On some points relating to the anatomy and habits of the Bactrian camel (Camelus bactrianus), and on the presence of intestinal glands not before noticed / by Edwards Crisp.

On some Points relating to the Anatomy and Habits of the Bactrian Camel (Camelus bactrianus), and on the Presence of Intestinal Glands not before noticed. By Edwards Crisp, M.D., F.Z.S., etc.

I shall endeavour, in this paper, to notice chiefly certain parts of the anatomy of this animal which, as I believe, have escaped the observation of, or have not been fully investigated by previous inquirers; or if investigated, the mode of research has been different to that which I have pursued. This leads me to mention two practices that I have for a long time followed, and which, as far as I know, I was the first to adopt, and the utility of which, I think, is especially apparent in an investigation like the present. These consist in the filling of some of the hollow organs—as the various portions of the intestinal tube, for example—with water, to ascertain their capacity, and in the distention of some parts with liquid plaster of Paris to show their form and to exhibit injections of the blood-vessels or absorbents in a better manner. A part of the injected stomach of a Llama (before the Society) treated in this way, to show the form of the water-bags and the course of the vessels supplying them, well exemplifies the advantage of this method.

The *Camelidæ* are some of the most interesting animals, not only as regards their structure, but also in reference to their habits and utility, with which the anatomist has to deal. Their history is too well known to need repetition here; but it will not be out of place to notice the Camels (one- and two-humped) now in the Society's Gardens. These consist of an old male Bactrian Camel with one of the humps down*, of a female of the same species born in the Crimea in 1855, and of a male Camel about forty years of age. I learn that, since the formation of the Society (1826), one Bactrian Camel died of dropsy, and that two Camels have been born in the Society's collection; one of these died, and the other was reared and afterwards sent to Edinburgh. A Camel (Bactrian) was born in Edmunds's travelling menagerie last year. I believe the only place in Europe where Camels are now bred for profit is Pisa. Of all the animals in our menageries, probably the Camel is the most healthy. To return to the Camels in the gardens of the Society, I learn from the keeper that their consumption of food is about equal to that of the Horse, and that they do not drink, even in hot weather, more

* It is well known that these humps often diminish in size, and that the fatty matter of which they are composed is again replaced; but Mr. Bartlett informs me, "from inquiries he has made of many persons connected with travelling menageries, that when the hump falls in this manner it never recovers its erect position."

than six gallons * daily, and in winter about three gallons. There is one remarkable feature in the male Camel that is not, I think, generally known. On the back of the neck, just behind the ears, are two glandular elevations that furnish, especially during the rutting season, a very offensive secretion. This, as will be seen by the paper smeared with it, is of a dark colour, and very like the sepia of the Cuttlefish (*Octopus*), and might, I believe, be used advantageously as a pigment. I find that this secretion is from a large number of agminated glands seated under the skin in the situation above named. They are about $\frac{1}{5}$th of an inch in length and $\frac{1}{7}$th of an inch in breadth, and are represented in Plate IV.

In speaking of the generative function, with which these glands are intimately connected, let me notice the mode of copulation of the *Camelidæ*, known to many. The male, often after very ungallant usage to his spouse, compels her to drop down in her usual position when at rest, and in this way copulation is accomplished. In my paper "On the Dentition and Mode of Copulation of the Elephants" (Lancet, 1854, p. 198), I believe that I was the first to point out the mode of copulation of these animals. The female places her head upon the ground, elevates her haunches, and thus the act of copulation is affected. I am not acquainted with any other quadrupeds in which the females assume the position I have described in the Elephants and Camels, including the Llamas.

One great source of difficulty in this investigation has been the confusion that has arisen respecting the names of the two species of Camel, Dromedary and Camel being applied to both by different authorities. It would be well, I think, if the term Dromedary were abandoned, and the names One- or Two-humped Camel used in its place.

Daubenton, in Buffon's 'Histoire Naturelle,' 1744, vol. xi. p. 255, has given a long description of the anatomy of the Camel, with a number of measurements of the bones and of various parts. He represents the stomach as consisting of five compartments; and he gives the length of the alimentary canal, exclusive of the cæcum, as eighty French feet. He says that the two races (Camel and Dromedary) mix, and that their progeny is the most vigorous.

Sir E. Home (Phil. Trans., 1806) describes the stomach of a Camel that was killed at the London College of Surgeons, 1805. "The animal was supplied with a large quantity of water before death, and this fluid was found in a pure state in the water-bags; these cavities, moreover, contained none of the food."

In the first volume of our 'Proceedings,' part 2, 1832, p. 126, Mr. Spooner gives some notes on the Dromedary (*Camelus dromedarius*, Linn.)—the animal I have before spoken of that died of dropsy. "In the structure of the stomach he found nothing to add to the accounts already given by Daubenton and Sir E. Home. He stated, however, that the cells of the first stomach contained food, and, like

* The Elephant, as I am informed by the keeper, will sometimes in hot weather drink twenty pailfuls of water daily, although the capacity of its stomach is only about one-third that of the Camel.

John Hunter, he had some doubt as to the correctness of the supposed water-holding function of these cells." Prof. Owen remarked "that he had found food in the water-cells of Llamas; but he thought it probable that this had been forced into them by moving the animals after death."

In the Hunterian Museum (556 to 559) are preparations of the water-cells of the Llama and Camel, with a description by Professor Owen.

Cuvier ('Leçons d'Anatomie Comparée,' 1836, tom. iv. p. 72) gives a very short account of the stomach of the Camel, which he describes as having four cavities. The total length of the intestinal tube in the Dromedary (one-humped) is given as 38·456, the proportion to the body being 1 : 15·5. In the Camel, the total length of the intestinal canal is 42·213, the proportion to the length of the body being 1 : 12·3 (Table, p. 193).

I am not acquainted with any recent writer who has given a minute account of the visceral anatomy of the Camel.

The Bactrian Camel (*Camelus bactrianus*) (two-humped), a part of which I have lately dissected, was an old male that had been long in a travelling menagerie, and was killed in consequence of old age, disease, and emaciation.

I had not an opportunity of examining the brain; but judging from the cast of one in the Hunterian Museum, from which the drawing before the Society was taken, the weight is about 24 ozs., a proportion of about $\frac{1}{700}$ or $\frac{1}{800}$ to the body—a small brain for an animal possessing so great an amount of docility and intelligence. The brain of an Indian Elephant that I weighed was about 12 lbs. in weight.

The eye weighs 1 oz. 148 grs.; the lens 58 grs. There is a peculiarity connected with the eye of the Camel and Dromedary that I have not seen noticed by any writer on these animals, although it can scarcely have escaped observation. If the eyes of the three animals I have spoken of in the Society's collection are inspected, it will be seen that pigmentary masses are suspended from the pupil and pass into the anterior chamber, so as to form a kind of curtain to regulate the admission of light—a beautiful provision in an animal so exposed to the sun's rays. In one of the Camels a loop of pigmentary membrane is seen in the anterior chamber of both eyes. Unfortunately I omitted to examine this part after death in the Camel I dissected.

The tongue is long, narrower in the centre, and more expanded at the base and extremity; the buccal villi long and numerous. The larynx presents no remarkable peculiarity, except that the anterior part of the thyroid cartilage is less prominent than in most of the ruminants.

The trachea is of nearly uniform calibre; it consists of seventy-five rings, and is 3 feet 11 inches in length.

The thyroid glands are of an oblong shape, and entirely separate. They weigh about one ounce and a half.

The heart weighs 6 lbs. 4 ozs.; it measures 11 inches from the

base to the apex. The parietes of the left ventricle are 1½ inch in thickness, and the septum measures the same. The parietes of the right ventricle are 8 lines in thickness. The tricuspid valve is formed by the expansion of ten tendinous slips, which proceed from two elevations (corneæ columnæ) of the right ventricle. There is no heart-bone, as in many of the ruminants; and the apex of the heart is less pointed than in the Antelopes and *Cervidæ*.

The lungs present the most remarkable specimen of disease that I have met with in these organs. They both have a whitish nodulated appearance, and contain scarcely a square inch of healthy structure, the general mass being made up of hard tubercles containing a large proportion of earthy matter. The lungs are about of equal size, and the right (the only one I put into the scale) weighed 20½ lbs., a great proportion of this being made up of carbonate of lime. The bronchial glands are much enlarged, and are composed of a larger proportion of earthy matter than the lungs. This disposition to the formation of earthy matter in the lungs is very common in the ruminants. I have met with it to a great extent in the *Leucoryx* and in other Antelopes; and in the common sheep the *Echinococcus*-cysts are often converted into chalky and ossific material. As this Society is both zoological and physiological, let me digress for a moment to point out the beautiful law of compensation that exists in all animal bodies, so that when one organ is impaired, or, as in this instance, almost destroyed, one or more parts take on a compensatory action. In this case the blood was aërated by the lining membrane of the trachea and by that of the larger bronchial tubes, the process of depuration being performed chiefly by the liver (which was normal in structure) and by the intestinal glands. I have seen numerous examples of this in the Quadrumana and in other orders. The normal structure of the lungs may be almost entirely destroyed by disease, and the animal may linger on for a long period; but when both lungs and liver are seriously affected, life is soon terminated. There is one practical and useful fact that I have alluded to in a former paper, in connexion with tubercle in the lower animals, viz. that it is much more prevalent in the *vegetable* feeders.

Mr. Gilchrist, in his essay on the 'Diseases of the Camel' (India, 1846), does not mention the presence of tubercle in the lungs or in other parts, this lesion being probably the result, as in other animals, of close confinement, and often, in travelling menageries, of a vitiated atmosphere.

The liver weighs 23½ lbs. It consists mainly of one lobe, with two slight divisions. The under surface is curiously formed into several thin flaps, which pass in a horizontal direction. No gall-bladder is present, and, with the exception of three tubercles, the viscus is in a normal state.

The spleen weighs 25 ozs., and is of the usual fan-like shape that it assumes in most of the ruminants. The splenic vein contains five pairs of valves; these are also present in the gastric and abdominal veins.

The pancreas is of the usual branched form that is found in the ruminants; it weighs only about 10 ozs.—a very small organ for an animal with such a large and complicated stomach.

The kidney weighs 2 lbs. 1 oz., and is of the usual form of this organ in the ruminants; the renal bodies, as is the case in all the ruminants that I have dissected, are not in contact with the kidneys. The mamillary processes are unusually long (3 inches). The pelves of the kidneys are filled with solid, hard, white fat, and from this finger-like masses proceed between the cones. I have on a former occasion mentioned a remarkable local accumulation of hard fat around the heart of an old and emaciated Eland (*Oreas canna*) of a similar character. Both renal bodies were much diseased—a very unusual occurrence in the lower animals. The left renal vein contains five pairs of valves, the right vein only two pairs.

I had not an opportunity of examining the generative organs.

I now come to the most interesting part of the inquiry, viz. the form, capacity, and anatomical relations of the alimentary canal. I scarcely need say that a minute description of the stomach alone would occupy many pages, and the time would not be ill spent; but there are few who would care to hear the details. I have inverted the stomach; and the drawing, of the natural size, before the Society represents it in this position. The rumen, instead of being covered with villi, as in all ruminants (except in the other *Camelidæ*), has a smooth surface lined with pavement-epithelium. In this cavity are two sets of water-cells, the one consisting of about ninety-four, and entirely distinct, the other composed of about seventy-eight cells, and connected with the second stomach—that which would correspond to the reticulum (honeycomb) in ordinary ruminants. From the œsophagus proceeds to the second stomach (reticulum or true water-bag of some authors), an elevated ridge of the mucous and muscular coats, which conducts the food to the last-named cavity, but does not enclose it, as is supposed to be the case with the double ridge in other ruminants. The second stomach, or water-bag, is composed almost entirely of cells, but of less capacity than those before named, although the subdivisions are more numerous; these amount in all to about 380. The large cells in the rumen will contain about two or three ounces of water; but, if all were filled, the capacity of each would be much diminished. I found no traces of food in any of these cells, but a large quantity of small pieces of coal, an old nail, and bits of glass, the weight of all amounting to about 24 ozs. This animal, like many in a diseased state, had probably a depraved appetite, and hence the presence of these extraneous bodies. Ellis, the keeper of the gardens, tells me, however, that these animals, at certain times, are very "nasty feeders," and will eat almost anything. The next stomach, which has been called the third, corresponds to the maniples; but, as will be seen when the dimensions are given, it is comparatively much larger, and the large mucous folds present in other ruminants are scarcely perceptible. The fourth cavity (or digestive stomach of other ruminants) is small, but extremely vascular and elevated into ridges, like the digestive

stomach of the Dolphin or Porpoise. These ridges evidently increase and decrease in size, according to the activity of the digestive process; and this explains the highly tortuous condition of the arteries. This cavity is shut off from the next, which I call the fifth stomach, by a strong muscular valve. The last-named stomach is thin and dilated, and terminates in the duodenum, although the great contraction at this part can scarcely be called valvular. Daubenton, who gives five stomachs to the Camel, has not included the last cavity; but I think it is entitled to be called a fifth stomach; indeed, if we reckon the two sets of water-bags in the rumen, the Camel may be said to have seven stomachs.

No one can form a proper notion of the immense size of the Camel's stomach unless it is seen distended: when in this state, the following are the measurements and the capacity of the various parts:— The length of the œsophagus 6 feet; of the rumen 43 inches, its circumference 5 feet 6 inches, and it holds twenty gallons of water. The length of the second stomach is 21 inches, and its capacity about six quarts. The third stomach is 34 inches in length, and holds about three gallons of water. The fourth stomach is 8 inches in length, and contains three quarts of water. The fifth cavity is 9 inches long, and holds about two quarts of water. The capacity of all is about twenty-five gallons three quarts; and the length of all, when distended, is 9 feet 6 inches. As regards the quantity of water that these cavities hold I, of course, cannot speak with perfect accuracy.

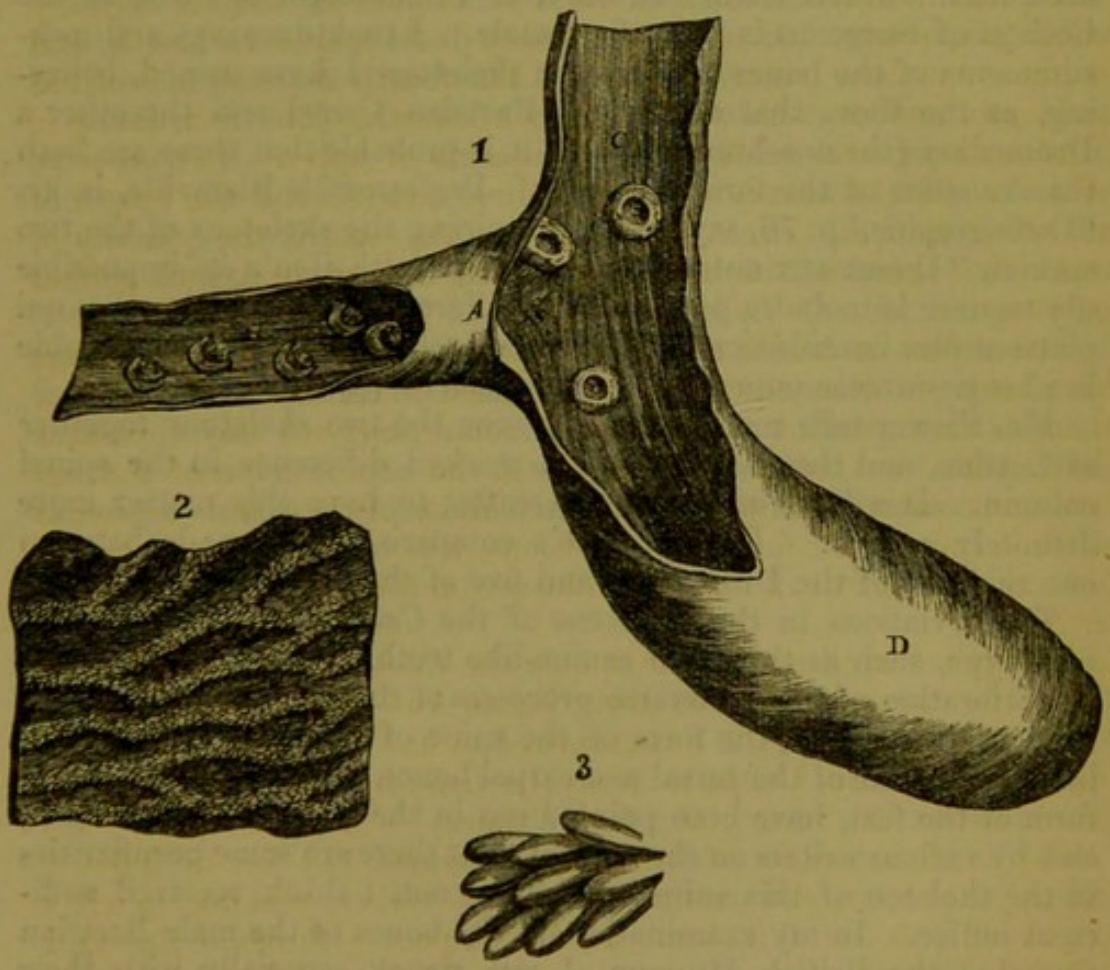
The muscular bands and the mode of closure of the water-bags have been so often described that I need not allude to them; but there is one piece of mechanism in connexion with this apparatus that I think has been overlooked, viz. the arrangement of the external muscular fibres of the rumen. Many of these wide muscular strips terminate in finger-like divisions, which are so spread out as to exercise, I believe, a material influence on the closure of the water-cavities.

I supposed until recently that only the *Camelidæ* had water-cavities in the stomachs; but on dissecting an Antelope from Siberia, the Saiga (*Antilope saiga*), I was surprised to find two large water-bags in the rumen; and I hope to bring the visceral anatomy of this rare animal before the Society at a future time.

The small intestines of the Camel measured 114 feet by 2 feet 6 inches, the colon and rectum 27 feet 6 inches, making in all a length of 159 feet 6 inches. In the Alpaca (*Auchenia pacos*) I found the length of the alimentary tube 70 feet, whilst that of the Huanaco (*Auchenia huanaco*) was 95 feet.

In my paper on some parts of the anatomy of the Giraffe and Nylgau (P. Z. S. 1864, p. 63), I stated that the investigation of the intestinal glands of the lower animals had been much neglected, and that a wide field was left for future inquirers. The dissection of this animal reveals another curious structure in connexion with the intestinal mucous membrane. Near to the cæcal valve I found eight large glandular folds of the mucous membrane; three of these

were circular, the largest measuring $1\frac{1}{2}$ inch in diameter, the folds forming a circular receptacle that would contain about 2 drachms of fluid; one of these was seated at the commencement of the cæcum, and two on the colon, near to the ileo-cæcal valve. In the ileum, within a space of 6 inches from this valve, were five folds of the mucous membrane, of a crescentic shape, the largest about 1 inch in width, their crescentic edges being all towards the ileo-cæcal valve; the largest of these would hold about a drachm of fluid. In other parts of the ileum, a short distance from the last named, were slight folds of the lining membrane, but assuming a crescentic shape. To the naked eye these, both circular and crescentic, appeared to be mucous follicles surrounded by the folds above described; but on putting them under the microscope, they were seen to be composed of club-shaped villi, about $\frac{1}{20}$th of an inch in length, and having much the appearance of those on the surrounding mucous membrane, but of larger size.



1. The cæcum and portions of the ileum and colon: B. ileum; C. colon; D. cæcum; showing the circular and semilunar folds. 2. The elevations on the lining membrane of the small intestine. 3. The same, magnified.

The ileum, over a considerable extent of its surface, presented a whitish-streaked, mottled appearance, arising from transverse rows of elevated villi, as seen in fig. 2; the magnified representation of these villi is shown in fig. 3. The rectum in several parts was folded into

longitudinal ridges, as in the Giraffe; but these were of small size and not so well defined.

Skeleton.—The skeleton of the Bactrian Camel, so-called, is described by Professor Owen in the Museum Catalogue of the College of Surgeons; and I need not occupy much time in noticing this part of the structure of the animal, although there are some points, I think, of great interest connected with it. I have carefully examined two skeletons of the Camel—one a Bactrian, at the British Museum, and the skeleton above alluded to, at the College of Surgeons; and, although they are said to be of the same species, I find a great difference in the length of many of the bones, but there is no important difference in the form: the skeletons are both those of old animals. In the British Museum specimen I find the united length of the spinous processes of the dorsal vertebræ to be 110 inches, while those of the College specimen are only 92 inches; and so with the bones of the extremities. These differences in the length of the bones may arise from a difference of sex only, as I believe the skeleton at the College of Surgeons is that of a female. I took drawings and measurements of the bones of both the skeletons I have named, believing, at the time, that one was a Bactrian Camel and the other a Dromedary (the one-humped); but it is probable that these are both the skeletons of the former animal. Professor De Blainville, in his 'Ostéographie,' p. 76, says, after examining the skeletons of the two species, "Quant aux autres parties du squelette, il m'a été impossible d'y trouver la moindre particuliarité différentielle autre que celles qui peuvent être considérées comme individuelles, et que l'iconographie la plus rigoureuse pourrait à peine signaler" (p. 86).

Mr. Flower tells me that he has seen the two skeletons together at Leyden, and that he observed a marked difference in the spinal column. It will be interesting hereafter to have this matter more definitely settled. De Blainville's comparison was made between one skeleton of the Dromedary and five of the Camel.

The deviations in the skeletons of the *Camelidæ* from the ruminant type, such as the three canine-like teeth in each jaw, the want of perforation of the transverse processes of the cervical vertebræ for the vertebral artery, the form of the spine of the scapula, the peculiarities in some of the tarsal and carpal bones, and the more flattened form of the feet, have been pointed out in the Hunterian Catalogue, and by various writers on the subject; but there are some peculiarities in the skeleton of this animal that have not, I think, received sufficient notice. In my examination of the bones of the male Bactrian Camel at the British Museum, I was struck especially with their great weight and solidity; and I believe, judging from the examination of the bones of nearly all our well-known large quadrupeds, that there is no animal with bones so weighty in proportion to their bulk as those of the Camel. I find that the skull of the Ox is much larger than that of the Camel, but the skull of the Camel is the heavier of the two; and the same remark applies to the Horse's skull, where, taking proportion into account, the weight of the Camel's skull greatly preponderates. In two Camels' skulls that I weighed,

one from a male animal and the other from a female, the one weighed 10 lbs., the other 12 lbs.,—the small lower jaw of one weighing 4½ lbs. Of the skulls of two Horses weighed, one was 10½ lbs., and the other 11 lbs.

But there is another remarkable peculiarity in the skull of the Camel, that has not been, I think, sufficiently noticed, viz. the Gorilla-like form of the upper and back part; indeed I can find no animal that has so great a resemblance to the Gorilla in this particular as the Camel. The large size, too, of what are called the true canine teeth, which in some male Camels exceed the length of 2 inches (out of the gum), is another curious affinity; and the early obliteration of the cranial sutures may be mentioned as a third, although I believe, from the examination of a great many skulls of the Gorilla, that they are earlier effaced in this animal; but the rough and unequal condition of the cranial surface for the firmer attachment of muscle is far greater in the Gorilla.

In the Camel the occipital, the sharp parietal, and the triangular frontal ridges are all present, as in the Gorilla; but the occipital ridge is often deeper than that in the anthropoid Ape.

Another deviation in the *Camelidæ* is worthy of notice: they have only twelve ribs, whilst the great majority of ruminants have thirteen; the Giraffe, as is well known, has fourteen. The number of lumbar vertebræ in the Camels is seven, as in the Oxen. Under the microscope there is a marked difference in the hair of the Bactrian Camel and that of one-humped Camel: the former is of a more woolly character. As is well known, the blood-corpuscles of the *Camelidæ* are of an elliptical form; but in the animal I have lately dissected, from the great amount of pulmonary disorganization, the white corpuscles of the blood were very abundant, and these were all round—a fact, I think, of some physiological importance.

[*From the* Proceedings *of the* Zoological Society of London, March 14, 1865.]
