

the daily rate of aerobic glycogen consumption is very low⁴ and consequently the variations in glycogen content between various batches of worms may falsify any result. It was unfortunately not possible to conduct the experiments over a longer period, because too many worms die after 3 weeks anaerobiosis.

Summary. Some specimens of larval *Eustrongylides ignotus* could be maintained

for 4 years *in vitro*. The worms survived for long periods in media showing a pronounced partial lack of oxygen, but they did not tolerate complete absence of oxygen for very long periods. Anaerobically kept worms seemed not to feed but they consumed from their body reserve about three times as much glycogen as worms starving under aerobic conditions.

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Effect of Acute A-V Fistula on Circulation Time and Auricular Pressure in Dogs.

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The physiological effects of A-V fistula have long been the subject of extensive experimental investigation. Added impetus has been given to this work by successive wars. The existence of such effects as the Nicoladoni-Branham phenomenon, increased pulse pressure, decreased diastolic pressure, and the relationship of these changes to the size and location of the fistula, have been definitely established. On the other hand, another group of physiological effects or the explanation thereof, such as increased cardiac output,^{1,2,3} increased blood volume, and increased pressure in the large veins proximal to the fistula,^{4,5} have been matters of considerable controversy. Finally there are some effects which have been studied incompletely or not at all. The present investigation was undertaken to determine the effect of A-V fistula, first, on femoral and jugular circulation times and the relationship between the two, and second, on auricular pressures.

Method. Thirty observations were made

on 5 dogs. The animals were anesthetized with nembutal intravenously, 1 grain per 5 lb of body weight. The right femoral artery and vein, and right jugular vein were exposed under rigid aseptic conditions. Right femoral arterio-venous fistulae were made in the manner described by Holman.⁴ Femoral and jugular circulation times, using the cyanide method described by Robb and Weiss,⁶ were determined before and after the fistula was made. All injections into the femoral vein were made at a point just proximal to the site of the fistulous opening into the vein. The injections into the jugular vein were made at a point midway between the lower edge of thyroid cartilage and sternum. Next, auricular pressures were determined with the fistula open and closed. A No. 10 French catheter, with tip cut off, was introduced into the right auricle by way of the right jugular vein according to the method of Richards *et al.*⁷ Heparin was added to the saline in the catheter to prevent clotting. In one dog (No. 5) auricular pressures were not studied until 5 months after the fistula was made. All readings were made in duplicate and mean readings were determined.

¹ Lewis, T., and Drury, A. N., *Heart*, 1923, **10**, 301.

² Ellis and Weiss, S., *Am. Heart J.*, 1929-1930, **5**.

³ Grollman, A., *Cardiac Output*, Hopkins, 1932.

⁴ Holman, E., *Arterio-venous Aneurysm*, Macmillan Company, 1937.

⁵ Reid, M. R., and McGuire, J., *Annals Surg.*, 1938, **108**, 643.

⁶ Robb and Weiss, S., *Am. Heart J.*, 1932-1933, **8**.

⁷ Richards, Cournand, Darling, Gillespie, and Baldwin, *Am. J. Physiol.*, 1942, **136**, 115.

TABLE I.

Dog No.	Femoral circulation times					Jugular circulation times				
	Before fistula		After fistula		Diff. + or --	Before fistula		After fistula		Diff. + or --
	Readings	Mean	Readings	Mean		Readings	Mean	Readings	Mean	
5	9.8 9.0	9.4	6.5 6.9	6.7	-2.7	6.2 6.2	6.2	8.8 8.0 8.7	8.5	+2.3
17	8.0 7.8 8.0	7.9	6.0 6.8 6.6	6.5	-1.4	6.4 6.5	6.5	7.5 7.5	7.5	+1.0
18	8.4 8.0	8.2	5.6 5.6	5.6	-2.7	7.3 7.7 7.0	7.3	7.2 7.0	7.1	-.2
19	7.5 7.5	7.5	5.2 4.5 4.5	4.7	-2.8	6.4 5.8 5.8	6.0	5.1 5.3	5.2	-.8
20	9.8 10.0	9.9	7.0 6.9	7.0	-2.9	9.8 8.2	8.0	7.9 8.1	8.0	±0
Mean	8.52		6.0			6.9		7.3		
Standard deviation	±0.826		±0.777			±1.267		±1.338		
"t"	6.3					0.81				
P.	<0.01					>0.4				
	Significant difference					No significant difference.				

Results. Studies of the femoral circulation times showed that a statistically significant speed-up of circulation occurred when a femoral arterio-venous fistula was produced in the vascular tree. The mean reduction in femoral circulation time in the 5 dogs was 2.64 seconds or 30.9%. On the other hand, jugular circulation times gave varying results. A-V fistula in 2 dogs caused a mean increase of the jugular circulation time amounting to 1.63 seconds. In 2 dogs it caused an insignificant decrease of the jugular circulation time, and in one dog no change was observed. (Table I.)

In the 5 dogs there was a rise in auricular

pressure when the fistula was open. The mean increase in pressure amounted to 3.2 cm of H₂O, or a rise of 71.1%. (Table II.)

The measurements of auricular pressures obtained in Dog No. 5 were not included, because no control readings were obtained when the fistula was first made. The rise in pressures in the 4 dogs with acute fistulae was statistically significant.

Discussion. The results indicate that the introduction of a femoral A-V fistula into the circulation will cause the following two important changes: first, speed-up of circulation in the fistula circuit, and second, an increase in auricular pressure. These two observations together suggest that a greater volume of blood is being brought to the right auricle during a given period of time. Therefore, if the heart is not failing, it must put out more blood in the same given period of time. This provides indirect evidence that an A-V fistula causes an increase in cardiac output.

On the other hand, statistical analysis demonstrated that the circulation time in the jugular circuit showed no significant change. It is known that the jugular circulation time is practically a measurement of the rate of

TABLE II.
Mean Auricular Pressure—CMs H₂O in Experimental A-V Fistulae.

Dog No.	Fistula closed	Fistula open	Difference
17	4.7	8.8	+4.1
18	3.5	6.4	+2.9
19	6.2	9.3	+3.1
20	3.7	6.4	+2.7
Mean	4.5	7.7	
Standard deviation	±1.06	±1.33	
"t"	3.2		
P.	<0.05		
∴ Difference is significant.			

flow through the pulmonary circulation to the carotid sinus. Since the jugular circulation time did not change significantly, it is obvious that the increase in rate of blood flow occurred primarily in the segment of the fistula circuit extending from the fistula to the heart.

The significant increase in auricular pressure caused by an A-V fistula seems to substantiate the work of Holman, who maintained that there was an increase of pressure in the proximal venous portion of a fistula circuit.

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Value of Sunflower Seed Protein.

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From statements of a recent report, the nutritive value of sunflower seed meal would appear to depend more on its content of B-complex vitamins than of protein, even though 53% of the product studied was protein.¹ In a study of the biological value of the protein of sunflower seed meal by the nitrogen balance method, it was concluded that this protein is inferior to that of soybean meal, and is "in the same class as the better cereals oats, wheat, and barley."² These reports indicate that sunflower seed meal is of only mediocre value as a source of protein. On the other hand, the amino acid analysis of sunflower seed meal compares very favorably with analyses of beef muscle and other tissue proteins of high value.^{3,4} On the basis of known chick requirements,⁵ the meal should be adequate as a sole source of protein with the possible exception of a slight deficiency of lysine. The obvious disagreement between the biological and analytical data led us to conduct further tests with the chick.

Two-week-old White Leghorn chicks were segregated into groups on the bases of weight and gain during the second week after hatching, and were given the experimental diets, which were (except for the protein sources) identical with those previously used.^{6,7,8} All the protein (20% of the diet) was supplied by a South American sample of sunflower seed meal which contained 46.7% protein (N $\times$ 6.25) or by a laboratory-prepared meal which contained 39.9% protein. Supplemented casein and deboned sardine meal served as positive controls in these experiments.

The data on sunflower seed meal presented here (Table I) indicate quite clearly that the value of this product for chick growth and efficiency of feed utilization is very high. It compares favorably with other recognized complete sources of amino acids for the chick. In fact, the protein of sunflower seed meal is the most complete vegetable protein for chick growth that we have studied. This result is in agreement with the amino acid analyses of the protein^{3,4} and the known chick requirements.⁵ It is apparent that even lysine is present in adequate amount, although lysine is deficient in many cereal and oilseed meal proteins.

¹ Day, A. G., and Levin, E., *Science*, 1945, **101**, 438.

² Mitchell, H. H., Hamilton, T. S., and Beadles, J. R., *J. Nutrit.*, 1945, **29**, 13.

³ Block, R. J., and Bolling, D., *Arch. Biochem.*, 1945, **6**, 227. Also earlier private communications from R. J. Block.

⁴ Grau, C. R., and Almquist, H. J., *Arch. Biochem.*, 1945, **6**, 287.

⁵ Almquist, H. J., *Trans. Am. Assn. Cereal Chemists*, 1945, **3**, 158.

⁶ Grau, C. R., and Almquist, H. J., *Proc. Soc. Exp. Biol. and Med.*, 1944, **57**, 187.

⁷ Almquist, H. J., and Grau, C. R., *Poultry Sci.*, 1944, **23**, 342.

⁸ Grau, C. R., and Almquist, H. J., *Poultry Sci.*, 1944, **23**, 486.