GROWTH STIMULATION OF BLOW-FLY LARVAE FED ON FATIGUED FROG MUSCLE

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(With One Text-figure.)

I. INTRODUCTION.

Exercise increases the size and functional capacity of muscles. It is possible that this muscular hypertrophy may be due to a hormone produced during muscular activity, and that such a hormone may influence other parts of the body of an animal.

Starting from this idea, Bělehrádek (1922, 1924 *a*) fed tadpoles of *Rana fusca* with resting muscle of adult frogs of the same species, and with adult muscle which had been fatigued by electrical stimulation through the nerve. He found that the weight of the tadpoles fed with fatigued muscle was increased by 28 per cent., and that they metamorphosed earlier. This was confirmed by Siebert and Petow (1925) with *Rana temporaria*. Bělehrádek (1924 *b*) found further that the growth stimulation is not specific between the frog and the toad.

We have undertaken an investigation of the effect on the growth of blow-fly larvae of feeding with fatigued as contrasted with resting frog muscle. We have found that here, too, fatigued muscle stimulates growth. The first part of our work, which is now being continued, is reported below.

II. GROWTH.

Larvae of the blow-fly, *Calliphora erythrocephala* Meig, were fed on (*a*) resting, and (*b*) fatigued muscle of the frog, *Rana temporaria*. The larvae were reared in the dark at 23°.

For each experiment a batch of eggs, together with the meat on which the eggs were laid, was taken from the breeding cage and kept in a tube covered with bolting silk until the larvae had reached an individual weight of about 2–5 mg. The larvae were then divided into two equal batches, and each batch was weighed.

The two batches of larvae were then reared in wide glass tubes covered with bolting silk and were fed with minced leg muscles of the frog. Fresh food was given daily. The muscles of one leg were more than sufficient to feed the largest batch of fully grown larvae for 24 hours.

The food was prepared as follows. Each day a frog was killed by stunning. The sciatic nerve of one side was cut immediately to prevent contraction of the leg muscles, which were then dissected off, minced and given to one batch of larvae.

The other leg was then removed, together with its sciatic nerve, and the latter was stimulated electrically for 10 minutes. The tetanised and fatigued leg muscles were then dissected off, minced and given to the second batch of larvae. (In both cases the sciatic nerve was rejected before mincing the muscle.)

Each batch was counted and weighed daily. For weighing, the larvae were first cleaned on damp filter-paper and then in bran (in the case of those over 20 mg.

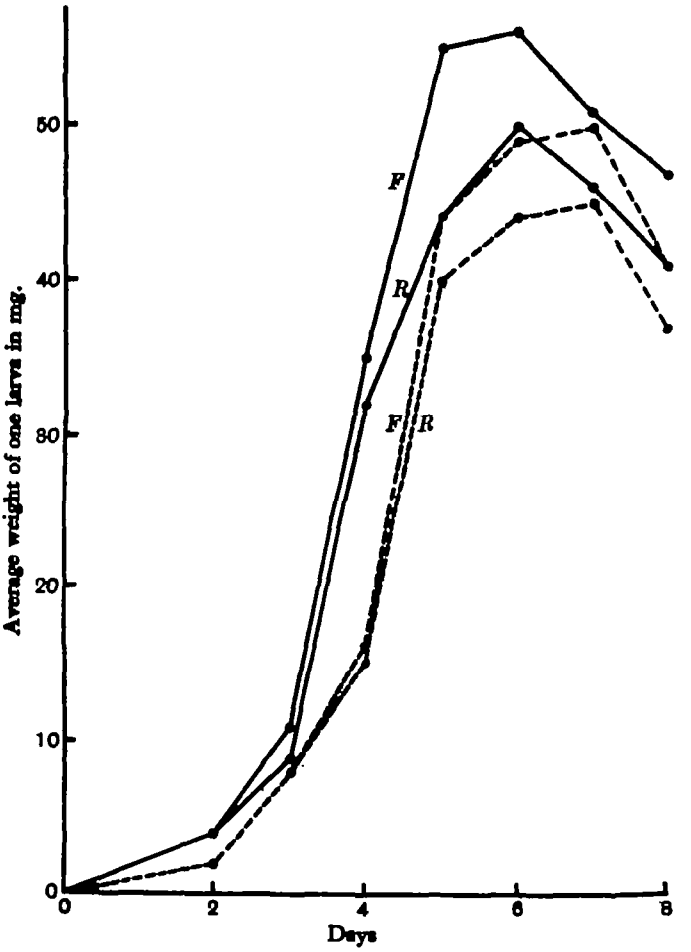

Fig. 1. Growth curves of blow-fly larvae. The full lines and the dotted lines represent two separate experiments. *R*, larvae fed on resting muscle; *F*, larvae fed on fatigued muscle.

only). The two batches were weighed within 15 minutes of one another, since growth is rapid.

The results showed that larvae fed on fatigued muscle become heavier than those fed on resting muscle. Fig. 1 illustrates the results of two experiments. The form of the growth curves is due to the fact that blow-fly larvae increase in bulk until they are 5 to 7 days old, after which they decrease in weight until pupation occurs at the age of 8 to 9 days. Table I shows the maximum weights attained by larvae in

18 experiments. These are all the growth experiments in which more than 35 larvae reached maximum weight in each batch. The curves of Fig. 1 are drawn from Exps. 59 and 64. It is seen from Table I that in 16 out of the 18 experiments the larvae fed on fatigued muscle were heavier than those fed on resting muscle, and that the average excess weight of a larva fed on fatigued muscle over that of a larva fed on resting muscle is 9 per cent. A series of experiments was also made to find the experimental error, larvae being divided into 2 lots, both fed on resting muscle. The greatest difference in weight per larva on the 5th day in 2 lots was 4½ per cent., the average difference being 2½ per cent.

Table I. *Average weights of larvae at the peak of the growth curve.*

Exp. no.	Resting muscle		Fatigued muscle		Increase in wt. %
	No. of larvae	Average wt. of 1 larva mg.	No. of larvae	Average wt. of 1 larva mg.	
31	71	41	71	49	19
41	83	34	86	42	24
43	54	61	54	62	2
44	36	57	48	67	18
45	46	50	44	53	6
47	45	52	44	52	0
57	37	68	35	73	7
58	50	56	50	59	5
59	84	50	80	56	12
63	148	47	144	55	17
64	75	45	69	50	11
65	109	47	104	51	9
67	60	66	68	68	3
70	64	57	53	68	19
75	53	69	60	77	12
78	63	61	64	65	7
83	56	68	53	67	1
84	38	83	39	85	2
				Average	9

A number of further experiments were made in which both the live weight and the dry weight of the larvae was determined. Larvae were fed as before on normal and on fatigued muscle. Every day 10 to 30 larvae were taken out of each batch, weighed alive, then killed with chloroform vapour, dried and weighed again. No significant difference was found between the larvae fed on fatigued and on resting muscle as regards the proportion of dry weight to live weight.

III. LENGTH OF LARVAL LIFE.

Although feeding blow-fly larvae on fatigued muscle increases their weight, it does not shorten the time required to attain the maximum weight (see Fig. 1).

Experiments were made to discover whether feeding on fatigued muscle alters the normal time from hatching to pupation. The numbers of larvae pupating were observed at short intervals. The results showed that feeding on fatigued muscle does not shorten the larval period.

IV. OXYGEN CONSUMPTION.

The rate of oxygen intake by larvae fed on the two foods was compared with a Barcroft manometer at 20°. Weighed larvae, protected by gauze, were placed in the bottle on damp filter-paper. The thermostat was kept in the dark. Table II gives the results (expressed as mm. manometer movement per gm. live weight per hour) and shows that there is no considerable difference in oxygen consumption between larvae fed on resting and on fatigued muscle.

Table II. *Oxygen consumption.*

Age of larvae days	No. of exps.	Oxygen consumption mm./gm./hr.		Difference between (2) and (1) %
		Resting muscle (1)	Fatigued muscle (2)	
3	5	434	422	− 3
4	8	308	321	4
5	8	208	221	6
6	5	134	135	0
7	3	124	158	27

V. HEART BEAT.

The rate of heart beat was measured by confining larvae in a "cradle" of modelling wax, having an aperture over the heart and holes for air to reach the spiracles. In each experiment measurements were made at the same temperature. The results are given in Table III. It is evident that feeding with fatigued muscle increases the rate of heart beat. The greatest increase is seen to occur about the time of the peak of the growth curve. The average percentage increase in heart rhythm on the fifth day of development in Exps. 1–4 is 14.

Table III. *Rates of heart beat.*

Exp. no.	Age of larvae days	Resting muscle		Fatigued muscle		Increase in heart rate %
		No. of larvae studied	Heart beats per min. (average)	No. of larvae studied	Heart beats per min. (average)	
43	3	4	102	4	102	0
	5	4	117	4	129	10
	6	4	96	3	102	6
83	4	8	116	9	125	8
	5	10	102	5	110	8
	6	7	121	8	129	7
	9	4	155	6	152	− 2
84	2	4	100	5	103	3
	5	10	89	11	111	25
	6	6	92	4	99	8
85	3	4	159	5	158	0
	4	6	140	6	163	16
	5	8	147	7	164	12
	6	5	136	5	136	0
86	3	6	132	4	147	11
	4	8	149	9	157	16

VI. SUMMARY.

Blow-fly larvae were fed on (1) resting, and (2) fatigued frog muscle. The larvae fed on fatigued muscle attained a body weight 9 per cent. greater than those fed on resting muscle, and the rate of their heart beat was increased by 14 per cent. The length of larval life and the oxygen consumption was the same in the two sets of larvae.

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