as shown by the test. Pragmatism may be vicious when narrowly conceived, but the pragmatic attitude leads us away from dogmatic idealism toward intelligent action. The German army, in its conduct toward its own members as well as its treatment of the unfortunate peoples who come under its power, does indeed strive for "values" independently of pleasure or pain. Nationalistic idealism can be made the excuse for deeds which could find no justification in the presence of the simplest enquiries into consequences, as measured by those supposedly negligible phenomena, human pleasure and pain. Münsterberg, great-hearted and striving after good, would not have so far forgotten the relations between cause and effect; but we must combat any philosophy, any course of action, which does not incessantly seek justification by results measured in human welfare.

T. D. A. COCKERELL

SPECIAL ARTICLES

A RHYTHMICAL "HEAT PERIOD" IN THE GUINEA-PIG

DURING the past six years we have been using guinea-pigs in an extensive breeding experiment and it has become more and more evident as our work goes on that the existing notions of the ovulation periods in these animals are of no practical value, or are practically incorrect. In a number of the experiments it became important to know accurately when the females "came into heat" and when ovulation took place. We had concluded, from numerous observations as well as theoretically, that the female guinea-pig very probably had a definitely regular and periodic sexual cycle if it could be worked out exactly. On account of the need of this exact information, we have studied the œstrous cycle in these animals during the past eighteen months.

Most other attempts at a solution of this problem have centered in a study of the ovary, which necessitated either its removal by operation or the killing of the animal. In either case the procedure brought to a conclusion the observation or experiments on the ovulation cycles in that specimen. Recognizing, on the other hand, that no thorough investigation of the uterus and vagina in the living female had been made, it occurred to us that possibly œstrous changes might take place even though they are so feebly expressed as not to be noticeable on casual observation. The absence of an apparent œstrous or proœstrous flow from the vagina of the guinea-pig has, no doubt, been the chief reason for the general lack of knowledge of the œstrous cycle. It was, therefore, determined to make a minute examination of the contents of the vaginæ of a number of females every day for a long period of time to ascertain whether a feeble flow might exist, although insufficient in quantity to be noticed at the vaginal orifice or vulva.

The observations were made by using a small nasal speculum which was introduced into the vagina and the arms opened apart by means of the thumb screw. This instrument permits an examination of the entire surface of the vaginal canal. In this way the vaginæ of a number of virgin females have been examined daily and smears made from the substances that happened to be present in the lumen.

By the use of such a simple method, it was readily determined after examining the first lot of animals for a few months that a definite sexual period occurs lasting for about twenty-four hours and returning with a striking regularity every fifteen or sixteen days. During this twenty-four hour period the vagina contains an abundant fluid which is for about the first half of the time of a mucous consistency. The vaginal fluid then changes into a thick and cheese-like substance which finally becomes slowly liquefied and serous. This thin fluid exists for a few hours and then disappears. Occasionally toward the end of the process a slight trace of blood may be present, giving the fluid a bloody red appearance, otherwise it is milk-white or cream color.

According to the changes in appearance and consistency of the vaginal fluid, one may distinguish four different stages. The first stage having a mucous secretion, a second stage the cheese-like secretion, a third stage with the fluid becoming serous and a fourth stage, not always recognized, during which a bloody dis-

charge is present. The duration of these several stages is subject in the different animals to individual variations. The first stage, however, is generally longest and lasts from six to twelve hours or even more, and during this time there is a gradually increasing quantity of the mucous secretion which at its height is very abundant and fills the entire lumen of the vagina. The second stage is shorter, lasting from two to four hours, and passes gradually over into the third stage which lasts from four to six hours. The fourth stage is the shortest, only about one to two hours long, and for this reason it is often missed in examining the animals during the periods. It is also possible, as mentioned above, that the fourth stage may not typically exist in all individuals and the quantity of blood present is very different in the different specimens. The succession in which these stages follow one another is remarkably definite. We have never observed any change in the typical sequence of the stages and the time consumed by the entire process is closely the same in all cases.

A macroscopical examination of the uterus and vagina during this period of sexual activity shows the entire genital tract to be congested. The vessels to the ovary, uterus and vagina are large and conspicuous, the uterine horns and the vagina are slightly swollen and inflamed. However, as soon as this short period of activity is over, the congestion disappears and the uterus and vagina take again their normal pale aspect. At the same time the vaginal fluid diminishes and the vagina, especially during the first week after the sexual activity, is as clean as possible, showing none of the secretion. The external vaginal orifice, which during the period of activity is more or less open, actually showing in a few cases a little fluid or some blood, closes and becomes less accessible after the period.

During the second week following œstrus a little mucous discharge begins to appear in the vagina and increases progressively, indicating that the new period of activity is nearer and nearer approaching. The orifice of the vagina is sometimes open during this stage and thus explains why this sign, which was observed before, does not make it possible to detect the actual time of the regular œstrous activity.

The complete results of the present study which will be published in full elsewhere may be stated in brief as follows.

Guinea-pigs kept in a state of domestication and under uniform environmental conditions possess a regular diœstrous cycle repeating itself in non-pregnant females about every sixteen days throughout the entire year with probably small and insignificant variations during the different seasons.

During each cycle typically corresponding changes are occurring in the vagina, the uterus, and the ovary; a given stage in one of these organs closely accompanying parallel stages in the other two.

Each period of sexual activity lasts about twenty-four hours and is characterized by the presence of a definite vaginal fluid, which is not sufficiently abundant to be readily detected on the vulva, but is easily observed by an examination of the interior of the vagina.

The composition of the vaginal fluid changes with the several stages of change occurring in the uterus and vagina.

(*a*) To begin with, during what we term the *first stage,* the fluid consists of an abundant mucous secretion containing great numbers of desquamated vaginal epithelial cells. At this time sections of the vagina show an active shedding or desquamation of its epithelial lining cells. The cells of the uterine epithelium are loaded with mucus, and an active migration of polynuclear leucocytes is taking place from the vessels of the vagina and uterus out into the stroma and towards the epithelial layer.

(*b*) During the *second stage* the contents of the vagina become thick and cheese-like on account of the great accumulation of desquamated epithelial cells. The walls of the uterus and vagina become congested and the migration of leucocytes becomes still more active.

(*c*) The leucocytes reach the epithelium and vigorously invade its cells and intercellular spaces during the *third stage.* These wandering cells become enclosed within and apparently dissolve the breaking-down dead cells of the epithelium. The vaginal fluid becomes

thinner under the dissolving or digesting action of the leucocytes. The congestion in the uterus and vagina becomes still more pronounced, giving rise to small blood masses or hæmatomata beneath the epithelium. The epithelium of the uterus is highly disorganized, vacuolized and richly invaded by the leucocytes, so that portions of it fall away en masse, actually carrying with it in some cases cells of the stroma.

(*d*) The *fourth stage* is merely a continuation or result of the activities of the third. The falling away of the epithelial pieces and stroma cells permits the escape of the small hæmatomata or blood knots, thus causing a slight bleeding into the lumen of the uterus and vagina. These traces of blood often give a reddish aspect to the vaginal fluid. At this same stage a regeneration process begins from the necks of the uterine glands and also apparently from the epithelial infoldings in the vagina, so that the lost epithelium becomes rapidly replaced almost before it has ceased falling away.

The regeneration process in the guinea-pig is very short, lasting only a few hours, from six to twelve in all.

Ovulation seems to occur spontaneously during every heat period without exception. The rupture of the follicles with the consequent ovulation takes place about the end of the second stage or the beginning of the third; that is, during the presence of the thick cheese-like vaginal fluid.

During the diœstrum or intermenstrual period there is very little fluid to be found in the vagina. This scant fluid consists of mucus in which are some atypical squamous cells from the vaginal wall and many leucocytes. A number of the leucocytes are old but there are probably new ones arriving almost continuously from the wall of the vagina. The only time at which the vagina seems to be practically free of leucocytes is immediately before and during the first and second stages of the œstrous period described above.

A marked correlation exists between the œstrous changes in the uterus and the developmental cycle of the corpora lutea. When the corpora lutea are highly developed and apparently active the mucosæ of the uterus and vagina show a normally vigorous and healthy condition. While on the other hand, when the corpora lutea begin to degenerate during the second week after the "heat period" the mucosæ of the uterus and vagina also begin to shown signs of degeneration and the process of desquamation slowly commences. At about two weeks after the last "heat period," when the wholesale destruction of the mucosa begins, the corpora lutea are almost completely degenerated. The breaking of the Graafian follicles occurs during the œstrus as a result of a congestion which began in the theca folliculi at about the same time as the congestion of the stroma of the uterus and vagina. And finally when the regenerative growth of the uterine mucosa sets in, the ovaries then possess new corpora lutea in an active state of differentiation which were derived from the recently ruptured follicles.

It, therefore, might be imagined that the secretion from the corpora lutea exerts a protective influence over the uterus and vagina while the absence of this secretion permits the breaking down and degeneration of the uterine epithelium typical of the "heat period."

C. R. Stockard,
G. N. Papanicolaou

THE IOWA ACADEMY OF SCIENCE

The thirty-first annual session of the Iowa Academy of Science was held at Grinnell College, Grinnell, on April 27 and 28. The opening meeting was called to order on Friday afternoon by President Stewart, of the State University. After the transaction of preliminary business the president delivered his annual address on "Recent advances in physical science and the relation of the Iowa Academy to scientific progress." Professor Conard, of Grinnell, who had been the academy's delegate to the tenth annual meeting of the Illinois Academy of Science, gave a report of that meeting. A number of papers of general interest were read and the president announced that other papers would be read before the appropriate sections, which were: 1, Geology; 2, Zoology and Botany; 3, Mathematics, Physics and Chemistry.

Professor R. A. Millikan, of the University of Chicago, was to have given the annual address, but