GROWTH OF THE FINGERNAIL CLAM, *SPHAERIUM TRANSVERSUM* (SAY) IN FIELD AND LABORATORY EXPERIMENTS[1]

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ABSTRACT

Field and laboratory experiments on Pool 19 of the Mississippi River in summer and fall of 1967 revealed that S. transversum *can complete its life cycle in about a month or less. In laboratory experiments, many newborn clams entered a resting state and did not grow for 33 days after they were born; later, some grew large. Medium-sized clams grew slowly but gave birth to young that often grew faster and larger than their parents. In field experiments, clams that were moved from an open-river site (where the clam population was high) to a retainer in a cove (where the population was low) grew faster and became larger than those remaining at the collection site; they also grew larger than clams in laboratory experiments.*

Fingernail clams were abundant in Pool 19 of the Mississippi River during a 1966-68 survey of the benthos. Densities of *Sphaerium transversum* reached over 100,000/m^2 in some areas (Gale, 1969) in spite of heavy predation by leeches, fish, and waterfowl. In autumn of 1967, diving ducks harvested about 24% (2,085,125 kg) of September's standing crop of fingernail clams (Gale, 1973; Thompson, 1973). Life history data were collected in an effort to determine the cause of the clam's success. The objective in this study was to determine how fast *S. transversum* grows.

PROCEDURES

Growth experiments were conducted during the summer and fall of 1967. Laboratory experiments were conducted in a field laboratory above Ft. Madison, Iowa (about 200 m upstream from the Ft. Madison/Niota bridge). Water pumped from near the river channel into the laboratory kept temperatures and chemical conditions similar to those in the river and provided clams with food.

Clams were housed in individual plexiglass rearing chambers, 3.8 cm square and 5.0 cm deep inside (Fig. 1, A); the upper 3.3 cm of the chambers were covered on two sides with plastic screen (mesh with 12 openings/cm) for water passage. A set of nine rearing chambers was placed in each of nine painted plywood compartments (Fig. 1, B). A 5-cm baffle kept water levels about 6 mm below the top of the rearing chambers. Clams could not escape or move between chambers without crawling out of the water.

Each rearing chamber contained about 10 cc of strained clayey silt from the river bottom where experimental clams were collected. Water in the chambers was initially 3.5 cm deep but decreased to about 2.5 cm as chambers silted in. Compartments holding the chambers had a maximum flush rate of 6 minutes; fluctuating pump discharge and partial clogging of distribution tubing reduced flushing rate.

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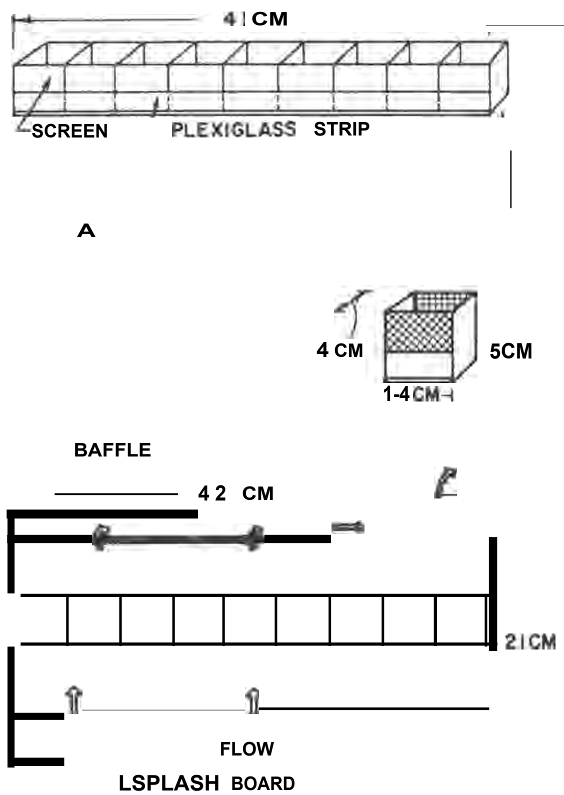

G. 1. *Rearing apparatus.* **A.** *set of nine rearing chambers (side view).* **B,** *compartment with rearing chambers in place (top view).*

One large (over 10.0 mm long), two medium (4.0-6.0 mm long) or four small (newborn) clams were randomly assigned to each chamber; each compartment had three chambers of clams of each size group (chamber identification numbers were adjusted for presentation in Table 1). Large and medium-sized clams were collected in the river, but small clams were born in the laboratory. Small clams were removed with camel-hair brushes (Thomas, 1959) within an hour after their birth in pans of river water and measured with an ocular micrometer. Larger clams were measured with a vernier caliper; damaged clams were discarded. Similar sized clams were used as chambermates so that marking was unnecessary and handling was minimized.

The laboratory growth experiment began July 21, 1967; after 33 days, 3 units were removed, the 27 chambers cleaned, and the contents screened. Clams were measured as before and living ones returned to their respective chambers (Table 1) with fresh substrates.

To measure clam growth in the field, two retainers with 80 clams each were submerged in the river on July 6. One retainer was put in a sheltered cove adjacent to emergent and

TABLE 1. *Reproduction and growth of S.* transversum *in chambers in the laboratory between 21 July and 23 August, 1967, and numbers present on November 15.*

	July 21		August 23						November 15	
Chamber	No. per chamber	Length mm	No. Dead	No. broken in handling	No. with no growth	Lengths of those which grew (mm)	Young No.	Young Length (mm)	Numbers Living	Dead
1-6,9	4	1.7-2.2	3	3	19	2.7 2.8 3.0 3.4 4.3 5.3 5.7	0	–	100	22
7	4	2.0-2.3	0	1	0	5.1 6.0 8.1	2	1.4	13	9
8	4	2.0-2.3	0	0	0	3.0 3.4 4.9 6.5	1	1.8	22	7
10-18	2	4.9-5.7	6	0	0	6.0 6.2 6.2 6.5 6.6 6.8 6.9 7.0 7.2 7.5 8.1 9.0	76	1.6-6.0	170	65
19-27	1	10.2-12.1	9				53	1.6-9.0	237	32

Chambers 7 and 8 were treated the same as 1-6 and 9, but are listed separately since the clams showed reproduction and more growth. The clams with shells broken in handling on August 23 had not grown, nor had the dead clams in 1-6 or 19-27, but five in 10-18 had grown 0.1 to 2.6 mm and one showed no growth.

submergent vegetation (transect 5 station 2 of Gale, 1969, p. 11) where there were less than 1,000 clams/m ; the other was placed in open water (transect 4 station 14 (if Gale, 1969, p. 11) where there were about 42,000 clams/m .

Each retainer (Fig. 2, A) held 40 rearing tubes (Fig. 2, B) suspended through holes in a plexiglass plate by aluminum rods. Rearing tubes were 7 to 8 cm lengths of polyvinylchloride pipe (I.D. 2.5 cm) with plastic screen attached near the bottom; a painted wooden disk closed the lower end of the screen. A tube like that in Figure 2, C could be constructed and cleaned more easily.

Two randomly selected clams 5-7 mm long and 10 cc of strained clayey silt from station 14 were placed into each tube. The retainer was then forced into the river bottom until the two plexiglass flanges on the sides halted penetration with the rearing tubes just above the substrate.

The retainer at station 2 was removed on September 6. It had been turned over and many tubes nearly filled with mud. Tube contents were screened and the clams counted and preserved in

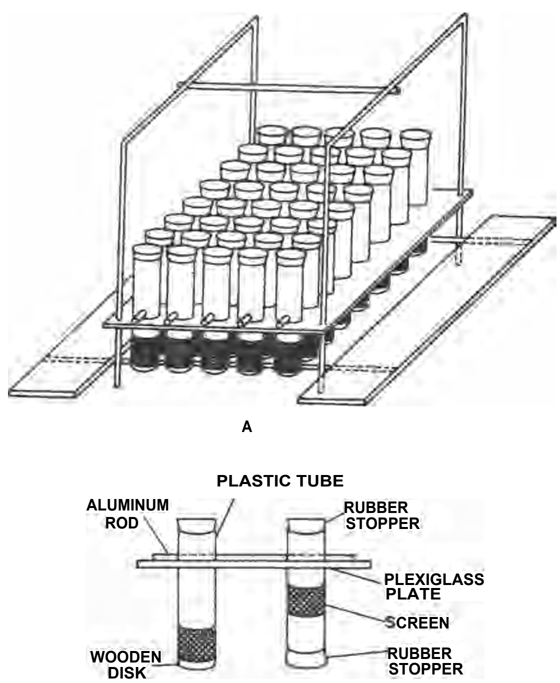

FIG. 2. *Rearing apparatus used in maintaining* S. transversum *in the field.* A, *clam retaining apparatus;* B, *enlarged side view of a rearing tube used in 1967;* C, *rearing tube with alterations.*

10% buffered formalin. Buoys marking the retainer at station 14 disappeared by September, and the retainer was lost.

RESULTS

Clam Growth in the Laboratory

Although the nine large clams stocked in chambers 19-27 died shortly after the experiment started, 53 young, 1.6-9.0 mm long (Table 1), were produced (some may have been second generation offspring). In only 33 days, or less, one of the offspring had grown approximately 7.0 mm in length (newborn clams in Pool 19 average 2.2 mm long) (Gale, 1969) to near maximum size. (*S. transversum* usually do not exceed 12.0 mm in Pool 19, but clams up to 15.9 mm long and 8.1 mm thick were found.) Reproduction in chambers 7 and 8, where newborn clams had been stocked, demonstrated that *S. transversum* not only could grow large in a month but could complete its life cycle as well.

Many newborn clams, stocked in chambers 1-9, had not grown by August 23 (Table 1) and some of them did not move for several minutes after removal from their chambers; some seemed dormant (in a resting state). The periostraca of the nongrowing clams were discolored and chalky.

Most of the 12 medium-sized clams that survived in chambers 10-18 grew slowly with a mean length increase of 1.3 mm. Clam growth in chamber 12 was not determined because five clams exceeded the initial size of parental stock and offspring and parents could not be distinguished. In most instances, offspring of the medium-sized clams grew rapidly and one was 9.0 mm long.

By November 15, when the chambers were reexamined, reproduction had occurred in all but two of the 27 chambers. Reproduction was maximum in chambers where one large clam had originally been stocked (19-27) and one clam left 79 descendants. Many of the clams that seemed dormant in August (chambers 1-9) had grown to 9.0 mm or longer (Fig. 3). Most of the clams stocked in chambers 10-18 had died without reaching 9.0 mm, and many were smaller than their offspring. Because observations of growth in chambers 28-81 did little more than confirm observations in chambers 1-27, precise data were not collected.

In November the periostraca of nearly all clams longer than 2.5 mm were speckled with dark deposits and some were nearly black. *S. transversum* usually seems very clean, and it is not known why deposits had accumulated on the clams.

Clam Growth in Field Experiments

Clams grew well in the rearing tubes at station 2, and after 62 days, 45 were 4.0 mm or more thick; the largest was 13.8 mm long and 6.6 mm thick. Clams in the tubes were larger than those living at station 14, the collection site (over 5,000 clams were examined there in mid-September but none was 4.0 mm thick). That four clams in each of 2 tubes were over 5.0 mm thick means that within 62 days, one or both stocked clams grew to maturity and discharged young that also had grown large.

Clams in the tubes contained many embryos and one large individual that seemed to have given birth to 35 young (its chambermate had died before reaching reproductive size) contained 86 embryos. A few of the 35 young may have been second generation offspring.

A specimen of *Sphaerium striatinum,* placed into a tube by mistake, had grown to a thickness of over 4.0 mm but had not given birth.

Clams in 21 tubes were dead, perhaps from senility, leech predation, or other causes (Gale, 1973). One live clam had a fungal growth nearly covering outer portions of the inner gill; embryos in the gill seemed unaffected.

DISCUSSION

In laboratory and field experiments, *S. transversum* grew extremely fast and completed its life cycle in about a month or less. Rapid growth has been noted for some other species of *Sphaerium. Sphaerium partumeium* grew large in 7 to 10 weeks in laboratory experiments (Thomas, 1965) and gave birth when less than 14 weeks old; clams grew even faster in the field. *S. partumeium (as M partumeium)* reared by Krull (1936) grew to 4.5 to 5.0 mm long in about two months and gave birth. *Sphaerium corneum, Sphaerium rivicola,* and *Sphaerium solidum*

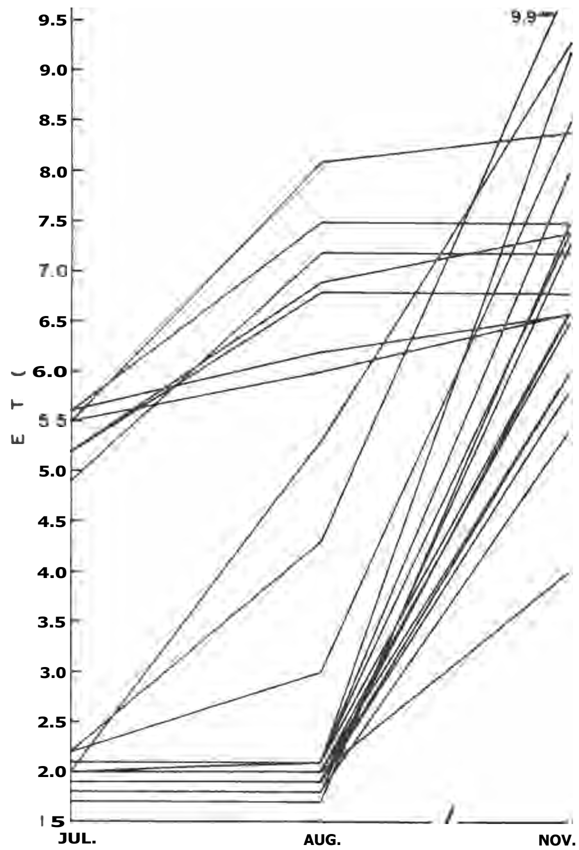

FIG. 3. *Length changes in small and medium-sized S.* transversum *in the laboratory, 1967.*

suspended in baskets in the Elbe River grew rapidly (Thiel, 1928, 1930), and some *S. corneum,* born in early summer, matured, gave birth, and died that autumn.

If *S. transversum* in the natural environment grew as rapidly as those in laboratory and field experiments, several generations could be produced annually. At station 14, however, medium-sized clams seemed to have grown only 2 mm longer in July and 3 mm in August (Gale, 1972), considerably less than those in growth experiments. Clam growth may have been hindered at station 14 by high clam density. Also, the clams were probably debilitated by high infestations of larval trematodes (Gale, 1973).

Although clam growth rates in the laboratory and at station 2 were similar, clams grew much larger at station 2. Because parental stock of both groups came from the same site and presumably from the same genetic stock, some factor or factors in the laboratory seem to have stunted the clams. Clams at some sites in the river did not reach maximum size either. Thiel (1928) observed that *S. corneum* in the Elbe River did not grow to maximum size in "overpopulated" areas. The fact that some medium-sized *S. transversum,* which did not grow much during the first 33 days of the laboratory experiment, remained smaller than their offspring in November (Fig. 3), suggests that, once growth is arrested or retarded, it is not completely compensated for later, when growth conditions become favorable.

Why some clams had initial growth lags and their chambermates did not is not clear, but delayed growth does not seem to have been genetically controlled (Gale, 1972). Delayed growth may involve metabolic slowdown that enables clams to bury themselves deep in the substrate to escape predation, parasitism, or unfavorable water conditions (Gale, 1973). In temporary ponds in Michigan, Kenk (1949) found that only fairly young *Sphaerium occidentale* and *S. partumeium* (as *S. truncatum*) survived the dry period.

It is sometimes pointed out that fast growth is of great advantage to inhabitants (such as some fingernail clams) of temporary ponds, because they can take advantage of a short growing period. One might conclude that, through evolution and natural selection, the advantage of being able to survive short growing periods has produced clams with tremendous growth rates. But, the fact that *S. transversum* grows rapidly but does not often inhabit temporary ponds, suggests that other factors produced rapid growth. This rapid growth may be a form of preadaptation. That *S. transversum* may have originated in temporary ponds and then moved to other habitats merits consideration.

But, regardless of why *S. transversum* grows rapidly, the fact that it can complete its life cycle in about a month may be a major factor in its success in Pool 19, where predation pressures are great. If a population is to sustain itself under heavy predation, quick growth and reproduction would be advantageous, if not essential, for the shorter the prereproductive period, the greater the probability an organism has of reproducing before being consumed.

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