

began to rise coincident with the onset of recovery. The decrease in concentration of humoral immune substances during a severe generalized infection appeared to be due to the combination of "S" substance with the normal immune bodies.

When the pneumococcus infection was more localized as in the case of true lobar pneumonia, a quite different sequence of events was observed to occur. Several animals in which extensive lobar pneumonia was produced showed well marked concentration of humoral immune bodies in the blood throughout the course of a fatally terminating infection.

These findings would suggest that after the inception of pneumococcus infection in the dog and cat the chief function of natural anti-pneumococcus substances in the blood is to limit or prevent blood invasion. In the presence of localized pneumococcus infection, the persistence of these circulating antibodies appears to have little effect either in preventing the spread of the process or determining the outcome of the disease.

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Ultraviolet "Point Radiation" Focussed Through a Quartz Rod and Effect on Fundulus Heart Beat.*

MARIE A. HINRICHS.

From the Hull Physiological Laboratory, University of Chicago.

In a series of papers, the first of which appeared in 1912, Tschachotin¹ described a method of focussing ultraviolet radiation into a cell by means of a system of quartz oculars and objectives in a microscope. The following experiments make use of a principle well-known to physicists, and recently demonstrated by Wolf² to be of value in biological experiment, namely that ultraviolet radiation will follow a quartz rod, be it straight or bent, because of internal reflection. If the rod is drawn out to a fine point, radiation effects may be limited to a small area.

As will be seen from the accompanying sketch, a quartz rod was placed at right angles and close to the burner of a mercury-vapor lamp. A shutter control was interposed between the rod and the

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¹ Tschachotin, S., *Biol. Centralblatt*, 1912, xxxii, 623.

² Wolf, E., *The Collecting Net* (Woods Hole), 1929, iii, 20.

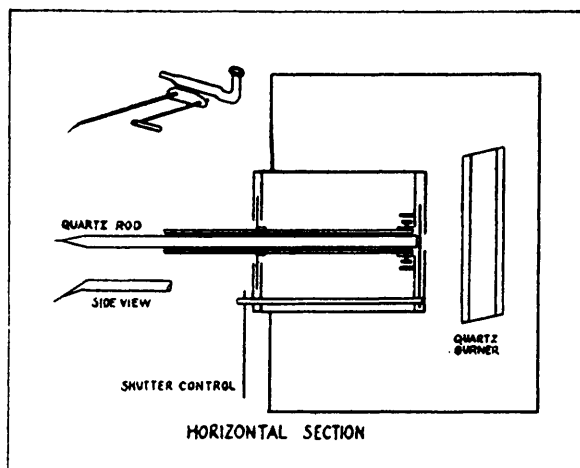


FIG. 1.

burner. The length of the rod was 29 cm. with a 45° bend at 1.0 cm. from the tip. (In order to minimize "leakage", the area just above the tip was painted with opaque paint, or in some cases covered with a glass cap.) The rod was held in place by a universal joint, as indicated, and was freely movable in all directions. A very small change of position at the fixed end afforded considerable range of movement at the free end. A movable stage, not indicated in the diagram, aided in focussing the radiation on the desired spot on the heart.

The experimental material was young *Fundulus heteroclitus*, a small salt-water minnow. Shortly after hatching, the body wall is still transparent so that heart movements can be studied through it. The animals were quieted with a sea-water solution of chloretone, and turned ventral side up. In each case, a record was made of the rate of heart beat before and after radiation. The various regions of the heart (Sinus, Atrium, Bulbus) were radiated at different times, and the effect of such exposures on both the general heart beat and on the separate regions of the heart is indicated in the following tables.

It will be seen that, at room temperature, short exposures in the sinus region increase the rate of heart beat, while longer exposures decrease it. Exposures in the bulbus region produce an increase in every instance. When the heart beat has been previously slowed by a decrease in temperature, longer exposures in the sinus region produce an increase in rate, whereas, at room temperatures, such exposure usually produce a decrease in rate of heart beat. (See Table I.)

TABLE I. *Effect on General Heart Beat.*

Original rate Beats/min.	New rate Beats/min.	% Gain	Exposures made on		
			Sinus	Atrium	Bulbus
(Figures indicate duration of exp. in minutes.)					
			min.	min.	min.
112	141	26	0.5		
121	137	13	3.5		
151	142	-6	4.5		
126	122	-3	6.0		
151	149	-1	9.0		
161	177	10	9.0		
126	122	-3	10.0		
* 36	41	13	11.0		
* 47	63	33	13.0		
151	162	7		5.0	
121	139	15	0.5		0.5
111	128	15			1.0
151	157	4			4.5
111	123	11			9.0
121	174	21	0.5		9.5

* Kept on ice throughout experiment.

A study of regional effects (Table II) showed that exposures of from 1 to 5 minutes, in the region of the sinus, were generally stimulative in all regions of the heart. A 12-minute exposure was slightly depressing. Two-minute exposures made in the sinus region (in the cold) produced a stimulation in all regions, the average stim-

TABLE II. *Regional Effect on Heart Beat.*

Original Rate*	Region Exposed		Effect on rate of (% Gain)		
			Sinus	Atrium	Bulbus
† 47	sinus	0.5 min.	+ 9%		+ 1%
116		1.0	+18		+18
† 47		2.0	- 6	+ 1%	+ 2
† 47		2.0	- 5	+16	+10
† 47		2.0	+ 8	+12	+ 8
† 47		2.0	+ 8	+13	+ 4
† 53		2.0	+25		+23
† 53		2.0	+32		+30
† 60		2.0	+ 6		+ 8
116		2.0	+16		+16
116		5.0	+17		+11
126		12.0	- 9		- 6
† 47		bulbus	1.0 min.	+19%	
116	2.0		+12		+18
† 53	2.0		+17		+27
† 60	2.0		+13		+18

* Rate measured as beats per minute.

† Kept on ice. ‡ Excess of chloretone added.

ulation being greatest in the bulbus region, less in the atrium, and least of all in the sinus region. Similar effects are obtained by applying radiation in the bulbus region.

It was found that the average gain in rate of heart beat following radiation was noticeably greater when the heat had been previously slowed through a lowering of the temperature of the sea-water in which the eggs were kept. Table III shows a record of such a series of exposures. The average Q_{10} was slightly greater for nonradiated than for radiated hearts.

TABLE III. *Effect of the Combined Action of Low Temperature and Ultraviolet Radiation on the Rate of Heart Beat.*

Temp. 20 degrees C.				10 degrees C.			
Normal	Radiated	% gain in rate	Q_{10}	Normal	Radiated	% gain in rate	Q_{10}
*109	*155	42	2.14	*51	*62	21	2.50
131	142	8	2.57	51	66	29	2.15
137	136	- 1	2.80	49	69	41	1.97
112	150	34	2.00	56	63	12	2.38
100	104	4	2.27	44	52	18	2.00
119	127	7	2.48	48	50	4	2.54
112	150	34	2.43	46	76	65	1.97
128	132	3	3.56	36	43	19	3.07

* Figures in columns so marked represent number of beats per minute.
 Average % gain in rate at 20 degrees—16 $\frac{3}{8}$ %.
 Average % gain in rate at 10 degrees—26 $\frac{1}{8}$ %.
 Average Q_{10} normal hearts—2.53.
 Average Q_{10} radiated hearts—2.32.

The effectiveness of applying radiation to a restricted area by such a method as this depends on the degree of local change in physiological activity induced in that area, and should find further application in embryological and physiological study. A series of experiments involving "point" radiation studies on the chick embryo is now under way.

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