MOVEMENTS OF SMALL SOFT-SHELL CLAMS (*Mya arenaria*)

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The fact that small soft-shell clams can come up out of the soil, can move voluntarily, and can be carried about by current or wave action was fully described by Kellogg in 1901 and 1905; but the extent of their movements has not been investigated. The general assumption since then seems to have been that clams ordinarily move little after they have dug into the flat. Clams that are attached by their byssi to floating objects or are washed about at the water's edge usually are thought to have been washed out accidentally.

The important question, of course, is not whether clams can move but how many move about and how important this movement may be in determining the final distribution of the adults on any flat. If most of them move about until they are nearly half an inch long (12 - 13 mm.) then we must try to attract them up to this size and induce them to stay if we are trying to increase a natural set. Also, any population estimates based on clams less than half an inch long will be of little or no value in estimating future production. For the same reasons, transplanting the very small clams would be of doubtful benefit.

In order to learn more about the importance of clam movements, an experiment was carried on from May 1951 to November 1952 to determine how many moved into a square foot area in a given time. Trays 1 foot square with screened bottoms were filled with clam-free mud, set down flush with the flat. The sides of the tray were wood, 2-1/2 inches high. The bottom was plastic fly screen with 15 meshes per inch one way and 17 the other. Each trayful of clam-free mud was left in the flat for about 2 weeks, and then taken up and replaced by another. Thus each "movement tray" contained only those clams that had moved in during the previous 2 weeks, while square-foot samples of the adjoining flats indicated the density of clams of all sizes where there was no time limit on the period over which they might have accumulated. A few movement trays were left down for shorter and longer periods. The mud in the biweekly collecting trays was flush with the sides, and the whole thing was down flush with the surrounding flat. In fact, after they had been in place a day, they were hard to find, so they did not offer an unusual barrier or eddy to collect water-borne clams faster than the surrounding flat.

The trays were set out on flats at Hales Cove and at Ordways in the Town of Newbury, Massachusetts. The Hales Cove flat was a relatively soft mixture of fine sand and silt; Ordways was similar, but firmer, with more shell fragments. Clams over an inch long were practically absent on both flats, but various clam-farming experiments carried on nearby showed that physical conditions were suitable for clams.

During the first summer, the controls, samples of the surrounding flats, were taken during the course of some other work, they were therefore not always taken on the same days and they were not taken as often as the movement trays were taken up and screened. During the second summer, control samples were taken on each day that a movement tray was taken up.

Indications of movement from biweekly collections

As tables 1 and 2 and figure 1 show, we found small clams, 2 to 12 mm. long, in our movement trays and in the surrounding flats at all times of the year. There was no sign of growth as would be expected if the clams were staying in one place. Furthermore, when clams were more abundant than usual in the surrounding flats they were also abundant in movement trays. In both series of samples and in both summers the clams were fairly abundant in May, there were fewer in June and July, and they were most abundant in September and October. The peaks of abundance do not correspond with storms, but are seasonal in nature. A peak of abundance of 2- to 12-mm. clams has appeared in Hales Cove in September and October from 1950 to 1954 and it probably is an annual event, as clams of the current year class grow large enough to be seen. The early spring peak seems to represent clams that overwintered at less than 2 mm. and have started to grow.

The data from the biweekly movement tray collections show that a large proportion of the clams in a small area may have been there only a few weeks. The proportion of newcomers would appear to vary somewhere between 5 and 50 percent, with a grand average of 16 percent for all movement trays and all controls, from February 23 to October 28, 1952.

Whatever the true rate or extent of movement may be, the results show that small byssus-bearing clams have a true wandering stage. Even after clams have burrowed voluntary movement is normal, and probably has an important bearing on the numbers of clams maturing in any one spot.

Observed movements in laboratory and field

Small clams in pans of soil and salt water in the laboratory behaved much as Kellogg (1901) said. All we can add is that we saw them move a little farther and saw larger clams moving. On June 19, 1952, four clams each about 4 mm. long were placed on the soil in a pan. All burrowed in less than 5 minutes. After 15 minutes, one started to move horizontally, plowing a furrow 2 inches long in 15 minutes. After an hour, another came part way up, and plowed along through the sand with just its umbones exposed. This one traveled 4 inches in 15 minutes. Even larger clams, 7 to 12 mm. behaved in a similar way, the best performance being a track 8 inches long made by a 7 mm. clam in half an hour or less. The furrows or tracks left by the moving clams were seldom straight; most of them were curves, or even complete loops and spirals.

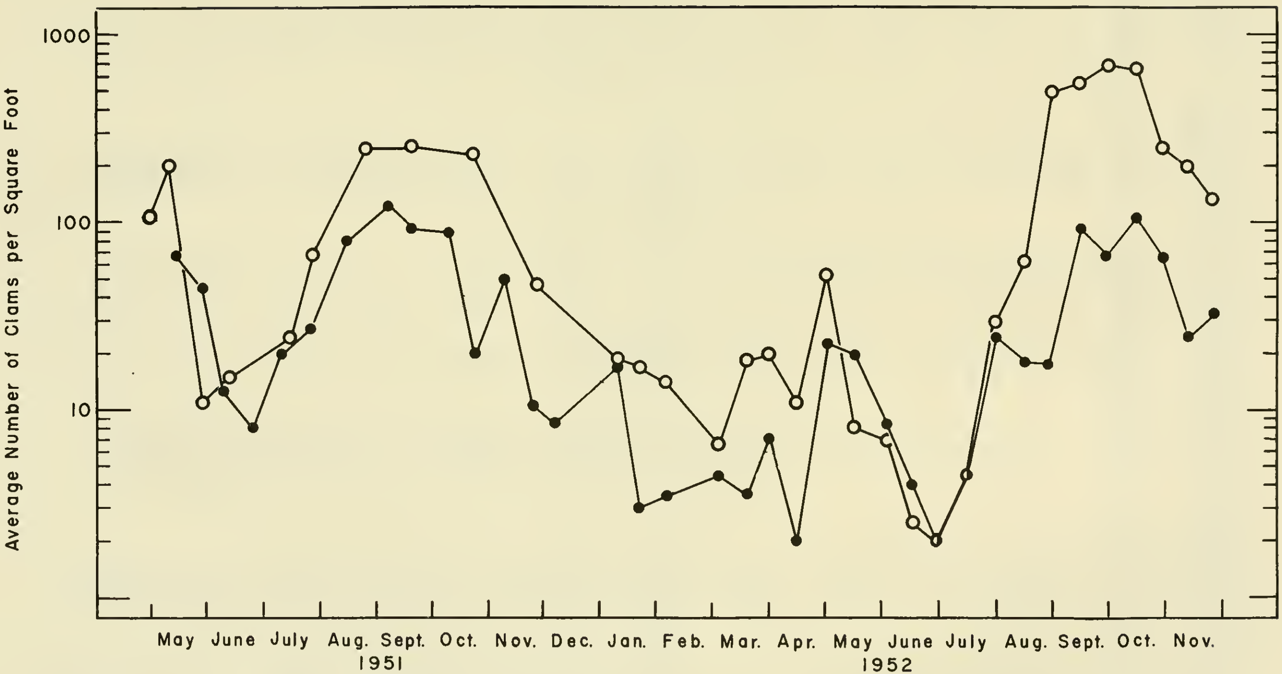

Figure 1. Average numbers of juvenile clams per square foot in biweekly collections from movement trays (open circles) and controls in surrounding flats (closed circles) from Ordways and Hales Cove flats, Plum Island Sound, Massachusetts (Points for controls May 29 and July 26, 1951, January 10, 1952, and all points in November 1952 represent single square foot samples All others are averages of two single samples from the two flats All points are plotted as N+1)

Table 1. Data from 1-square-foot samples on Ordway Flat.

Date	Movement-tray samples					Control samples			
	Days tray down	Number of clams	Size, mm.			Number of clams	Size, mm.		
			Average	Min.	Max.		Average	Min.	Max.
1951									
Apr. 30						142	7.2	2	18
May 11						206	5.7	2	21
15	12	119	5.2	3	12				
28	13	50	4.9	2	12				
June 12	15	12	4.0	2	9	19	4.7	2	11
25	13	13	3.9	3	6				
July 10	15	18	4.6	2	9				
17						39	4.0	2	8
27	17	34	3.7	2	9				
Aug. 16	20	116	2.9	2	6				
27						398	3.1	2	6
Sept. 7	22	150	3.2	2	6				
20	13	143	3.0	2	4	464	3.1	2	5
Oct. 10	20	111	2.9	2	4				
23	13	33	3.0	2	5	392	2.8	2	4
Nov. 9	17	88	3.2	2	5				
26	17	2	3.5	3	4	50	3.4	2	5
Dec. 6	10	12	3.4	2	5				
1952									
Jan. 10	35	16	4.1	3	6	17	3.7	2	7
23	13	3	3.3	3	4	9	4.8	2	7
Feb. 5	13	2	4.5	4	5	9	3.6	2	6
Mar. 3	26	2	3.5	3	4	7	4.4	2	7
18	15	3	4.0			4	4.0	3	6
31	13	5	4.6	4	6	28	4.3	2	8
Apr. 15	15	0				14	4.4	2	8
May 1	16	29	7.0	3	14	54	4.2	2	12
15	14	27	3.9	2	9	10	5.0	2	11
June 3	19	3	5.3	4	8	5	4.0	3	8
16	13	1	4.0			2	5.5	3	8
July 1	15	1	6.0			1	8.0		
15	15	5	4.0	2	8	3	3.0	2	4
30	15	17	3.1	2	7	25	3.4	2	6
Aug. 15	16	25	4.0	2	8	88	3.5	2	8
28	13	14	2.9	2	9	490	2.7	2	7
Sept. 16	19	66	3.6	2	6	746	2.9	2	6
29	13	98	3.7	2	8	970	2.8	2	8

Table 1 (continued)

Date	Movement-tray samples					Control samples			
	Days tray down	Number of clams	Size, mm.			Number of clams	Size, mm.		
			Average	Min.	Max.		Average	Min.	Max.
1952									
Oct. 1	2	12	3.8	2	5	802	3.1	2	6
7	8	45	3.5	2	7	970	3.0	2	9
9	10	59	3.7	2	7	874	2.9	2	10
13	14	156	3.1	2	6	648	3.0	2	5
28	15	78	3.0	2	4	340	3.1	2	8
28	29	162	3.1	2	6				
28	29	136	3.1	2	5				
Nov. 12	15	28	3.1	2	6	210	2.8	2	10
12	42	60	2.8	2	4				
25	49	88	3.0	2	6	136	3.0	2	7
25	13	32	3.3	2	9				

Table 2. Data from 1-square-foot samples on Hales Cove.

Date	Movement-tray samples					Control samples			
	Days tray down	Number of clams	Size, mm.			Number of clams	Size, mm.		
			Average	Min.	Max.		Average	Min	Max.
1951									
Apr. 30						74	5.8	2	16
May 10						195	6.6	2	26
15	13	14	6.6	4	15				
28	13	38	6.3	2	22				
29						10	4.6	2	8
June 12	15	12	3.8	3	9	10	4.5	3	13
25	13	1	7.0						
July 10	15	20	4.7	2	9				
16						18	3.5	2	10
26	16	19	5.3	2	8	64	5.4	2	9
Aug. 16	21	43	3.0	2	6				
22						99	3.4	2	8
Sept. 7	23	102	3.3	2	8				
20	13	42	3.0	2	6	51	3.3	2	10
Oct. 10	20	65	3.0	2	5				
23	13	5	3.4	2	5	62	3.2	2	6
Nov. 9	17	8	3.8	2	5				
23	14	17	3.0	2	4	40	3.3	2	6
Dec. 6	13	3	2.7	2	3				

Table 2 (continued)

Date	Movement-tray samples					Control samples			
	Days tray down	Number of clams	Size, mm.			Number of clams	Size, mm.		
			Average	Min.	Max.		Average	Min.	Max.
1952									
Jan. 23	48	1	3.0			23	4.2	2	8
Feb. 5	13	3	3.0	2	4	17	3.8	2	7
Mar. 3	27	5	3.2	3	4	4	4.5	3	7
18	15	2	3.5	3	4	31	3.8	2	8
31	13	7	4.3	2	7	10	4.6	2	9
Apr. 15	15	2	11.0	11	11	7	3.7	2	10
May 1	16	14	5.3	3	12	49	4.0	2	15
15	14	10	4.2	2	8	4	3.8	3	5
June 3	19	12	3.5	2	5	7	3.6	3	5
16	13	5	6.8	6	7	1	7.0		
July 1	15	1	3.0			1	4.0		
15	14	2	5.5	3	8	4	2.8	2	3
30	15	30	3.5	2	9	31	3.1	2	5
Aug. 15	16	9	3.1	2	7	32	3.3	2	5
28	13	19	3.6	2	9	495	2.6	2	6
Sept. 16	19	114	3.0	2	8	349	3.1	2	7
29	13	32	2.9	2	4	394	2.9	2	8
Oct. 13	14	54	2.8	2	4	608	2.7	2	5
28	15	50	2.8	2	4	162	2.8	2	4

Sometimes clam tracks just like those seen in the laboratory may be found in the field. Their comparative scarcity is probably due to their impermanence. Since they are very small furrows, and made under water, it would take very little current or rippling to obliterate them. Therefore, they seldom would last until after the tide left the flat, and when they do last that long they probably represent only a fraction of the tracks made during the preceding high tide. Some very clear tracks were seen on a firm sandy flat at Essex in April 1953. These varied in length from 2 or 3 inches up to about 10 inches, and were rather evenly scattered over the flat at a density estimated at 1 per 25 or 35 square feet. By carefully digging with a jackknife blade, a 5- to 8-mm. clam could always be found precisely at one end or the other of the small furrow.

Thus it seems the small clams have two methods of moving when they come up out of the soil. They may crawl short distances, or they may be carried longer distances by currents. In either case the clams have some influence on their dispersal, as pointed out by Baptist (1955). He found that the smaller clams (2-13 mm.), which were moved most extensively by the currents, also burrowed more rapidly and in larger numbers per allotted time than did larger clams (14-22 mm.).

Experiments with spat-catchers

Experiments with screen "spat-catchers", similar to those described by Turner (1949) also indicated large-scale movement of small clams. In 1950, some monofilament plastic screen, called "Saran", with eighth-inch mesh was staked out on several flats to collect or protect small clams. Nine strips, 8 to 10 feet long and 3 feet wide, were staked down on five flats on May 10. One of these collected or protected nearly 2,000 clams, 4 to 21 mm., per square foot by June 21, when a control sample of the surrounding flat had only 6 clams 5 to 8 mm. Predation undoubtedly had cleaned out the surrounding flat, but the dense population under the Saran was largely the result of movement of small clams. These clams were too large and accumulated too early in the year to have settled out of the plankton as larvae from the current year's spawning, and they were not abundant before the Saran was put down. Small clams were often found on top of the Saran, sometimes about 1 or more per square foot where the Saran was wrinkled. The Saran was not successful as a collector that summer because the clams were smothered by silt and detritus that collected under the Saran.

In 1951 a strip of Saran was staked down at Hales Cove on April 12 when the immediate area had about 57 clams, 3 to 16 mm. long, per square foot. On April 20, a square foot under the Saran had 351 versus 74 beside it. On May 31, the "score" was 521 clams, 2 to 29 mm., compared to 10. (This was after the predaceous green crabs and horseshoe crabs had started preying on clams in the unprotected flat.) On that date, the Saran was replaced with 1-inch mesh chicken wire, which had proved so successful in protecting an adjacent plot of transplanted clams and native 1949-year-class clams the year before (Smith, Baptist and Chin, 1955). However, in 1951 the wire did not save the 1950-year-class clams collected in the spring. Only 25 clams per square foot were found under this wire on October 26, and these ranged from 3 to 5 mm., so must have belonged to the current 1951 year class. The 1950 year class, which was so abundant in May, had completely disappeared, apparently by "voluntary movement" out of the area. Predators may have removed some of the small clams, because green crabs, horseshoe crabs, or birds are capable of reaching down through the meshes of the chicken wire and getting small clams near the surface. Also predaceous snails can go down through the meshes or tunnel under the wire to devour the clams. However, it does not seem likely that these predators could have gotten all the clams since the same type of protection was very effective on the same flat the year before.

The above experiences showed that large numbers of small clams could be gathered and protected by Saran, but did not solve the problem of bringing them up to market size or even to the less motil sizes, such as 20 mm. and over.

To try to bridge this gap, more Saran was put out in the spring of 1954. These trials differed from previous ones in one important respect. The edges of the screens were not held with stakes, but were completely buried so that detritus did not collect underneath and smother the clams 2/. Two strips of Saran were sewn together with unraveled Saran filaments to make pieces 6 feet wide and 8 to 12 feet long. On April 15, three strips were put out in Plum Island Sound, one at Hales Cove on moderately soft mud, one on Horseshoe Flat on firm compact sand, and one on the Parker River flat, with fairly loose sand. On May 28 a strip was put out in Hampton, New Hampshire. This flat was composed of firm sand but it had an unusually large population of worms, particularly Nereis and Clymenella. Nereis tunnels with rust-colored walls practically honeycombed the flat.

Of the three strips of Saran in Plum Island, one produced a good crop of clams but the others had little or no effect because of shifting sand. The one in the Parker River was completely buried and naturally had no effect. The one on the firmer sand of Horseshoe Flat was alternately covered and uncovered as small dunes or ripple marks moved across it. The effect of this was to collect clams of the current summer in September and October, but none of the larger 1953 clams survived. On the stable soil at Hales Cove, September, October, and December samples showed 1,000 to 1,500 clams per square foot under Saran, while the controls varied between 40 and 300. Even more important than these large numbers is the fact that there were 12 to 62 clams, larger than 25 mm., per square foot under the Saran.

On February 18, 1955, this plot was sampled again. The Saran had washed away, but many clam holes marked the plot. A square-foot sample had only 215 clams, but 19 of them were over 25 mm., therefore 1953 clams, and large enough to be sedentary. The control had 39 clams, all under 12 mm. The success of Saran at Hales Cove was due to the fact that detritus was kept out by burying the edges of the Saran and the soil did not shift. Also small clams were present. The results are not due to random variation.

The Saran at Hampton seems to have been a special case that raised more problems than it solved. In spite of the stable soil, neither the Saran nor the control ever had many clams from June through November. On February 15, when the surface of the flat became cleaner and firmer than it had been, square foot samples had 188 under the Saran and 26 beside it. Apparently this flat was not suitable for small clams, at least during the summer. I am inclined to suspect the worms had something to do with the situation, either directly or indirectly.

2/ This method was used successfully by the Clam Commissioner of Essex, Massachusetts in 1953.

Conclusions

Juvenile clams have a true voluntary wandering habit that persists for some time after they are able to burrow, or until they reach a length of at least one half inch (12-13 mm.). This movement is extensive enough to have an important bearing on the number of clams that will mature in any one place, and it must be taken into account in any assessment or management of clam flats.

Experiments with "spat catchers" have demonstrated that small clams can be collected and protected until they grow to over 25 mm. by placing plastic screening on the flat, provided the soil is stable and conditions are otherwise suitable for clams.

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