PREPARATION OF THE FOETAL COMPOUND STOMACH
AS AN AID IN THE TEACHING OF RUMINANT
NUTRITIONAL PHYSIOLOGY

ELLIOTT LEE HIX

Kansas State College

THE nutritional physiology of the ruminant compound stomach has come into a new era, and the research of the experimental animal husbandman, phsiologist, biochemist, and bacteriologist has put a new face on modern concepts of rumen physiology (Elsden and Phillipson, 1948; McCandless and Dye, 1950; Kesler et al., 1951; Parrish and Fountaine, 1952).

Early studies of the topographical anatomy of the ruminant stomach (Cordier, 1894; Sisson, 1923; Lagerlof, 1928) and of the dynamic factors (Schalk and Amadon, 1928) have more recently been confirmed (Lambert, 1948; Grossman, 1949) and the dynamic factors extended and clearly demonstrated (Wise and Anderson, 1939; Hale et al., 1940; Danielli et al., 1945; Phillipson, 1947).

Of great practical importance to the animal nutritionist and physiologist is the means by which the ruminant derives its nutriment from the coarse fodders comprising its diet (Marston, 1939; Phillipson, 1942; Phillipson and McAnally, 1942; Barcroft et al., 1944), the intermediary metabolic processes (Gray, 1948; McCandless and Dye, 1950), and the activities of the rumen microflora (Hastings, 1944). A recent review by Huffman (1953) deals with many aspects of the compound stomach.

The teaching of ruminant nutritional physiology to graduate and undergraduate students of animal husbandry, nutrition, physiology, and allied fields of study can be quite difficult and entirely confusing to the student without the aid of a three-dimensional animated prototype of the compound stomach. Furthermore the undergraduate student is likely to be more utilitarian in his attitude as his precepts are directed by the desire for practical knowledge, failing completely to appreciate the full significance of the fundamental physiologic nature of the ruminant. No amount of didactic instruction, however forcefully it may be presented, is apt to change this attitude.

Since the undergraduate students concerned have time in the normal course of their studies for the acquisition of only elementary knowledge

1 Contribution No. 196, Department of Animal Husbandry, Kansas Agricultural Experiment Station, Manhattan.
2 Present Address: Department of Pharmacology, KCOS, Kirkville, Missouri.
of anatomy, chemistry, and physiology, the demonstration aid simplifies and replaces extensive discussion. The purpose of this paper is to describe a method of preparing a compound fetal stomach as a teaching and in ruminant nutritional physiology.

Preparation of the Stomach

The bovine foetal stomach of 175 to 195 days of prenatal development is prepared because of its desirable size. The tissues and vascular system at this stage of development are completely differentiated and well developed, and the proportionate size of the four compartments is approximately comparable to that of the adult ruminant stomach.

The stomach is dissected from the foetus along with about an inch of esophagus and an inch of duodenum, the contents are washed out thoroughly with warm tap water, and the stomach is placed in strong formalin solution (5 percent) for hardening. After several days in formalin the stomach is washed again with warm water and injected, first through the esophagus and later through the duodenum, with paraffin wax (m.p. 50–57 degrees C) preheated to a temperature of 85–90 degrees C. A large 50 ml pyrex syringe and large bore hypodermic needle are used for the injection. Immediately after the injection of the paraffin, the stomach is held under cool running tap water to hasten the setting of the wax. Manipulations at this time and application of pressure forces the paraffin evenly into all compartments and molds the stomach in the natural desired proportions. Slight hardening of the tissues by the previous formalin treatment reduces the elasticity of the stomach compartments so that their natural proportions are attained easily. Small "bull dog" haemostats are used to close off the esophagus and duodenum to prevent leakage of paraffin during the manipulation. Air pockets sometimes develop but are easily removed by puncturing with a small gauge needle and followed by injection of paraffin. Air pockets must be removed before further treatment.

After the stomach has been shaped properly and the paraffin has set, it is dried thoroughly in the absence of heat. This causes the tissue to shrink tightly around the paraffin producing a smooth surface. The dried stomach is then freed of external fat and any adhering tissue. To preserve the stomach and render it more resistant to handling, a heavy coat of banana oil-cellulose acetate in acetone is applied. A second coat is applied to give the stomach rigidity and permanence of form, and consists of a mixture of 50 percent cement (colorless and

---

8 A similar product can be purchased at any hobby shop. It is commonly referred to as "clear dope", manufactured by Testor Chemical Company, Rockford, Illinois.
transparent when dry) and 50 percent banana oil-cellulose acetate in acetone. Any number of coats may be applied in order to achieve the desired thickness; however, two coats will give a thickness of approxi-

Figure 1. The prepared and mounted foetal bovine compound stomach of 180 days prenatal development. The stomach is mounted in its natural position supported on 1/16th inch steel wire and balsa wood base. Clearly visible is the rumen, reticulum, omasum, and abomasum or "true stomach" which constitute the four anatomically distinct compartments of the ruminant stomach. The honeycomb structure of the reticulum, the lamella of the omasum, the several folds in the abomasum, and the relationship of the esophageal groove (E.G.) to the several compartments is also observab

mately 1/64th inch and provides an excellent protective shell sufficient to withstand severe handling.

Any fat present in the fibroelastic tissue covering the stomach will be solubilized by the acetone vehicle and on drying the fat will be incorporated in the cellulose acetate coating in such a manner as to expose it in a permanent white cover. This effect can be observed in figure 1. While this tends to give the stomach a more normal appear-
ance, and in itself is not too objectionable, it does cover up many of the underlying structural features. To avoid this the fat is extracted with diethyl ether. After hardening the stomach in formalin it is washed with water, placed in 500 ml of ether, and allowed to stand for 18 hours. The stomach is then injected with paraffin as indicated. This procedure is to be recommended as it increases the transparency of the stomach tissue and more clearly exposes the structural features.

The prepared stomach is mounted on a balsa wood base using steel wire as illustrated in figure 1. External details may be added to a degree commensurate with the level of instruction for which the stomach is to be used. The stomach has a glossy appearance; the protective cement-cellulose acetate shell is completely transparent and rigid; the tissues are preserved indefinitely in their natural state; and unlike most prepared biological specimens, the stomach has a pleasant aroma.

**Summary**

A method for the preparation of the foetal compound stomach as a visual aid in ruminant nutritional physiology is described. The method consists briefly of hardening the stomach in formalin, filling it with paraffin, and applying several coats of cellulose acetate in acetone and a cement-cellulose acetate mixture. The preparation preserves the stomach tissue in its natural state for an indefinite period, lends rigidity to the stomach, and renders it resistant to frequent handling.

**Literature Cited**


