

THE DOG'S BOILERS AND THEIR FUEL.

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THE secret of life lies in the gift of drinking in sunshine, either raw as plants do, or worked up into what we call foods, as animals must, and using its warmth for selfish purposes. The green-stuff of plants catches the sunlight, which sets to work building the stem-leaf house, and then storing it with starch and sugar. Then comes the animal and, most greedily, eats up the plant, crystallized sunshine and all, and uses it first to build his own body-house, then to move it about and warm it.

The first and most important need of the dog-engine is plenty of fuel. It was to move about in search of this, that his racing-machine grew up. So that his body is like a locomotive, not only in having a running-gear and "wheels," but a "fire-box" as well, in which his food-fuel can be burnt and turned into heat and horse-power, or more correctly, "dog-power." As you would expect in any fire-box, there are two openings, one for taking in fuel, the other for getting rid of stuff that will not burn properly, called ashes or waste.

These are the opposite ends of the body, so that the dog's fire-box is in the form of a longish tube, known in Latin as the *alimentary canal*, or in plain English, *food-tube*. This is the form of the body-furnace in all backboneed animals, and most backboneless, though some of the simplest and earliest of these have a mere pouch, with but one opening.

But the food-tube of the dog is very far from being a simple canal, of uniform calibre from mouth to anus. As you look at it, you see that about a foot down from the mouth it balloons out into a pear-shaped pouch, the stomach, then becomes small again and thrown into a large number of coils, the last of which is somewhat larger than the others. Altogether in fact, instead of being just the length of the body, it is between five and six times as long.

Is there anything in the food of the dog to explain this state of affairs? Why does he need a stomach-pouch, and coils of intestine?

A pouch is used to store or carry things in, and if you recall

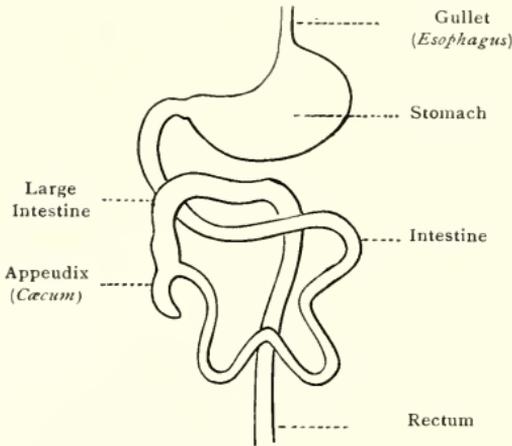


FIG. 1.
FOOD TUBE OF DOG.
(From Flower).

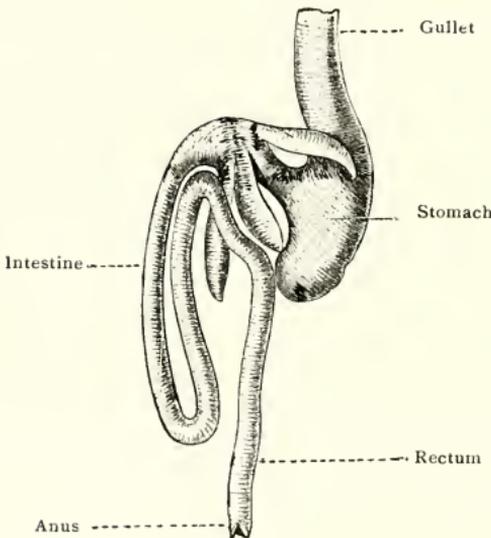


FIG. 3.
FOOD TUBE OF FISH (PERCH).
(From Wiedersheim).

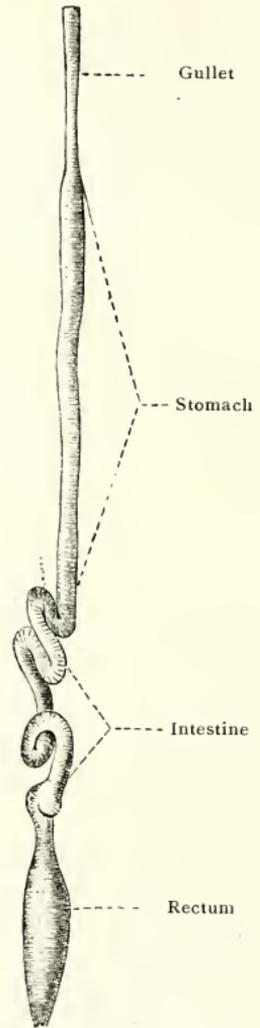


FIG. 2
FOOD TUBE OF NEWT
(From Wiedersheim)
showing simplicity and
straightness.

the kind of food that the dog lives upon, you see at once how much he needs a place, where he can stow away a quantity at one time to be digested at leisure. When he catches a deer, or a wood-chuck,

all that he is sure of is what he can eat on the spot. He is compelled to be greedy, for if he leaves any of it till next day, or even next meal, it is almost sure to be stolen before he comes back. So he gorges himself with all that his stomach will hold. Indeed if you can come upon a wolf while he is feasting on the body of a heifer, or yearling colt which he has pulled down, you can sometimes ride or run him down, inside of a mile, so enormously has he loaded down his stomach, not merely for present but also for future use.

This then is the primary use of a stomach, a storage-, or delay-place for food, until it can be gradually absorbed. But would not this delay be an excellent time for beginning to melt it for absorption? In an early and simple stomach, like the fish's, where the food is chiefly other fishes, shrimps, worms, water-weeds and such-like soft, watery things, which need only to be kept warm and moist, to melt of themselves, you will find little else in its lining but a pavement of thickish, smooth cells. But if you will look at the lining of the dog's stomach, you will see that it looks thick and velvety, and with a magnifying-glass you can make out swarms of tiny, little openings, like pinpricks, dotted all over it. These are the mouths of tiny pouches of the inner cell-sheet, known as glands, which manufacture and pour out a sour juice, called the stomach- or in Latin, *gastric juice*.

This has a curious power of melting meat, and can dissolve a moderate stomach-full in two, or three hours, though the huge gorges that the wild dog takes may require two or three days, during which he sleeps most of the time, in his burrow, or on a sunny hill-side, and doesn't like to be disturbed. Indeed it is a rule, with wolf-hunters, that unless you can get your hounds to the place of his last kill within twelve or fifteen hours after he has left the carcass, so that the pack has a chance of "cold-trailing" him to his lair, it is better to wait two or three days, until hunger drives him abroad again, for as long as he lies still, he, of course, makes no trails, and to beat the woods on the mere chance of stumbling upon him, would be like hunting a needle in a hay-stack, unless you happen to know just what thicket he "lies up" in.

This explains the meaning of that simple, pear-shaped pouch in his food tube, which we call the stomach. But what of the long coils, not unlike a live garden-hose, into which the rest of the tube is thrown? Evidently these are not adapted for storing the food or for letting it rest in one place until it can be melted; but if you will open the tube and look at a portion of its lining under the microscope, you will get a suggestion as to the meaning of this loop

of coil form. Instead of being, like a stomach, dotted all over honeycomb fashion with tiny little openings of glands, the lining of this part of the tube, known from its narrowness as the *small intestine*, is covered with tiny, fingerlike projections standing up all over its surface; and it will not take you long to guess that like fingers elsewhere the purpose of these is to pick up things, and that the business of this part of the intestine is to take up, or *absorb* the food which has been melted in the stomach. But why should it be so long? A simple experiment will answer the question.

If you will take a sheet of blotting-paper, hold it on a gentle slant and endeavor to pour a stream of ink down it, you will find that although it runs briskly enough for the first inch or two, before it reaches the bottom of the sheet the current stops completely, as it has all been soaked up by the paper. Now this is, roughly speaking, almost exactly the process which is going on in the dog's small intestine, and for the matter of that in the intestine of all animals including ourselves, and it follows, that the longer the tube of living blotting-paper, the more completely will the melted food be absorbed. But it must not be supposed, that nothing else but absorption of the melted food takes place in the small intestine. A good deal of further melting goes on as well, for although the lining membrane in the greater part of the intestine has lost most of the gland pouches which pour digestive juice into the stomach, yet this is only because, so to speak, these have all been piled together in two great masses, each of which opens by a tube nearly the size of a quill into the bowel, just beyond the stomach. The largest and solidest of these, on the right side of the tube, is known as the liver; the smaller and more loosely built, upon the left and behind the stomach, is the pancreas.

These are simply very complicated gland-pouches which have budded out from the lining of the tube, like a little plant or shrub whose stems are hollow. The leaves of the shrub are the cells which manufacture the digestive juice, the stalks are the smaller collecting pipes and the stem is the discharge tube or duct of the gland, through which this digestive fluid is poured into the food tube.

But it will strike you at once, that the huge, solid liver is much larger than would be needed, simply to manufacture and pour into the canal the bitter brownish or greenish bile; and your suspicion would be quite correct, for in addition to aiding digestion in this way, the liver also receives the blood from the walls of the food tube loaded with nourishment which has been soaked up out of it, and sends this on another step in the direction of being turned into

blood and body fuel. It also filters out and neutralizes many poisons which get into the blood both from the food-tube and from the waste-processes of the body-cells.

Then if you will look at a food-tube which has been blown up and allowed to dry, you will see that after the coils of the garden-hose part of it comes a third, very much wider portion, curiously puckered and pleated along its sides, known as the large intestine. In the lining of this you will find no fingers whatever and very few gland openings, and this, together with the curious way in which its walls are pouched and puckered by three narrow bands of muscle fibre, which run along its outer wall like draw strings in the mouth of a bag, would suggest that it is merely a place of detention for the remains of the food until its moisture and such traces of nourishment as the fingers of the small intestine have left in it have been soaked out of it.

The saving of this loss of moisture is really a very important thing, for none of our body cells can live unless kept continually in water, and saltwater at that. We are still sea-animals in ninety-nine per cent. of our structure. When the parts of the food which are too hard or tough or coarse to be melted by the digestive juices have had all the nourishment and surplus moisture sucked out of them they are discharged through the second or terminal opening at the end of the food tube known as the anus. Like other furnaces, the body fuel-tube is constructed with two openings, one to receive fuel and the other to get rid of ashes or waste.

If then the food tube of the dog has grown into its present shape to match the amount of food which is put into it, we would expect that animals living upon widely different food would be found to have developed a somewhat different shape both of stomach and intestine, and if you will look at this drawing of a sheep's stomach, you will see at once that this is just what has occurred.

In place of a single, pear-shaped swelling or pouch in the course of the food tube, you find a most complicated-looking bag of four pouches or chambers opening into one another, the whole being nearly four times the size of the stomach of a dog of the same weight. But to remember the difference in the food is sufficient to explain this at once.

The dog, of course, under natural conditions lives almost entirely upon meat, which is quite a concentrated food and three or four pounds would make a fairly satisfying meal. A sheep, on the other hand, lives upon grass, leaves and hay with a little grain in the winter time, and these foods are extremely coarse and low in

nourishment-value. It would take from twenty to forty pounds of green grass to make a satisfactory meal for a sheep as against the three or four pounds of meat which a dog of the same size requires, so that just as a place to store food, the sheep's stomach needs to be much larger. Not only this but coarse hay and such foods are much harder to melt in the stomach, more difficult of

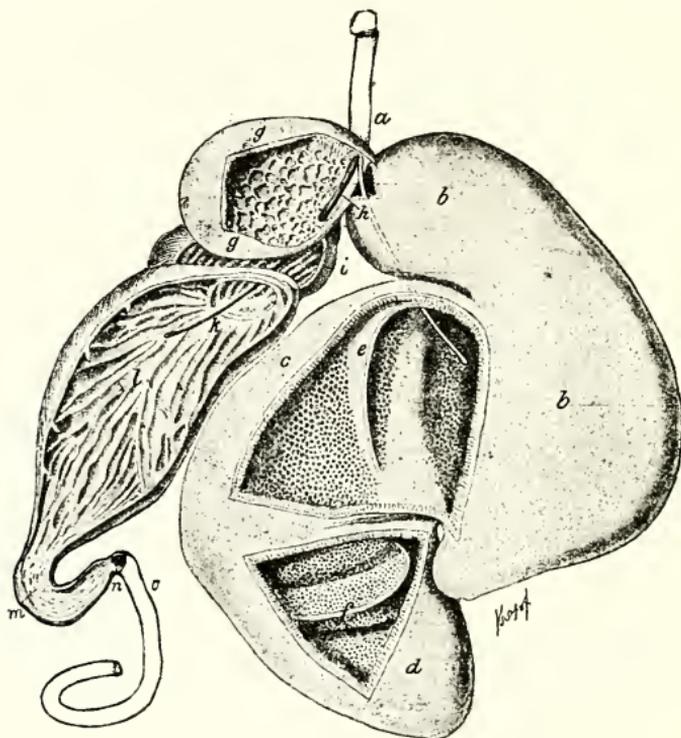


FIG 4.—STOMACH OF SHEEP. (From Oppel.)

a, Gullet *Esophagus*; *b, c, d*, the three subdivisions of the paunch, marked off from one another by the folds *e* and *f*; *g*, reticulum; *h*, œsophageal groove; *i*, psalterium; *k*, aperture leading from the psalterium into the abomasum (*l, m*); *n*, pyloric valve; *o*, intestine.

digestion; indeed, neither the dog nor ourselves could digest enough of them to live more than a few days upon a diet of grass, leaves or green vegetables, and this you see is matched by the numerous divisions of the sheep's stomach.

So hard of digestion is a grass diet, that it is not sufficient to bite it off, chew it and swallow it, but it has been found necessary to put it through the curious process of returning from the stomach to the mouth, to be carefully chewed or masticated a second time, and that is the meaning of the first or largest pouch at the right of

the sheep's stomach as you look at it, known as the paunch, which is simply a storage bag, where the grass and leaves, taken in by the sheep while grazing, can be stored until the animal has time to lie down in a quiet place and devote its entire attention to, as we say, "chewing the cud," or masticating carefully for a second time the food, as it is returned to it from the first pouch of the stomach. This is what is known as *ruminating* and has given the name *ruminants* to this class of animals. Curiously enough, from the fact that sheep and cows look so peaceful and meditative while they are going through with the second eating of their food which they seem to enjoy thoroughly, the term has actually been applied to the mental process in ourselves known as "thinking over things."

From this second grinding the cud is passed back through the second and third stomachs where it undergoes a sort of churning process and then passes into the last compartment of the stomach (to the left of the picture) which corresponds to almost the entire digestive stomach in the dog and in ourselves. Indeed if you will look closely you will see that it is nearly the same pear shape as the greater part of the dog's stomach.

Now let us turn to the small intestine. At first sight this appears entirely unchanged, but it looks somehow much more complicated and if we proceed to measure its length, we find that it is nearly three times that of the dog's intestine, that is to say, while this part of the food tube in the dog is from four to six times the length of his body, in the sheep it is from twelve to fifteen times the body-length, and this is only what we would naturally expect, when we remember that it has to deal with food that is much more difficult of digestion and consequently requires a longer absorptive surface to soak it up completely. The second or larger part of the intestine differs from that of the dog only in this same direction of being longer and slightly more complicated, to match the more watery character of the food. The shape and length of the food-tube in different animals match quite closely the character of their food, just in the same way as do their teeth. By looking at an animal's teeth you can usually tell quite accurately not only what sort of food he lives on, but also what sort of stomach and about what length of food-tube he has.

A curious proof of the close relation between teeth and food-tube is to be found in those toothless "animals" the birds. These, as you all know, have no teeth but simply a horny covering of the jaws known as a beak. In the birds of prey this beak is curved and sharp so as to be capable of tearing up the food to some extent,

but in the greater majority of birds, both those who live on grain and seeds, and those who live on insects, the beak is simply a quick-acting pair of pincers for picking up the corn and catching the insects, which are then swallowed whole.

How then is their food canal to manage food in large, hard pieces like this, which has never been ground by teeth before it is swallowed? As everywhere else in the animal kingdom, nature is ready with a substitute. Instead of teeth, moved by powerful jaw

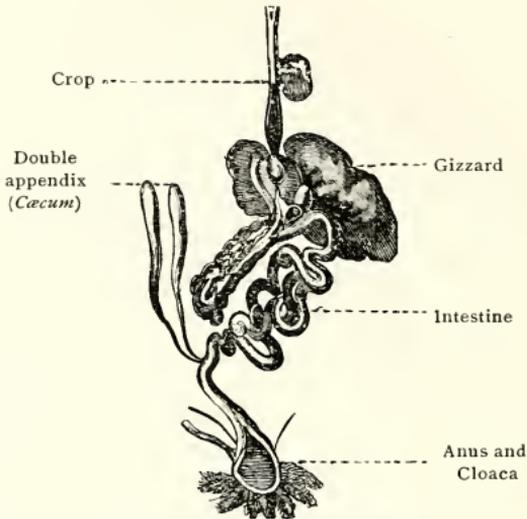


FIG. 5.—FOOD TUBE OF BIRD.
(From Holder).

muscles, developed at the *opening* of the canal to form a grinding apparatus, near the *middle* of it, just beyond or more exactly in the last portion of the stomach, we find a thick, hard globe, about the size of a walnut in a fowl, for instance, known as the gizzard. On cutting into this we find, little as it looks like it from the outside that it is really a pouch with immensely thick walls, made up of strong muscle and tendon and lined with a thick leathery, almost horny, layer. The small hollow in the center of the pouch is usually filled with bits of gravel and pebbles.

What can be the use of such a strange-looking structure as this? If you would clasp your two hands together as if you were about to wash them in imaginary soap and water, then drop into the hollow between the palms a piece of chalk, say, or a lump of hard clay, and rub it backward and forward between the palms, you will find that you can break it up into small pieces and gradually

to powder. If, however, you drop in three or four other small pieces of chalk or dry clay and especially one or two pieces of squarish bits of stone, or any small object with a rather rough surface and some corners on it, you will find that you can grind the clay or chalk into powder nearly twice as rapidly, and that you can even break up grains of corn, thin-shelled hazel-nuts and walnuts in this curious form of mill, and this is precisely the meaning and action of this tremendously thick-walled pouch at the end or "door" of the stomach.

The food is here ground into powder, *after* being softened and soaked in the crop and stomach instead of *before*, as in animals. Nature can make a grinding-apparatus at any part of the food-tube where it seems most desirable. With this exception and addition of a pouch-like swelling of the gullet, at the lower part of the neck, where food can be stored and soaked before being passed on to the stomach, the bird food-tube is practically the same as the animal's.

It matches the character of the food in precisely the same way, for in birds which live upon flesh or fish or soft bodied insects, the walls of the gizzard are extremely thin, because such food after being torn up by the beak needs comparatively little grinding and the length of the food-tube is short in proportion to that of the body. In the grain-eating birds on the other hand, its walls are extremely thick and strong, because their food cannot be properly melted for absorption until it has been ground, and the food-tube is long in proportion to the length of the body, just as in grass- and grain-eating animals. As an instance of how quickly a food-tube can adjust itself to change in the diet, it has been found that the gulls in the north of Scotland, which during one part of the year live largely upon grain and seeds, and another part of the year chiefly upon fish, grow a much thicker walled gizzard during the time that they are living on grain than they have in the other half of the year when they live upon fish. Curiously enough, in the ant-eaters, some armadilloes and other animals of that class, which have lost their teeth and hence are known as "edentates," the lowest part of the stomach has become greatly thickened and lined with horny plates almost exactly like a bird's gizzard.

As we have seen that our own teeth are intermediate between those of the flesh eaters and those of the grain eaters, although much nearer to the former than the latter, so our food canal is also intermediate between the two, although it is so little removed from that of the dog that nearly everything that we have said of the dog's food-tube is true of our own. Our stomach is a little larger,

on account of the larger amount of potatoes, vegetables and such like bulky foods that we eat, but its shape is almost exactly the same, and our food-tube, for the same reason, is about six times the length of our bodies instead of about five times as in the dog.

But we again come under precisely the same rules as the rest of our animal cousins in this respect, for negroes and other races of men living in warm climates where there is abundance of vegetable food, such as rice, bananas, yams, maize and fresh fruits, to be had the year round, and whose diet is in consequence more largely vegetable than that of our northern races, have added about another body's length to their alimentary canal. The same sort of lengthening has been proved to take place in the food-tubes of poor children in the city slums, who are fed upon coarse, innutritious and indigestible food. In them the canal may actually become ten or twelve times the length of the body.

It is said by some observers that the Esquimaux, in the frozen North, who are compelled by their climate to live almost exclusively upon animal food, and that very largely in its most concentrated form of fat or oil, have shortened theirs nearly a body's length.

You must not however conclude, from what we have seen of the shape of the dog's canal, that his food is or ought to be entirely meat or flesh. There are very few animals indeed that live absolutely and entirely upon a flesh diet. Those who take their flesh in the form of fish, such as the seals, some fishes, and the flesh-eating birds, are almost the only ones. Even when wild, although two-thirds or three-fourths of his diet consists of the flesh of animals and birds that he can capture, the dog also eats a certain amount of fruit during the season. Indeed the best place to find tracks of wolves, foxes and bears in the height of summer is in the patches of wild raspberries, wild cherries, salmon-berries and so forth, and later in the groves of wild plum trees. Some dogs will even go so far as to crack and eat nuts when they can find them, and nearly all these wild animals when captured, if given bread or sweet-stuff or even potatoes and carrots will eat them in fair quantities.

I dare say most of you have seen dogs biting off blades of grass and swallowing them, but this is not for food, merely their way of taking medicine for certain digestive disturbances. Since the dog has become domesticated, sleeps for the most part under cover, spends a good deal of his time in-doors and has only about half the need of exercise or the opportunity for it, that he had in the days when he would find his breakfast on foot, on waking in

the morning, he no longer needs such a concentrated, highly nourishing and stimulating diet as one of pure meat. Indeed, too much meat will seriously upset his digestion, and, fanciers assure us, give him that unpleasant "doggy" smell, which is the principal objection to his being received in the parlor, as a member of the family.

A diet consisting of a mixture of animal and vegetable foods, meat and bones with potatoes, rice, oatmeal, breads and biscuits of various descriptions will be found to be the best for his health under domestication, and though sugar forms but a very small part of his diet, when in a state of nature, only during the short fruit-season in fact, yet a small amount of it in his food is of great importance and one of our best known brands of dog biscuit owes part of its value to the fact that it contains sugar in the form of dates. In fact, so closely does the dog's alimentary canal correspond to our own that when he is brought under domestication and housed and "cityfied" as we are, he thrives best on almost precisely the same diet that we ourselves use. There is no better food for any dog than an abundance of household scraps, and dogs in kennels who are fed in large numbers, upon specially prepared and purchased foods, seldom thrive as well as those who get the "little-of-all-sorts" diet which any household scraps can give in perfection. As for the dogs and their cousins the bears, in captivity, a well-mixed diet, like our own, is found to agree with them far better than a purely animal one.

Of course here as everywhere else, the food fuel must be regulated according to the kind and amount of work required of it, and for hounds and other hunting dogs, setters, collies, and dogs that are used to draw carts and wagons, larger quantities, in proportion, of meat and larger total amounts of food are required, than in the case of pet and lap dogs of all sorts, or the ordinary city dog, who is confined for the most part to a small yard and has only an occasional formal run of an hour or so as an apology for exercise.

The more nearly vegetative a dog's existence becomes, the lighter and more vegetable should his diet be. In fact, some unfortunate little wretches of lap dogs, toy spaniels and pugs, can only be kept alive at all and in any temper short of fiendish, by cutting down the meat in their diet almost to the vanishing point. Some of them are kept by fanciers, when training for a particular beautiful coat of hair, for show purposes, upon a diet of toast, dipped in tea, or milk-and-water; shavings, instead of sea coal, under their boilers.