NATURAL HISTORY OF GONIABASIS LIVESCENS (MENKE) IN DOUGLAS LAKE MICHIGAN

CONTINUATION REPORT

1939

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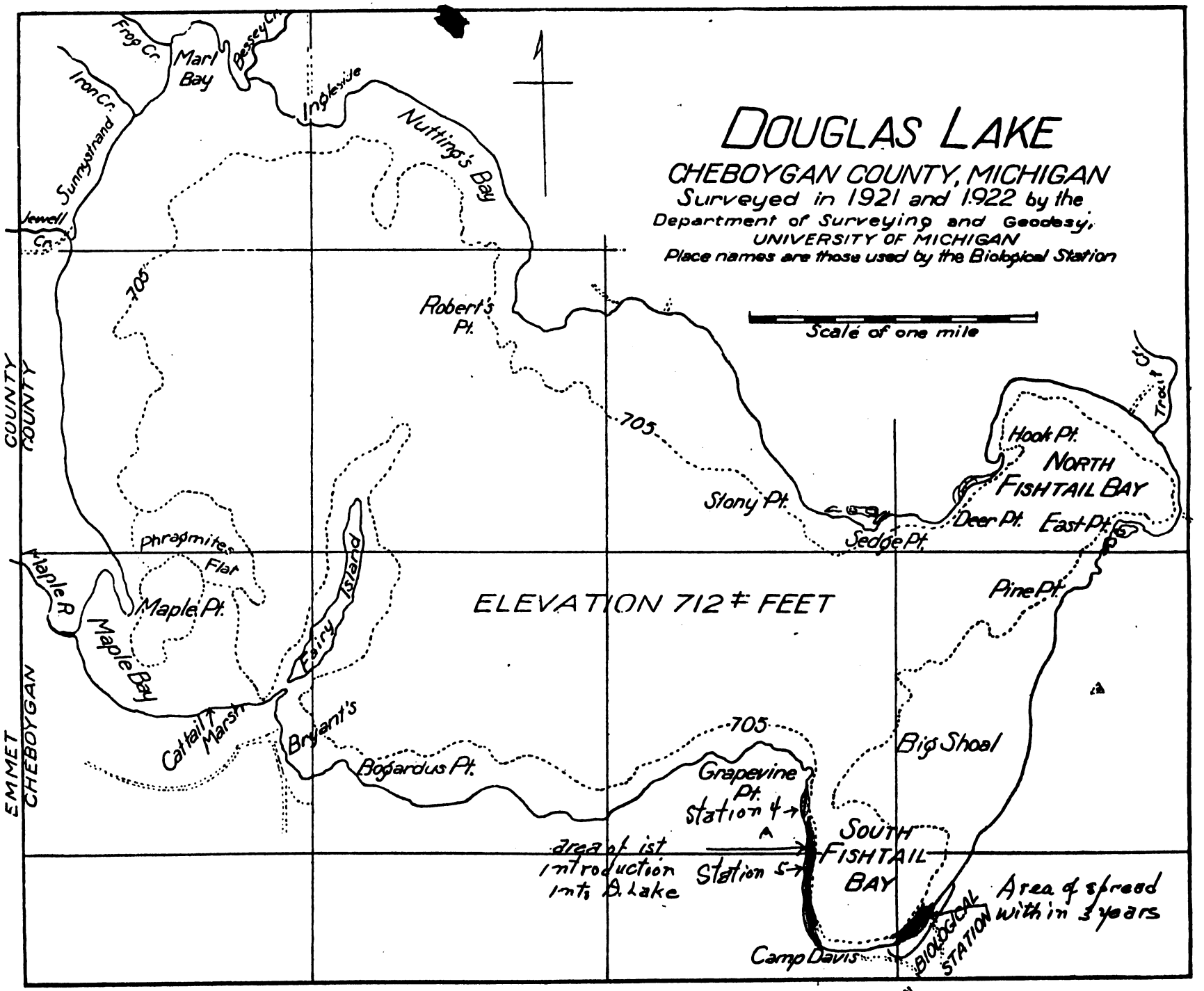
INTRODUCTION

As was stated in a report of 1937 under the same title, Goniabasis livescens is an inhabitant of the sandy shaols in which the descent into deep water is abrupt and reasonably close to shore. In that report the statement was made that the sanil thrived best on those shoals which were more protected from the sweep of the west and northwest winds. Experiences of the past two years give strong evidence that the snails may eventually establish themselves on snoals which are decidedly more exposed to those winds. At this stage of the study it is too early to predict their success on Big Shoal, which is not far distant from the point to which they have spread northeastward from the region where they were first introduced by Prof. H. B. Baker in 1913. However, at their present rate of migration they will soon reach a region of the shoals where strong west and northwest winds sweep the shoals .

During the past two years their spread in large numbers has been observed as indicated on the map of Dpuglas Lake. Region of migration in two years past is indicated in orange, showing relation to the spread from their original point of introduction. Progress of at least 200 yards has been made


DOUGLAS LAKE
CHEBOYGAN COUNTY, MICHIGAN
Surveyed in 1921 and 1922 by the
Department of Surveying and Geodesy,
UNIVERSITY OF MICHIGAN
Place names are those used by the Biological Station
Scale of one mile
ELEVATION 712 ± FEET
705
Frog Cr.
Marl Bay
Bessey Cr.
Iron Cr.
Inglenook
Nutting's Bay
Sunnystrand
Jewell Cr.
Robert's Pt.
Stony Pt.
Sedge Pt.
Deer Pt.
East Pt.
Hook Pt.
NORTH FISHTAIL BAY
Trout Cr.
Pine Pt.
Big Shoal
Phragmites Flat
Maple R.
Maple Pt.
Maple Bay
Fairy Island
Cattail Marsh
Bryant's
Bogardus Pt.
Grapevine Pt.
Station 4
Station 5
SOUTH FISHTAIL BAY
Area of 1st introduction into D. Lake
Area of spread within 3 years
Camp Davis
BIOLOGICAL STATION
COUNTY
COUNTY
EMMET
CHEBOYGAN

upshoal to the northeast. At present the snails may be said to have reached a point of disappearance at a point opposite the site of the mess hall of the old biological station. At this point the snails seem to be limited to the very edge of the declevity.

Apparently the necessity of support such as firm sand, boulders, submerged timbers, etc., has been exaggerated. It has been the contention of some members of the Biological Station for some years that the snails would not spread very far up the shoal due to lack of firm support. During the past two years the sanils have spread over a portion of the shoal which, in the latter part of the time of the session, the sand is so loose that one sinks to a depth of two to three inches in walking over it. Also at this time of the year the sand is full of "pock marks" where dedecomposition gases have broken loose in large bubbles. Apparently the need of firm support has not been a limiting factor in the migration of the snails toward wider and less favorable shoals.

STUDIES PURSUED

Several phases of intensive study were carried on simultaneously, the most discouraging of which were the attempts to learn details of oviposition. Other studies included:

1. Another series of measurements in an attempt to learn the life span.
2. Measurements to determine rate of growth of juveniles.
3. Measurements as a means of comparing lake and stream forms.
4. Measurements to determine age groupings.
5. Detailed and random samplings to find miniature specimens in an attempt to learn if possible types of habitat suitable to oviposition.

6. Plantings to determine other habitats suitable to the success og Goniabasis .
7. Studies in sex determination.
8. Observations of development in any egg masses which might prove to be those of Goniabasis.
8. Limited observations in food preferences.
9. Observations of any peculiar behavior on the part of the snails which might
   a- prove to be keys to the solution of the many unsolved questions concerning the adults.
   b- reveal unusual points of interest regarding the natural history of the animals.

1. Oviposition

In addition to constant observation of rocks, logs, and loose sand for possibilities of eggs, a prolonged effort was made to secure oviposition under aquarium conditions. On July 8th Stations 4 and 5 (See map of Douglas Lake) were sampled to secure snails from a variety of conditions existing within the same general areas. These snails were placed into small jars of about one fourth pint capacity. If two snails were found together, both were placed into the same jar on the assumption that they might be copulating; otherwise only one snail was placed into each jar. Altogether eighty eight jars were used. As it is impossible at this stage of familiarity with the snails to recognoze sexes in the field, it was of course quite obvious that many males were probably so confined to the jars.

Severl snails were taken from each of the following kinds of situations:

1. From the face of the declevity in Station 4 where the shoal is only about ten feet wide. Sand was placed into

the jars , but in this case no assurance could be had that the sand had come from the immediate region of the individual snail. Snails were located on the face of the declevity by means of the water telescope and taken from approximately two meters of water.

b. Eight jars containing one or more snails each were obtained by random sampling on the shoal of Station 4 in water approximately one third meter deep. A small dipper was used and in each case the snails with a small amount of sand were placed into separate jars. If two were found together, they were both taken.

c. A dozen jars of snails were obtained by a similar method in water apprximately one half meter in depth. Here several pairs were taken together. Results, however , tended to disprove any possibility of copulation. It seems rather definiitely certain that feeding on the shells of other snails, not even of the same species is a common occurrence among Goniabasis, even when not confined in aquaria in close quarters.

d. Twelve other jars of specimens were obtained from submerged logs at varying depths up to one meter. In each instance the log was scraped at the place where the snail was taken, and the marl- blue green algae accumulations placed into the jar with the snails. None were taken in this sampling which even suggest ed the possibility of copulation.

e. In the remainder of the jars snails were placed which had been picked at random over the upper portion of Station 5. Water varied from one fourth to three fourths meter in depth. A small amount of sand and flocculent marl was taken with each specimen.

The jars and snails, numbered to indicate locality and situation were placed in the aquarium shelter and observed at very frequent intervals, every day for a while and later every other day. Water supplies were changed almost every day, depending upon the conditions of temperature and humidity. At no time was anything observable which had the slightest resemblance to eggs or oviposition. Almost four days were spent beginning August 3rd and lasting intermittantly through the 10th in minute examination of the sand in which the snails had been while in the jars. Tyler screen and the binocular microscope were used very extensively. Not a single specimen of minute snail was found in any of the jars. A few clumps of material which had the suggestion of eggs proved to be debris. The marl- algae encrustations were examined very closely, but gave no evidence whatever of conatining eggs or small snails.

The following are listed as psssible reasons for the failure of the experiment:

a- Season of oviposition was past.

b- Concentration of carbonates by evaporation might have created an artificial situation of mineral content not favorable to the snails. , However, this seems to be a far-fetched possibility, when the snails feeding on marl encrustation from logs were considered

c- Hydrogen ion concentration was unfavorable to the snails. Krecker * disregard the importance of pH

d- Lack of food. Examination of the sand however showed, that after the period of time covered in the experiment,

* Krecker, F. H. Conditions under which Goniabasis livescens occurs in the Island Region of Lake Erie. Ohio Jl. Science 1923.

flocculent marly material was plentiful in the jars. Certainly the snails in the jars containing materials scraped from the logs, were not short of food, for the algae in the marl continued to thrive even better in the weak light of the aquarium shelter.

f- Improper condition of light and temperature. Some superficial evidence is available pointing to a definite positive phototropism under laboratory conditions, but nothing is available which will cast any light on the question of failure to oviposit.

The above named reasons for failure to oviposit are merely offered as possible reasons. No evidence is available which might point to any definite limiting factor. The work of VanCleave and Jewell * tells nothing of the manner in which oviposition under laboratory conditions was secured

2. Growth of juvenile specimens

Knowing that a knowledge of the rate of growth of an organism is one important step in the determination of life span, a study was undertaken with juvenile specimens(those ranging from 4.0 mm to 9.0mm) as shown on the second mode of Figure 2.

Snails were collected in quantity from the edge of the declevity opposite Old Log Lab. Coarse and medium medium mud screens were used. Of the juveniles taken three sizes were segregated, viz., 6.0 mm , 6.5 mm, and 7.0 mm in lengths. Segregated groups were identified by use of contrasting colored quick-drying enamel. To do this the snails were placed onto a blotter and rotated quickly to remove excess water as soon as possible. A brief drying period followed in the open air, after which the spires were dipped for several whorls in thick enamel.

* Nautilus : 44; 15 1930-1931

Another brief period of drying in open air followed after which the snails were thrown into running tap water, lest the chemicals of the enamel be toxic to the animals. Some half dozen snails were treated at one time to prevent death by desiccation. Careful handlin was necessary to prevent the following :

a- Dipping too deeply and allowing enamel to cover the operculum.

b- Dropping the snails from the forceps entirely ento the enamel.

c- Death by desiccation

d- Getting the snails dry enough for the enamel to stick well and keeping them out of water long enough for the enamel to harden.

The marked groups were then confined to an open cage 30 inches high and approximately three feet in diameter. The cage was made of ten feet of 16-mesh galvanized wire with the ends fastened together tightly. Before confining all three groups to the cage, the bottom was completely scraped with a framed screen used in bottom sampling for snails in the loose sand and gravel. The screen, for want of a better name,is called a limnological or aquatic "dustpan." The cage was placed over the bare area, and tacked lightly to four stakes for support. It was located near the face of the declevity in the same area from which the collection was originally taken before measurement. Top of the cage was about six inches under water and open. At first the cage was observed three times a day to prevent the snails from climbing over the top and escaping. After a few days little tendency to climb was in evidence, and only a few remained on the surface of the sand. Befroe the snails had been placed into the cage a goodly amount of loose marly sand was sifted into the cage.

As long a time as possible was allowed before the snails were removed and remeasured, an interval of 22 days between July 22nd and August 16th.

Measurements and results are tabulated below:

	Group 1	Group 2	Group 3
Color	White	Red	Yellow
Length	6.0 mm	6.5 mm	7.0 mm
Number measured	46	20	24
Number recovered	35	10	20
Not counted because of error in 1st measurement	4	This group not considered; too few to be significant	2
Av. length after 22 days	6.519 mm		7.627mm
Allowance for error	1.000 mm		1.000 mm
Net av. after 22 days	6.419 mm		7. 527 mm
Net gain for 22 days	0.419 mm		0.527 mm
Average gain per day	0.019 mm		0. 024 mm

A study of the above figures indicates a rather slow growth rate for this time of the year.

Discussion and implications

a- Personal errors indicated in the table are of two kinds.

(1) Dropping measured snails into the wrong group in first segregation

(2) Breaking the tender tip of the spire in closing the calipers, hence the allowance of 0.1 mm in securing net growth averages.

b- As a study of Chart 2 shows that there is no group intermediate between miniatures and juveniles, one is led to the conclusion that rapid growth between the two groups must occur chiefly in other parts of the year than the summer months.

c- With the success of the method of marking assured the experiment should be repeated with the following changes:

(1) A closed cage should be used, preferably at least 4 x 6 ft bottom dimensions and moved frequently, being sure that plenty of flocculent marly material is sifted into the cage at each new location.

(2) The cage should be closed at the top to prevent the entrance of fish. Two rock bass were discovered inside the cage one morning, and the suggestion arises that they might have fed on the young snails clinging to the lower regions of the cage.

(3) The experiment should also include two other groups:

(a) So-called adults, between 10.0 mm and 18.0 mm in length.

(b) So-called"mossback" adults, those which had acquired a decided coating of marl. In general this group includes snails whose length exceeds 18.0 mm.

Studies with the latter groups should give some data relative to the larger group which appears in the third mode of Chart 2

3. Comparison of stream and lake forms

The question has persisted for some years at the Biological Station as to the degree of variation of Goniabasis since its introduction into Douglas Lake in 1913 by Prof H. B. Baker. The suggestion has even arisen that Goniabasis is but Pleurocera greatly changed over a long period of years. Late in July 276 specimens were collected by Miss Elsie Townsend of this Station

and later turned over to the writer for such use as could be made of them. The bluntness of the spires was at once interesting and challenging and Chart 3 was developed as a result of measurements and comparisons with lake forms previously measured. More than 2000 specimend of Goniabasis livescens had been collected by hand method by the 1938 class in Natural History of Invertebrates. These were subsequently remeasured by the writer using vernier calipers. In order to pick a number of lake forms which would be somewhat comparable to the number of river forms being studied, every fifth measurement of the 1938 groups was employed in producing the chart.

Length/only and diameter was considered in the comparisons. For statistical purposes diameters were used as a basis of comparison with lengths of both kinds of snails. For method of securing diameter measurements see 1937 report , page 7. Diameters, referred to as width in Chart 3 were doubled and used as a basis of comparison to length. It was from this method of measuring and comparing that the extreme difference in the two forms was made so noticeable. If the diameter doubled exceeded the length, the excess was recordee as a plus value. In all but nine specimens this held truen in the river snails. If diameter doubled was less than length, the difference was recorded as a minus value. In no instance did a lake snail yield a plus value.

Aside from the value in revealing the extremes of develop- in the two forms, the chart quite definitely shows a unimodal curve for each form, thus indicating that each group seems to fall into a single growth range. However, the elusive answere as to duration of life span still persists. Greatest value in the study lies in revealing the possibilities which might grow out of a four or five year programme of comparison of lake and river forms .*

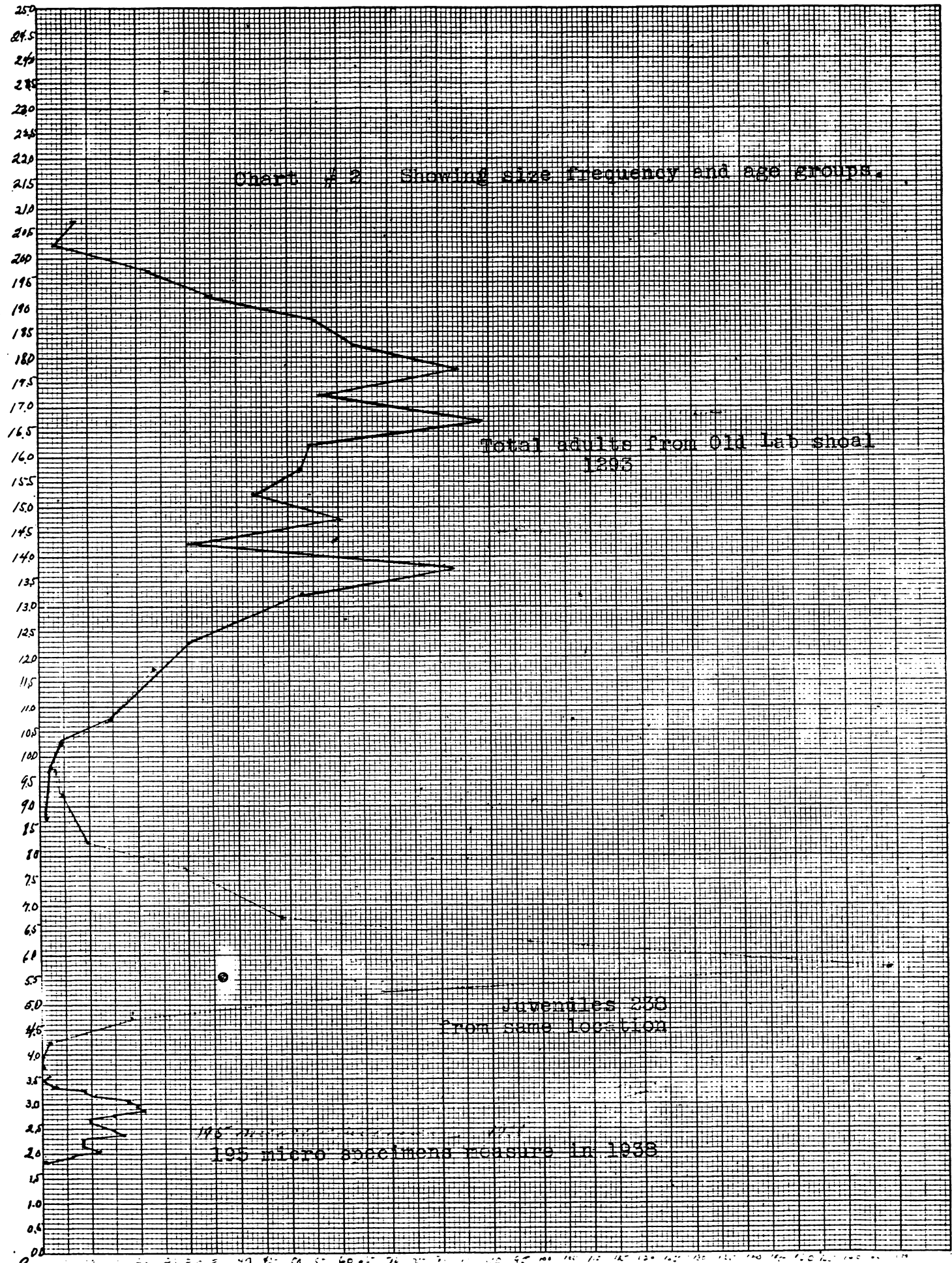
* See Programme of 1940

4. Study of age groupings

Charts 1 and 2 grew out of an extended series of measurements of miniature, juvenile, and adult speciemns, these terms being arbitrary names assigned size groups. In Chart 1 only juveniles and adults are represented. Three groups of juveniles were measured for length at close intervals, also two groups of adults, all coming from a small area near Old Log Lab. In each size range the outermost curve of the graph represents a total fo frequencies for that particular size range. A sutudy of the chart shows that the juveniles fall quite definitely into one size range, with 5.5 mm lengths predominating.

The grouping of the adults is still open to question. With 1300 specimens measured the chart still suggests the possibility of a bimodal grouping. In view of the fact that in the field one finds the adults falling into two distinct groups as to appearance, viz., medium sized well polished specimens and larger "mossbacks", the thought still persists that possibly the upper part of the curve represents quiescent specimens which continue to elongate a limited amount in that period before the approach before the onset of senescence.

If such be the case, it seems fairly safe to assume that the life span covers at least a four year range. If the measurement of 3000 - 4000 specimens revealed a rounding off of the points of the curve, it still seems fairly safe to assume that the life span is greater than three years. The assumption is made on the basis of this fact: If the life span coverse but three growing seasons, it would seem but natural that juveniles would be taken in greater quantities than adults identical screenings as there would naturally be a dying off of senescents of the third season. Such is not the case. By identical sampling



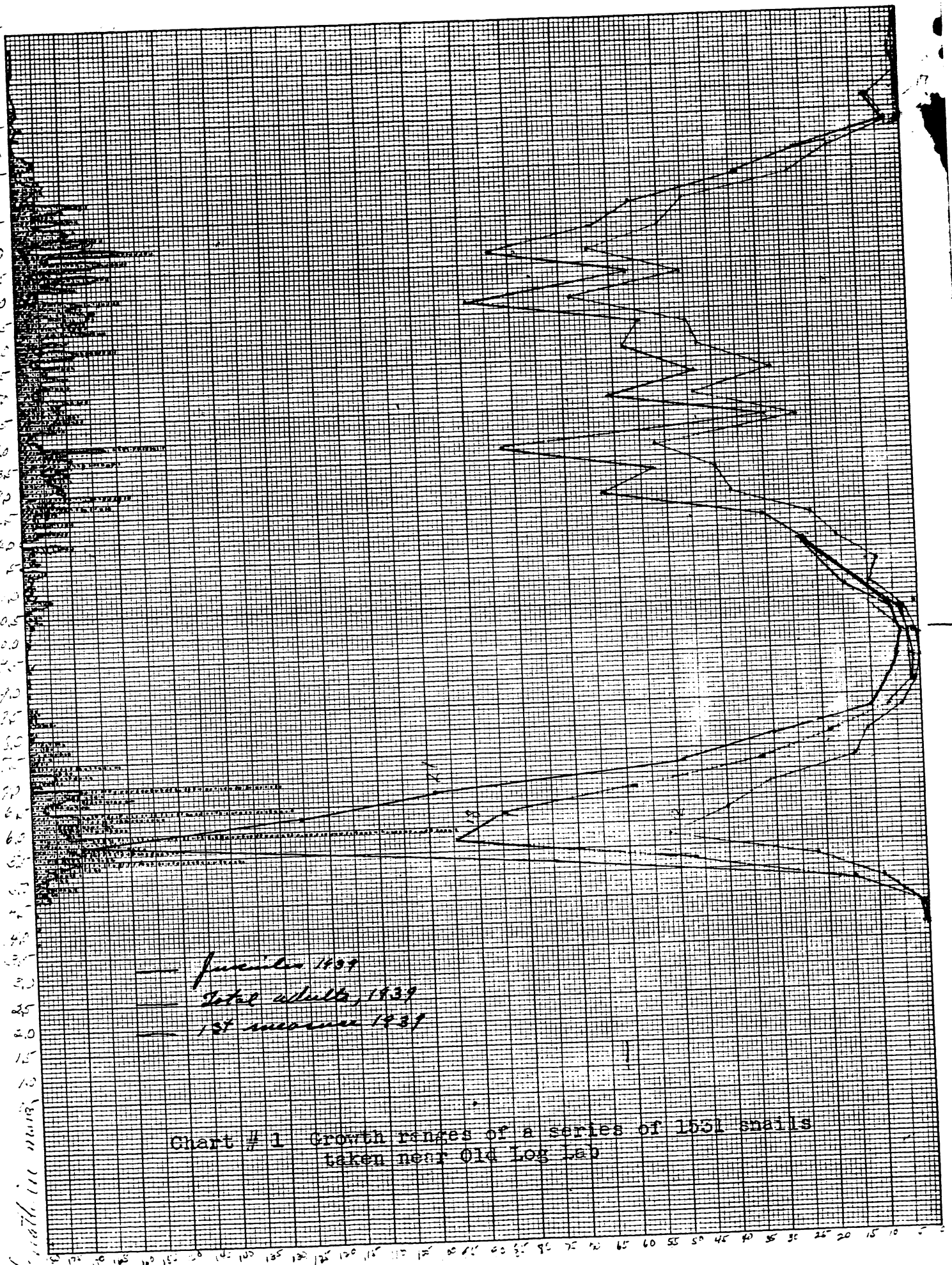


Chart # 1 Growth rings of a series of 1551 snails taken near Old Log Lab

methods in the same area the proportions were 238 juveniles to 1293 adults. Further investigation is necessary.

Miniatures cannot well be included in the general statement regarding expected proportions with respect to adults. In the first place continued search has failed to reveal any miniatures in the area where the 1531 specimens were taken. In the second place miniatures have been found in other sites, chiefly Station 4, only in the topmost sand. In sampling for adults and juveniles, it is necessary to scoop the sand to a depth of an inch or more. This involves too much sand for the successful separation of miniatures with either a 30-mesh screen or the finer Tyler screems.

That miniature(1.0mm to 5.0 mm) snails represent first season specimens and juveniles measuring 5.0 mm tp 10.0 mm represent second season specimens seems fairly safe to make. As for adults it seems also fairly safe to assume that adults of 12.0 mm or more represent a group which lasts more than the third season.

5. Newly hatched snails

The search for newly hatched and miniature snails has proven at once gratifying and very disappointing. Such search should be of value from at least three standpoints:

a- Extremely small snails could not have migrated very far, especially in protected coves such as Station 4 and the finding of them should cast some light upon the approximate place of oviposition

b- The earlier in the season they are found the better the chance of securing accurate data as to growth rates. To date this data has not been successfuly secured at wide enough intervals to yield satisfactory results or conclusions.

c- Habitat preferences of miniatures is indicative of food preferences of the smaller specimens, a questionable point in the natural history of Goniabasis.

To date no very successful method has been found for measuring miniature specimens of Goniabasis and remeasuring the the same individuals in any quantity. No screening for cages is available which will retain them except copper or brass which would probably be toxic to small snails crawling over it and feeding from it. First measurements by ocular micrometer are quote successful when the snails are very small, but later in the season they are too large for measurements with the ocular micrometer and too small for the vernier calipers. Present somewhat unreliable information points to an average growth of about 1.5 mm before the close of the session of the Biological Station.

This year small snails were not found until the middle of July. By middle August specimens 2.5-3.00 mm were very common in the shallow waters of Station 4. They were secured too late for accurate measuring and plotting.

The results of three season's search for very small snails make it reasonably safe to state the very small specimems are most likely to be found in protected waters such as Station 4 one fourth to one third meter in depth in the zone of finely divided material, flocculent marl, lying between the ripple swept shoals and the loose gravel of the deeper water. In Station 4 this zone is twenty feet wide and ranges from one fourth to one half meter in depth.

The same situation prevails in Station 5 where there is a rubble beach. If the young snails are hatched on the rocks or fine sand between them they are probably carried to this zone by the mild undertow of the ripple swept beach.

Since in Station 4 there is no rubble beach, and since there seems to be no relation to the presence of small snails and the proximity to a line of submerged logs lying at right angles to the shore, there is strong evident that the eggs are laid in the fine sand of the flocculent marl zone. This is further substantiated by the fact in this zone often 75% of the adults are submerged, as shaown by repeated screen samplings. That there is some relation of the factors above outlined and oviposition is a thought not yet ready to be abandoned.

In some ways the situations in Station 4 and the shoal near Old Log Lab seem to be quite in opposition to each other. In the first place no miniature snails have been found on the shoals of this side of the lake at any time durinf the period of the session of the camp. Since juveniles are very numerous it seems that only one place remains for them, viz., the face of the declevity. None have been found there with any sampling devices used to date. In the second place juveniles have been found only near the face of the declevity. This lends further evidence to the belief that in this region eggs are laid down the face of the declevity. In the third place adults of this region seem to prefer the areas adjacent to the edge of the declevity instead of being scattered over the shoal to the waters edge as in Stations 4 and 5. The thought arises that influence of strong winds is an important factor in the natural history of the snails of this region.

Chief disappointment of this aspect of the summer's work lies in the failure to secure eggs, even by the most diligent search and then suddenly find that newly-hatched specimens are in a region in quantity.

6. Transplants of snails

Three transplants have been made, two of which are virtually replants of last year.

a- One was made on the west shore of Lancaster Lake where a narrow sandy shelf with an abrupt declevity closely resembles that of portions of Douglas Lake where Goniabasis now thrives. No trace was to be found of snails planted there a year ago.

b- Another introduction was made on the east shore of Munro Lake where there is no declevity and no deep water. The snails were placed in water one half meter deep and 100 metaers from shore. This was also a replant. Both places were well marked by known and fixed landmarks.

c- The above plantings were made July 10th with 200 snails in ach location.

c- A third introduction was made in another part of Douglas Lake. At a point between the north east angle of Big Shoal and South Fishtail Bay, at the edge of the declevity, 120 marked specimens were released August 16th. If the snails survive and the enamel markings last, some valuable evidence of migration may be secured.

7. Sex determination

The better part of two days was consumed in studying sex characters. There are as yet no safe secondary characters. A small pit just posterior and lateral to the base of the right tentacle marks the females, and this is made visible by placing the snail retracted operculum up against the edge of a watch glass and viewing it under water as the foot is projected.

tt Once the observer has learned the position and is able to distinguish the pit from a fold of tissue, the sexes are easily separated. providing the snail does not lie quiescent and fail to expand the foot for a long period of time. Snails in water of 70 - 80 deggrees Fahrenheit will generall respond. As yet it is not possible to detect sexes in the field with a hand lens.

8. General Natural History observations

The following were gathered at random at random and from many situations:

a- There appears to be no definite factor controlling the migration. Paths cross and recross, and even after severe blows of wind for some hours, the snails exhibit np apparent direction preference.

b- On several occasions after short period of quiescence circular tracks, six inches or less in diameter are frequently noticed. It sometimes appears that two snails have entered onto the same track making.

c- On numerous occasions in the past three seasons the remark is heard that the snails are disappearing from a given region. Screen sampling reveals often that they are only submerged.

d- Marl gathering seems to be common to many specimens while others remain well polished at all times as far as can be observed. No determining factors are offered in explanation.

e- Recognition of miniatures in sand samples is not as difficult as might well be expected. If a very small amount of sifted sand is stirred into a whirl-

with a cover of water
ing movement in a large culture dish/and then allowed to come to rest, the sand will settle first while the snails and fine debris will continue to whirl. The snails will settle next and the fine debris continue to whirl around. It is at the time of the snail's settling that they are most easily recognized from fine black sand and loose fine debris. Also, even the smallest Goniabasis can be recognized by its characteristic fall through water. A lens is not necessary in deciding between a small bit of sand and a young snail. Pick it it in a medicine dropper and let it fall through an inch or two of water. The manner of falling is characteristic.

SUMMARY

1. There is ample evidence pointing to the fact that Goniabasis may eventually occupy sandy shoals more windswept that those it no occupies.

2. At the present rate of spread over the more sandy and wider shoal s the question may be decided without any interference such as transplanting on the part of research workers. A spread of 200 or more meters up shoal has been witnessed in a period of three summers.

3. The much-talked-of matter of support necessary for maintenance of the snail in a given area appears to be exaggerated. More time and experimental evidence is necessary before sweeping statements can be made.

4. The per od of life span appears to be four years or more.

5. The question of oviposition, time and place, remains a mystery, as far as Douglas Lake is concerned.

6. A five year or longer study of stream and lake forms and the changes involved when introduced to new habitats may have some serious effects upon the taxonomy of the Family Pleuroceridae.
7. Chemical -physical factors of the snail's ecology have not been given serious study as yet.

Programme for 1940

A. On Douglas Lake

1. Collect measure and mark(lacquer) Variuos size groups of snails to see if and how much growth takes place between June and August

   a- Juveniles to be marked, measured and released in quantities near the Old Log Lab at a very definite spot near the Old Log Lab.

   b- Check on the snails marked and released on August 16th for ability to survive

   c- Devise if possible some means of measuring and confining miniatures for measurements later in the session.

2. Exert every possible effort as so on as possible again in the season for konwledge of eggs and oviposition.

3. Begin a definite periodic series of chemical-physical data for the most common areas of Douglas Lake being studied; also get physical-chemical data on any regions outside Douglas Lake in which the snails are colected.

4. Get a series of Burt Lake snails for comparison by an expert with Douglas Lake forms.

B. On Black River and Black Lake

1. Collect and determine length- width ratios;

   a- Well out in the lake away from river influence

   b- At the mouth of the river- where lake water becomes river water.

   c- In Sec. 21 upstream from the dam

   d- In Sec. 17 at the boundary between Secs. 16 and 17

   e- Further down stream at different habitats foward Cheboygan

   NOTE: Purpose of this series is to determine if the Length-Width ratios change in definite manner from the lake downstream. See chart comparing river and lake forms inthis report.

2. Obtain chemical-physical data on above locations.

3. Collect and measure a population of typical lake forms and transplant them to a snail-free area in the river. When a new generation has had opportunity to mature, collect in the same area and measure the new generation for length-width ratios. Note particularly if the new generation shows a tendency to lose sharp turrets and pointed apex and otherwise come to resemble river forms.

4. Collect and measure a opulation of typical river forms and transplant them to a snail-free area in some lake, preferably Black or Long Lakes; when a new generation has had time to mature collect in the same area and measure for length-width ratios. Note particularly if the new generation shows a tendency to gain sharp turrets and pointed apex and show other resemblances to typical lake forms.

5. Make very definite notes and and descriptions with photographs of every location from which collections are made.
6. If Long Lake is chosen as an experimental area, it should first be carefully chaecked to make sure it is snail free.
7. Spare no pains to learn of oviposition in any of the situations under consideration.

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