Evaluation of Fertility in the BULL and BOAR

JOHN B. HERRICK
and
H. L. SELF

Evaluation of Fertility

in the

BULL and BOAR

JOHN B. HERRICK, B.S., M.S., D.V.M.
Extension Veterinarian
Professor of Veterinary Obstetrics
Iowa State University

H. L. SELF, B.S., M.S., Ph.D.
In Charge, Outlying Experimental Farms
Animal Husbandman (Reproduction)
Iowa State University

Iowa State University Press, *Ames,* **Iowa, U.S.A.**

DR. JOHN B. HERRICK is well known to professional men and to livestock men as well, for his duties as extension veterinarian and professor of veterinary obstetrics at Iowa State University. He is also veterinary editor for the *Artificial Insemination Digest* and has served as staff editor for the *Veterinary Journal*, veterinary editor for the *National Livestock Producer*, and has authored many articles. Following his B.S. degree in vocational agriculture, Dr. Herrick earned his D.V.M. degree in 1946 and M.S. degree from Iowa State in 1950. He has published more than 50 articles dealing with the diseases of cattle in various veterinary journals and farm magazines. In addition to presenting many papers at veterinary meetings in various states, he was invited to present a report at the Veterinary Congress in Madrid, Spain, in 1959. He has served as a member of the National Brucellosis Committee for many years, and on the National Grub Committee, the National Mastitis Council, and as veterinary advisor in the National Association of Artificial Breeders. During 1960 he was advisor to the veterinarians in Argentina concerning the problems of reproduction in cattle. His record includes membership in the American Veterinary Medical Association and presidency of the Iowa State Veterinary Medical Association.

DR. H. L. SELF has been in charge of Outlying Experimental Farms of the Iowa Agricultural Experiment Station since 1960. He is recognized for his continuing research on the effects of management and environmental factors on meat animal production. A graduate of Texas A & M College, he earned his M.S. at Texas Technological College and the Ph.D. degree at the University of Wisconsin in 1954. He accepted an assistant professorship at the University of Wisconsin where he was involved in swine research dealing with physiology of reproduction, genetics, carcasses, artificial insemination, and nutrition. He came to Iowa State University as a swine extension specialist in 1959. In 1960 Dr. Self was placed in charge of Outlying Experimental Farms of the Agricultural Experiment Station for continuing research on the effects of management and environmental factors on meat animal production. Dr. Self has participated in state, regional, national, and international conferences and symposiums on reproduction and artificial insemination of swine. He is a member of the American Society of Animal Science, Sigma Xi honorary fraternity, and Phi Sigma honorary society.

Library of Congress Catalog Card No. 62-16490

Introduction

INCREASED NEED for the evaluation of fertility in sires has promoted greater interest in this subject by research personnel and practicing veterinarians. Such an evaluation is needed by breeders of livestock, both purebred and commercial, for prospective herd sires in order to minimize chances of losing a crop of offspring. In many cases the animal in question is a young male without a breeding record, so pregnancy diagnosis in females served is not possible. Thus, an opinion regarding potential fertility of the male is often confined to observations made only on the male in question.

Individual tests or any series of tests used in evaluation of male fertility may not be completely reliable, but collectively they do provide an aid to the veterinarian in arriving at a fertility evaluation. This evaluation plus early recognition of complete sterility in a male can be of great economic benefit to the breeder.

Economic efficiency in livestock is determined by the reproductive performance in individual herds. Many livestock producers overlook this standard of herd efficiency. Historically, a great deal of emphasis has been placed on phenotype evaluation in the livestock industry, but more recently performance testing has become an integral part of most cattle, sheep, and swine improvement programs. As the trend continues toward use of sires that have been production tested, it becomes increasingly important that males with superior production traits also be efficient from a reproductive standpoint. The financial investment involved does not allow a producer to wait for a time-consuming progeny test to determine fertility of a potential herd sire. Fertility tests and clinical evaluations can be used to estimate breeding efficiency in individual animals and to a certain extent in families. It is recognized that such a classification is not always exact, but it provides more reliable evaluation than is presently available from other procedures.

The evaluation of fertility, in a strict sense, is an evaluation of the normal character of the semen, especially the spermatozoa and the ability of the latter to unite with a normal ovum to form a zygote capable of surviving the periods of gestation and parturition as a "normal" individual. In a general sense, fertility evaluation is an over-all evaluation of the sexual health and physical well-being of a male. This helps to determine whether he is a vigorous breeder and whether he may transmit infectious organisms to the female. Although individual observations and the case history may be singly unimportant when recorded systematically (see chart in appendix) in an over-all examination, they provide a basis for a useful evaluation as to the breeding and physical soundness of the male.

Contents

1. Production of the Male Germ Cell —A Brief Review

SPERMATOGENESIS – development of the spermatozoa – starts with the primordial germ cells or gonocytes. The exact embryological origin of these primordial cells is still a subject for academic discussion, but it is agreed that they converge on the gonadal area, where they multiply and after some months develop into spermatogonia. Further divisions of the spermatogonia result in cells termed primary spermatocytes. Each primary spermatocyte divides into two cells called secondary spermatocytes. These give origin to the spermatid (spermatoblast) which transforms into sperm or spermatozoon. This latter process is called spermiogenesis. The time necessary for development of a mature spermatozoon from a spermatogonium is estimated at 20 days in the rat and much longer in some other species, possibly from 40 to 50 days in the bull, boar, and ram. Research indicates that 49 days, 42-45 days, and 39 days are required to complete the entire process of producing spermatozoa in the bull, ram, and boar respectively.

The entire developmental phase of the spermatozoa takes place in the wall of tubes that form a network in

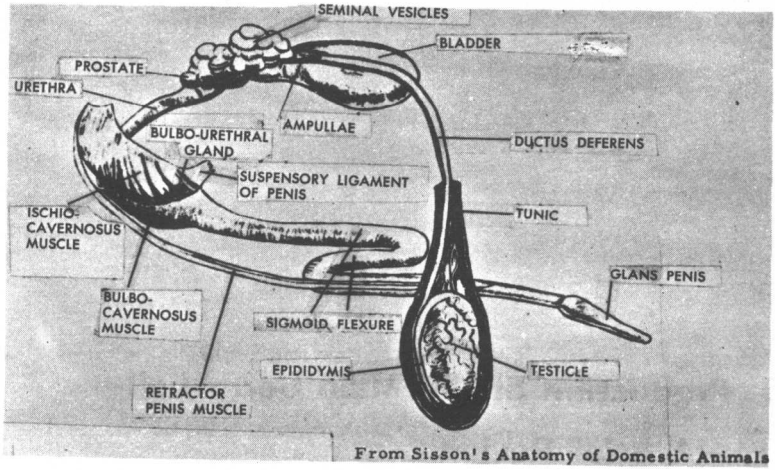

Fig. 1.1. Male reproductive organs.

the stromal portion of the testes. These tubes are called seminiferous tubules, and they converge and join together at the apex of each lobule of the testes as efferent ducts called the rete testes. Spermatozoa are transported from their respective areas of origin in the seminiferous tubules through a dozen or more efferent ducts. These ducts then enter the epididymis, an oblong, soft mass of compressed tubules attached to the top of the testis and extending along the front or top side of the testicle. The ductus deferens, which constitutes part of the spermatic cord, leads from the caudal portion of the epididymis, crosses the ureter, and empties into the lumen of the urethra. Immediately prior to this latter junction, the ductus deferens enlarges into a fusiform enlargment called the ampulla. The size and role of the ampulla vary by species, being larger and more important in the bull than in the boar. Proceeding distally a short distance along the canal from the ampullae, bilateral invaginations of the ductus deferens are found. These are the seminal vesicles. The ductus deferens then pierces the prostate in such a manner that the prostate forms a "collar" in the shape of a horseshoe or doughnut around the urethral canal. The bulbo-

urethral glands are located distally from the prostate and empty into the posterior part of the pelvic urethra. The male reproductive organs are illustrated in Figure 1.1.

The spermatozoa are nonmotile while in the seminiferous tubules and the epididymis. They are moved through the efferent ducts with the aid of cilia and a small quantity of liquid. Spermatozoa removed from the epididymis are observed to have protoplasmic droplets on the middle piece or the proximal portion of the tailpiece; however, the majority of these droplets disappear during the "maturing" that occurs while the sperm are held in the epididymis and before the spermatozoa are ejaculated. Spermatozoa are stored in the epididymis for some time, and it is here that maturation occurs, resulting in loss of the protoplasmic droplets mentioned above. The exact significance or function of these droplets is not clearly understood at present.

2. Erection and Ejaculation

ERECTION of the penis occurs as a result of stimulation of the nervi erigentes, which is composed of parasympathetic fibers from the second and third sacral nerves. Current concepts of the mechanism of erection are based on two phenomena: (1) expansion of arteries and contraction of the corresponding venules, both under nervous control, thus causing additional blood to enter the corpus cavernosum penis and allowing less blood to leave, and (2) compression of the dorsal veins of the penis against the ischial arch by the ischiocavernosus muscle, thus again limiting the venous flow of blood from the penis.

When spermatozoa are forced into the urethra under stimulus of copulation, secretions of the ampullae and the accessory glands are instantaneously added. The total fluids from all these sources are then designated by the term semen.

Emission of semen is initiated by stimulation of the glans penis. The stimulus is received by the internal pudendal nerve and is produced by a combination of temperature, pressure, and gentle friction within the genital tract of the female. Delivery of semen into the

male urethra from the several glands is due to a sympathetic response via fibers in the hypogastric plexus. This response results in the chain of events leading to the emission of semen which is referred to as ejaculation.

In the ejaculation process, spermatozoa are mixed with the accessory gland secretions as the enlarging mass of fluids moves through the urethra and past the orifice of each accessory gland. Secretions from the seminal vesicles and prostate are added before the mixture enters the urethra. The bulbo-urethral secretions are deposited in the pelvic urethra.

When erection occurs, secretions that contain few sperm may be observed during early phases of sexual excitement. These secretions are thought to originate in the bulbo-urethral glands. Prostatic secretions may be observed in early phases of ejaculation in both the bull and boar. These are followed by sperm-rich portions of the ejaculate. However, the pattern of ejaculation is not discretely uniform, even among ejaculates from the same male. The contribution of the seminal vesicles varies among species. These glands produce voluminous quantities of accessory fluids in the boar, but relatively minute quantities in the bull. In some animals the seminal vesicle secretions follow the sperm-rich portion of the ejaculate, but apparently accompany the sperm-rich portion in the bull. In the boar the distribution of citric acid in the ejaculate indicates that the seminal vesicular fluids are present to varying degrees throughout the entire ejaculate (Bialy and Self, 1959). Spermatozoa constitute about 10 per cent of total volume of the ejaculate in the bull and ram and less than 5 per cent in the boar.

Spermatozoa are transported from the epididymis, through the ductus deferens, and into the urethra. Simultaneously, stimulation causes the accessory glands to contract, thus forcing their secretions into the canal where they become mixed with the spermatozoa. Duration of coitus is short for the bull, ejaculation occurring

when the "thrust" is made. Stimulation appears to be due more to temperature of the genital tract than to friction or pressure; thus, temperature of the water in an artificial vagina for bulls is of primary importance. On the other hand, a boar requires an average of 7 to 9 minutes to complete a service, with the range of time extending from 3 to more than 20 minutes. In contrast to the bull, the boar's penis seems to be relatively insensitive to temperature, but does respond to pressure or a firm grip on the glans penis.

Reflex stimulation as obtained with an electro-ejaculator will cause ejaculation in the bull and ram, but has not become a routine technique for collecting semen from boars.

3. Steps in Fertility Evaluation

THE FOLLOWING ORDER is suggested so that examination can proceed in an orderly manner.

1. Prepare and have readily available the Data Recording Sheet and the equipment necessary to complete all phases of the evaluation. (See Long Form, page 112, for sample Data Recording Form.)
2. Obtain a complete history of the individual animal in question and determine the general health situation of the herd of origin (also the present herd, if different from the herd of origin).
3. Obtain samples of preputial fluids from bulls for trichomonad and *Vibrio fetus* examination in the laboratory. This should be done prior to semen collection.
4. Collect and evaluate semen immediately by its gross macroscopic appearance and soon thereafter with respect to microscopic characteristics of the spermatozoa.
5. Collect blood samples for serological studies.

6. Test for tuberculosis and Johne's disease in bulls.
7. Complete the general physical examination.
8. Recheck all forms to ascertain that data have been accurately and completely recorded.

4. Methods of Collecting Semen

EVALUATION of semen is dependent upon obtaining a sample as representative as possible of a normal ejaculate. Samples obtained in any fashion deviating from the normal method of ejaculation may be misleading. This fact must be constantly kept in mind when evaluating semen.

Various collection techniques have been employed for a number of years. An artificial vagina or an electro-ejaculator properly used will give satisfactory results in the bull and ram. However, as stated previously, the electro-ejaculator is not entirely satisfactory for boars. Brief descriptions of several methods that have been used with varying success follow.

MASSAGE TECHNIQUE

Gentle massage per rectum of the accessory sex glands of the bull, particularly the seminal vesicles and ampullae, will release seminal fluids into the prepuce in some animals. In some bulls massage will also cause sufficient erection of the penis to obtain extension beyond