STUDIES ON THE LIFE HISTORY OF
ACELLA HALDEMANI ("DESH." BINNEY.)

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INTRODUCTION

There are several problems that are outstanding in regard to the snail *Acella*. Among these are the breeding season, length of life, and whereabouts during most of the year. This paper is written in answer to these questions.

This species, the slendest of American Lymnaeas, has a limited range, in the Great Lakes Drainage, from Vermont to northern Minnesota, and from lower Canada to northern Illinois and northern Ohio. Described by Jay, from Lake Champlain in 1839, little was known of the ecology for many years. Kirkland has contributed many interesting observations. Baker, in monographing the American Lymnaeas, has collected all the available notes on *Acella*. All of the earlier collectors found the species only in the fall of the year, and only in the adult condition. One important reference in the literature has been overlooked. This is the note of DeCamp's collection of *Acella* (6) "in one year in May. He once told me he collected eighty-five on the rushes, 'where they had come to spawn'." Just why Kirkland should have forgotten this lead, is hard to understand. In later notes (1) he says, "This is a deep water species, which migrates shoreward in the fall, doubtless for spawning purposes, as adults only have been captured, — ".

Baker (3) after finding young individuals in July 1916, says, "It may be that the animal descends to the Pond-weed Zones in the winter and lays its eggs on the *Potamogeton* and that they subsequently hatch out in the spring."

In the course of studies on the mollusks of the Northeastern Wisconsin Lakes, *Acella* was found. Additional collecting in these lakes at various times of the year has resulted in tracing the complete life history.
The writer is indebted to the following people: Dr. F. C. Baker, Univ. of Ill. Museum; Dr. W. J. Clench, M.C.Z. at Harvard; Dr. Paul Bartsch, U. S. Nat. Museum; and Dr. W. G. Van Name, Am. Mus. Nat. Hist.; for information regarding Acella in the collections of these museums; to W. A. Dence, N. Y. State College of Forestry for loan of specimens; to Paul Armand, Fishtrap Lake, Vilas Co. Wis.; to G. E. Burdick, for assistance in Photography and to Prof. Chaceey Juday for chemical data on the lakes and many helpful suggestions and criticisms.

The ecological conditions under which Acella is found in Vilas Co., Wisconsin, are restricted. The observed average pH of the lakes it inhabits in this region is between 7.36 and 7.7. The amount of fixed carbon dioxide present in these same lakes is also within relatively narrow limits of variation.

<table>
<thead>
<tr>
<th>Lake</th>
<th>pH</th>
<th>Fixed CO₂</th>
<th>p.p.m.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fishtrap Lake</td>
<td>7.36</td>
<td>18.36</td>
<td></td>
</tr>
<tr>
<td>Harris Lake</td>
<td>7.7</td>
<td>17.0</td>
<td></td>
</tr>
<tr>
<td>High Lake</td>
<td>7.7</td>
<td>22.56</td>
<td></td>
</tr>
</tbody>
</table>

The narrowness of the limits under which Acella has been found in these lakes is made significant by the fact that the variation in all the lakes of the district for which there are data is so much greater. There are lakes here that have an average pH of 4.4 and others as alkaline as 8.9. The range in hardness of water of these lakes is indicated by the fixed carbon dioxide content, which is as low as 0.2 in some lakes, and as high as 31.5 p.p.m. in others (Fig. 1).

<table>
<thead>
<tr>
<th></th>
<th>pH</th>
<th>Fixed CO₂</th>
<th>p.p.m.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum</td>
<td>4.4</td>
<td>0.2</td>
<td></td>
</tr>
<tr>
<td>Maximum</td>
<td>8.9</td>
<td>31.5</td>
<td></td>
</tr>
</tbody>
</table>

It was at first thought that the species would be restricted to a muddy type of bottom (silted), but further observations have shown that the species is found in situations having both sand and silt bottoms, though perhaps more often on the silted type. This is in direct support of the observed preference for a more or less protected situation.

As regards its niche in the habitat, it is primarily an inhabitant of vegetation. But what becomes of the snail, when the winter conditions kill down the annual growths of such plants as the reeds, pond lilies, etc.? Assuredly it must have some other places for protection from being silted under on the bot-
FIG. 1. Distribution of lakes of the Northeastern Wisconsin District in regard to hydrogen-ion concentration (pH) and hardness of water (represented by fixed carbon dioxide in parts per million), with the restricted distribution of Acella indicated on the same scales.
tom and for the procuring of food. It is pretty well established that this species feeds on the small filamentous algae growing on the plants on which it has been collected. Why should not this snail be found on any other object in the habitat upon which these plant foods are found? It stands as unquestioned that the snail should be able to move on the bottom, in order to travel from one plant to another, and the observations of the species both in the juvenile and the adult stages, show that it frequently moves about over the bottom.

The fallacy that has done most to create the mystery in regard to *Acella*, is the inference that it must migrate, since it had been found in shallow water only in the adult stage. As will be evident from observations to be mentioned later, this erroneous idea must be given up; there are, in fact, only occasional wanderings of individuals away from the places where they feed to another plant or log.

As previously noted by Kirkland and Baker, this species is more sluggish in its movements than others of the family. This slowness of motion will account in part for the colonial habits, since none of the individuals ever go very far from the spot where they hatched from the egg, and near the same place they will lay their eggs, thus keeping the species in the same location from generation to generation.

The habitat of *Acella* has always been listed by previous writers as vegetation. Decamp, Kirkland and others have recorded it from rushes (*Scirpus*); Sargent (5) mentions having collected it from the under side of pond lily leaves; Baker (3) has recorded it from Oneida Lake, N. Y., from the following plants: "Smith's bullrush (*Scirpus smithii*) on the stem. Floating pond-weed (*Potamogeton natans*) on leaves and stem. Pond-weed (*P. interruptus*) on leaves and stem. White water-lily (*Castalia odorata*) on leaves and stem. Yellow water-lily (*Nymphaea advena*) on leaves and stem."

The writer has found the habitat of *Acella* even more variable, including objects other than vegetation. The eggs have been noted on rushes, on the dead and decaying portions of *Potamogeton* and burreed plants, and on the small sticks and logs on the bottom, in the same zone of vegetation.

Juvenile individuals have been collected from *Potamogeton*, from Yellow water-lily leaves, from burreed leaves and stems, and from rushes (*Scirpus, 2 species*), and from stumps and
snags in the same marginal zone. One stray individual was taken from silt bottom in deeper water and another from gravel bottom (at mouth of Dead River, Illinois). Adults have been collected from rushes (both living and dead stems), from Potamogeton, burreed, pickerel weed, yellow pond-lily stems, and from snags and logs. This last mentioned habitat of snags, etc., has been observed only in the spring season.

As to depth of water in which Acella is to be found, Kirkland says, (1) "in water from one to three feet deep; and invariably from six to eight inches from the bottom, the apex of the shell pointing downwards, — though in a few instances the apex has been upwards, as if in the act of descending." Baker says it is found in water of about the same depth limits (.3 to over 1 m. deep.). The writer has noted the following depths: Dead River: most of the Acella were found near the surface, in from 4 to 24 inches of water; Fishtrap Lake: the snails were generally distributed, from near the bottom to near the top, on all parts of the plants, and with the apex of the shell pointing in any direction, in water 10 to 30 inches deep; in the channel between Fishtrap and High Lakes: in 15-36 inches of water, just on the edge of the current, the snails always within 18 inches of the surface; High Lake: near the surface in water 10 to 18 inches deep; Harris Lake: in water 16-20 inches deep.

Three of the colony locations in Vilas County were examined on February 1st and 2nd, 1931, to find out to what winter conditions these snails are subjected. At the site of the colony on Fishtrap Lake, the following conditions were found: ice 9 inches thick, 2 inches slushy-snow ice, and about 10 inches snow over all; the temperature of the water was 1.5 degrees Centigrade; the depth of water was 24 inches. No specimens were found at this time. The channel between Fishtrap and High Lakes showed the following: ice ½ to 3 inches thick; snow covering the ice 8 to 10 inches thick; water about 10 inches deep; water temperature 1.5 degrees Centigrade. Two adults were found on decaying burreed stems on this date. Harris Lake showed: 1 foot of ice, 2 inches soft snow-ice, and 2 to 4 inches of snow; water 2 feet 5 inches deep; water temperature near 0 degrees Centigrade, since it froze rapidly over the holes cut in the ice, even at 1 p. m. No Acella found here,
because the exact location of the colony was not found. These measurements indicate conditions for the snails in a mild winter. In the case of the channel habitat, the extremely thin ice indicates either that there are springs in this swamp along the channel, or that the current is spread out more than in the summer when the water is open.

Egg masses of these animals were seen on May 16, 1925 from Dead River, Illinois, on the stems of rushes. At this time, the eggs had not hatched, but the embryonic shell was of such size as to almost fill the egg capsule. These egg masses were identified as belonging to Acella by the shape of the embryonic shell, which, as Baker (1) has said, is peculiar in that it alone of all the slender Lymnaeids shows elongation of the nuclear whorls. Again May 10, 1930, egg masses were found sparingly on the stems, leaves, of Potamogeton and burreed plants, in the colony previously discovered on the south side of Fishtrap Lake, Vilas Co., Wisconsin. Further collections have brought out the fact that in this northern Wisconsin region, the period of egg laying extends from some time previous to May 10 to about the middle of June. One egg mass was collected on June 21, 1930. When examined, it was in the early developmental stages.

The process of egg laying was observed on March 5, 1931. One of the adult individuals in an aquarium in the laboratory was seen laying eggs on the leaf of eel-grass (Vallisneria). The process is as follows: The animal remains almost stationary, with the long axis of the shell parallel to the leaf, and pointing upward; first, the gelatinous covering of the eggmass is laid down in part and then the long, oval egg capsules are deposited inside this envelope; when all the eggs are laid, the covering of the egg mass is completed and the animal moves slowly away. As the eggs are being deposited, the snail moves forward very slowly, just enough to make room for them. The whole process of laying this egg mass containing eight eggs, took approximately fifteen minutes. For the first few hours after deposition, the egg mass is less transparent than it becomes later. The gelatinous material of the sheath is apparently more dense, and somewhat milky in appearance. The milkiness disappears as time passes, apparently as the sheath absorbs more water, and swells to full thickness.
The egg masses are elongate, semi-cylindrical, with rounded ends. The width is approximately two millimeters; the length varies from 3.5 to 6 mm. The individual egg capsules are 1 mm. long and 0.6 mm. wide. The gelatinous outer covering of the egg mass is about 0.3 mm. thick. The number of eggs varies from 3 to 12 (Plate XI, fig. 1-4).

Eggs from the individuals collected in February were first seen one month later (March second). In the case of the individuals collected in May, eggs were seen one week after the date of collection (Plate XI, fig. 1). This indicates that egg laying is controlled by some sort of rhythm which is attendant on the arrival of more favorable conditions of growth in the spring. Temperature seems to be the controlling factor, or the immediate one at any rate.

The problem of studying the growth of the earliest juveniles of *Acella* is much more easily accomplished when the eggs are brought into the laboratory and hatched out in small aquaria. In this way the rate of development may be more accurately noted and the obvious difficulty of searching over all surfaces of the water plants in a colony location for minute individuals that are less than 2 mm. in length is overcome. The specimens upon which the early growth studies were made, were all raised in battery-jar aquaria, kept under more or less constant temperature conditions, though somewhat warmer than those prevailing in the shallow water habitats.

After three days, the embryos are in the trochophore stage, slowly revolving in the uppermost end of the elongate egg capsule. About five days after the eggs are laid, the embryos have developed a shell and are seen to be continually crawling (or moving by ciliary action?) in all directions over the inner surface of the capsule (Plate XI, fig. 2-3). At the end of ten days, hatching of the young has started and continues over four or five days. (Plate XI, fig. 4.) There is apparently some variation in the hatching of the snails as in the growth of the young afterwards.

The shell is 1.3 to 1.5 mm. in length when the young are hatched; its width is about 0.5 mm. Sixteen days after the eggs are laid and about three after the young individuals are hatched, the shell averages 1.8 mm. in length and 0.6 mm. in width. In twenty days (one week after hatching) the young
Fig. 2. The growth of *Acelia*, including experimentally raised individuals. The vertical lines represent variation in size from the average.
individuals vary in size from 1.6 to 3.4 mm, with an average shell length of 2.6 mm. The nuclear whorls of these individuals shows as a portion visibly distinct from the growth that has occurred since hatching. (Plate XI, fig. 5-6). After a month (two weeks after hatching) the shell of the juvenile individuals varies in length from 2.4 to 3.5 mm., with an average size of 3.1 mm.

One group of juvenile *Acella* was raised in the laboratory for three and one half months. Measured shortly after hatching (June 22, 1930) they averaged 1.8 mm. in shell length, varying from 1.4 to 2.0 mm. One month later (July 23, 1930) they measured between 3.5 and 7.0 mm. with an average length of 5.5 mm. At the end of six weeks (August 6, 1930) they were between 5.7 and 11.7 mm. long. The average was 8.5 mm. One individual 9.0 mm. long was found dead August 22, 1930. (Plate XII, fig. 34). After nine weeks (Sept. 1, 1930) they averaged 10.8 mm. with a variation of 7.6 to 13.9 mm. One individual found dead on Sept. 30, 1930, had grown to a length of 14.0 mm. (Plate XII, fig. 35). The shell length of the remainder (dead Oct. 5, 1930) varied from 8.7 to 15.0 mm., with an average of 11.6 mm. (Plate XII, fig. 36-41).

Juvenile individuals have been collected in the summer months of the year only. Baker, in the course of ecological studies on Oneida Lake, New York, found immature individuals on July 17 and 24, 1916. He says, "The specimens collected were all young, none exceeding 11 mm. in length, the greater number being 3 to 5 mm. long. . . . Five specimens gave the following measurements:

- Whorls 2; length 3.0; breadth .6; aperture length 1.5; breadth .5 mm.
- Whorls 2 1/4; length 4.0; breadth 1.0; aperture length 2.0; breadth .75 mm.
- Whorls 2 1/2; length 5.5; breadth 1.4; aperture length 2.0; breadth 1.0 mm.
- Whorls 3; length 8.0; breadth 1.7; aperture length 3.5; breadth 1.0 mm.
- Whorls 3 1/4; length 10.5; breadth 2.5; aperture length 5.0; breadth 1.5 mm.

The whorls are usually flatsided as in the adult shell, but in two specimens, they were somewhat rounded."

Of the few specimens of these juvenile individuals of *Acella* loaned by the New York State College of Forestry, two were
dated July 17, 1916. These were 4.0 and 5.4 mm. long and averaged 4.7 mm. in shell length (Plate XI, fig. 7-8). Another specimen, collected July 24, 1916, measured 10.0 mm. (Plate XI, fig. 9).

Juvenile *Acelia* were collected on July 31, 1930, from a small bit of marshy shore in a small bay at the southeast corner of High Lake, Vilas Co., Wisconsin. Measurements of these varied from 4.6 to 14.9 mm., with the average of 9.7 mm. shell length. (Plate XII, fig. 1-11). Again on August 2, 1930, juveniles were found in the small bay immediately to the west of that collected in a few days previously. The shell length of these individuals varied from 6.7 to 16.5 mm. with an average of 11.4 mm. (Plate XII, fig. 12-15). The Fishtrap Lake colony of *Acelia* was searched for young on August 15, 1930. This search revealed one empty juvenile shell and seven live ones. These had a shell length of 8.0 to 18.4 mm. with an average of 14.3 mm. (Plate XII, fig. 16-20). The Harris Lake colony was located by the finding of juveniles on August 16, 1930. Here, the individuals varied in size between 8.6 and 20.0 mm. with an average shell length of 15.0 mm. (Plate XII, fig. 21-25). One individual was collected from Dead River, Illinois on August 22, 1925. This specimen, almost full grown, was taken by a member of Dr. W. C. Allee's Field Zoology Course of the University of Chicago, in the course of ecological studies on Dead River. This individual had a shell length of 19.2 mm.

Specimens collected in September and October in Oneida Lake, N. Y., by Baker, were loaned by the New York State College of Forestry. Thirty-seven specimens collected Sept. 10, 1916 vary in size from 12.3 to 21.8 mm., with an average shell length of 16.9 mm. Eight collected Sept. 14, 1916 vary from 18.8 to 22.0 mm., with an average shell length of 20.3 mm. Five collected Sept. 18, 1916 vary from 18.5 to 25.2 mm., with an average length of 21.6 mm. Five individuals collected October 12, 1915 vary from 18.0 to 25.0 mm., with an average of 21.9 mm. shell length.

Of the specimens collected in Dead River, Illinois on October 13, 1929, twenty-two individuals were measured. They vary in size between 18.1 and 26.5 mm., with an average shell length of 22.8 mm. (Plate XII, fig. 26-29, 42). Of the *Acelia* collected in Fishtrap Lake, Vilas Co., Wisconsin on November 16, 1929, sixty-one were measured. They vary in size between
18.2 and 25.2 mm., with an average length of 21.6 mm. (Plate XII, fig. 30-33, 43).

Two individuals were collected from the colony in the channel between Fishtrap and High Lakes on Feb. 1, 1931. These measured 15.4 and 16.1 mm. when collected. The average shell length was 15.7 mm. That these individuals are not just juveniles that have not completed their growth is indicated by the amount of erosion evident at the apex of the shell. These had just 3 and 3½ whorls remaining when collected. Observations on the growth of these two specimens while they were in the laboratory are of interest. Measured before they started laying eggs, on February 24th, they were 16.1 and 17.3 mm. long. Measured at the end of the egg laying period, they were seen to be 16.0 and 17.2 mm. long, respectively. Later, on March 19, they showed a total length of 17.7 and 18.7 mm. From these observations it is evident that shell growth stops during the egg laying period. The decrease in length at this time, may be explained by continued erosion of the shell.

There were thirty-seven adult individuals collected from the Fishtrap Lake colony on May 10, 1930. The erosion of the spire of these shells is in direct contrast to the perfect specimens collected the preceding fall. Instead of 5 full whorls, there were only 2 to 3 whorls to the shell. The tip of the animal was about one quarter turn behind the eroding tip of the shell. These varied in length from 16.8 to 24.1 mm. with an average shell length of 20.4 mm. These shells also show some additional shell growth, after a winter ring on the shell. When kept in the laboratory, these same individuals show more shell growth after the date of collection. Examination of the individuals that lived longest, under laboratory conditions, shows as much as two or three millimeters growth of shell beyond the line of the aperture on the date of collection. Again on June 17, 1930, six adults were collected from the Fishtrap Lake Colony. These individuals also show a winter ring with additional growth beyond. The smaller shells, probably those that were under slightly less favorable growth conditions the preceding summer, have more nearly cylindrical shells, while the larger ones, with a shell of greater diameter, have the aperture flared out distinctly, more especially on the second season's growth. These varied in length from 15.6 to 21.7 mm., with an average shell length of 19.3 mm. Thirty-three individuals
were collected from the colony in the channel between Fishtrap and High Lakes on June 21, 1930. They have an average shell length of 16.5 mm., varying between 14.5 and 19.8 mm. These *Acella* show the same erosion of the apex of the shell as was noticed on the individuals collected in May and on June 17. There were about three whorls remaining. The shell shows a crowded group of growth lines, representing the winter and there is a narrow band of new shell growth, lighter in color from one to two millimeters in width. This evidently represents the growth up to the date of collection, this season. (Plate XII, fig. 45-50). One adult individual was found in the second High Lake colony on July 31, 1930. While there is not much erosion of the apex of this shell, the surface is pitted somewhat (Plate XII, fig. 44). This individual measured 24.0 mm. when collected. The writer was unable to keep any of the *Acella* alive in the laboratory beyond August 11, 1930. That these snails died of "old age" is the most probable explanation. This opinion is supported by observations on the amount of general activity and of the heart beat rate, contrasting them with the juvenile individuals being reared in the laboratory. The heart beat rate of the individuals in their second season (after laying eggs) is approximately one-half that of the juveniles two weeks after they are hatched.

The Dead River habitat was examined for *Acella* in October 1924 and again in November 1925. These searches resulted only in the finding of empty shells, probably those of the season preceding. These shells are all full grown, with the flared aperture with a thickened peristome. In some of the individuals, a rest mark and an additional band of shell representing the second season's growth can be seen.

The growth of *Acella* is shown graphically in Fig. 2.

The shell of this species shows variation in convexity of whorls and shape of the aperture. An analysis of this variation, shows that it has a correlation with the type of plant habitat. In the material studied by the writer, two growth forms can be seen. One is the form produced when the individuals live on rushes (*Scirpus*). This narrow growth form has flat-sided whorls and a proportionately narrower aperture. Measurements of the individuals from Dead River, Illinois, collected from rushes, show the following average:
Aperture length 9.7 mm. Breadth 3.2 mm.
Length-breath ratio 33.0%

This average includes the measurements from 22 specimens. The wider growth form is produced when Acella grows on other plants, such as: yellow and white pond lilies, burreed (Sparganium), and pondweed (Potamogeton). This wider growth form has slightly more convex whorls, and a wider aperture, with the outer portion of the peristome evenly arched.

Measurements of the wide form are as follows:

<table>
<thead>
<tr>
<th>Location</th>
<th>Date</th>
<th>Number of individuals</th>
<th>Aperture length</th>
<th>Breadth</th>
<th>Length-breath ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fishtrap Lake, Vilas Co., Wisconsin</td>
<td>Nov. 16, 1929</td>
<td>61</td>
<td>8.9</td>
<td>3.4</td>
<td>38.2%</td>
</tr>
<tr>
<td>Channel between Fishtrap and High Lakes, Vilas Co., Wis.</td>
<td>February 1, 1931</td>
<td>2</td>
<td>7.3</td>
<td>2.8</td>
<td>38.3%</td>
</tr>
<tr>
<td>Fishtrap Lake, Vilas Co., Wis.</td>
<td>May 10, 1930</td>
<td>37</td>
<td>9.2</td>
<td>3.5</td>
<td>38.0%</td>
</tr>
<tr>
<td>Fishtrap Lake, Vilas Co., Wis.</td>
<td>June 17, 1930</td>
<td>6</td>
<td>8.8</td>
<td>3.3</td>
<td>37.5%</td>
</tr>
<tr>
<td>Channel between Fishtrap and High Lakes, Vilas Co., Wis.</td>
<td>June 21, 1930</td>
<td>36</td>
<td>7.6</td>
<td>2.8</td>
<td>36.8%</td>
</tr>
<tr>
<td>High Lake, Vilas Co., Wis.</td>
<td>July 31, 1930</td>
<td>1</td>
<td>10.0</td>
<td>4.0</td>
<td>40.0%</td>
</tr>
</tbody>
</table>

The wide growth form is illustrated by fig. 30-33, 43-50; Plate XII. The narrow form is illustrated by fig. 26-29, 42; Plate XII. The difference is strikingly seen on comparison of figures 42 and 43.

**Summary**

The snail *Acella* has a life-span of only one year. The eggs are laid in the spring, a month or so after the ice leaves the
PLATE XI.

FIG. 1. Newly laid eggs of Acella. May 21, 1930.
Still unsegmented after 28 hours.

FIG. 2. Eggs of Acella laid May 17. Average development at 5 days.

FIG. 3. Eggs laid May 17. Maximum development at 5 days.


FIGS. 7-8. Juvenile individuals collected by Baker in Oneida Lake, N. Y.
July 17, 1916. N. Y. S. C. F. #834 g.

FIG. 9. Juvenile individual collected by Baker in Oneida Lake, N. Y.
July 24, 1916. N. Y. S. C. F. #1021 d.

A convenient scale for figures 1-4 is furnished by the individual egg capsules, which are approximately 1 mm. long. Figures 5-9 enlarged 10 diameters.
PLATE XII.

Figs. 1-11. From colony #1, High Lake, Vilas Co., Wis. July 31, 1930.
Figs. 12-15. From colony #2, High Lake, Vilas Co., Wis. August 2, 1930.
Figs. 30-33. Fishtrap Lake, Vilas Co., Wis. Nov. 16, 1929.
Figs. 34-41. Experimentally raised. Hatched from eggs, June 22, 1930.
  Fig. 34. Dead, Aug. 22, 1930.
  Fig. 35. Dead Sept. 30, 1930.
  Fig. 36-41. Dead Oct. 5, 1930.

Fig. 42. Dead River, Lake Co., Ill. Oct. 13, 1929, specimen showing narrow growth form as found on Rushes (Scirpus).

Fig. 43. Fishtrap Lake, Vilas Co., Wis. Nov. 16, 1929, specimen showing wider growth form as found on Burreed, Pondweed, etc.

Fig. 44. High Lake, Vilas Co., Wis. July 31, 1930, specimen in second season.

Figs. 45-50. Channel between Fishtrap and High Lakes, Vilas Co., Wis. June 21, 1930, specimens in second season showing extreme amount of erosion.

All figures slightly enlarged.
lakes. The juvenile individuals hatch and grow to full size by early fall. They overwinter as adults, lay eggs the following spring and die by mid-summer.

_Acella_ does not migrate to deep water, but remains in the zone of vegetation near shore at all times of the year. When the vegetation has been killed down by winter conditions, the snags and logs serve as a substitute habitat on which to live and lay eggs.

The shell of this species shows variation directly produced by the habitat. The individuals living on rushes (Scirpus) have narrower apertures, with almost parallel margins, while those from other plants show greater convexity of the whorls and wider apertures, with more evenly arched outer lips.

**BIBLIOGRAPHY**


