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ELEPHANT AND RHINOCEROS LYMPH-NODE HISTOLOGY

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Plates 40–41 and Two Text-figures

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SYNOPSIS

The histology is described, for the first time, of certain of the lymph nodes of the African Elephant (*Loxodonta africana* Blumenbach), of the Great Indian Rhinoceros (*Rhinoceros unicornis* Linn.) and of the African Black Rhinoceros (*Diceros bicornis* Linn.): reference is made to the nodes of the African White Rhinoceros (*Ceratotherium simum* Gray). All nodes studied prove to be hæmolymph organs.

Introduction

The role of the lymphatic system, and in particular of the lymph nodes, in both health and disease, requires no emphasis, yet much remains unknown regarding the organization and function of this cinderella of the body systems. Knowledge concerning lymph-node structure is confined mainly to the nodes of man and to those of the more familiar laboratory and domesticated animals. Despite the admitted difficulties attendant upon the collection in the field of fresh, well-fixed material suitable for histological study, the economic no less than the scientific import of the lymph nodes would urge their more intensive study, since not only have wild animals of many species themselves to face the hazards of epizootic disease, but they also may serve to transmit disease to domesticated stock in those tropical and subtropical regions wherein strenuous efforts are presently being made towards its improvement and enlargement. Lymphatic tissue from almost any undomesticated species of mammal would appear therefore to be worthy of careful examination and record: and it is with the intention of augmenting the current limited knowledge of this subject that the present observations are submitted.

Material and Methods

Microscopical examination was made of certain of the lymph nodes from a young female African Elephant (*Loxodonta africana*), from a young female African Black Rhinoceros (*Diceros bicornis*), and from an adult male Great Indian Rhinoceros (*Rhinoceros unicornis*). The elephant material was taken from the carcase of a wild-shot animal successfully embalmed by an intravascular formalin injection immediately after death, with resultant excellent preservation. The specimen, deposited in the London Hospital Medical College, is the property of the Anatomical Society, to which body, as to Professor R. J. Harrison, we are deeply grateful for permission to secure material therefrom for study. The rhinoceros material, from animals dying in Whipsnade Park, we owe to the courtesy

of the Zoological Society of London and to Mr. E. H. Tong, Director of the Park. The *Diceros* material was indifferently, the *Rhinoceros* material satisfactorily, preserved.

Cervical lymph nodes of *Loxodonta* were paraffin blocked, cut at 10 μ and stained by hæmatoxylin and eosin: one small cervical node was serially sectioned at 10 μ and similarly stained. Juxta-renal and bronchial lymph nodes of *Rhinoceros*, and juxta-renal, epicardial and epitracheal lymph nodes of *Diceros* were paraffin blocked, cut at 10 μ and stained by various methods, e.g. hæmatoxylin and eosin, hæmatoxylin and van Gieson's stain, orcein and van Gieson's stain, Weigert's resorcin fuchsin, Masson's ponceau-fuchsin light-green stain and Masson's acid-fuchsin aniline-blue stain.

Observations

African Elephant. (Pl. 40, fig. 1, 2, 3, 4.) Under low-power magnification the most obtrusive histological feature of the cervical lymph node is its extraordinary vascularity—the abundance of blood vessels and of vascular spaces conferring upon the organ a remarkable sponge-like appearance. High-power examination shows the relatively large vascular spaces to contain blood cells, some a majority of polymorphonuclear leucocytes, some a mixture of polymorphs and monocytes and others a few polymorphs plus the remains of erythrocytes. In certain areas of the sections the erythrocytic débris in the tissue spaces is strongly reminiscent of splenic structure.

The node displays the customary capsule, cortex, medulla and secondary nodules. Cortex and medulla are sharply differentiated and the secondary nodules contain small but distinct intrinsic bloodvessels. Paratrabecular sinuses are well developed. Most of the obtrusively evident vascular spaces, which so permeate the sections, are bloodvessels, often containing lymphocytes and the laked remains of erythrocytes. Generally, throughout the sections, erythrocytes are seen to have escaped in great quantity into the nodal tissue spaces. In some of the sections, isolated little groups of extravascular giant cells occur in the centres of the secondary nodules, containing, additionally to their nuclei, scattered granules of chromatin—an appearance possibly indicative of phagocytosis.

As might be expected from the intensity of its interior vascularity the node manifests an elaborate and abundant blood supply. At intervals its fibrous capsule is pierced by numerous fine single vessels, some of which may be lymphatics whose distinction from bloodvessels is not always practicable on purely histological evidence. Other, larger vessels—unmistakably bloodvessels—approach the capsule in characteristic bundles or leashes, each comprising an artery (nodal artery) between two venæ comitantes, but having a triad of smaller vessels interposed between the artery and each of the accompanying veins (text-fig. 1A). The major vessels of each bundle are traceable through the capsule into the node. The finer vessels are more difficult of assessment: they may be branches (or tributaries) given off (or received) by the major vessels at some distance from the capsule, but it is more likely that they are lymphatic vessels whose precise connection with the node cannot be determined from the sections.

Immediately outside the nodal capsule the main artery of each bundle is clearly apparent lying between its two companion veins: here, or more commonly within the capsule substance, the two veins unite so that one (nodal) artery and one (nodal) vein come to lie side by side. Occasionally the union of the venæ comitantes occurs immediately outside the capsule, where the nodal artery is still accompanied by the dual triad of finer (? lymphatic) vessels already noted.

The nodal artery and its companion vein(s) penetrate the capsule independently and each immediately acquires a conspicuous sheath of perivascular lymphoid tissue. Within

1

2

4

[*To face p.* 210]

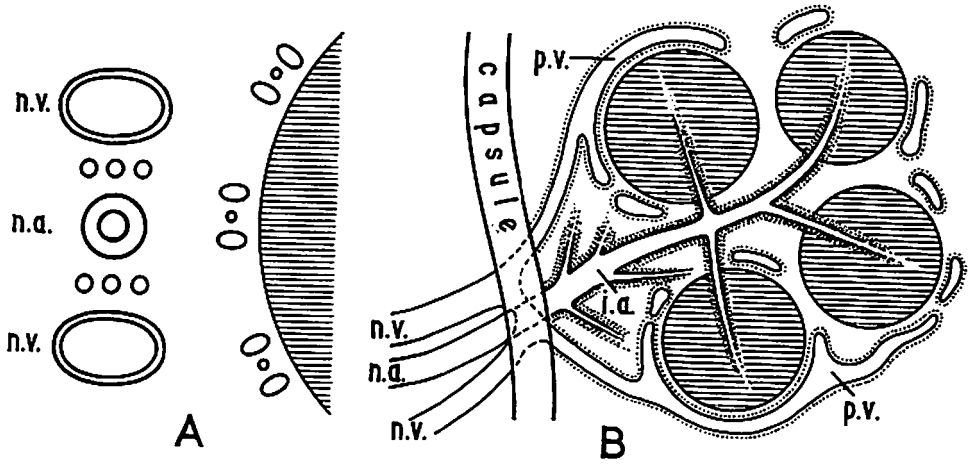
1

2

4

the node the artery immediately divides into a leash of fine branches while the vein runs a recognizably independent course for some distance before establishing continuity with one or other of the large intra-nodal vascular spaces. This relationship of the vein is so generally and obviously evident that the great majority at least of the vascular spaces are demonstrably venous in nature. Within the node both the entrant (nodal) artery and its branches and the emergent veins are heavily and characteristically clothed with lymphoid tissue, the arteries rather more abundantly so than the veins (text-fig. 1B).

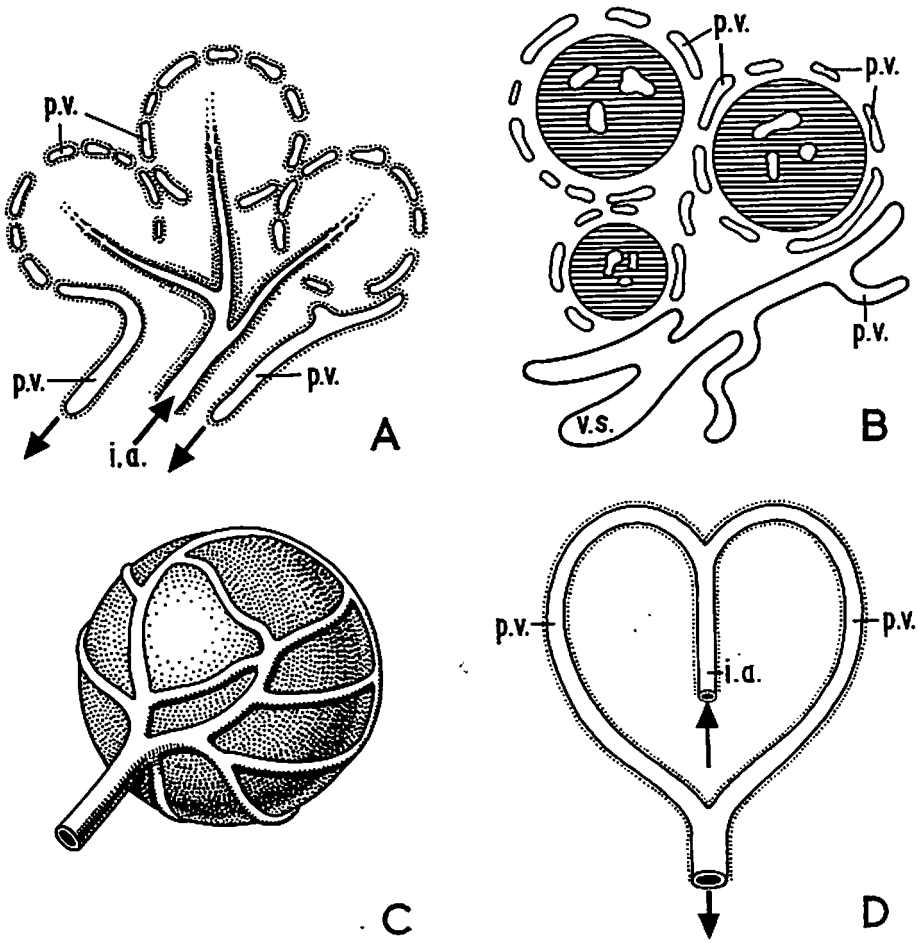
The principal arterial twig of the intra-nodal leash (the intra-nodular artery) runs a relatively long course (often the entire length of a section) and is densely clothed with perivascular lymphoid tissue. This vessel gives off a spray of fine, capillary-sized twigs, one to each of the adjacent secondary nodules of the node, and each intra-nodular twig is likewise intimately invested with lymphoid tissue (text-fig. 1B, 2A).



Text-figure 1.—Showing (A) a leash of nodal vessels and their capsular relationship; (B) nodal vessels piercing the capsule and their intranodal disposition.
n.a. = nodal artery; n.v. = nodal vein; i.a. = intranodular artery; p.v. = perinodular vein; v.s. = venous space. Perivascular lymphoid tissue represented by dots.

Each of the secondary nodules is thus provided with an intrinsic arterial supply and each is surrounded by a dense plexus of perinodular veins, in the form of an investing basketwork, which drains into one or other of the intra-nodal venous spaces and thence into an emergent nodal vein. The veins of the perinodular venous plexus, the intra-nodal vascular spaces and the tributaries of the emergent nodal veins are all closely surrounded by lymphoid tissue (text-fig. 2A, B, D).

The intra-nodular arterial vessels and the perinodular venous vessels are of almost capillary size. Careful high-power study of successive sections establishes a continuity of lumen between the two series of vessels, i.e. the presence in the secondary nodules of an arterio-venous anastomosis (text-fig. 2D). The intra-nodular arterial vessel (or one of its offshoots) is traceable into a secondary nodule from the base almost to the periphery. Its extremely tenuous walls are surrounded by a particularly dense aggregation of lymphoid tissue. No subsidiary microscopical branches are given off and the sole outlet for the contained blood cells is into the undoubtedly venous capillary vessels constituting the basket-like perinodular plexus.



Text-figure 2.—Showing diagrammatically (A) and (B) the relationships of bloodvessels and secondary nodules of two microscopic fields, (C) the venous plexus around an isolated secondary nodule, and (D) scheme of the arterio-venous anastomosis associated with a nodule.
n.a. = nodal artery; n.v. = nodal vein; i.a. = intranodular artery; p.v. = perinodular vein; v.s. = venous space. Perivascular lymphoid tissue represented by dots.

The cervical lymph node of this young *Loxodonta* specimen thus proves to be a hæmo-lymph gland, structurally much akin to the spleen, and equipped with an intrinsic vascular pattern characterized by the presence of abundant arterio-venous anastomoses.

Rhinoceros. (*a*) *Indian.* (Pl. 41, fig. 1, 2.) A juxta-renal lymph node shows a less well marked distinction between cortex and medulla than is usual in mammalian lymph nodes and the secondary nodules are somewhat diffusely arranged. The vasculature is extremely copious; erythrocytes are present in the tissue spaces; considerable quantities of iron pigment are distributed in irregular fashion throughout both the cortex and the medulla, and the organ has all the histological characters of a hæmolymph node. A para-bronchial node reveals an identical hæmolymph pattern of organization and differs only in its manifestations of intrusive carbon particles due to atmospheric pollution.

Rhinoceros. (*b*) *African Black.* (Pl. 41, fig. 3, 4.) A juxta-renal node presents a preponderance of cortical tissue, an epitracheal node a predominance of medullary substance,

and an epicardial node a slight preponderance of cortex relative to medulla. The capsules of all these nodes are composed of fibrous tissue admixed with a very scant amount of unstriped muscle. The trabeculæ are extraordinarily thick and contain, amid their white fibrous tissue, some odd scattered fibres of plain muscle; the intramedullary trabecular pattern is extremely complex. A marginal sinus and paratrabecular sinuses are recognizable. The medulla contains macrophages full of iron pigment and in every medullary field (at $\times 150$ magnification) one or two eosinophil leucocytes occur. The remains of erythrocytes are present in the tissue spaces. A rich vascular pattern is apparent generally. Within and between the secondary nodules occur numerous large vascular (venous) spaces which attain a maximal incidence and development in the medulla. The hæmolymph nature of the nodes is histologically unmistakable.

Rhinoceros. (c) *African White.* A preliminary note (Aumonier & Cave, 1960) on the histology of certain exceptionally well preserved lymph nodes of *Ceratotherium simum* emphasized the almost spleen-like and obtrusively hæmolymph nature of these structures. Intercostal, superficial cervical and deep cervical glands were studied, in $10\,\mu$ sections stained by hæmotoxylin and eosin and by Foot's silver method for reticulum. All the nodes studied presented a fibrous capsule, well-marked trabeculæ, a marginal sinus and paratrabecular sinuses. The marginal sinus of the deep cervical gland contained blood and was possibly functioning as a vein. An abundance of relatively enormous sinusoids characterized all the nodes. In the deep cervical node no clear differentiation of cortex from medulla was observable, the secondary nodules of lymphoid tissue being somewhat diffused throughout the organ: the superficial cervical node showed both scattered patches of lymphoid tissue as well as an aggregation of secondary nodules: the intercostal gland showed a confluence of relatively massive secondary nodules. The several secondary nodules were penetrated by "ensheathed" (intra-nodular) arteries and were invariably surrounded by vascular spaces, many of which, from their haemocyte content, were clearly veins, others of which were probably of a lymphatic nature. Extravascular blood in great quantity occurred generally in the tissue spaces, and plasma cells were abundant in all the nodes. Portions of the deep cervical node proved histologically indistinguishable from splenic tissue. It is not known whether lymph nodes from unexamined regions of the body were also of hæmolymph organization, but the limited sample examined suggests that this may be so.

Discussion

The relatively few lymph nodes so far examined of *Loxodonta*, *Rhinoceros*, *Diceros* and *Ceratotherium* prove unmistakably to be hæmolymph nodes. The limited range of material studied is obviously preclusive of dependable conclusions as to whether or not all the body nodes of these several large tropical forms are likewise of the hæmolymph variety, and as to whether or not the possession of hæmolymph nodes is as equally characteristic of other large-bodied tropical mammals. It may be noted, however, that the remarkably sharp cortico-medullary differentiation seen in *Loxodonta* is not sustained in the rhinoceros specimens and is indeed altogether lost in the deep node of *Ceratotherium*, the histological organization of which so closely resembles that of the spleen that portions of the node could pardonably be mistaken for splenic tissue.

The remarkable general similarity of nodal vascular patterns in the nodes of all species studied strongly suggests that the detailed arterial and venous arrangements described for *Loxodonta* hold equally good for *Rhinoceros*, *Diceros*, and *Ceratotherium*. This point

however can be satisfactorily determined only by future study of serially sectioned nodes from these latter forms.

It remains to be decided whether the haemolymph organization of the nodes in the forms studied is a permanent anatomical feature, or whether, under appropriate physiological stimulus, "ordinary" lymph nodes may undergo metaplasia in a hæmolymph direction. On this last point information is most likely to be forthcoming from the clinical researches of the tropical veterinarians, before whom, in this connection, lies an exceptionally wide and attractive field of enquiry.

REFERENCE

AUMONIER, F. J. & CAVE, A. J. E. (1960).—A note on the visceral histology of *Ceratotherium*. *J. R. micr. Soc.*, **78**, 120.

DESCRIPTION OF PLATES 40–41 (see after p. 210)

PLATE 40

Fig. 1.—*Loxodonta africana*, juv. Cervical lymph node. Showing nodal artery and vein, and intervening (? lymphatic) vessels alongside capsule. × 100. Hæmatoxylin and eosin.

Fig. 2.—*Loxodonta africana*, juv. Cervical lymph node. Showing nodal artery piercing capsule and companion vein already inside capsule. × 100. Hæmatoxylin and eosin.

Fig. 3.—*Loxodonta africana*, juv. Showing the long course of the intranodular artery. × 100. Hæmatoxylin and eosin.

Fig. 4.—*Loxodonta africana*, juv. Showing intranodal venous space and perinodular veins joining same. × 100. Hæmatoxylin and eosin.

PLATE 41

Fig. 1.—*Rhinoceros unicornis*, ad. Juxtarenal lymph node. Showing capsule, trabecula, venous spaces and general vascularity. × 100. Hæmatoxylin and eosin.

Fig. 2.—*Rhinoceros unicornis*, ad. Juxtarenal node. Showing an intranodular arterial branch, large venous space and some perinodular veins. × 100. Hæmatoxylin and eosin.

Fig. 3.—*Diceros bicornis*, juv. Epicardial node. Showing portion of capsule, a large venous space and the general vascularity. × 100. Hæmatoxylin and eosin.

Fig. 4.—*Diceros bicornis*, juv. Epitracheal node. Showing capsule, nodal artery therein and very numerous intranodal venous spaces. × 100. Hæmatoxylin and eosin.