

THE EFFECT OF ISOLATION ON THE BREEDING
HABITS OF BOARS

by

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A THESIS

submitted to


OREGON STATE COLLEGE

in partial fulfillment of
the requirements for the
degree of

MASTER OF SCIENCE

June 1956


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Date thesis is presented May 10, 1956

Typed by Sylvia Elliott

ACKNOWLEDGMENT

The writer is deeply indebted to the members of the staff of the Department of Animal Husbandry at Oregon State College for advice and assistance rendered. Special appreciation is extended to Dr. F. F. McKenzie, Head of the Department of Animal Husbandry, for his advice and assistance in conducting this study and for his critical reading and helpful suggestions in the preparation of this thesis. Thanks are expressed to T. K. Johnson, swine herdsman, and Allen F. Anglemier for their assistance and suggestions on the care and management of the boars.

Finally, the writer expresses his indebtedness to his fiance, Miss Sylvia Rae Elliott, for her patience and assistance in the preparation and final typing of this thesis.

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THE EFFECT OF ISOLATION ON THE BREEDING HABITS OF BOARS

INTRODUCTION

The problem of fertility in farm animals has for a long time been the subject of much research and observation. Various phases and aspects of the problem have been studied; hormonal, genetic and behavioral studies have been conducted. One aspect of behavior which has not been investigated by animal breeders as thoroughly as other aspects is the effect of experience or prepuberal play on the future breeding ability of young animals. Perhaps the more immediately recognizable aspects of fertility have been responsible for this. Or perhaps this aspect was thought to be nonexistent. At any rate, up to the present time, it has not been a major area for investigation in the field of animal science.

On the other hand the distinction between instinct, or innate behavior, and experience, or learned behavior, has been the subject of much study by psychologists. Among these "instinctive" factors which have been investigated by psychologists is the reproductive act. Much has been done in the field of comparative psychology to

determine to just what degree the copulatory act is learned and to what degree it is innate.

Craig (12, pp. 121-133) in 1914 reported on male doves raised in isolation. He recorded their behavior in breeding situations and made notes of other sexual actions. In 1922 and 1923 Stone (34, pp. 95-153 and 35, pp. 469-473) raised young male rats in isolation. He recorded their breeding ability as normal animals and as desensitized and decorticated animals. In 1926 Stone (38, pp. 73-83) reported on the breeding habits of isolated female rats. Louttit (22, pp. 247-265, 23, pp. 293-304 and 24, pp. 305-315) in 1927 experimented with the sexual patterns of male and female guinea pigs raised in isolation. A considerable amount of research has been done on the subject by Beach (3, pp. 457-472 and 4, pp. 121-136) since about 1940. He raised male rats in isolation and reported on their sexual behavior with receptive females. Most recently Young and his associates (41, pp. 162-165 and 42, pp. 397-403) have conducted a series of experiments dealing with the effect of experience on mating behavior of guinea pigs.

These various experiments along with those of other investigators have shed some light on the problem. However the results of the various investigations have shown variation when the same species has been dealt with. There

are indications that there is a great deal of species variation also. There even seems to be quite a difference between strains of the same species and between individual animals. As yet, none of the investigators have conducted experiments with any of the larger farm animals.

In an effort to gain information that may be useful to animal science on the problem of fertility, this experiment was undertaken. It was decided to use male animals, since their part in the sexual acts seems to require more physical effort than does the part of the female. Pigs were chosen as the subject animal, since their prolificacy enabled the use of closely related animals of the same ages in order to reduce variables. Furthermore, their capacity for rapid growth and early maturity made the study less time consuming.

Of course, this is just the beginning, and it should lead to further observations of other farm animals. The problem has many aspects which are not yet clear.

HISTORY

Early Work

Since most of this work has been done in the field of comparative psychology, it has been necessary to obtain most of the literature from psychology journals; some information was also available in books dealing with animal fertility and in physiology journals.

An early study in this area has been presented by Craig (12, pp. 121-133). In his report on the observation of male doves raised in isolation, he has stated that the sexual reaction of the male is innate in origin, but the stimuli for eliciting this behavior is learned through experience. He reported that when the doves were only in contact with human beings, the sexual act was often directed at some part of the attendant even though a receptive female was present. He observed that once the animals had copulated, they seemed to adapt quickly. Both instinct and experience played a part, but instinct was the most important, and learning, according to Craig, only served to facilitate the instinctive act.

About this same time, Shepard and Breed (31, pp. 274-285) in an experiment on the pecking instinct of chicks came to the conclusion that maturation is a key factor in the development of an instinct.

Stockard and Papanicolaou (33, p. 229) in a study on breeding of guinea pigs in 1919 reported that a male isolated from females for a long time would invariably try to mount and copulate when placed with a female regardless of whether or not she was receptive.

In 1922 Rogers (29, pp. 21-51) removed the cerebral cortex in a group of pigeons in an effort to determine if that part of the brain was the site of mating behavior instinct. He found that the birds soon began to mate normally, but it seemed as if they had to relearn the mating procedure.

The Work of Calvin P. Stone

Calvin P. Stone (34, pp. 95-153) in 1922 reported on the effects of isolation of a group of young male albino rats. However, these animals were put with other individual animals from time to time to test their developing sexual responses. He concluded that play activities do not preclude the larger sexual activities and that the copulatory act of the young male is nearly indistinguishable from that of the older male.

Stone (35, pp. 469-473) again tested rats raised in isolation and normal rats and found that they all copulated on the first attempt and that they would copulate even after being completely desensitized.

In work with rabbits (36, pp. 430-435 and 37, pp. 372-385) Stone found that neither the loss of the sense of smell nor the loss of two-thirds of the cerebral hemisphere affected copulatory ability.

Again Stone (38, pp. 73-83) tested prepuberally isolated rats, this time females, and again they mated normally. Thus, it would seem from Stone's observations that copulatory ability is instinctive and not learned and that the role of sensory stimuli is not known.

The Work of C. M. Louttit

Soon after Stone's work, a series of experiments was conducted by Louttit (22, pp. 247-265, 23, pp. 293-304 and 24, pp. 305-315) in which he observed the reproductive behavior of guinea pigs. He tested pairs of guinea pigs which had been raised in isolation by putting them together before the age of appearance of sexual aggressiveness. These animals showed the same degree of sexual development in their activities on the first day of association as did normal control animals which had been living in co-habitation. He concluded that the amount of previous association with animals of its own kind does not affect the age of appearance of various responses. He also concluded that maturation was of greater importance than association or experience in the development of reproductive behavior.

The Work of Frank A. Beach

The work of Beach began in the late 1930's and since that time he has contributed much material on the problem of instinctive behavior. Beach (2, pp. 225-262) has stated that instinctive behavior may be modified by experience, especially in the cases of more intelligent individuals. In one experiment (3, pp. 457-472) he raised male rats in isolation and then subjected them to partial decortication. Among other data he recorded were the number of copulations, copulatory attempts, male's responsiveness to receptive females, and atypical attempts to copulate. He observed that the rats raised in isolation and subjected to partial decortication reacted quite comparable to experienced rats which had been partially decorticated. He found also that the percentage of post-operative copulators in both cases was inversely related to the amount of cortex which had been removed. Males which were raised in isolation and which copulated were no different from experienced males in their sexual behavior.

In another test, Beach (4, pp. 121-136) compared the copulatory behavior of rats raised in isolation, co-habitation, and segregation; the isolated animals were in individual cages, the cohabitators in mixed groups of males and females, and the segregated in like-sex groups. He found that the highest proportion of copulators was among

the isolated animals with the cohabiters second and the segregated males third. He reported that the majority of the isolated males copulated perfectly in the first attempt and were much more responsive to the females than the other two groups of males. The isolated animals also started to copulate earlier in the tests than did the other two groups. Beach gave two reasons for the high score of the isolated group. First, he attributed the high rating to greater excitement due to the novelty of contact with another animal. The other reason was that the isolated animals were heavier. The copulators in each group were heavier than the non-copulators. He concluded that the relative inactivity of the segregated males may have been due to homosexual tendencies.

To determine the effect of the senses in eliciting mating behavior Beach (5, pp. 163-207) raised rats in isolation and removed one, two, or all three of the following senses: smell, sight, and the sense of touch of the lips and snout. He tested these males with seven incentive animals: receptive females, females receptive but immobilized, castrated, non-receptive females, younger and smaller males, young female guinea pigs, and young female rabbits. He found that two-thirds of the inexperienced unoperated males copulated with a well-organized pattern, and a few of the inexperienced males deprived of one sense

copulated. None of the inexperienced animals which had been deprived of more than one sense would copulate. All of the experienced animals would copulate without two of the senses, but none with the loss of three senses. Beach concluded that in most cases only the female is the incentive for the inexperienced male, and none of the three senses tested were essential by themselves to copulatory behavior in the inexperienced animal. Normal males receive stimuli from the receptive female which contribute to the arousal of sexual excitement, but none of the senses are essential to copulation if the copulatory threshold is low enough. Individual males differ in height of copulatory threshold.

In still another test on sexually inexperienced male rats, this time on the effect of testosterone propionate on copulatory behavior, Beach (6, pp. 227-247) found that inexperienced males differ in their ease of sexual arousal as individuals. The appearance of copulatory behavior depends on the ease of arousal of the male and of the incentive animal. He also found that testosterone propionate would increase the susceptibility of arousal of a male by any incentive animal.

In two reviews of available information on arousal of sexual excitement, Beach (7, pp. 173-198 and 8, pp. 240-306) has pointed out that sexual organization, courtship

and copulation, is a part of what is known in psychology as innate endowment. That is, these sexual acts are instinctive and can be performed quite normally without previous association and experience. His opinion was that individual differences quite often account for one animal being sexually aroused by an incentive animal while another is not. Moreover, a male's excitability threshold may vary in height from day to day, and successful experience may increase excitement while failures reduce it. He proposes the idea of a central excitatory mechanism in the cerebral cortex which is affected by testicular hormones.

Beach (9, pp. 254-280) describes experiments conducted with two male dogs raised in isolation and then each subjected to copulatory tests with a receptive bitch. He found that the males did not mate the first time, and it was only after several opportunities that they did copulate. However, when they finally did copulate, their behavior was nearly the same as experienced animals. His conclusion was that failure to mate the first time does not mean that previous sexual experience is necessary for normal copulation, but the failure is probably due to inhibition of the male's responsiveness by the strange environment. Beach did say that an inexperienced male is more likely to mount in abnormal positions but later suppresses this tendency as a result of chance intromission.

Kagen and Beach (17, pp. 204-208) reported in 1953 on two experiments on the effects of early experience on the mating behavior of male rats. All the rats were raised in individual cages from infancy to adulthood (from 30 days on). Some of the rats were exposed weekly to receptive females of their own age; others were exposed to other males, and the rest were kept isolated. At 99 days all males were tested with receptive females. There was no significant difference in copulation, but ejaculation was infrequent in males which had been periodically exposed to either males or females. Their conclusion was that this sexual inferiority of the exposed males was due to the habits, formed during the prepuberal tests, of playful wrestling, pawing and climbing over. These habits of play in some cases could not be sufficiently overcome in adulthood for successful mating to occur.

The Work of William C. Young

The work of Young and his associates has been done primarily on guinea pigs and is quite recent. Valenstein, Riss, and Young (41, pp. 162-165) conducted an experiment on the comparative sex drive of genetically heterogeneous and inbred strains of male guinea pigs. Some were isolated at weaning and some isolated a week before the trials began. The trials consisted of the males being placed with

receptive females. It was found that the inbred males were significantly lower in sex drive, and therefore, it was concluded that mating behavior may have a genetic basis. Little mention was made of the effects of isolation. However, in a later experiment the same investigators (42, pp. 397-403) attempted to determine if sexual behavior is innately organized or is affected by experience. In all the trials with receptive females, the isolated males showed much more sexual excitement and activity than the social males. But in the achievement of the copulatory act, the social males seemed to perform quite normally, while the isolated males had difficulty. It was concluded, therefore, that contact with other animals has an organizing action on the development of the copulatory pattern of the male guinea pig. This influence of contact can be exerted early in life. They further reported that genetic differences account for the age of appearance of organized sexual behavior, and these genetic differences are not overcome by the administration of large amounts of exogenous androgen. Another observation was that sufficient experience for the organization of the copulatory pattern can be gained through association with males as well as females.

These observations on guinea pigs were the opposite of those of Louttit with the same species (22, pp. 247-

265, 23, pp. 293-304, 24, pp. 305-315), wherein he claimed that no observable differences could be noted in the age of appearance of sexual responses or the ability with which they were performed. However, Louttit's experiments did not include presenting a prepuberally isolated adult male with a receptive female as did Young's experiments.

Other Related Work

The study of instincts has been an open area for psychological research for some time. In a discussion of the fundamental drives, published in 1926, Tolman (40, p. 354) stated that learning and unlearning were the principal factors involved in the recognition of a certain sex object as the one which would result in ultimate quiescence of physiological urges.

Avery (1, pp. 373-396) in 1925 observed the initial copulation of a young male guinea pig which had been raised in isolation. He reported that all the actions, including pursuit, mounting and intromission, were complete and normal.

In a discussion on sex development of apes Bingham (11, pp. 1-29) in 1928 reported that successful copulation may depend on experience. The experience may be gained through heterosexual or homosexual play or through masturbatory actions.

Lashley (21, p. 453) in 1938 in a review of reproductive behavior commented on Stone's work with isolated, desensitized male rats. His suggestion was that there is a specific sex mechanism which is neither entirely sensual nor entirely hormonal. He felt that it is a drive which needs only to be awakened by some physiological trigger.

In his work with chimpanzees, Yerkes (43, pp. 115-136) compared the social and sexual life of his chimpanzees to that of man in regards to the role of experience in perfecting the basic patterns of sexual behavior. He also compared man and the chimpanzee on sexual maladjustments, such as masturbation, rape and prostitution.

Zingg (45, pp. 487-517) has reported on wild men and extreme cases of isolation. He wrote that there is evidence that humans which have been purposefully or neglectfully isolated at an early age show no sexual desires in the presence of the human female. Learning must first take place, and, at first, it may even be very distasteful to the wild man.

Nissen (25, pp. 438-440) has reported that chimpanzees, segregated by sex during their adolescent period and having no chance for close-range observation of mating behavior, will not copulate at the first opportunity presented. After a few months of cohabitation, they will eventually do so. It is a possibility that they learn the

copulatory pattern by imitation. However, they do show an innate readiness, according to Nissen, that is possibly developed through maturity. Once the pattern is established, it appears to be uniform for the species; this is more true for males than females. Females will sometimes copulate at the first opportunity if the male is experienced. There is also quite a variation between individual males.

In a test on the effect of isolation on aggressive behavior of mice, King and Gurney (19, pp. 326-330) found that males raised with other males were more aggressive than males raised in isolation. However, males raised with males were not more aggressive than males raised with females. There may be a relationship here to sexual aggressiveness and breeding ability.

MATERIALS AND METHODS

Experimental Animals

A great deal of work has been done with laboratory animals on the effect of experience on mating behavior. However, the farm animals have been neglected in these studies. Perhaps one of the reasons for this is the length of time it takes most farm animals to reach maturity. Another reason may be the inability to obtain animals of similar genetic background.

The farm animal which is the most logical selection as an animal with which to begin an experiment of this type is swine. Swine are noted for prolificacy, fast growth, and early maturing ability. By using an inbred strain for the tests it should be theoretically possible to eliminate or minimize the different variables which are encountered.

The Oregon State College swine herd is the oldest continuously maintained purebred Berkshire herd in the state. For some years now the herd has been inbred, and this makes it a good source of experimental animals. Scott (30, pp. 526-530) has stated that highly inbred strains of animals may give clear-cut results experimentally if used wisely.

Six boars were selected for the experiment. They were boars which showed desirable characteristics of breeding animals, at least as far as this could be determined at the time of selection (three weeks of age). The litters from which the boars came were farrowed on March 26 and 27, 1955. Two of the boars were littermates. Three were the sons of one sire, and three were the sons of another sire, but all six had the same grandsire in both the pedigree of the parental dam and the pedigree of the parental sire. Thus, all six boars were inbred to the same line; three were 19.5 per cent inbred, and three were 15.6 per cent inbred. This amount of relationship between the test animals was as close as could be obtained in the Oregon State College swine herd at the time this experiment was undertaken.

Methods Of Care And Management

The six boars were given three different treatments. Two were weaned and isolated at three weeks of age. Two more were weaned and isolated at eight weeks of age. The last two were weaned at age eight weeks and raised with barrows until the time of testing. Table 1 shows the boar numbers and the methods by which they were handled.

TABLE 1

Methods Of Handling The Six Boars	
Boar Number*	Method of Handling
28-3	Weaned and isolated at age 3 weeks
63-3	Weaned and isolated at age 3 weeks
39-8	Weaned and isolated at age 8 weeks
54-8	Weaned and isolated at age 8 weeks
18-8S	Weaned and raised socially at age 8 weeks
56-8S	Weaned and raised socially at age 8 weeks

* The last number indicates the age of weaning. The letter S indicates social raising.

Boars number 28-3 and 63-3 were weaned and isolated at three weeks of age. They were fed homogenized cow's milk for the first ten days in diminishing amounts, and at the end of that time the milk was stopped, but they continued to receive the regular creep ration which was being fed to the rest of the pigs in the barn. They were kept in the barn in adjoining pens until eight weeks of age, and there was little difference in their weights at that time (see Table 2).

Numbers 39-8 and 54-8 were weaned and isolated at eight weeks of age. At this time these two and numbers 28-3 and 63-3 were put on pasture in moveable pens. These pens were eighteen feet long and ten feet wide, and each one was divided lengthwise down the middle. At one end was erected a sunshade. This gave each pig ninety square feet. The pens were on skids so that they could be moved

about the pasture. The boars could all see one another, and the members of each group could smell one another, but there was no opportunity for physical contact. In addition to the pasture they were fed the regular growing ration twice daily.

Numbers 18-8S and 56-8S were weaned at eight weeks of age and kept in the barn with the barrows from all the litters which were weaned at the same time. Three weeks after weaning they were put on pasture along with the barrows.

At age eight weeks all six boars weighed within a range of twenty pounds of one another. Number 18-8S was the heaviest and number 63-3 was the lightest. Table 2 gives the weights of all six boars at birth, eight weeks, sixteen weeks, and twenty-nine weeks.

TABLE 2

Weights In Pounds Of Boars At Different Ages				
Boar Number	Birth	8 Weeks	16 Weeks	29 Weeks
28-3	3.0	32.5	135.0	295.0
63-3	3.5	32.0	130.5	260.0
39-8	3.1	44.0	119.5	276.0
54-8	3.5	35.0	116.5	266.0
18-8S	3.6	52.0	159.0	315.0
56-8S	3.0	35.0	120.5	253.0

The boars were kept on pasture all summer long and weighed weekly. During part of the summer they all received buttermilk in addition to their regular ration.

In the fall all the boars were moved back into the barn and put in separate pens, with the exception of numbers 18-8S and 56-8S which were kept together. On November 3, 1955, when the boars were seven and one-half months old, the tests were begun.

Handling During Breeding

The health, the handling or management, and the inheritance of breeding animals are three of the principal factors to be considered when determining reproductive proficiency. These things are especially important in the male animal which may be subjected to a great deal of use as a sire. The health and the genetic background of these animals were good, and the animals were given good treatment in the period before the breeding trials. Special care was taken to follow recommended practices during the breeding trials, but no help or training was extended the boars in any way during their attempts to copulate.

It is generally agreed that a certain psychology is involved in the handling of breeding animals. Rice and Andrews (28, p. 186) report that underlying causes of sterility are often not known. They also state, however, that overuse can result in sterility (28, p. 182).

In some species of animals the males are satiated for a long period of time following one service, for instance, the guinea pig, but in other species the males are active for many services without cessation for more than a few minutes, for instance, rabbits and rats. Kerruish (18, pp. 125-130) has emphasized the importance of foreplay and temporary frustration in teasing bulls to uphold conception rate in artificial insemination centers. Perry (27, p. 110) states that highly bred animals are finely balanced from the standpoint of nervousness, and they often must be handled carefully and even trained if they are to serve an artificial vagina. Enders (14, p. 16) and Kokolsky (20, p. 12) have stressed the importance of training in the breeding of fur-bearing animals.

Boars of various inbred lines show an independent occurrence of sexual development according to Green and Winters (15, pp. 55-62). They stated that the study of problems of sexual maturity of boars should take into account genetic constitution, season of farrow, and season of year of collection of data. Davidson (13, p. 406) has stated that repeated frustrations will often lead a young boar to give up in despair, and this may cause a conditioned reflex leading to refusal to breed.

With these things in mind the animals were handled according to recommended practices of boar management as

outlined by Smith (32, pp. 20-22), and as far as possible, the boars were kept on a regular routine during the breeding trials. However, in order to completely test the boars' own reactions no physical assistance was given whatsoever to aid them in copulation. Again each boar had an opportunity to serve the same gilt, but a different gilt was used in each of the two trials.

Table 3 gives a schedule of the trials. It shows the type of trial and the date on which it was conducted.

TABLE 3

Schedule Of Breeding Trials	
Date Of Trial	Type Of Trial
November 3, 1955 P.M.	Ten-Minute Trial
November 18, 1955 P.M.	Ten-Minute Trial
December 2, 1955 P.M.	Ten-Minute Trial
December 3, 1955 A.M.	Thirty-Minute Trial
December 3, 1955 P.M.	Thirty-Minute Trial
December 5, 1955 A.M.	Ten-Minute Trial

The records kept included observations made on every act which the boar made while in the pen with the gilt. The comparison of the boars was made on the amount of excitement which they displayed toward the gilt, number of attempts to mount, abnormal mounting, normal mounting, protrusions, copulation, and ejaculation. Sometimes the penis entered the anus, but ejaculation did not occur. The only time ejaculation did occur in any quantity was

when normal copulation was achieved. None of the boars failed to ejaculate when normal copulation did occur. The boars were always tested by groups. The controls, numbers 18-8S and 56-8S, were first, and in that order; the boars isolated at eight weeks of age, numbers 54-8 and 39-8, were next, and in that order; and those isolated at three weeks of age, numbers 28-3 and 63-3, were last, and in that order.

Experimental Procedure

Two different types of trials were conducted, but the basic procedure was the same for both. The first type of trial consisted of placing a receptive gilt of the same age and size as the boars in a breeding crate and bringing the boars to her one at a time. The breeding crate was used in order to facilitate future semen collections with the artificial vagina. Each boar was given ten minutes with the gilt and then returned to his pen. During this period detailed observations were made of every action of the boar. This was done in order to compare the boars on breeding ability. Four different trials were conducted using the breeding crate, and each time a different receptive gilt was used. However, the same gilt was retained for the duration of each single trial in order that the boars would all have the opportunity to copulate with the

same female. The crate was located in a corner where the boar and the gilt would not be disturbed, and the only person in the pen was the person making the observations.

The second type of breeding trial consisted of attempting to pen mate the boars to a receptive gilt of the same age and size. The boars were each brought from their individual pens to a pen in which the receptive gilt had been placed. They were together in this pen for a thirty-minute period, which was believed to be quite sufficient time for normal mating. Detailed notes were kept on the behavior of each boar, and at the end of the period the boars were removed. This trial was run twice the same day, and the only person present was the observer.

RESULTS

Ten-Minute Trials With The Breeding Crate

First ten-minute trial. The first boar to be tested was number 18-8S, one of the control boars. During this first trial he showed only mild interest toward the gilt. He mounted normally once, and, although the penis protruded and entered the anus, normal copulation did not occur. The boar made only one more attempt to mount before being removed.

Boar number 56-8S, the other control boar, was mildly interested, but he spent more time smelling the pen and the gilt. He often chopped his jaws and frothed at the mouth. He mounted only once, and there was no erection or protrusion.

Number 54-8, which was weaned and isolated at eight weeks of age, showed a little more interest in the gilt. He chopped and frothed continuously throughout the trial. He mounted successfully twice out of six attempts, but no erection or protrusion was seen.

The other boar isolated at eight weeks, number 39-8, showed his excitement by chopping and frothing also. He made two attempts to mount from the side and several normal attempts. He mounted successfully twice, but, although both times there was an erection and protrusion, he did not copulate.

The next boar was number 28-3, weaned and isolated at three weeks of age. This boar showed very little interest, and he spent most of the ten minutes inspecting the pen, smelling the gilt, and chopping his jaws now and then. He made no attempt to mount.

Boar number 63-3, also weaned and isolated at three weeks, showed quite a bit of excitement at first by his chopping and frothing. However, he quickly subsided and spent the rest of the time inspecting the enclosure and the crate without attempting to mount.

In this first trial a marked difference was seen between the three groups of animals. The control animals, numbers 18-8S and 56-8S, were mildly interested but not vigorous in their attempts to mate. The boars isolated at eight weeks, numbers 54-8 and 39-8, were quite active, vigorous, and masculine; they showed the most sexual excitement. Those two boars isolated at three weeks, numbers 28-3 and 63-3, were curious, but they showed very little sexual excitement. None of the animals showed any kind of a well-organized mating pattern.

Second ten-minute trial. The second ten-minute trial was conducted two weeks later. Boar number 18-8S was much more vigorous than he had been in the first trial. He mounted successfully the three times that he tried, and

each time there was an erection and protrusion. However, he did not copulate.

Number 56-8S was more interested this time also. He mounted normally twice. The first time there was an erection and protrusion, and he attempted by thrusting vigorously to copulate. The second time there was no protrusion.

Number 54-8 showed approximately the same vigor as in the first trial. In three attempts he mounted successfully once, and he stayed mounted for three minutes trying vigorously to copulate. Even though he thrust quite vigorously with the protruding penis, he was unsuccessful in achieving copulation.

Number 39-8 was slightly less interested than he was the first time. He chopped and frothed, but he spent a little more time inspecting the pen. He mounted five times, but only the last time was there an erection and protrusion. There was no copulation.

Number 28-3 displayed a little more interest in the gilt than he did in the first trial. He would sniff at the gilt's vulva, leave, and return again repeatedly. He did not chop or froth, and he made no attempt to mount.

Boar number 63-3 was more interested this time also. He spent most of the ten minutes frothing, chopping, pawing, and sniffing at the gilt. However, he still made no attempt to mount.

Again, as in the first trial, the boars showed group characteristics rather than individual characteristics in their behavior. The control animals were both a little more excited than during the first trial, but they still did not show a vigorous desire to mate. The animals isolated at eight weeks, 54-8 and 39-8, were more oriented to the ano-genital region of the gilt, and they seemed less excited and more sure of themselves than in the first trial. The boars isolated at three weeks, 28-3 and 63-3, showed more interest and excitement in the presence of the female, but they still did not attempt to mount. The most vigorous pair was 54-8 and 39-8.

Third ten-minute trial. Two weeks later the third ten-minute trial was carried out. The first boar, number 18-8S, mounted three times. The first time, he attempted to copulate vigorously. However, the penis entered the gilt's anus, and copulation was not accomplished. He gradually seemed to lose interest, and near the end of the trial he was not active.

Number 56-8 was a little more active. He chopped and frothed and mounted as soon as he was admitted to the pen. The penis entered the anus, and he did not copulate or ejaculate. He mounted three more times and made vigorous, but unsuccessful, attempts to copulate.

Boar number 54-8 was much less interested at first than he was during the first two trials. He spent much more time near and around the gilt, chopping and frothing, but he mounted only twice, one of these times on the side. During the few minutes while he was mounted normally, he tried to copulate very vigorously.

Boar number 39-8 was the opposite of number 54-8. He was quite active when first brought in, and he successfully mounted three out of the four times he attempted. However, only once was there any erection or protrusion. Near the end of the trial he seemed to tire and lose interest.

Number 28-3 showed much more vigor and libido than he had shown previously. He mounted twice very quickly, and the second time, he copulated almost at once. He ejaculated and then withdrew the penis and continued to ejaculate. This was the first boar to successfully copulate.

Although number 63-3 displayed a great deal of interest in the gilt and continually smelled and chopped about, he was not as active as number 28-3. He mounted successfully once in three attempts, but he was too far to one side. Even though there was a protrusion and a slight amount of some sort of ejaculate, he did not attempt vigorously to copulate.

During this trial the boars began to show more individual characteristics; whereas previously they had shown more group characteristics. Number 18-8S was only mildly interested, while number 56-8S, the other control was much more excited and vigorous in his attempts to copulate than he had been previously. Numbers 39-8 and 54-8 were both less vigorous than before, and number 28-3 copulated, while in comparison number 63-3 was only mildly interested.

Fourth ten-minute trial. This trial was conducted three days after the third trial and two days after the two thirty-minute trials, which will be reported on separately. Thus, the boars underwent four trials in four days.

Boar number 18-8S displayed only a mild interest during this last trial. He mounted successfully twice in four attempts, but one was on the side. There was no erection or protrusion, and toward the end of the trial he seemed to lose interest almost entirely.

Number 56-8S was very active. He entered and almost immediately mounted, copulated, and ejaculated. However, this seemed to be the result of a chance intromission. He mounted twice more without copulating, but there was some ejaculate.

Number 54-8 was active, vigorous, and excited all during the trial. He mounted and stayed mounted almost

the entire trial except for a few seconds. He tried very vigorously to copulate, but he was unsuccessful. There was, however, a small ejaculation of some sort.

Boar number 39-8 was quite excited and vigorous in his attempts to mate also. He mounted five times, and each time he made vigorous attempts to copulate. He was unsuccessful, although there was some ejaculate.

Number 28-3 was very vigorous and excited. He mounted three times out of five attempts, and each time there was a protrusion and a small ejaculate--but no copulation. He displayed a great deal of libido all through the trial.

Boar number 63-3 was also quite active. He seemed well oriented to the gilt's ano-genital region, and he mounted successfully five times out of seven attempts. There was, however, only one erection and protrusion with a slight ejaculation. He displayed a good mating pattern, but it was not complete to the point of copulation.

In this test there again seemed to be more individual than group differences. Number 18-8S was very sluggish and seemed to tire quickly. Number 56-8S quickly copulated. Numbers 54-8 and 39-8 were both quite excited and eager to copulate. Number 28-3 was slightly more aggressive than number 63-3, but both actively sought to copulate. Quite possibly all of the boars would have copulated had the gilt been more cooperative. However, she was

irritable in the crate and frequently made herself unavailable for copulation. Table 4 shows the measures on which the boars were evaluated and an individual comparative rating for each ten-minute trial.

Thirty-Minute Pen-Mating Trials.

The first thirty-minute trial. The two thirty-minute trials were run on December 3, the day after the third ten-minute trial and two days before the last ten-minute trial. It was a pen-mating situation. The gilts were very receptive and in no way restrained except by the four walls of the pen.

When boar number 18-8S was first brought in, he seemed to have much libido. He mounted immediately, however, his penis entered the anus of the gilt. He attempted to mount the gilt several times after that during the first ten minutes of the half hour. During the second ten minutes he alternately left and returned to the gilt; he seemed to have lost much of his energy. The last part of the half hour he attempted unsuccessfully to mount several times, rooted the gilt around a bit, and then seemed to lose interest. Twice he attempted to mount the head.

Boar number 56-8S displayed only mild interest when brought in to the gilt. During the whole time he made only one attempt to mount. The rest of the time he spent smelling the gilt or smelling around the pen.

TABLE 4

Evaluative Measures Of Sexual Ability
In Ten-Minute Trials

Boar No. & Trial No.	Libido	Attempts To Mount	Mounts		Protru- sions	Copulation & Ejaculation	Rating With Other Boars
			Normal	Abnormal			
Boar #18-8S							
1	Medium	2	1	0	1	0	2
2	Medium	4	4	0	1	0	2
3	Medium	4	4	0	2	0	6
4	Low	5	1	1	0	0	6
Boar #56-8S							
1	Low	1	1	0	0	0	4
2	Medium	2	2	0	1	0	3
3	Medium	3	2	0	2	0	2
4	Medium	3	3	0	3	1	2
Boar #54-8							
1	Medium	5	1	0	0	0	3
2	Medium	2	1	0	1	0	4
3	Medium	2	2	2	2	0	4
4	High	2	2	0	2	0	4
Boar #39-8							
1	High	7	2	1	2	0	1
2	High	5	4	0	1	0	1
3	Medium	4	3	0	0	0	5
4	High	5	4	0	3	0	5
Boar #28-3							
1	Low	0	0	0	0	0	5
2	Low	0	0	0	0	0	5
3	High	4	1	1	2	1	1
4	High	4	2	1	3	0	1

Table 4, continued

Boar No. & Trial No.	Libido	Attempts To Mount	Mounts		Protru- sions	Copulation & Ejaculation	Rating With Other Boars
			Normal	Abnormal			
Boar #63-3							
1	Low	0	0	0	0	0	6
2	Low	0	0	0	0	0	6
3	Medium	4	0	1	1	0	3
4	High	6	5	0	3	0	3

Number 54-8 was quite actively interested in the gilt. At first he seemed a little wary, and the gilt fought back when he rooted her. However, as time went on, he began to show more confidence. He successfully mounted once in seven attempts during the first ten minutes. There was an erection, protrusion, and slight ejaculation, but there was no copulation. During the second ten minutes he attempted to mount the head once and then lost interest for a while. Again in the last ten minutes he attempted to mount three times, once on the head, once on the side, and once normally. He showed much more confidence in his masculinity when the gilt fought back at him.

Number 39-8 came in chopping and frothing, and he kept this up most of the time he was with the gilt. He rooted vigorously at the gilt, but he was a little wary when the gilt fought back. He attempted six normal mounts, a head mount, and a side mount during the first ten minutes. During the second ten minutes he was less vigorous. He rooted and pawed the gilt and mounted once in two attempts, but he fell off. He made three attempts to mount normally during the last ten minutes, and he seemed much more confident and aggressive when the gilt fought back at being rooted out of a corner.

Boar number 28-3 was very active and vigorous during almost the entire half hour. He made many attempts to mount, and at first he did not seem well oriented to the gilt's ano-genital region because of attempts to mount the head and sides. He did not make a successful mount, but he showed no fear of the gilt whatsoever, and he readily rooted her out of corners or rooted her up if she laid down. At the very last he seemed to tire and lose interest.

When number 63-3 entered the pen, the gilt was lying down, and he immediately mounted her head. She got up, and he continued to try to mount from the head and sides. After about ten minutes he became oriented, and on the third attempt he mounted successfully, copulated, and ejaculated. After dismounting he attempted to mount once more, but he was tired. Although he still sniffed and rooted the gilt, he was only mildly interested.

In this first thirty-minute trial, the boars again showed mostly individual differences. Numbers 18-8S and 56-8S were only mildly active. Numbers 54-8 and 39-8 seemed wary at first but quickly seemed to gain confidence. Number 28-3 was quite aggressive and active, but he did not copulate. Number 63-3, on the other hand, was the only one to copulate. Numbers 28-3 and 63-3 were a little more inclined to mount in atypical positions.

The second thirty-minute trial. This second thirty-minute trial was conducted during the afternoon of the same day of the first thirty-minute trial. A different receptive gilt was used.

Number 18-8S entered and made one attempt to mount, but after that he displayed practically no interest in the gilt. The gilt had to root him repeatedly for attention. Most of the time he spent inspecting the pen and eating.

Boar number 56-8S was very active the first ten minutes of the half hour. He rooted, chopped, and frothed, and he mounted and dismounted four times, once on the side. The fourth time there was a protrusion and a small amount of ejaculate. The boar's penis entered the anus twice, but there was no copulation. After this the boar gradually lost interest. He still rooted and sniffed the gilt's vulva during the second ten minutes, but during the last third of the period the gilt had to root him for attention.

Number 54-8 entered and sniffed the gilt and rooted her once. The gilt fought back, and the next ten minutes were spent in a vigorous battle. After the fight both animals rested for about five minutes and then the boar began to try to mount. On the fourth attempt he mounted and copulated after first entering the anus. He

ejaculated and then dismounted, but he continued to show some interest in the gilt and made about eight more attempts to mount before he was removed from the pen.

Number 39-8 was quite active and vigorous during most of the half hour. He chopped, frothed, and rooted the whole time. He made many many attempts to mount, and most of them were in the normal position. He successfully mounted seven times, and each time there was a protrusion and a small amount of ejaculate. He tried quite vigorously to copulate, and he entered the anus once. When the gilt laid down or became unavailable in a corner, he would root her into a more available position. He showed much libido.

Boar number 28-3 came in and immediately began to attempt to mount. On the seventh attempt he mounted and copulated, the penis first entering the anus. Ejaculation immediately followed. During the next twenty minutes the boar mounted twice and made many more attempts. Near the end of the half hour he became quite tired, and both he and the gilt laid down.

Number 63-3 was quite vigorous at first and made many many attempts to mount. However, most of the attempts were at the side, and he successfully mounted the side once followed by a protrusion and a slight ejaculate of some sort. During the last half of the test he began to tire

and lose interest. Although he continued to root and sniff at the gilt, no copulation occurred.

In this trial number 18-8S was very inactive and showed the least desire to mate, while number 56-8S was active for only part of the period. Number 54-8 copulated after he proved his own masculinity, and number 39-8 was also quite active and eager with a well-organized pattern. Number 28-3 copulated, and number 63-3 was active even though he had copulated earlier in the day. Again individual differences were more pronounced than group differences. The isolated animals did show a little more tendency for atypical mounting than did the control group, but the isolated animals showed much more libido than the control group. Table 5 shows how the boars were evaluated during the thirty-minute trials and their individual ratings. Table 6 gives the comparative ratings of the boars in each of the six trials.

Evaluation Of Each Boar

Boar number 18-8S was one of the most vigorous boars of the six in the first two ten-minute trials. In the third ten-minute trial he rated the lowest. As the other boars became more active, it seemed that he became less and less vigorous by comparison. During both the thirty-minute trials he showed strong initial interest, but he

TABLE 5

Evaluative Measures Of Sexual Ability
In Thirty-Minute Trials

Boar No. & Trial No.	Libido	Attempts To Mount	Mounts		Protru- sions	Copulation & Ejaculation	Rating With Other Boars
			Normal	Abnormal			
Boar #18-8S							
1	Low	8	0	1	1	0	5
2	Low	1	0	0	0	0	6
Boar #56-8S							
1	Low	1	0	0	0	0	6
2	Low	4	3	1	4	0	5
Boar #54-8							
1	High	11	1	0	1	0	3
2	High	12	1	0	1	1	2
Boar #39-8							
1	High	14	2	0	0	0	4
2	High	29	8	0	6	0	3
Boar #28-3							
1	High	18	0	1	0	0	2
2	High	19	3	1	3	1	1
Boar #63-3							
1	High	14	1	1	1	1	1
2	High	23	0	1	1	0	4

TABLE 6

Boars' Comparative Ratings		
Trial Number	Rating	Boar Number
<u>Ten-Minute Trials</u>		
1	1	39-8
	2	18-8S
	3	54-8
	4	56-8S
	5	28-3
	6	63-3
2	1	39-8
	2	18-8S
	3	56-8S
	4	54-8
	5	28-3
	6	63-3
3	1	28-3
	2	56-8S
	3	63-3
	4	54-8
	5	39-8
	6	18-8S
4	1	28-3
	2	56-8S
	3	63-3
	4	54-8
	5	39-8
	6	18-8S
<u>Thirty-Minute Trials</u>		
1	1	63-3
	2	28-3
	3	54-8
	4	39-8
	5	18-8S
	6	56-8S
2	1	28-3
	2	54-8
	3	39-8
	4	63-3
	5	56-8S
	6	18-8S

soon became tired and almost completely inactive. This boar never once copulated, and he showed the least vigor of all the boars at the end of the tests as far as desire to mate was concerned.

Boar number 56-8S was not as active as number 18-8S in the first two ten-minute trials, but by the third trial he was showing the same amount of activity and vigor, which was very low. During the two thirty-minute trials he showed that possibly he needed to learn his role as a male. The first time he was lethargic and disinterested, but the second thirty-minute trial he was at first quite active and only tapered off near the end. He was much more active during the last ten-minute trial, and he copulated within a short time. This was, perhaps, a chance intromission. It appeared from the mating trials that he was the more vigorous of the two controls, but he still rated at the bottom along with number 18-8S when compared with the other boars.

It seemed from the first ten-minute trial that number 54-8 was a little uncertain as to his role. However, in the second and third trials he began to show more activity and interest than he had previously. During the first thirty-minute trial he was again slow to show his masculinity, but he became more aggressive as the time went on. The second thirty-minute trial was marked by fighting with

the gilt, but he showed masculine mastery and soon proceeded to copulate. He was quite active during the fourth ten-minute trial also. This boar was a slow starter, but he eventually showed vigor and libido which exceeded that of the two controls and was equal to that of number 39-8.

Boar number 39-8 was not overly vigorous in the first two ten-minute trials, but in comparison he was the most active and vigorous of the six. However, in the third ten-minute trial he did not rate quite as high as number 54-8. During the thirty-minute trials he was very aggressive and showed much libido, and he seemed to gain confidence in his masculine abilities as time went by. He rated higher than the two controls, but not as high as number 54-8. During the fourth ten-minute trial he was less vigorous, but he was thought to be off feed. This boar never did copulate during the breeding trials, but he seemed to have a well-organized courtship pattern.

During the first two ten-minute trials boar number 28-3 showed lack of interest, enthusiasm, and activity, but in the third trial he exhibited a complete change. He was the first of the six boars to copulate. In the thirty-minute trials he displayed a great deal of masculinity and vigor. In his excitement he attempted to mount the head and sides often at first, but by the end of these

two trials he had oriented himself rather well. He copulated early in the second thirty-minute trial. Also, he was quite active and mounted well during the fourth ten-minute trial. By the end of the trials this boar could be rated at the top of all the boars as far as activity, masculinity, and libido were concerned.

Boar number 63-3 was also lacking in vigor, interest, and, perhaps, knowledge in the first two ten-minute trials. In the third ten-minute trial he was much more interested and active. He was quite active during the two thirty-minute trials, and he copulated normally early in the first trial; this was, perhaps, a chance intromission. He did not mate in the second thirty-minute trial, but this was understandable in a young boar which had served a gilt only a few hours previously. This boar was quite excited and active, but he attempted to mount the head and sides a great deal at first. He was quite active during the fourth ten-minute trial also. On the basis of the breeding trials alone this boar rated second as far as libido and masculinity were concerned.

Follow-Up

Ordinarily the experiment would be completed at the end of the evaluation of the breeding ability of these boars, but fortunately it was possible to conduct some

follow-up on these boars. Boars number 18-8S, 56-8S, and 28-3 were retained at Oregon State College for semen studies. Boar number 63-3 became sick and died, and at his death he was found to have quite normally developed sexual organs with live sperm present in the testes. Boar number 54-8 was used to breed several gilts in the Oregon State College herd and was then sold to a commercial breeder. He settled all the females to which he was bred. Number 39-8 was retained as a herd sire at Oregon State College, and he proved to be a good breeder and settled all the females to which he was bred without any returns to estrus.

DISCUSSION

The purpose of this experiment was to determine the effect of experience gained prior to puberty on the breeding ability of boars. The question of whether mating behavior is instinctive or learned goes along with this also. With these things in mind the experimental boars were tested and their actions compared.

Management and handling enter very strongly into any breeding situation. Davidson (13, p. 406), Perry (27, p. 110), Rice and Andrews (28, p. 182 and 186), and Smith (32, p. 22) all report on the necessity of handling breeding animals in a manner which will facilitate their future use. This experiment would seem to indicate that isolation in itself does not affect the breeding ability of boars which are handled according to recommended practices. It is quite conceivable, however, that, if a boar which had been previously isolated was just turned loose with a herd containing females of mixed sizes and ages, he might turn out to be a poor breeder. As Davidson (13, p. 406) has pointed out, the psychological effect of being bullied by bigger and stronger females might produce a conditioned reflex leading to refusal to breed. On the other hand, this could just as easily happen, and actually has happened, to boars raised in a social situation. Boars must be trained to be effective breeding animals as

Smith (32, p. 22) has stated. This training is not complicated, and it involves only a few simple management techniques which good swine men perform as a matter of course. The fact that the two experimental animals which were isolated at eight weeks, numbers 54-8 and 39-8, became good herd sires indicates that management is a key factor in any breeding situation.

In this matter of breeding ability individual differences seemed to be more pronounced than group differences as far as the experimental boars were concerned. In this experiment, after the first two trials, individual differences were much more evident than group differences. This was true despite the fact that the animals were inbred to some extent. The behavior of each of the boars differed from that of each of the other boars in many areas, just as there were many areas of behavior in which there was agreement. Beach (5, pp. 163-207) found, when testing the effects of the senses on mating behavior of rats, that the females give off stimuli which affect the senses of the male in a manner which will cause him to surpass his copulatory threshold. Each male has a copulatory threshold which he must rise over in order to mate. Some males have a lower copulatory threshold than others. With some males none of the stimuli are necessary as an incentive for copulation, and other males must be greatly stimulated. In this same test Beach found that only the female is an

incentive to the inexperienced male. Beach (6, pp. 227-247, 7, pp. 173-198, and 8, pp. 240-306) has stated that inexperienced males differ in their ease of sexual arousal as individuals. The ease of sexual arousal of the female is important also, and this may often account for one male being aroused by a particular female while another male is not.

With these things in mind it seems reasonable to assume that one reason for the failure of the two boars, numbers 18-8S and 39-8, to copulate may have been due to the fact that their copulatory threshold was high. This may have been more true of number 18-8S than of number 39-8. Number 39-8 tried hard to copulate during most of the tests, but number 18-8S was quite sluggish, especially near the end of the trials. The other boars also showed individual differences in height of copulatory threshold. Numbers 28-3 and 63-3 needed very little incentive to copulate, and numbers 54-8 and 56-8S needed a little more stimulation.

It would seem from the observations made on these experimental boars that in swine the desire to mate is instinctive and so are the actions which are necessary for its accomplishment. This agrees with the findings of Craig (12, pp. 121-133) with doves, Stone (34, pp. 95-153, 35, pp. 430-435, and 38, pp. 73-83), Beach (3, pp. 457-

472, 4, pp. 121-136, 5, pp. 163-207, 6, pp. 227-247, 7, pp. 173-198, 8, pp. 240-306, and 9, pp. 254-280) with rats and Louttit (22, pp. 247-265, 23, pp. 293-304, and 24, pp. 305-315) with guinea pigs. On the other hand, the ability to cope with the most important variable, the female individual, is learned through experience. Thus, the accomplishment of the sexual act is neither entirely innate nor entirely learned. Again it is up to the manager or herdsman to see that this experience is successful in nature in order that the boar will become a good sire.

The two thirty-minute trials were indicative of the role of experience in accomplishing the sexual acts. None of the boars seemed certain as to their roles in the pen-mating situation during the first trial. Number 63-3 did copulate during the first thirty-minute trial, but this was probably more of a chance intromission than the result of any well-organized mating pattern. All of the boars were at first excited, and the isolated boars showed more activity than did the controls. This agrees with the findings of Valenstein, Riss, and Young (42, pp. 397- 403) with guinea pigs. By the time of the second trial the boars all seemed to better recognize their roles in courtship and copulation. Despite the fact that the control boars, numbers 18-8S and 56-8S, were fairly well oriented to the ano-genital portions of the gilts' anatomy, they

had to learn part of the courtship pattern of rooting the female into position and nuzzling her. This was the part which seemed hard for them to perform. They went at it in a sluggish manner and seemed almost unconcerned with their male responsibilities. The isolated boars quickly organized their patterns of courtship through experiences gained by trial and error. Thus, it would seem that contact with other animals of the same sex does not necessarily have an organizing influence on the breeding habits of boars. The findings here disagree with those of Valenstein, Riss, and Young (42, pp. 397-403). They found the opposite to be true with the male guinea pig. The fact that these control boars were sluggish and poor breeders may have been the result of their experiences in being raised together and with the castrate males. Beach (4, pp. 121-136) found that male rats raised together were relatively unresponsive to females when compared with males raised in isolation and males raised with females. He suggested that this unresponsiveness by the segregated males may have been due to homosexual tendencies. Perhaps that was the case in this situation with the boars.

There is no doubt in the mind of the investigator but that all six boars, given the proper training, could have become effective herd sires. Two of them have, and these two were numbers 54-8 and 39-8, which were isolated

at eight weeks. Again the key phrase is "given the proper training". It would appear from the tests that the training necessary for the control boars would have to have been more intense than that for the isolated boars. Since it is evident that proper management is essential for breeding success, it seems from the standpoint of time involved in training that it would be better to raise breeding boars in separate pens. This is, of course, impractical in most cases. Isolation at three weeks is especially impractical, as yet, from the standpoint of economy and selection. However, this problem of prepuberal experience and its relation to fertility should not be one which good swine men will have to worry about. It is evident that isolation does not affect the breeding ability of boars.

SUMMARY AND CONCLUSION

This experiment was designed for the purpose of studying the effect of isolation on the breeding habits of boars. Two boars were weaned and isolated at three weeks of age. Two boars were weaned and isolated at eight weeks of age. Two boars were weaned at eight weeks of age and raised with barrows; these were the control boars. These six boars were all within one day of being the same age.

At the age of seven and one-half months the boars were subjected to a series of six breeding tests to determine their breeding abilities. They were given four ten-minute trials and two thirty-minute trials. The ten-minute tests were attempts to mate the boars to gilts restrained in a breeding crate. The two thirty-minute trials, which came between the third and the fourth ten-minute trials, were pen-mating trials in which the gilts were in no way restrained. The boars' actions were observed and recorded for comparison.

During the first two tests the control boars seemed to be better prepared as breeding animals than did the isolated boars. However, as the trials progressed, individual differences began to overshadow the group differences. It was quite noticeable near the end of the trials that one of the control boars was very sluggish. The other boars developed fairly well-organized patterns of

mating. The two boars isolated at eight weeks both became herd sires.

The conclusions to be drawn from this experiment are quite evident:—

1. Isolation in itself does not affect the breeding ability of boars.

2. Individual differences are as important in determining breeding efficiency in a test like this as are group differences.

3. Management and handling are important factors in the training of young boars to perform well as sires.

4. In swine the desire to mate is instinctive and so are the physical activities which are necessary for the accomplishment of the mating act.

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