V. *On the Chemical Analysis of the Contents of the Thoracic Duct in the Human Subject.*

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THE contents of the thoracic duct in the human subject having never been obtained in sufficient quantity for the purposes of chemical analysis, I resolved to avail myself of an opportunity which lately presented itself in the execution of a criminal at the Old Bailey.

Through the kindness of Messrs. Macmurdo and Holding, the medical officers of Newgate, and with the assistance of my friends Mr. Hilton and Mr. Samuel Lane, I was enabled to commence operating upon the body one hour and a quarter after death, and before it had become cold, although the thermometer stood considerably below 32° Fahr., and the body had been exposed on the scaffold during one hour. The subject was muscular and of the middle height, and the prisoner had not become emaciated during his confinement in jail. On the evening preceding his execution, he had partaken of some supper, consisting of about 2 oz. of bread and 4 oz. of meat; and the next morning, he drank two cups of tea, and ate a piece of toast made from the quarter of a round of a quartern loaf, and about a quarter of an inch in thickness. This breakfast was taken at seven o'clock A.M., one hour before death. He swallowed a glass of wine just before mounting the scaffold.

The contents of the posterior mediastinum having been previously included in a ligature from the left side, the thoracic duct was reached without much difficulty by raising the right lung, and dividing the pleura which forms the right boundary of the posterior mediastinum. The duct was easily found, being distended with chyle: it was seized immediately below the point at which it was intended to divide it. The operator detached it as much as possible from its cellular connexions, and holding it between the thumb and finger, it was divided while thus compressed. The fingers and lower part of the duct were then well washed by pouring clean water over them in order to be certain that no serous secretion or blood might become mixed with the chyle. The divided extremity of the duct was next placed in a perfectly clean glass bottle, into which its liquor flowed freely; its motion being facilitated by gently kneading the abdominal contents. In this manner nearly six fluid drachms of chyle were obtained, the physical characters of which were as follows:—It was of a milky hue, with a slight tinge of buff. Its consistence was much the same as that of milk. The latter portion which was obtained (four drachms being received in a first, and

two drachms in a second bottle) coagulated on becoming cold; but the portion received in the first bottle being retained in the hand of Mr. HOLDING, and thus kept at a higher temperature, did not coagulate during a full hour; and on subsequently being allowed to cool to the same extent as the specimen obtained in the other bottle, it still remained perfectly fluid. The coagulation which took place in the other specimen was however very slight; and a partial resolution of the clot occurred after a few hours had elapsed*. The specific gravity of this fluid was 1·024. Chemical examination yielded the following results.

When fresh, it was neutral in its reaction on test papers; a portion, however, which was kept some days, became slightly acid during decomposition.

The application of heat coagulated it strongly. The addition of nitric acid also produced a strong curd.

Acetic acid did not coagulate it, but, on the contrary, rendered it somewhat more pellucid. The addition of acetic acid and the subsequent addition of a solution of ferrocyanuret of potassium produced a strong white flocculent precipitate. A portion of the fluid was next submitted to analysis in the following manner.

The proportion of water was ascertained by careful evaporation over a water-bath until no decrease of weight was observed by further application of heat; the loss indicated the weight of the water. The solid extract obtained was finely powdered, digested with ether for a day in a closed vessel, and then again similarly treated with a second portion of the menstruum; lastly it was washed with ether. The ethereal solutions thus obtained were mixed together and evaporated; the solid residue was estimated as fatty matter. The portion insoluble in ether was next treated with boiling distilled water, and allowed to digest at a temperature of about 57° FAHR. for twelve hours. It was then again similarly treated, care being taken to pour off the first digested portion of water as nearly as possible without disturbing the deposit, before adding the second quantity. The solid matter was then placed on a filter washed with distilled water, dried and weighed as albumen. The filtered liquors and washings were collected and evaporated together, and the dry result treated with successive portions of alcohol, of the specific gravity 0·832, until everything soluble in that menstruum was dissolved out. The insoluble portion was then dried and weighed as "animal extractive matter and salts soluble in water only;" and the alcoholic solutions being evaporated, their extract was estimated as "animal extractive matter soluble in water and alcohol." The salts were obtained from these extractives by incineration and carefully conducted decarbonization; and their weights being subtracted from that of their respective extractives, the difference gave the true weight of the animal extractive matter with which they had been combined. The quantitative analysis, conducted as above, yielded the following result in 100 parts:—

* The fibrin of the lymph and chyle of the Ass coagulate with sufficient strength to admit of separation and estimation in analysis.

Water	90·48
Albumen with traces of fibrinous matter	7·08
Aqueous extractive	0·56
Alcoholic extractive, or Osmazome	0·52
Alkaline chloride, carbonate, and sulphate, with traces of alkaline phosphate and oxide of iron	0·44
Fatty matters	0·92

The fatty matters extracted in this analysis possessed, for the most part, the same characters as those of the blood, being separable by boiling in alcohol, and subsequent cooling, into a crystalline fat, which was deposited as the alcohol became cool, and an oily matter which was completely soluble in cold alcohol; these fats differed, however, from those of the blood in not containing phosphorus, which was proved by their yielding an alkaline, instead of an acid ash on incineration. The albuminous matter was not of the dead white colour observed in that obtained from pure chyle, owing, doubtless, to the contents of the thoracic duct containing a considerable proportion of lymph. On incinerating this albumen, an ash was obtained, containing phosphate of lime and traces of oxide of iron. The whole of the spontaneously coagulable albumen or fibrin*, which presented itself as clot in part of this chyle, is estimated as albuminous matter in this analysis, as it was found quite impossible to separate it without considerable loss, and the coagulum was very slight and broke down very rapidly.

The aqueous and alcoholic extractives mentioned in this analysis agreed in most respects in chemical characters with those obtained from the blood, with the exception that the aqueous extractive yielded a ferruginous ash, which is never the case with that principle as procured from the blood. I have ascertained by experiment that pure chyle obtained from the lacteals of the Ass yields an aqueous extractive containing iron; it is, therefore, to the chyle and not to the lymph that we owe this property of the aqueous extractive. The salts, obtained by incineration from the alcoholic extractive, yielded a larger proportion of alkaline carbonate than is obtained from the blood, indicating a larger proportion of an alkaline lactate in the contents of the thoracic duct. I have alluded to the dead white colour of the albuminous matter obtained from pure chyle, and stated that the admixture of lymph in the contents of the thoracic duct interfered with its developement in the albumen obtained from the fluid the examination of which I have detailed. Some months ago I had an opportunity of tracing this effect to its true cause, namely the presence, in the chyle, of an opake white organic matter identical with a substance existing as a constituent of the saliva, and which appears to act an important part in the process of nutrition. I have obtained this animal substance on a former occasion in consider-

* I have thought it right to apply to fibrin the term spontaneously coagulable albumen, the recent observations of LIEBIG and others having shown it to be chemically identical with albumen.

able quantity from the chyle of the Ass, and found it to exhibit peculiar characters, which I have described in the Medical Gazette for January 1, 1841, to which I may refer also for a comparative analysis of the chyle and lymph of this vegetable feeder. It has frequently been stated by observers, that chyle, when set aside to coagulate, assumes a pink colour if exposed to the air; this is stated to be the case by MÜLLER in the chyle from the thoracic duct of the Horse. My own observations do not agree with this statement; for fluid taken from the thoracic duct of the Dog, Ass, and Cat, as also that lately obtained from the human subject, showed no such change of colour when under the conditions mentioned by MÜLLER. There were, indeed, a few blood-corpuscles to be seen by microscopic examination; but these were so few in number and so divided as not to manifest their colour, and were, I have no doubt, taken up by the divided mouths of some of the absorbents which emptied themselves into the thoracic duct during the period occupied by us in obtaining its contents. Mr. SAMUEL LANE was, I believe, the first observer who traced the existence of the blood-corpuscle in the chyle to its true cause, and showed that chyle might be procured free from such contamination, if the contents of the thoracic duct were speedily obtained. I have had occasion in this analysis to verify my former views concerning the cause of the white colour of the chyle, which I feel confident is chiefly attributable to its containing the opake white salivary matter as a constituent. This substance is always, however, mixed with a certain proportion of fatty matter. It may be obtained from chyle by agitation with ether; when we find it to subside through the ether, and to float on the surface of the chyle which has now become cleared.

The microscopic examination of human chyle has been much neglected. From the appearances observed in the specimen lately obtained, I am enabled to state that its corpuscles are of the same description as those in the chyle of purely animal and vegetable feeders. They consist of two classes, viz.—1. Larger spheroidal bodies, varying in size, but for the most part larger than the blood-corpuscles, semitransparent, and granular on the surface. The largest of these corpuscles are nearly twice the diameter of those of the blood. 2. Minute granules varying in size from about $\frac{1}{16}$th the diameter of the blood-corpuscle to a size which scarcely admits of their being seen, except by the aid of a perfect light and a microscope capable of magnifying to about 750 diameters, when they appear to form a kind of back-ground on which are seen the larger corpuscles first noticed. These granules have been described by Messrs. LANE and GULLIVER as existing in the chyle of animals. Mr. LANE has likewise described a molecular motion in them, which I have had occasion to verify. Besides these corpuscles and granules we also detect fatty globules in the chyle, varying greatly in size. If we compare the analysis I have given of the contents of the thoracic duct with the analysis of the blood, we cannot fail to be struck with the very great excess of fatty matter existing in the former. We have a large quantity of an hydrocarbonous ingredient constantly entering the blood, and becoming consumed with great rapidity, as proved by the small percentage

of fatty matter contained in the mass of blood. Whether this hydrocarbonous matter is exhaled by the lungs and skin in the form of water and carbonic acid, or whether, on the contrary, an absorption of nitrogen and oxygen occurs in the process of respiration, so as to convert the fat of the chyle into albuminous matters for the purposes of secretion and nutrition, is not yet determined; many circumstances, however, seem to favour the latter view; thus, the chyle of an animal fed on beans and oats, substances very different in quality from fatty matters, is found to contain a very large proportion of fat, destined, no doubt, for some useful purpose of the animal economy, and which would scarcely be produced from aliment in order to be subjected to a direct process of excretion. The proportion of "extractive matter soluble in water and alcohol" or osmazome, will be found greatly to exceed the amount of that principle contained in the blood; agreeing well with what we know concerning the universal distribution of this substance as a constituent of the soft parts of the human frame.