering had become quiescent and some had buried themselves after a short migration. None had become attached to the posts.

During the day a few small boulders and a piece of water-soaked log were placed along the original line of "planting". By the following day about twenty five individuals had attached themselves to logs or rocks. A thinning of the population was easily seen, yet unaccounted for. A track of seven meters length bespoke an indefinite wandering, as it crossed and recrossed itself several times. A few were dead, lying operculum up. Several more were found buried a few centimeters in the loose sand.

Within a week fewer than 100 were to be seen, with more evidence of indefinite wanderings, but none to any extent as far as could be noted. By July 15th about twenty five specimens were to be seen, apparently prospering but not migrating more than a few meters per day as shown by the tracks. Of these about a dozen were attached to logs, posts or stones. On August 15th when last observed only a few remained. These were about equally divided between attached

Substratum Experiment - *Goniabasis livescens*

DATE	Cage II	Kind of substratum	area of cage bottom	No. of specimens	Temperature		No. alive	No. dead	%	% of total dead
					at surface	at bottom				
7-14-37	1	sand only	676 sq mm	33						
7-30-37	1				22°	21½°	26	7	21.2	21.2
8-9-37	1						3	23	88.4	90.9
8-16-37					26°	24°	2	1	33.3	93.9
8-14-37	2	mark marl	729 sq mm	35						
7-30-37	2	rocks			22°	21°	34	1	2.8	2.8
8-9-37	2	bottom					32	2	6.25	8.5
8-16-37	2	bare			26°	24½°	31	1	3.2	11.4
7-14-37	3	scoured	625 sq mm	33						
7-30-37	3	clean			22°	21½°	28	5	15.1	15.1
8-9-37	3	boulders					20	6	30.0	33.3
8-16-37	3				26°	24½°	13	7	53.8	54.5
7-14-37	4	submerged	1369 sq mm	60						
7-30-37	4	logs			22°	22°	59	1	1.69	1.69
8-9-37	4						48	10	20.6	18.3
8-16-37	4				26°	24½°	39	8	20.5	31.6

Summary of the % of mortality:

I Sand only 93.9%

II mark-rocks 11.4%

III clean boulders 54.5%

IV submerged logs 31.6%

Cage #4 had several pieces of cedar logs. These were obtained by lifting submerged logs high enough to saw out pieces without exposing them to the dry air before placing them in the cage. Sixty snails were used as the cage was a large one.

The cages were examined three times as indicated by the dates on the chart, In each case the percentages were figured for mortality to date(1) with respect to the total population in the beginning (2) with respect to the number in the cage during the interval immediately preceding.

On clean sand but three snails remained alive at the close of the period, this cage having had a mortality of 93.9% of its total population. The snails in Cage #2 with marl encrusted rocks for a substratum came through with a mortality of 11.4% and of those which died it is possible one perished in a seam in the trap. Those in Cage #3 with clean rocks fared poorly with a mortality of 54.5 %. Those in the cage #4 with submerged logs as a substratum had a higher mortality than was predicted as logs had appeared to be an excellent substratum for the species.

In surveying the results as shown in the chart one is impressed with the fact that neither food nor substratum(support) should be designated as the limiting factor in a population's failure to maintain itself on a given area. This experiment should be repeated using larger traps, larger populations, and allowing all the time available for the experiment to run. All things considered this is the most successful experiment carried out in the summer's work.

GENERAL OBSERVATIONS

1. *Goniabasis livescens* moves by "steps" or by a movement somewhat resembling that of the "inchworm". Apparently the foot is anchored and the animal drawn slightly forward. This seems to be followed by relaxation and fixation of a the foot on a new hold and then contraction repeated.
2. Dead or dying specimens rest aperture up as far as can be noted.
3. While they may be found very near, the snails were seldom found in beds of Chara fetida.
4. While there is not enough evidence to bear out a broad statement, shells of diseased specimens on the loose sand seem to lose their lustre as compared with healthy ones. This was noted in the finding of snails which were dead but not yet expanded.
5. The most common associates on the loose sand were Physella sayi crassi, *Stagnicola* sp., *Gyraulus* sp., bloodworms, aquatic oligochaetes, and scattering *Campeloma decisum*. On the logs and rocks the most common associates were caddis fly larvae and the naiads of dragonfly.
6. No instances of reversal of symmetry were noticed.
7. The largest specimen found measured 23.3 mm in length; the smallest 1.172mm. the most common size was that ranging from 17 to 19 mm. Snails ranging from 3.0 to 5.0 mm were not found.
8. In this lake Goniabasis appears to "swarm" on the wide camp shaal each summer. This summer the "swarm" appeared rather suddenly and over a wide expanse of the shoal almost all at the same time. A survey showed that they had reached the site of the old

camp by August 18th and there left off rather suddenly. They were much more numerous near the edge of the shelf and did not become very numerous along the waters edge on the wider portions of the shoal.

Summary

1. In Douglas Lake Goniabasis livescens (Menke) is an inhabitant of the sandy protected shoals of the South Fishtail Bay Region.
2. Goniabasis livescens was introduced into this lake some twenty five years ago by Prof. H. B. Baker.
3. The snail thrives well in the protected parts of the bay on loose sand or on submerged logs.
4. Except for the August "swarm" on the wider and less protected parts of the shoal, Goniabasis seems to prefer the parts of the shoal where the deep water approaches closely to the shore.
5. Present evidence indicates that the failure of the snail to maintain itself on the wider parts of the shoal centers around food as well as lack of support.
6. The absence of snails ranging from 3.0mm to 5.0mm, from the minute to small juveniles, indicates a seasonal growth period as yet unexplained.
7. The finding of occasional snails varying widely from the general population indicates the possibility of a different species or hybridization carried to a decided extent, and leaves a whole

field open for continued research.

8. The sudden appearing of the snails in a summer "swarm" on the wide and unprotected parts of the shoal indicates a deep water population as yet unknown.

9. The random findings of the summer's work leave the whole field scarcely untouched and work should be continued along the following lines:

a- The introduction of the snails in quantity into those parts of the lake where they do not now exist to see if they are able to maintain themselves there.

b- Continued efforts to hatch eggs under controlled conditions.

c- Development of a better technique and avoidance of personal errors in the study of growth and variation.

d- Repeating with larger traps and populations the experiments on food and support in relation to their ability to maintain themselves in a given situation.

e- Repeated efforts at migration studies by marking of a population and returning it to its habitat so that direction, extent, and time of migration may be definitely followed.

f- A search of the deep waters for the size of the summer dwellers there and the depth to which they are able to live.

Literature Cited

Numbers refer to references in the paper.

1. Private letter to Dr. Eggleton

2. Krecker ,? (This refers to Krecker's paper on the study of support at Pit-in-Bay but the paper has been returned and The slip with official title has been mislaid.