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The Effect of Temperature Change on the Reaction Time of *Helisoma trivolvis* (Say)

PAUL K. GAUER[1]

Abstract. A study of reaction speed, at different temperatures, of fresh-water snails (*Helisoma trivolvis*) is reported. Organic response to mechanical stimuli shows a definite relationship of reaction speed to the environmental temperature. There is an increase in rate of reaction from 40°F to 98°F; and a subsequent leveling off trend from 98°F to 110°F. Snail size has no appreciable effect upon reaction speed. Learning by experience is suggested.

The purpose of this research is to study the speed of reaction of the fresh-water snail in relation to environment. The hypothesis of this study is that environmental temperature has a direct effect on the speed of reaction of the fresh-water snail. The availability and convenient size of *Helisoma trivolvis* makes observation and experimentation with them practical.

Preliminary observation showed that the gastropods withdrew into their shells after being stimulated mechanically. In a short time they would again emerge from their shells; first the foot,

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then the tentacles would become visible. It was then apparent that an experiment could be devised whereby the speed of emergence recorded at different temperatures would give the relationship of reaction speed to the temperature of their surrounding environment.

Procedure

Ten snails were chosen at random from available stock and placed in separate containers. These ten snails were numbered with the largest, therefore possibly the oldest, having the lowest number, and ranging to the smallest at number 10. The actual range in shell size was 15-7 mm at maximum diameter.

The apparatus was arranged so the temperature of the water could be regulated and maintained. The thermometer was checked and water temperature was controlled by adjusting switches on the control box which operated two heat lamps contained in an environmental simulation chamber.

Time trials consisted of placing the snails, kept at room temperature, into the pre-temperature controlled water; then, after sufficient time to become accustomed to the water (4-5 minutes), they were tapped on the shell with a glass rod, causing them to retract into their shells. The time recorded taken when the tentacles became visible was the time it took them to again emerge from their shells.

Trials were made at various temperatures, but not in any set order. Trials were spaced approximately ½ hour apart, and numbered about five trials a day. Temperatures from 40°F to 110°F at two-degree intervals were used. The time of reaction varied widely for each snail and for each temperature. The complete set of average times and temperature trials is contained in Table 1, page 495.

Fig. 1, page 494, is an interpretation of the results of these trials. It represents each of the ten snails at each temperature. An average (dotted line) is contained also on this graph. This average and the median on Fig. 2 are especially useful in interpretation of data.

Interpretation of Data

Variability of the trials made is indicated on Table 1, page 495. Following the ten trials from left to right on the chart it is seen that the snails vary widely at any one temperature in their speed of reaction. Looking at the vertical dimension, it is similarly noted that any one of the snails does not follow a smooth pattern of reaction time change throughout the 36 different temperatures represented.

Table 2, page 497 is an attempt to draw meaning into the data

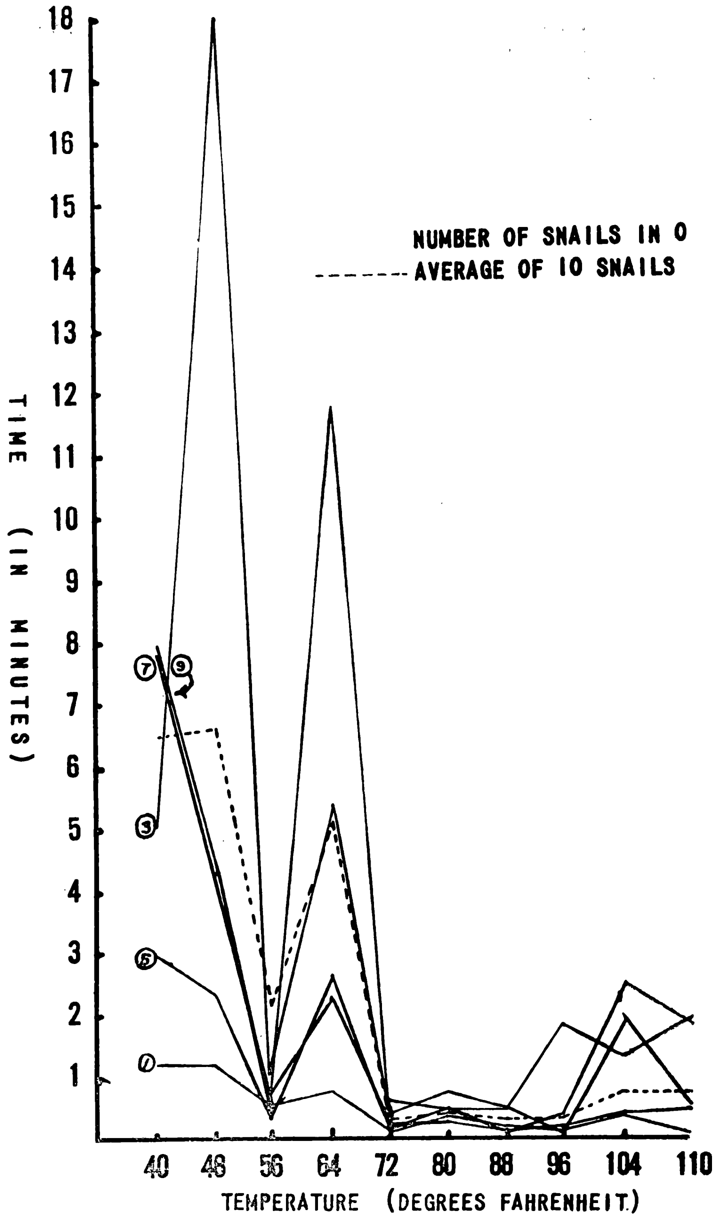

Figure 1. Results of experiments on temperature-reaction time of five snails. Average reaction time for all snails in the experiment is shown by the broken line.

collected from the experiment. The average reaction time of the snails at each temperature (abscissa) is an attempt to draw the ten snails together into a figure which is more representative

Table 1. Reaction Time of Snails at Various Temperatures

trial number	temperature	1	2	3	4	5	6	7	8	9	10
36	110	:10	:40	1:55	:60	:30	:40	1:53	2:04	:32	2:17
35	108	:14	:50	:60	:55	:42	:33	2:22	3:25	1:46	2:35
34	106	:06	:38	1:23	1:56	:23	1:22	1:48	1:04	1:25	1:23
33	104	:20	:45	1:23	1:04	:26	:56	2:32	1:23	1:54	1:22
32	102	:03	:23	:60	:54	:45	:28	1:06	1:55	1:08	1:16
31	100	:11	:34	:56	:32	:21	:23	1:09	1:22	1:05	1:21
30	98	:02	:28	2:25	:44	:17	:45	1:35	1:29	:12	1:15
29	96	:09	:16	1:49	:22	:15	:18	:30	:18	:12	:20
28	94	:06	:24	:43	:18	:25	:20	:24	2:23	:34	:31
27	92	:07	:32	:50	:15	:17	:13	:17	2:36	:15	:21
26	90	:11	:30	:50	:12	:21	:10	:25	1:50	:18	:10
17	88	:10	:35	:30	:17	:12	:20	:15	:07	:30	:17
16	86	:23	:40	1:10	:10	:17	:08	:50	:25	:33	:17
15	84	:09	:21	:21	:20	:12	:13	:20	:40	:35	:15
10	82	:06	:11	:07	:24	:15	:04	:10	:08	:32	:19
9	80	:20	:07	:03	:58	:30	:07	:22	:07	:48	:12
8	78	:20	:13	:30	1:00	:06	:25	:13	:19	:25	:20
7	76	:07	:59	:42	:48	3:02	:16	:11	:05	:32	:14
6	74	:23	1:24	:29	1:19	:18	:11	:21	:02	:35	:15
5	72	:08	:45	:44	:34	:13	:09	:18	:07	:27	:13
4	70	:27	:37	:28	1:01	:17	:15	:34	:07	:42	:11
2	68	:34	:50	6:02	8:32	:51	:22	:24	1:22	:23	2:00
3	66	1:01	1:23	:33	1:32	:58	:26	:16	:51	:15	:41
1	64	:48	1:45	5:20	5:32	2:40	5:15	2:20	:40	1:42	5:20
11	62	:12	1:52	:35	3:36	:13	2:20	:27	3:15	5:53	4:20
12	60	:56	1:20	3:55	1:17	:05	4:24	4:18	3:18	2:15	5:26
13	58	1:37	2:52	1:01	2:15	1:17	2:22	1:28	1:09	2:19	3:55
14	56	:38	:40	1:05	1:08	:27	:44	:43	:17	:30	:23
25	54	:25	1:30	2:06	3:40	1:35	2:00	1:30	1:36	:30	2:00
24	52	:37	1:50	2:10	4:50	1:50	:31	1:50	9:50	7:58	3:50
23	50	:10	1:04	2:03	1:15	1:55	:41	1:00	15:05	1:04	2:05
22	48	1:22	2:30	20:20	4:30	2:25	1:00	4:25	15:00	4:20	10:00
21	46	1:12	4:08	10:10	3:36	4:17	1:15	5:30	3:50	2:20	5:30
20	44	11:03	7:00	2:10	20:20	2:10	2:25	6:15	2:12	19:40	4:35
19	42	4:30	4:55	1:40	20:30	1:50	2:30	4:25	10:38	12:00	7:25
18	40	1:22	11:22	5:01	16:40	2:55	2:05	7:45	2:45	7:58	7:04

snail number

of average snail behavior at the specified temperatures.

The average of each snail (ordinate) in its total reaction time throughout the trials of the experiment shows that each snail has a tendency to react in a certain way in relation to the other snails in the experiment. For example during the 36 tests snail number 3 took a total of 5035 seconds, or an average of 2 minutes, 47 seconds for the trials. This is a great deal more than the total 1838 seconds, or average of 60 seconds recorded time for snail number 1.

The median is a meaningful figure in this experiment. The instability represented in the average figure isn't shown in the median. This is important since the reaction speed is variable in any one of the snails; and an excessively high figure or a minimal low figure in a trial may have a great effect on the average for the 10 snails.

The time over the reciprocal of the trial is an invented experimental device to take into consideration the order of the trials and its effect on reaction time by learning. It is possible that the snails 'learn' or get used to the tests, and so react faster. The time over the reciprocal of the trial consists of the time (average of

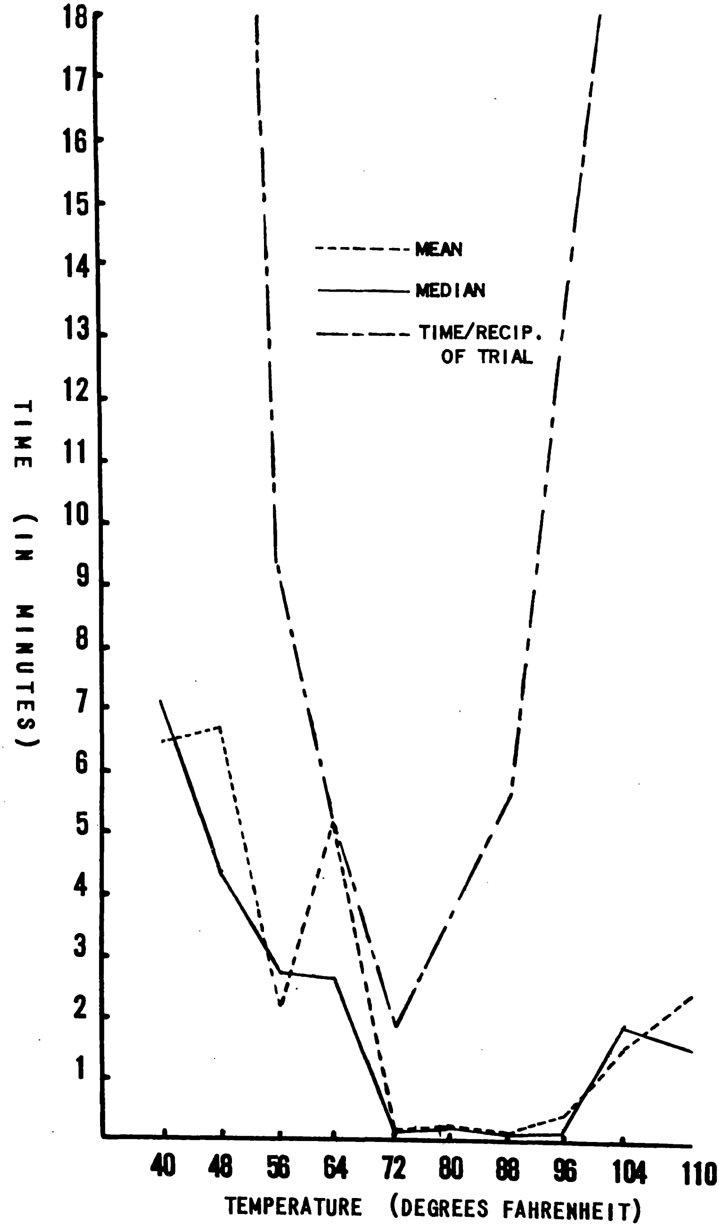

Figure 2. Results of experiments on temperature-reaction time of snails shown by mean median, and time over reciprocal of trial.

the ten snails at a certain temperature), over the number of the trial, into 1. The results of this calculation on each of the 30 temperature trials is recorded on Table 2. Hyperbolic figures, with

Table 2. Calculations on Reaction Time of Snails

trial no.	temp.	total (seconds)	ave.	median	time/ recip. of trial
30	98	552	:55	:44	27:30
29	96	269	:27	:18	13:03
28	94	448	:45	:24	17:16
27	92	343	:34	:17	15:18
26	90	297	:30	:21	13:00
17	88	193	:19	:17	5:23
16	86	293	:29	:23	7:22
15	84	206	:21	:20	6:55
10	82	136	:14	:11	2:20
9	80	241	:24	:20	3:36
8	78	231	:23	:20	3:04
7	76	416	:42	:32	4:54
6	74	317	:31	:23	3:06
5	72	218	:22	:18	1:50
4	70	278	:28	:27	1:52
2	68	1280	2:07	:50	4:14
3	66	475	:48	:51	2:24
1	64	2482	4:08	2:40	5:07
11	62	1363	2:15	3:10	6:03
12	60	1634	2:43	3:19	4:48
13	58	1214	2:01	1:37	7:22
14	56	395	:39	2:44	9:20
25	54	1012	1:40	1:35	41:30
24	52	2116	3:32	1:53	84:48
23	50	1582	2:38	1:15	60:34
22	48	3952	6:35	4:20	144:50
21	46	2688	4:11	4:08	86:48
20	44	4670	7:47	4:35	155:40
19	42	4223	6:58	4:55	132:22
18	40	3897	6:30	7:04	117:00

snail no.	1	2	3	4	5	6	7	8	9	10
total secs.	1838	3413	5035	7035	2312	2376	3792	5624	5647	4798
ave. time	:60	1:54	2:47	3:54	1:17	1:19	2:06	3:08	3:09	2:40

longer times noted at the extreme temperatures, are represented as a consequence of the order of the trials.

A great amount of stability is shown in the 70°F to 110°F range. The curve shows much slower reactions at lower temperatures and faster speeds in the higher temperatures with a slight rounding off of this trend at the 'extreme' 108° and 110° temperatures.

Conclusions

From the results of the study is shown the probability of a definite relationship of reaction speed to temperature for the fresh-water snail, *Helisoma trivolvis.* This relationship is one with slower reaction rates at the lower temperatures and with faster reaction rates at the higher temperatures in the temperature range studied.

No conclusion could be drawn as to the effect of the apparent age and size on the reaction speed. As indicated in Table 1, there is no set pattern in regard to size and time of reaction.

There is some indication of a degree of accommodation to the experience of the trials in the snails. It is believed that the amount of learning, if any, that occurred was insufficient to be measured in any way. It is not believed to be a major factor, and does not noticeably affect the snail's reaction time.

Survival of *Empoasca fabae* (Harris) (Cicadellidae, Homoptera) on Synthetic Media[1]

Douglas L. Dahlman[2]

Absract. Nymphs of the potato leafhopper were caged in small clear plastic snap boxes for individual survival studies. All experiments were conducted at 85°F in a darkened incubator, minimizing responses to light and varying temperature. The leafhopper nymphs were sustained on an agar gel matrix containing sugars and amino acids. Relative nutritional adequacy was evaluated by the time required to reach 50% survival. The lowest mortality rate occurred on a 7% sucrose-2% agar medium. Preferential utilization of the glucose fraction of sucrose was indicated. A medium composed of agar, sucrose, and the 10 amino acids essential for human and rat nutrition tripled the 50% survival time compared with agar controls.

Feeding by potato leafhopper, *Empoasca fabae* (Harris), induces extensive foliage injury (hopperburn) in many tuber bearing *Solanum* species. *Solanum tuberosum,* the commercial potato, is especially susceptible (Ball, 1919). It has been postulated that toxic substances injected into leaf tissue during leafhopper feeding induce hopperburn injury (Fenton and Ressler, 1922; Eyer, 1922; Granovsky, 1926). Nymphal stages produce the greatest amount of injury (Fenton, 1921).

Although knowledge of the nutritional requirements of insects is important to understanding insect-host relationships, to developing economic controls, and to maintaining these animals in the laboratory, the basic nutritional requirements of the potato leafhopper have not been reported in the literature.

Nutritional requirements have been completely defined for only a small number of insect species. Partial requirements have been defined for a larger number (Albritton, 1954). In most cases, investigators presented solid or semisolid diets to chewing insects. Criteria used for evaluation of relative nutritional adequacy were survival, growth and development, and adult fertility (Trager, 1953). More recently, the nutrition of

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