A COMPARATIVE STUDY OF THE LYMPHATICO-
VENOUS COMMUNICATIONS IN ADULT
MAMMALS.

I. PRIMATES, CARNIVORA, RODENTIA, UNGULATA AND MARSUPIALIA.

BY

CHARLES F. W. MCCLURE AND CHARLES F. SILVESTER.
From the Laboratory of Comparative Anatomy, Princeton University.

WITH THREE TEXT-FIGURES AND TEN PLATES.

Huntington and McClure¹ have shown in the adult cat (*Felis domestica*) that the communication between the lymphatic system and the systemic veins may normally occur on each side of the body, within either one of two or within two typical districts. These two districts include, approximately, the angle of confluence formed by the union of the external and internal jugular veins (common jugular angle) and the angle of confluence formed by the union of the external jugular² and subclavian veins (jugulo-subclavian angle). An examination of a large number of adult cats proved conclusively that neither one of these two districts predominates as the place of communication between the lymphatics and the veins, but that either

¹Huntington and McClure, The Anatomy and Development of the Jugular Lymph Sacs in the Domestic Cat (*Felis domestica*). A paper read before The Association of American Anatomists in Chicago, in 1907, published in THE ANATOMICAL RECORD, Volume II, 1908, and soon to be published in a more complete form in The American Journal of Anatomy.

²This vein, strictly speaking, is a common jugular vein in the cat, but on account of its large size, as compared with the internal jugular, is usually spoken of as the external jugular vein of which the internal jugular is a tributary.

one of the two or both may serve equally in this capacity and for this reason both districts must be regarded as constituting normal points of communication between the lymphatics and the veins.

In following the development of the jugular lymph sacs in the embryonic cat Huntington and McClure were able to establish the basis upon which the duplex character of the lymphatico-venous communication in the adult rests. They found that the right as

TEXT-FIG. I.—A reconstruction of the left jugular lymph sac of a 11 mm. cat embryo (*Felis domestica*) showing the relations of the thyrocervical artery to the jugular and subclavian approaches through which the two typical adult communications are established between the lymphatics and the veins. Ventral view. Drawn from a reconstruction made by Huntington and McClure after the method of Born.

well as the left jugular lymph sac in the embryonic cat invariably presents two caudally directed processes or prolongations which they termed, respectively, the Jugular and Subclavian approaches (Text-fig. I). These two processes, on each side of the body, are directed

toward and approach the district of the common jugular angle and the district of the jugulo-subclavian angle, respectively, and they observed that it is through either one of the two or through both of these processes that the adult communication is established, a circumstance which accounts not only for the presence of a double communication in the adult cat but also establishes it as a character of morphological significance.

In view of the uniform conditions which prevail in the adult domestic cat concerning the presence of two typical districts of lymphatico-venous communication on each side of the body, the present writers have undertaken to determine to what extent this same uniformity may prevail in adult mammals in general.

We have thus far examined twenty-five (25) species distributed among fifty (50) adult mammals (24 primates, 4 carnivora, 12 rodents, 5 ungulates and 5 marsupials). These mammals were chosen at random from the Princeton Collection so that the conditions observed in them represent fairly well the average conditions which one might expect to find in any other similar group chosen in the same manner. The lymphatic system of each mammal was injected with gelatine and then carefully dissected out in the appropriate regions on each side of the body. A drawing to scale was made of each dissection to facilitate comparison. All of the figures in this paper therefore represent accurately the arrangement of the lymphatics as met with in the regions of communication and it is worthy of notice that the lymphatics present a marked variability, more so than the veins, not only in the different species examined but among different members of the same species. These variations will not be dealt with to any extent in the present paper except in so far as it becomes necessary to speak of them in connection with the communications which exist between the lymphatics and the veins.

We may state at the beginning that we are warranted in drawing the conclusion from the adult mammals thus far examined that the lymphatic system normally communicates with the veins in these forms as in the adult cat, either at one of two or at two typical districts (common jugular and jugulo-subclavian districts) and that a communication at the two typical districts is the commonest of the

three possibilities which may normally occur on either side of the body. This is clearly shown in the following table (Table I) in which it is seen that a communication between the lymphatics and the veins occurred at the two typical districts on the right side of the body in sixty-two (62) per cent and on the left side in seventy-four (74) per cent of the mammals examined; also, when a communication was present, on either side, at only one of the two typical districts, it occurred more frequently at the common jugular than at the jugulo-subclavian district.

TABLE I.

SHOWING THE RELATIVE FREQUENCY WITH WHICH THE LYMPHATICO-VEINOUS COMMUNICATIONS OCCUR ON EACH SIDE OF THE BODY AT EITHER ONE OF THE TWO OR AT BOTH OF THE TYPICAL DISTRICTS OF COMMUNICATION IN THE FIFTY MAMMALS UNDER CONSIDERATION.

	Right Side.							Left Side.						
	Primates.	Carnivora.	Rodentia.	Ungulata.	Marsupialia.	Total.	Percentage.	Primates.	Carnivora.	Rodentia.	Ungulata.	Marsupialia.	Total.	Percentage.
Communication at Common Jugular District only.....	8	1	3	3	1	16	32	7	0	3	2	0	12	24
Communication at Jugulo-Subclavian District only..	2	0	1	0	0	3	6	0	0	1	0	0	1	2
Communication at both Districts.....	14	3	8	2	4	31	62	17	4	8	3	5	37	74

Text-fig. II is a diagram of the precaval system of veins showing the two typical districts of lymphatico-venous communication, encircled by rings, which are met with on each side of the body. Since we have found that the general plan of the communication is fundamentally the same on each side of the body, in that it normally occurs at either one of the two or at both of the typical districts of communication (Table I), our interest has been largely centered upon the determination of the combinations in which the communications may occur in the fifty mammals examined when both sides of the

body are taken into consideration. Since a communication may be normally established in one of three ways on each side of the body, it is evident, when both sides of the body are considered, that the lymphatico-venous communications may occur in nine possible combinations and that each combination may be regarded as a type of

TEXT-FIG. II. A diagram of the precaval system of veins showing the two typical districts of lymphatico-venous communication on each side of the body and the nine possible combinations in which communications may occur when both sides of the body are taken into consideration. Ventral view.

communication which characterizes the lymphatico-venous communication of a particular individual.

Each of the nine possible combinations is indicated in Text-fig. II by a series of arrows which radiate from a small circle enclosing the Roman numeral (I-IX) applied to the combination and is also

TABLE II.

SHOWING THE NINE POSSIBLE COMBINATIONS (TYPES OF LYMPHATICO-VEINOUS COMMUNICATION) IN WHICH LYMPHATICO-VEINOUS COMMUNICATIONS MAY BE NORMALLY ESTABLISHED IN AN INDIVIDUAL WHEN BOTH SIDES OF THE BODY ARE TAKEN INTO CONSIDERATION.

Type	Right Side		Left Side	
	Common Jugular District.	Jugulo-Sub-clavian District.	Common Jugular District.	Jugulo-Sub-clavian District.
I.	TAP	TAP	TAP	TAP
II.	TAP		TAP	
III.	TAP		TAP	TAP
IV.		TAP	TAP	TAP
V.	TAP	TAP	TAP	
VI.	TAP			TAP
VII.		TAP	TAP	
VIII.		TAP		TAP
IX.	TAP	TAP		TAP

The word 'TAP', under the district designated, indicates the presence of a communication at this district between the lymphatics and the veins.

TABLE III.

SHOWING THE DISTRIBUTION AMONG THE FIFTY MAMMALS EXAMINED OF THE NINE POSSIBLE COMBINATIONS OR TYPES OF LYMPHATICO-VEINOUS COMMUNICATION WHICH MAY BE NORMALLY ESTABLISHED IN AN INDIVIDUAL.

Type.	Primates.	Carnivora.	Rodentia.	Ungulata.	Marsupialia.	Number and Percentage of Individuals.
I.	12	3	8	2	4	29 or 58 per cent.
II.	5	0	2	2	0	9 or 18 " "
III.	3	1	0	1	1	6 or 12 " "
IV.	2	0	0	0	0	2 or 4 " "
V.	2	0	0	0	0	2 or 4 " "
VI.	0	0	1	0	0	1 or 2 " "
VII.	0	0	1	0	0	1 or 2 " "
VIII.	0	0	0	0	0	0
IX.	0	0	0	0	0	0
Total	24	4	12	5	5	50

shown in Table II, in which the word TAP indicates the presence of a communication under the district of communication designated.

The following figures illustrate examples of the different types of lymphatico-venous communication as met with among the fifty mammals examined:

TYPE I, Figs. 6, Pl. III (*Papio porcarius*), 16, Pl. VI (*Putorius vison*), 22, Pl. VII (*Cavia porcellus*), 26, Pl. VIII (*Sus scrofa domestica*) and 31, Pl. X (*Didelphys virginiana*).

TYPE II, Figs. 12, Pl. V (*Anthropopithecus troglodytes*), 21, Pl. VII (*Lepus cuniculus*) and 27, Pl. IX (*Sus scrofa domestica*).

TYPE III, Figs. 5, Pl. II (*Papio anubis*), 15, Pl. VI (*Canis familiaris*) and 30, Pl. IX (*Didelphys virginiana*).

TYPE IV, Figs. 4, Pl. II (*Papio anubis*) and 1, Pl. I (*Nycticebus tardigradus*).

TYPE V, Figs. 13, Pl. V (*Anthropopithecus troglodytes*)³ and 8, Pl. III (*Macacus rhesus*).

TYPE VI, Fig. 19, Pl. VII (*Lepus cuniculus*).

TYPE VII, Fig. 20, Pl. VII (*Lepus cuniculus*).

As shown in Table III the lymphatico-venous communication of every mammal examined fell within one of these nine combinations (Types I-IX). This circumstance, together with the fact that in twenty-nine (29) individuals or fifty-eight (58) per cent of those examined (Table III) the communication occurred on both sides of the body at the two typical districts of communication, and that this type of communication was commonly met with in each of the five orders of mammals examined (Type I, see Text-fig. II and Table III), indicates that the embryonic basis for the establishment of two typical communications on each side of the body must be fundamentally and potentially the same in the fifty mammals examined by us as that described by Huntington and McClure for the domestic cat. Although our present deductions do not lead us beyond a consideration of the conditions observed in the fifty mammals (25 species) it is evident, if this conception of two primary and

³It is significant to note in the two chimpanzees examined, in which the precaval system of veins resembles that in man, that Types II and V are represented.

typical districts of communication on each side of the body can be generalized for mammals as a whole, that a consistent description of the adult lymphatico-venous communications should rest upon a morphological interpretation of their development, and not upon the ill-defined and variable conditions which are at present described in works of anatomy as constituting the points at which the lymphatics communicate with the veins.

It is interesting to note that Type VIII, in which a communication occurs on both sides of the body only at the jugulo-subclavian district (angle of confluence formed by the union of the external jugular and subclavian veins), a region commonly assigned by anatomists as the point at which the thoracic and right lymphatic ducts tap the veins, *was not met with in a single one of the mammals examined.*

As shown in Table I and Table III, when a communication is present on each side of the body at only one of the two typical districts it is usually found at the common jugular (Type II) and not at the jugulo-subclavian district.

The assignment of the jugulo-subclavian angle as the point at which in general the lymphatics communicate with the veins in the adult, appears to us to be a correct interpretation for the cat and for the mammals we have thus far examined, only in the sense that the two districts of confluence formed by the union of the external and internal jugular and by the union of the external jugular and subclavian veins, respectively, be regarded as constituting a single district of communication.

Tables IV to VIII, inclusive, show in tabulated form the different species of mammals examined by us as well as the *type* of lymphatico-venous communication presented by each individual.⁴

The word TAP in each column, under the district designated, indicates the presence of a communication at this district between the lymphatics and the veins, while the absence of the word TAP indicates that a communication is wanting.

The number after the sex sign of each species indicates the cata-

⁴The nomenclature of the species mentioned in this paper follows that given in Trouessart's *Catalogus Mammalium, Quinquennale Supplement*. 1904.

TABLE IV.—PRIMATES.

	Type.	Right Side.		Left Side.	
		Common Jugular District.	Jugulo-Subclavian District.	Common Jugular District.	Jugulo-Subclavian District.
<i>Nycticebus tardigradus</i> ♀ 2374 (Fig. 1, Pl. I.)....	IV		TAP	TAP	TAP
<i>Callithrix jacchus</i> ♀ 2457.....	I	TAP	TAP	TAP	TAP
<i>Cebus capucinus</i> ♀ 2481 (Fig. 2, Pl. I.)...	I	TAP	TAP	TAP	TAP
<i>Cebus hypoleucus</i> ♀ 2472.....	I	TAP	TAP	TAP	TAP
<i>Ateles hybridus</i> ♂ 2433.....	II	TAP		TAP	
<i>Ateles hybridus</i> ♂ 2435.....	III	TAP		TAP	TAP
<i>Ateles nellerosus</i> ♀ 2476 (Fig. 3, Pl. I.)....	I	TAP	TAP	TAP	TAP
<i>Papio anubis</i> ♀ 2368 (Fig. 4, Pl. II.)...	IV		TAP	TAP	TAP
<i>Papio anubis</i> ♂ 2432 (Fig. 5, Pl. II.)...	III	TAP		TAP	TAP
<i>Papio porcarius</i> ♂ 2453 (Fig. 6, Pl. III.)...	I	TAP	TAP	TAP	TAP
<i>Papio porcarius</i> ♂ 2460.....	I	TAP	TAP	TAP	TAP
<i>Macacus speciosus</i> ♂ 2376 (Fig. 7, Pl. III.)...	II	TAP		TAP	
<i>Macacus rhesus</i> ♀ 2487 (Fig. 8, Pl. III.)...	V	TAP	TAP	TAP	
<i>Macacus nemestrinus</i> ♂ 2458 (Fig. 9, Pl. IV.)...	II	TAP		TAP	
<i>Macacus nemestrinus</i> ♀ 2459.....	I	TAP	TAP	TAP	TAP
<i>Macacus nemestrinus</i> ♂ 2461.....	III	TAP		TAP	TAP
<i>Macacus nemestrinus</i> ♂ 2483.....	I	TAP	TAP	TAP	TAP
<i>Cercocebus fuliginosus</i> ♀ 2394.....	II	TAP		TAP	
<i>Cercopithecus callitrichus</i> ♂ 2434.....	I	TAP	TAP	TAP	TAP
<i>Cercopithecus callitrichus</i> ♂ 2464 (Fig. 10, Pl. IV.)...	I	TAP	TAP	TAP	TAP
<i>Cercopithecus callitrichus</i> ♀ 2477 (Fig. 11, Pl. V.)...	I	TAP	TAP	TAP	TAP
<i>Cercopithecus callitrichus</i> ♂ 2478.....	I	TAP	TAP	TAP	TAP
<i>Anthropopithecus troglodytes</i> ♂ 2467 (Fig. 12, Pl. V.)...	II	TAP		TAP	
<i>Anthropopithecus troglodytes</i> ♀ 2468 (Fig. 13, Pl. V.)...	V	TAP	TAP	TAP	

TABLE V.—CARNIVORA.

	Type.	Right Side.		Left Side.	
		Common Jugular District.	Jugulo-Subclavian District.	Common Jugular District.	Jugulo-Subclavian District.
<i>Felis domestica</i> ♂ 2452 (Fig. 14, Pl. V.)..	I	TAP	TAP	TAP	TAP
<i>Canis familiaris</i> ♀ 2451 (Fig. 15, Pl. VI.)..	III	TAP		TAP	TAP
<i>Putorius vison</i> ♂ 2384 (Fig. 16, Pl. VI.)..	I	TAP	TAP	TAP	TAP
<i>Mephitis putida</i> ♂ 2362 (Fig. 17, Pl. VI.)..	I	TAP	TAP	TAP	TAP

TABLE VI.—RODENTIA.

	Type.	Right Side.		Left Side.	
		Common Jugular District.	Jugulo-Subclavian District.	Common Jugular District.	Jugulo-Subclavian District.
<i>Lepus cuniculus</i> ♂ 2363 (Fig. 18, Pl. VII.)..	I	TAP	TAP	TAP	TAP
<i>Lepus cuniculus</i> ♂ 2364 (Fig. 19, Pl. VII.)..	VI	TAP			TAP
<i>Lepus cuniculus</i> ♂ 2366 (Fig. 20, Pl. VII.)..	VII		TAP	TAP	
<i>Lepus cuniculus</i> ♂ 2367.....	I	TAP	TAP	TAP	TAP
<i>Lepus cuniculus</i> ♀ 2431 (Fig. 21, Pl. VII.)..	II	TAP		TAP	
<i>Cavia porcellus</i> ♂ 2359.....	I	TAP	TAP	TAP	TAP
<i>Cavia porcellus</i> ♂ 2360 (Fig. 22, Pl. VII.)..	I	TAP	TAP	TAP	TAP
<i>Fiber zibethicus</i> ♂ 2361.....	II	TAP		TAP	
<i>Fiber zibethicus</i> ♂ 2365 (Fig. 23, Pl. VIII.)..	I	TAP	TAP	TAP	TAP
<i>Fiber zibethicus</i> ♀ 2395.....	I	TAP	TAP	TAP	TAP
<i>Marmota monax</i> ♀ 2469 (Fig. 24, Pl. VIII.)..	I	TAP	TAP	TAP	TAP
<i>Sciurus hudsonius</i> ♀ 2466 (Fig. 25, Pl. VIII.)..	I	TAP	TAP	TAP	TAP

TABLE VII.—UNGULATA.

	Type.	Right Side.		Left Side.	
		Common Jugular District.	Jugulo-Subclavian District.	Common Jugular District.	Jugulo-Subclavian District.
<i>Sus scrofa domestica</i> ♀ 2436 (Fig. 26, Pl. VIII.).	I	TAP	TAP	TAP	TAP
<i>Sus scrofa domestica</i> ♀ 2437 (Fig. 27, Pl. IX.).	II	TAP		TAP	
<i>Sus scrofa domestica</i> ♀ 2438.....	III	TAP		TAP	TAP
<i>Sus scrofa domestica</i> ♂ 2439.....	II	TAP		TAP	
<i>Sus scrofa domestica</i> ♀ 2441 (Fig. 28, Pl. IX.).	I	TAP	TAP	TAP	TAP

TABLE VIII.—MARSUPIALIA.

	Type	Right Side.		Left Side.	
		Common Jugular District.	Jugulo-Subclavian District.	Common Jugular District.	Jugulo-Subclavian District.
<i>Didelphys virginiana</i> ♂ 2388 (Fig. 29, Pl. IX.)...	I	TAP	TAP	TAP	TAP
<i>Didelphys virginiana</i> ♀ 91.....	I	TAP	TAP	TAP	TAP
<i>Didelphys virginiana</i> ♀ 96 (Fig. 30, Pl. IX.)....	III	TAP		TAP	TAP
<i>Didelphys virginiana</i> ♀ 90.....	I	TAP	TAP	TAP	TAP
<i>Didelphys virginiana</i> ♂ 51 (Fig. 31, Pl. X.).....	I	TAP	TAP	TAP	TAP

logue number of the individual in the Princeton Collection. The individuals figured in this paper are also designated in these tables.

Before proceeding to a detailed description of the lymphatico-venous communications observed in the fifty mammals, we will first consider the general character of the two typical districts of lymphatico-venous communication.

Text-fig. III is a composite diagram of the precaval system of veins constructed on the basis of the conditions actually observed in the fifty mammals under consideration and should be constantly referred to in connection with the following description of the external and internal jugular and cephalic veins.

1. The External and Internal Jugular Veins.

The external jugular may be larger (Fig. 16, Pl. VI) or smaller (Fig. 12, Pl. V) than the internal jugular vein, or, of practically the same size (Fig. 5, Pl. II).

The common jugular district of lymphatico-venous communication may lie on the same level and in close proximity to the jugulo-sub-

TEXT-FIG. III.—A composite diagram of the precaval system of veins constructed on the basis of the conditions observed in the fifty mammals examined and with especial reference to the relations of the two typical districts of lymphatico-venous communication to each other. Ventral view.

clavian district as in *Papio porcarius* (Fig. 6, Pl. III) or, as is usually the case in the domestic cat, it may lie somewhat cranial to the jugulo-subclavian district as shown on the right side of Fig. 14 (Pl. V) and on the right side of Text-fig. III. In either case, however, the two districts of communication are separated from each other by the external jugular vein.

In the domestic cat the internal jugular vein at times gives up

its original connection with the external jugular and then drains into the innominate through the inferior thyroid vein. In a case observed by us in which this occurred (Fig. 14, Pl. V, left side), the common jugular district of lymphatico-venous communication was not transferred to the new angle of confluence formed by the union of the inferior thyroid and innominate veins but remained on the external jugular at the point where, as on the right side of the same individual (Fig. 14, Pl. V, right side), the internal jugular normally joins the external jugular vein.

2. *The External Jugular and Cephalic Veins.*

As is well known, the cephalic vein presents considerable variability in its relations to the external jugular and subclavian veins, not only in mammals in general but even upon opposite sides of the same individual. The complex of vessels connected with the external jugular and subclavian veins on both sides of Text-fig. III, represents a composite picture of the conditions observed in the fifty mammals examined by us and is an attempt to explain, from the standpoint of comparative anatomy, the variable conditions of the cephalic vein, as well as those sometimes presented by the external jugular, the transverse scapular and deep transverse scapular veins. One might infer from a study of comparative anatomy that this complex of veins may possibly represent a ground-plan arrangement and that the elements of which it is composed are capable of serving in variable capacities, not only in different individuals, but even upon opposite sides of the same individual.

In explanation of the basis upon which the above observations are made the following description of the conditions actually met with, to be compared with the diagram (Text-fig. III), is given.

One of the commonest terminations of the cephalic vein met with is its connection with the external jugular, as in *Felis domestica* (Fig. 14, Pl. V), *Canis familiaris* (Fig. 15, Pl. VI), *Putorius vison* (Fig. 16, Pl. VI), *Fiber zibethicus* (Fig. 23, Pl. VIII), *Cavia porcellus* (Fig. 22, Pl. VII), and *Sus scrofa domestica* (Fig. 26, Pl. VIII), where it is commonly established through the vessel C or D in Text-fig. III. It may be formed, as in *Macacus rhesus* (Fig. 8,

Pl. III), *Cercopithecus callitrichus* (Fig. 11, Pl. V) and *Cebus capucinus* (Fig. 2, Pl. I), through the retention of the vessels B and D in Text-fig. III, as is also the case in *Didelphys virginiana* (Fig. 31, Pl. X, left side). It may also be formed in *Didelphys virginiana* (Fig. 31, Pl. X, right side), as is more commonly the case,⁵ through the retention of the vessels A and D in Text-fig. III. In *Sciurus hudsonius* (Fig. 25, Pl. VIII) it may be formed through the retention of the vessel C in Text-fig. III, but vessels B and D may also be present where they, together with the external jugular vein, form a loop or ring through which the clavicle passes. In one specimen of *Ateles vellerosus* examined (Fig. 3, Pl. I), in which there is an asymmetrical arrangement of the veins on opposite sides, the cephalic vein is formed through the retention of the vessel A in Text-fig. III on the right side and by the vessel B on the left. Although the conditions observed in *Ateles* are probably abnormal, they serve as a good general illustration of the variability manifested by termination of the cephalic vein.

The elements which compose the complex of veins ordinarily entering into the formation of the cephalic also appear to be capable of functioning as the terminals of veins other than the cephalic. For example, in *Lepus cuniculus* (Fig. 20, Pl. VII) the transverse scapular vein appears to have been established through the vessel B in Text-fig. III which in *Ateles vellerosus* (Fig. 3, Pl. I, left side) and in part in *Macacus rhesus* (Fig. 8, Pl. III) constitutes the terminal of the cephalic vein. Also in *Marmota monax* (Fig. 24, Pl. VIII), as shown by its relation to the clavicle, the external jugular vein has largely transferred its drainage from its conventional pathway to the vessel B in Text-fig. III which now functions as the chief terminal of the external jugular vein.

At first sight one might regard the boundaries of the two typical districts of lymphatico-venous communication as being fundamentally modified in accordance with the variations presented by the veins in the region of the lymphatico-venous communications. Such does

⁵C. F. W. McClure, A Contribution to the Anatomy and Development of the Venous System in *Didelphys marsupialis*. Part I, Anatomy. Amer. Jour. of Anatomy, Vol. II, 1903 (see Fig. II, p. 377).

not appear to be the case, however, since the primary relations established by the union of the external and internal jugulars and by the external jugular and subclavian veins, respectively, definitely mark out the two typical districts of communication as evidenced by the constancy with which communications occur in connection with these districts, regardless of the variation presented by the veins.

We pass now to a consideration of the general character of the lymphatico-venous communications as met with in the fifty mammals examined.

When a communication occurred on either side, at either one of the two typical districts, it was usually single in character as shown in Table IX. In only a few instances were the lymphatics found to communicate with the veins within either of the two typical districts by more than one opening. A multiple communication between the lymphatics and the veins was found at the common jugular district of communication in *Ateles vellerosus* (Fig. 3, Pl. I, right side), in *Cercopithecus callitrichus* (Fig. 11, Pl. V, both sides), in *Felis domestica* (Fig. 14, Pl. V, right side), in *Macacus nemestrinus* (Fig. 9, Pl. IV, both sides) and the the jugulo-subclavian district of communication in *Canis familiaris* (Fig. 15, Pl. VI, left side) and in *Cercopithecus callitrichus* (Fig. 10, Pl. IV, right side).

As shown in the following table, only twelve (12) instances of a multiple communication at the two typical districts were met with and it occurred more frequently on the right than on the left side of the body.

One hundred and seventy-eight (178) points of communication between the lymphatics and the veins were observed by us on both sides of the body in the fifty mammals under consideration (89 on each side). Of these, one hundred and forty-two (142) were found either at the angles of confluence formed by the union of the external and internal jugular and by the union of the external jugular and subclavian veins, respectively, or were included within these two angles, as illustrated by Figs. 12, Pl. V, 13, Pl. V (*Anthropithecus troglodytes*), 3, Pl. I (*Ateles vellerosus*), 7, Pl. III

(*Macacus speciosus*), 8, Pl. III (*Macacus rhesus*), 1, Pl. I (*Nycticebus tardigradus*), 4, Pl. II, 5, Pl. II (*Papio anubis*), 22, Pl. VII (*Cavia porcellus*), 19, Pl. VII, 20, Pl. VII, 21, Pl. VII (*Lepus cuniculus*), 24, Pl. VIII (*Marmota monax*), 25, Pl. VIII (*Sciurus hudsonius*) and 27, Pl. IX (*Sus scrofa domestica*).

TABLE IX.

SHOWING THE PREDOMINANCE OF A SINGLE OVER A MULTIPLE COMMUNICATION AT EACH OF THE TWO TYPICAL DISTRICTS OF LYMPHATICO-VEINUS COMMUNICATION.

	Right Side.						Left Side.					
	Primates.	Carnivora.	Rodentia.	Ungulata.	Marsupialia.	Total.	Primates.	Carnivora.	Rodentia.	Ungulata.	Marsupialia.	Total.
Single Communication at Common Jugular District	19	3	11	3	5	41	22	4	11	5	5	47
Multiple Communication at Common Jugular District	3	1		2		6	2					2
Communication Wanting at Common Jugular District	2		1			3			1			1
Total	24	4	12	5	5	50	24	4	12	5	5	50
Single Communication at Jugulo-Subclavian District	13	3	9	2	4	31	17	3	9	3	5	37
Multiple Communication at Jugulo-Subclavian District	3					3	1					1
Communication Wanting at Jugulo-Subclavian District	8	1	3	3	1	16	7		3	2		12
Total	24	4	12	5	5	50	24	4	12	5	5	50

Three (3) points of communication met with did not fall either within the angle of confluence formed by the union of the external and internal jugular nor within the angle formed by the union of the external jugular and subclavian veins, but, as in Figs. 2, Pl. I (*Cebus capucinus*, right side), 28, Pl. IX (*Sus scrofa domestica*,

left side) and 14, Pl. V (*Felis domestica*, right side), they occurred on the veins slightly caudal to the angle of venous confluence (caudal to the common jugular angle in *Cebus* and *Felis*, and to the jugulo-subclavian angle in *Sus*).

Also, in addition to these three points of communication just mentioned, thirty-three (33) others were met with which did not fall within the common jugular nor jugulo-subclavian angles but which were dorsally or ventrally situated on the veins in close proximity to either one of the two of these angles.

Of these dorsal and ventral communications between the lymphatics and the veins, the former proved to be the more common of the two.

A dorsal communication between the lymphatics and the veins on both sides of the body at the common jugular district of communication is shown in Figs. 15, Pl. VI (*Canis familiaris*) and 17, Pl. VI (*Mephitis putida*). A dorsal communication between the lymphatics and the veins on the right side of the body at the common jugular district of communication is shown in Figs. 10, Pl. IV (*Cercopithecus callitrichus*) and 9, Pl. IV (*Macacus nemestrinus*) and at the jugulo-subclavian district of communication in Fig. 23, Pl. VIII (*Fiber zibethicus*). A dorsal communication between the lymphatics and the veins on the left side of the body at the jugulo-subclavian district of communication is shown in Figs. 29, Pl. IX (*Didelphys virginiana*) and 26, Pl. VIII (*Sus scrofa domestica*).

A ventral communication between the lymphatics and the veins on both sides of the body at the common jugular district of communication is shown in Figs. 11, Pl. V (*Cercopithecus callitrichus*) and at the jugulo-subclavian district in Fig. 17, Pl. VI (*Mephitis putida*). A ventral communication between the lymphatics and the veins on the left side of the body at the jugulo-subclavian district of communication is shown in Fig. 6, Pl. III (*Papio porcarius*) and on the right side of the body in Fig. 11, Pl. V (*Cercopithecus callitrichus*).

In consideration of the large number of communications observed within the common jugular and jugulo-subclavian angles (142), the presence of these thirty-six apparently variant forms appears to

find its explanation in the circumstances that the communications established between the embryonic jugular lymph sac and the veins are not confined exclusively within these two angles of venous confluence but may vary about the same in a sphere which we have designated a district of communication (Text-figs. II and III). The circumstance that angle, dorsal, and ventral communications may be found in the same individual, in which they hold definite relations to either one of the two typical angles of venous confluence and that, in some cases, dorsal and ventral communications are alone present (Fig. 17, Pl. VI), seems conclusive evidence that all of the points of communication observed by us between the lymphatics and the veins must have been established in the embryo in fundamentally the same manner as in the domestic cat and in definite relation to two typical districts of communication.

Received for publication July 9, 1909.

EXPLANATION OF PLATES I TO X.

Figs. 1 to 31, inclusive, were drawn to scale from dissections of adult mammals and represent *ventral* views of the veins and lymphatic vessels in the regions where the lymphatics communicate with the veins.

The veins are drawn in outline, the lymphatics are colored. The word TAP indicates a point at which the lymphatics communicate with the systemic veins.

The name of the species represented is given under each figure while a complete list of the mammals dissected and studied in connection with this paper may be found in Tables IV, V, VI, VII and VIII.