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ON THE REVERSAL OF HEART BEAT IN *BRANCHIOSTOMA LANCEOLATUM**

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It is known that in Amphioxus there is no definitely marked heart. Willey (1894) has stated that ' the place of the heart is taken functionally by the contractile blood vessel.' The occurrence of reversed peristalses has been mentioned by Wolf (1940, 1941). In this paper an attempt has been made to furnish an explanation for the reversed peristalses.

In Amphioxus the subintestinal vein, sinus venosus, endostylar artery, epibranchial artery, and the dorsal aorta are contractile and lead into each other. The contractions start at the posterior end of the subintestinal vein and travel forward into the afferent hepatic vein. The efferent vessel of the hepatic diverticulum continues the contractions into the sinus venosus whose contractions travel down, forwards into the endostylar vessel where the bulbils contract and propel the blood up the pharynx. Each contraction travels as a peristaltic wave owing to the presence of circularly arranged non-striated muscle bands in the vessels (Azariah, 1963). The peristaltic contractions are equivalent to the heart beats.

Material and Methods

Branchiostoma lanceolatum were dredged from the Madras inshore area and reared in the laboratory. Observations made over a period of 30 minutes on five specimens are given in the Table. Each live lancet was left in a petri-dish with sufficient sea water to cover it and was observed through the microscope. As the wave reached the sinus venosus the stop watch was set. The beats, whether forward or backward, as they pass through the sinus venosus were counted and timed. The number of forward and backward beats together with the time intervals are tabulated in the Table. It will be seen that the beats vary in duration, number and directions. An eye-piece micrometer was used to measure the velocity of the peristalses.

Observations and Conclusions

Müller (1844) observed the endostylar artery contracting once during every minute and was of the opinion that each contraction suffices for a complete circulation of the blood through the body. However, this is not confirmed by Wolf (1940) and by the present author. There is no uniformity in the number and duration of the contractions. Therefore, it is difficult to say how long a complete circulation will take. It has been found for the European forms of *B. lanceolatum* that the rate of beat at 20°C in the endostylar artery is 0.88 beat/minute and 1.64 beats/minute in the subintestinal vein (Nicol, 1960). In the tropical form, however, the contractions are quicker being 1.3 beats/minute in the endostylar artery and 1.8 beats/minute in the subintestinal vein. The velocity with which the peristalsis travels in the endostylar artery is 1.21 mm./second whereas it varies at different regions of the

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subintestinal vein. It is higher near the hindgut, being 0.0769 mm./second and mm./second anteriorly, when the temperature was 28°C.

Specimen length 9.5 mm.

$\underline{2.30}$	1.00	$\underline{1.10}$	2.05	$\underline{1.00}$	5.05	$\underline{1.50}$	8.20	$\underline{2.10}$	6.00	$\underline{1.15}$	1.15
(2)	(1)	(1)	(2)	(1)	(5)	(1)	(7)	(2)	(4)	(1)	(1)

Specimen length 10.5 mm.

$\underline{0.30}$	3.52	$\underline{1.03}$	0.32	$\underline{0.38}$	3.23	$\underline{1.17}$	0.33	$\underline{0.37}$	1.20	$\underline{1.30}$	6.53
(1)	(4)	(2)	(1)	(2)	(7)	(2)	(1)	(1)	(2)	(2)	(9)
$\underline{2.10}$	5 45	$\underline{1.10}$	1.25								
(3)	(8)	(2)	(3)								

Specimen length 10 *mm.*

$\underline{3.50}$	1.10	@ 1.45	5.00	$\underline{1.33}$	3.12	1.05	0.50	$\underline{4.30}$	0.40	$\underline{1.35}$	1.10		
(2)	(1)	(1)	(4)	(2)	(2)	*	(1)	(2)	(1)	(1)	(1)		
$\underline{1.38}$	2.12	$\underline{5.53}$	5.27	$\underline{6.50}$	6.25	$\underline{2.50}$	13.35	$\underline{1.15}$	7.10	$\underline{1.35}$	8.0	$\underline{0.53}$	2.00
(1)	(2)	(4)	(5)	(5)	(6)	(3)	(12)	(1)	(6)	(1)	(6)	(1)	(2)

Specimen length 25.5 *mm.*

16.00	$\underline{1.15}$	5.27	$\underline{1.27}$	6.48	$\underline{6.10}$	1.20
(10)	(1)	(3)	(1)	(2)	(3)	(2)

Specimen length 22.0 *mm.*

$\underline{4.00}$	6.25	$\underline{1.20}$	1.25	$\underline{2.35}$	4.15	$\underline{1.30}$	2.00	$\underline{1.15}$	6.35
(2)	(5)	(1)	(1)	(2)	(1)	(1)	(2)	(1)	(6)

Specimen length 22 *mm.*

(Cut at the anterior region of the pharynx)

6.45	$\underline{4.00}$	6.00	$\underline{1.15}$	4.20	$\underline{1.05}$	0.35	$\underline{6.45}$
(4)	(4)	(2)	(2)	(4)	(2)	(1)	(4)

Specimen length 22 *mm.*

(Cut at the middle region of the pharynx)

32.0
(12)

Specimen length 22 *mm.*

(Observations after three hours)

$\underline{1.05}$	1.25	$\underline{1.05}$	0.25	$\underline{10.05}$	1.25	$\underline{5.35}$	1.55	$\underline{5.20}$	1.25	$\underline{1.20}$
(2)	(1)	(1)	(1)	(9)	(1)	(4)	(1)	(4)	(2)	(2)

Underlined figures indicate the time taken in minutes for the backward beats.
Un-underlined figures indicate the time taken in minutes for the forward beats.
@indicates both forward and backward beats at the same time. Numbers in bracket indicate the number of heart beats.
* Animal not in rest.

Since there has been no attempt at any explanation of this phenomenon of reversal of heart beats, a few experiments were tried. The anterior end of the pharynx was cut at the region of the velum, laying open the tip of the endostylar vessel. There was practically no change in the number of beats (23 beats per 30.45 minutes). Later the anterior half of the pharynx was cut off and the beats were observed. All the beats were forward and there was no reversal at all for a period of 32 minutes. The total number of beats was reduced to 12. This specimen was left back in a dish of sea water. After about three hours the blood vessel was clotted over and closed. Observations of the sinus venosus showed that the normal number of 22 beats per 31.20 minutes increased to 28 beats in 31.05 minutes. Of these 28 beats, 22 were in the backward direction and only 6 were in the forward direction. These observations lead one to conclude that in an intact specimen the pressure of accumulated blood in the anterior region of the endostylar vessel is responsible for the origination of the backward beat, when half of the pharynx was cut off no such pressure could be built up and there were only forward beats. But with the closure of the cut end of the endostylar vessel, a higher pressure is built up in the new shortened vessel. This increases the backward beats and reduces the forward beats.

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SUMMARY

An account of the 'heart beat', its reversal, the nature of the peristalsis travelling along the subintestinal, afferent and efferent hepatic veins, sinus venosus and the endostylar artery, with an explanation of the reversal of heart beat, is given.

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