

GENERAL SCIENCE NOTES

DO RABBITS CHEW THE CUD?

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WHAT THIS ARTICLE IS ABOUT

This is an example of a purported error in the Bible. Leviticus 11:6 states that the hare chews the cud, while scientific information is generally believed to dispute the statement. However, there are more recent findings regarding the digestive patterns of the hare. Like the cow, it has a fermentation chamber with microorganisms to digest plant material. The hare and others of its type produce two kinds of fecal pellets; one kind is reingested and temporarily stored in the stomach until redigestion takes place, thus increasing the efficiency of food intake. This is quite similar to what goes on in the cud-chewing animals, like the cow, except that travel of the partially digested food is outside the body instead of a reverse internal pattern as found in the cow.

Leviticus 11:6 is sometimes used as an example of an error in the Bible; it states that hares chew the cud. Hares are not usually known as cud-chewing, or ruminating, animals. Is this really an error in the Bible, or did Moses know what he was talking about?

When a cow swallows a mouthful of grass, it goes first of all to one compartment of the stomach referred to as the rumen. The culture of microorganisms that exists in the rumen digests the grass and converts much of it into nutrients which the cow can utilize. Then the cow brings the microorganisms and leftover grass back to her mouth, one mouthful at a time. She chews it and sends it on through the rest of her digestive tract. Thus the cow really doesn't subsist directly on grass alone, but also on the protozoa and bacteria that she breeds in her rumen (Carles 1977).

The process of digestion of grass by microorganisms is referred to as fermentation, and it occurs in many other animals besides the cloven-hoofed ruminating animals. Special forestomachs for fermentation are also found in kangaroos, whales, dugongs, hippopotamus, sloths, and colobid monkeys (McBee 1971). Other modifications of the stomach or some part of the intestines to provide a fermentation chamber are found in rodents, rabbits and hares, gallinaceous birds, horses, hyrax (McBee 1971), and in mallards (Miller 1976).

Some herbivorous animals consume part of their own feces, thus recovering fermentation products that have passed through the digestive tract. This process of reingestion of feces occurs in many rodents (Thacker & Brandt 1955) and in all genera of hares and rabbits (Carles 1977, Hamilton 1955, Kirkpatrick 1956, Lechleitner 1957, McBee 1971, Myers 1955, Southern 1940, Watson 1954, Watson & Taylor 1955). Reingestion of

feces is an especially well-developed practice in Lagomorphs (rabbits and hares) and is important for their adequate nutrition.

Lagomorphs produce two kinds of fecal pellets which are produced at different times during the day. When the animals are active and feeding they produce the familiar hard pellets. When they cease their activity and retire to their burrows or resting areas, they begin producing soft pellets which they eat as soon as they are passed (Myers 1955). Rabbits reingest 54-82% of their feces (Eden 1940), which they apparently swallow whole, without chewing (Watson 1954). The soft pellets are composed of material from the fermentation chamber, which in the Lagomorphs is located in the cecum, a blind pouch at the beginning of the large intestine (McBee 1971). The soft pellets are composed mainly of bacteria, mixed with some plant material, and each pellet is enclosed in a proteinaceous membrane secreted posterior to the colon. These tough membranes remain intact for at least six hours after reingestion. When swallowed they pass to the fundus portion of the stomach, where they remain for several hours (Griffiths & Davies 1963). Other food that is swallowed moves past the accumulation of soft pellets and goes on through the digestive tract. The membranes around the pellets and a buffering solution in the pellets control the pH, so that fermentation continues in the pellets even though the rest of the stomach is acid (Griffiths & Davies 1963).

The process of cecal fermentation and reingestion helps the rabbit in several ways. Amino acids and proteins are synthesized by the bacteria in the cecum, using nonprotein nitrogen (perhaps urea). Amino acids are absorbed directly through the walls of the cecum and provide 4.4-21.8% of the animal's daily energy requirement (McBee 1971). Proteins synthesized in the cecum are carried to the stomach in the soft pellets. This protein is important to the nutrition of the rabbit. Experiments have shown that "nitrogen balance in the rabbit was reduced 50% if soft feces were not eaten" (McBee 1971). Fermentation and reingestion also improve utilization of sodium and potassium and provide 83% more niacin, 100% more riboflavin, 165% more pantothenic acid, and 42% more vitamin B₁₂ than would be available if soft feces were not consumed (McBee 1971, Myers 1955).

Is this special digestive process analogous to the rumination, or cud-chewing, in cows? There are both similarities and differences between the two processes. The rabbits are different in that they do not have a four-part stomach with a rumen, and the material that reaches their fermentation chamber has already been chewed and partially digested. Cows and rabbits are similar in that they both have a fermentation chamber with microorganisms that digest otherwise indigestible plant material and convert it to nutrients. Some of the rabbit microorganisms are different from those in cows, but many of them are the same or similar (McBee 1971). Both cows and rabbits also have a mechanism to pass the contents of

their fermentation chamber back to the mouth and then on through the digestive tract.

Madsen (1939) wrote an article entitled “Does the Rabbit Chew the Cud?” Southern (1940) concluded that reingestion has an advantage to the rabbit “equivalent to ‘chewing the cud’.” Griffiths & Davies (1963) concluded that “we consider that the fundus of the rabbit stomach, loaded with soft pellets, is analogous to the rumens of sheep and cattle.”

Carles (1977) compared cows and rabbits and reached the conclusion that rumination should not be defined from an anatomical point of view (the presence of a four-part stomach), but rather on presence of an adaptation for breeding bacteria to improve food. On this basis he stated that “it is difficult to deny that rabbits are ruminants.”

What is the correct explanation for Leviticus 11:6 — is it an error in the Bible, or is it evidence that Moses had a source of information far ahead of his time? Since rabbits and hares have a process that is so similar to cow rumination that it becomes a question of the technicalities of one’s definition of rumination, it would be difficult to justify interpreting Leviticus 11:6 as an error in the Bible.

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