Notes on Ruminant Ecology and Evolution and Rumination

Although the nature of ruminant evolution is still disputed, current theory based on genetic analysis suggests that the abomasum is evolutionarily the oldest compartment, the rumen evolved some time after the abomasums, and the omasum is the evolutionarily youngest stomach compartment. In addition According to the *Journal of Dairy Science,* volume 93, issue 4, the first ruminants evolved about 50 million years ago and were small (<5kg) forest dwelling omnivores.
In contrast, the first marsupials and their digestive systems split from egg laying mammals about 120 million years ago.
Today there are almost 200 living ruminant species in 6 families. Wild ruminants number about 75 million, range from about 2 to more than 800 kg, and generally prefer at least some browse in their diets. Nine species have been domesticated in the last 10,000 years. Their current combined population numbers 3.6 billion. In contrast to wild ruminants, domestic species naturally prefer at least some grass in their diets, and are of large body weight (BW; roughly from 35 to 800 kg), and excepting reindeer, belong to one family (Bovidae).

This portion of *The Grazing Academy* will compare some of today's common digestive systems and the look more closely at ruminant digestion in our domesticated species.
Ruminants take their name from the important digestive process called rumination that allows for rapid ingestion of feed and completion of chewing at a later time.
There are four steps to the rumination process: regurgitation, remastication, resalivation, and reswallowing. In cattle, rumination occupies up to 8 hours of the day, with one rumination cycle requiring about one minute. Recently ingested feed particles are first regurgitated via reverse peristalsis in the esophagus. Excess feed is then squeezed out and swallowed, leaving a bolus of roughage remaining in the mouth. This material is then remasticated, causing resalivation of the material. This resalivation is very important and necessary to provide adequate buffers for the rumen environment in the form of urea to maintain an appropriate pH level for both the animal and the microbes in the rumen. The material is then reswallowed and the process begins again.

As we will see in the videos shown in this portion of *The Grazing Academy* the basic anatomy of the ruminant digestive system is very different from all other mammals and is especially designed to digest foods high in cellulose.

The first portion of the ruminant digestive system (before the intestines) is divided into four parts: reticulum, rumen, omasum and abomasum. The term "four stomachs", when referring to ruminants are technically incorrect.

The reticulum is the most cranial compartment; its walls are lined with mucus membranes with subdividing ridges that form a honeycomb-like pattern. The walls secrete no enzymes, instead the reticulum functions in moving ingested feed into the rumen as well as initiating regurgitation during rumination.

The rumen is the next compartment encountered by the ingesta; it is the largest of all the compartments as it extends from the diaphragm to the pelvis and almost entirely fills the left side of the abdominal cavity. The walls of the rumen are covered in small tongue-like structures called papillae which serve to increase surface area for microbial growth and increase absorption of nutrients. The rumen functions as a fermentation chamber to allow the breakdown of cellulose of forages via microbial action. The rumen environment is ideal for the microbes, as it is moist, warm, anaerobic and of desirable pH; in return for a good home, the microbes provide the ruminant with volatile fatty acids, water soluble vitamins, vitamin K and high quality protein. A byproduct of this fermentation is large amounts of gases such as carbon dioxide and methane, which are normally removed from the body via eructation.

The omasum is the third portion of the system that ingesta pass through in the ruminant. It is spherical in shape and located to the right of the rumen and reticulum, as well as being the smallest of the four compartments. The inside walls are covered in muscular laminae that are studded with short papillae. Again, there is no secretion of enzymes by this organ, which functions mainly in absorption of excess water and reduction of particle size.

The abomasums is the final compartment of the system, and is the first section that secretes enzymes. It is structurally and functionally very similar to the "true stomach" of monogastrics.

From the abomasums the ingesta passes into the small intestine and then to the large intestine. These organs function much like other mammals as we will see in the video