Vaginal impedance measurement used for mating in the rat

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Summary

An apparatus consisting of 2 silver ring electrodes attached to a plastic rod and connected to a transistor indicator was used to measure electrical impedance changes in the vagina of rats. A statistically significant increase in electrical impedance occurred at proestrus. By determining when this peak occurs, the optimal time for pairing can be established. In paired animals the absence of the peak provides a reliable means of diagnosing pregnancy.

A relationship between the electrical resistance of the vaginal mucous membrane and mucus and individual phases of the oestrous cycle in farm animals has been described by several authors including Ajzinbudas & Doviltis, 1962; Ajzinbudas, Lashas, Doviltis, Bakshis & Kukis, 1964; Sadovnikova, 1965; Ajzinbudas, Norvaishas & Lashas, 1966; Cerne, 1968; Aisinbudas *et al.*, 1969; Podaný & Muzikant, 1970; Podaný, Muzikant & Canderle, 1971; Podaný & Muzikant, 1972. The lowest values occur at oestrus. The application of this method to the rat, as first reported by Bartoš (1975), will now be described.

Materials and methods

2 silver ring electrodes set 3 mm apart and firmly attached to a plastic rod, diameter 4·5 mm, were introduced into the vagina. The probe was cleaned in alcohol-ether before use. Electrical impedance was measured by a transistor indicator with a 1 kHz oscillator constructed by Petráň (1960). Henceforth, the term 'electrical impedance of the vaginal mucous membrane' (EIv.m.m.) will be used for brevity though it also involves the EI of mucus at the site of measurement. EIv.m.m. is presented in absolute values. The oestrous cycle is divided into the 4 phases, oestrus, metoestrus, dioestrus and proestrus. Wistar-Konárovice rats, aged approximately 8 weeks and weighing 250 g, were divided into 4 groups.

Group I. In 25 rats EIv.m.m. was measured 4 times daily at 0600, 1200, 1800 and 2400 h for 7 days. Vaginal cytology was examined when peak values were recorded (February 1974).

Group II. In 10 rats EIv.m.m. was measured 1-3 times daily for 31 days including 2 oestrous cycles, mating, pregnancy and parturition (February-March 1974).

Group III. In 24 rats EIv.m.m. was measured 3 times daily at 0900, 1400 and 1900 h for 5 days. In each rat 2 vaginal smears were examined each day to determine the stage of the oestrous cycle (July 1974).

Group IV. In 25 rats the cyclicity of EIv.m.m. was established. They were then subdivided into 3 groups: 10 were spayed—the operation was usually performed 17 h after recording the maximal value of EIv.m.m.—and 10 others underwent a sham operation. Thereafter, the EIv.m.m. of these animals together with the 5 intact (control) rats was recorded once daily at 1300-1500 for 3 weeks.

The method was applied in practice in order to determine the length of pregnancy in connection with ontogenic experiments (November 1975). In 40 rats EIv.m.m. was measured once daily at 1300-1600 for 5 days. If the EIv.m.m. exceeded 3000 Ω the rats were placed with a male and left overnight. An inspection for young was made 6 times daily. The day following proestrus was taken as Day 0.

All of the experimental animals, including the males, were kept in the same room, which was maintained at 19-26°C, mean 23°C. They received a standard diet DOS 2b (VELAZ, Lysolaje 15, Praha 6, Czechoslovakia) and water acidified with hydrochloric acid to pH 3·5 ad libitum.

Results

A cyclic increase in EIv.m.m. was found in 47 of 59 rats in groups I, II and III. The periodicity corresponded with an oestrous cycle length of 95-135 h, and peak values of EIv.m.m. occurred during proestrus. The mean values of EIv.m.m. were 14 942 (3400-30 000), 1973 (700-3700), 1644 (400-2500) and 1400 (400-2200) Ω at proestrus, oestrus, metoestrus and dioestrus respectively. The difference in EIv.m.m. between proestrus (14, 942 ± 2055 Ω) and the other phases of the oestrous cycle (1620 ± 13 Ω) was statistically significant ($P<0·01$).

Maximal values of EIv.m.m. were found to be higher during the summer months (mean 15 733 ± 3004 Ω) than in winter (mean 6751 ± 1543 Ω). Peak values of EIv.m.m. occurred between noon and midnight, the mean highest being at 1554 (± 50 min). A typical record of EIv.m.m. in an individual rat is shown in Fig. 1. Fig. 2 illustrates the theoretical course of EIv.m.m. during the oestrous cycle.

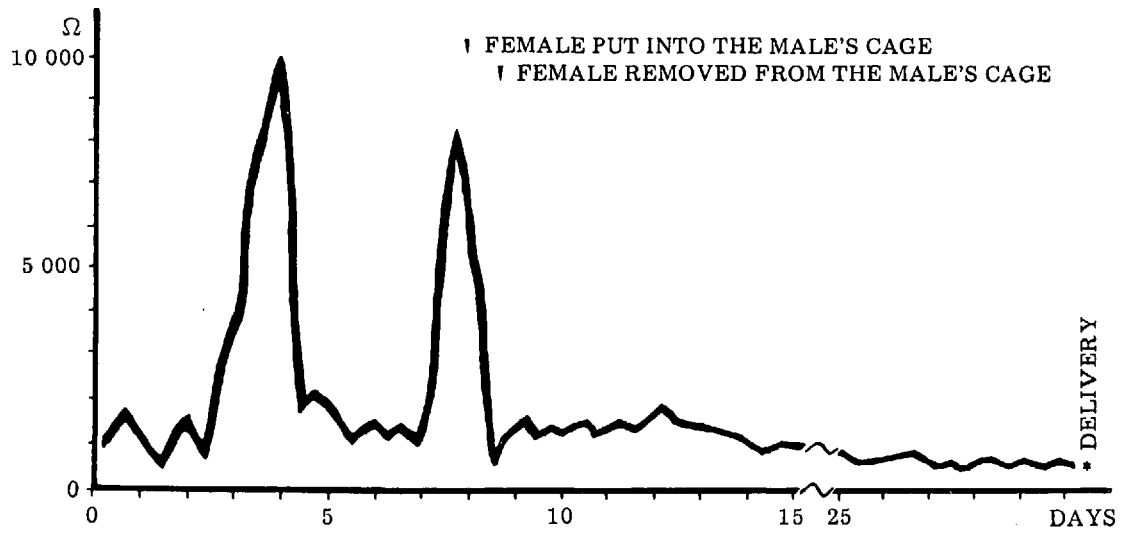

Fig. 1. An individual record of electrical impedance of the vaginal mucous membrane of a rat (experimental group II)

In the ovaries which were surgically removed (group IV) peak activity was evident macroscopically: histological preparations revealed ruptured follicles and early corpora lutea. The cyclicity of EIv.m.m. disappeared immediately after spaying. However, in the sham-operated animals cyclicity was not affected.

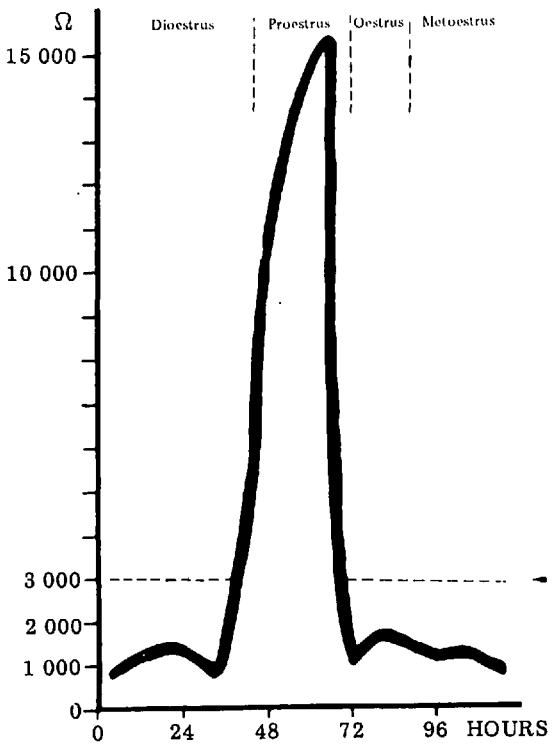

Fig. 2. Theoretical curve of the variation of electrical impedance of the rat vaginal mucous membrane during the oestrous cycle

Higher values than 3000 Ω were recorded in 36 of the 40 rats used for investigation of the length of pregnancy. 32 rats became pregnant as a result of the 1st pairing. The length of gestation was 22·9 days (22-23 days). Of the remaining 4 rats 1 failed to become pregnant even though it remained with the male for a month.

Measuring the EIv.m.m. in the 40 rats took about 10 min and was done by a single person.

Discussion

Although the course of EIv.m.m. during the oestrous cycle in the rat was similar to that reported for farm animals, the fact that peak values occurred at proestrus is at variance since the lowest values in farm animals were associated with oestrus. In the rat the values of EIv.m.m. recorded at oestrus were not the lowest. In the guinea-pig, too, an increase in EIv.m.m. occurred in proestrus (Bartoš & Sedláček, 1977). We suggest that the peak values of EIv.m.m. indicate maximal luteinizing hormone (LH) secretion corresponding with data published by Anderson & McShan (1966), who reported the highest concentration of LH from 6 to 12 h before ovulation. Everett (1948) fixed the time of ovulation at 0110-0230 in rats having 4·5 day cycles, as did also Marhan (1969), though with a less sharp time range. Hofmann & Schwartz (1965) indicated the time of maximal LH secretation to occur

between at 1400-1600, which is when we recorded the highest EIv.m.m. values.

Differences in the peak values of EIv.m.m. between winter and summer accord with the findings of Podaný & Muzikant (1970), who described a similar situation in cattle. Annual variation in the length of day light radiation might be responsible for the difference. Ajzinbudas *et al.* (1969) suggested that seasonal changes in diet could affect EIv.m.m. in farm animals, but in the laboratory where a standard diet is fed this factor can be ruled out.

Measuring EIv.m.m. has been used routinely in our Institute for determining the time to pair rats. Up till now over 300 rats have been successfully mated. The technique has also been used for diagnosing pregnancy since the absence of the cyclic peak is a reliable indicator of pregnancy.

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