

## CASE REPORT

### HYPERESTROGENISM IN FEMALE SWINE AS THE RESULT OF FEEDING MOULDY CORN

F. M. BRISTOL and S. DJURICKOVIC\*

#### Introduction

Many fungi have been isolated from mouldy grains and some of these isolates have caused a variety of syndromes (7). The first reports of a condition resembling estrus in sexually immature swine were made by Buxton in 1927 (3) and Legenhausen (10) and McNutt (12) in 1928. They associated vulvovaginitis with the feeding of mouldy corn. The condition affects primarily weaned gilts (8, 12, 15), but it has been described also in suckling piglets (15). McErlean (11) and Stamatovic *et al* (17), reported a similar condition when mouldy barley was fed.

Although morbidity is high in affected herds, mortality is rare and is associated with secondary complications resulting from vaginal prolapse (8, 12). Buxton (3) did, however, report an instance where the mortality was high.

*Fusarium graminearum* (*Giberella zeae*) was the predominant fungus isolated from affected corn and barley and it was shown to produce signs of estrus when fed experimentally to prepubertal gilts (4, 6, 13, 17). Stob *et al* (18), isolated an anabolic and uterotrophic compound from corn infected with *F. graminearum* which appeared to be responsible for the syndrome. An estrogenic metabolite, designated as F<sub>2</sub>, has since been isolated from autoclaved mouldy corn and pelleted feed (4, 13). The compound, F<sub>2</sub>, has also been isolated directly from *F. graminearum*. It appears to be a derivative of resorcinylic acid and has been named zearalenone (19).

#### Clinical Observations

The authors have investigated a number of outbreaks in which sexually immature female swine had clinical signs of prolonged estrus. The vulvas were markedly edematous and hyperaemic with a slightly turbid mucoid vaginal discharge (Figures 1 and 2). In one outbreak, 40 per cent of the affected gilts had varying degrees of vaginal prolapse (Figure

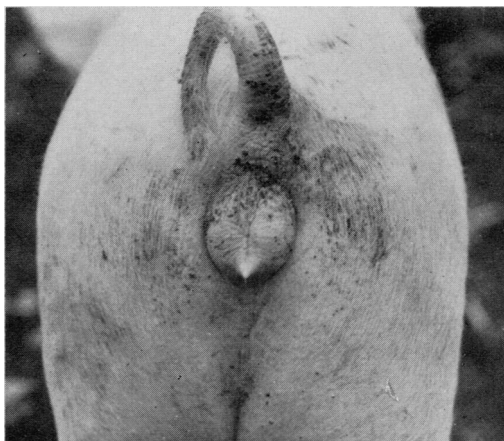


FIGURE 1. A four-month-old gilt with an enlarged edematous vulva.



FIGURE 2. Two eight-week-old females with enlargement of the vulva.

3) together with marked signs of tenesmus. Affected animals urinated frequently and the pens were often very wet as a result. Many of the affected animals had varying degrees of mammary development (Figure 4). The gilts generally had a positive "back pressure" test for estrus.

Vaginal biopsies taken from the anterior vagina were sectioned. The vaginal epithelium was ten to 15 layers in thickness. The super-

\*Department of Clinical Studies, Ontario Veterinary College, Guelph, Ontario.

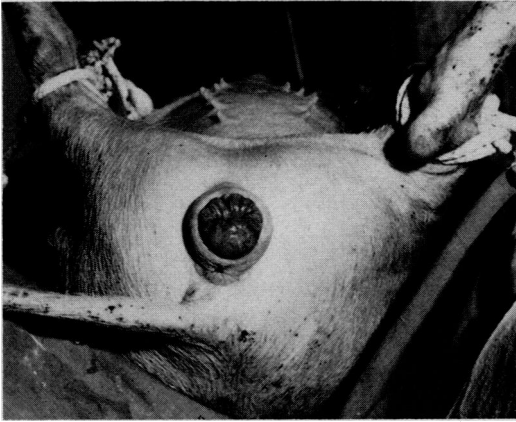


FIGURE 3. A four-month-old gilt with a prolapsed vagina.

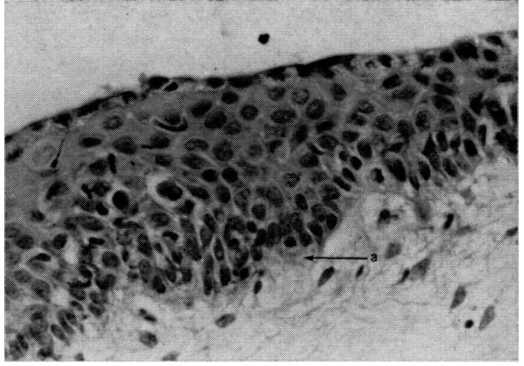


FIGURE 5. A section of the vaginal epithelium. The epithelium is approximately 12 layers in thickness. Note the presence of epithelial invaginations (a).  $\times 135$ .

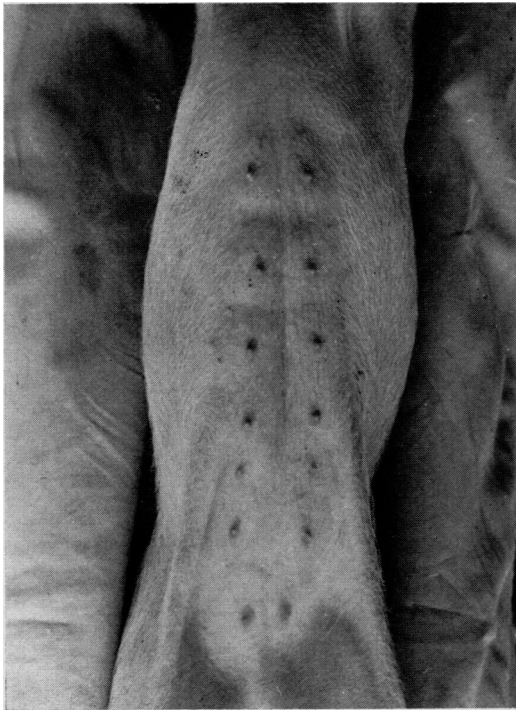


FIGURE 4. A ten-week-old gilt with enlarged mammary glands.

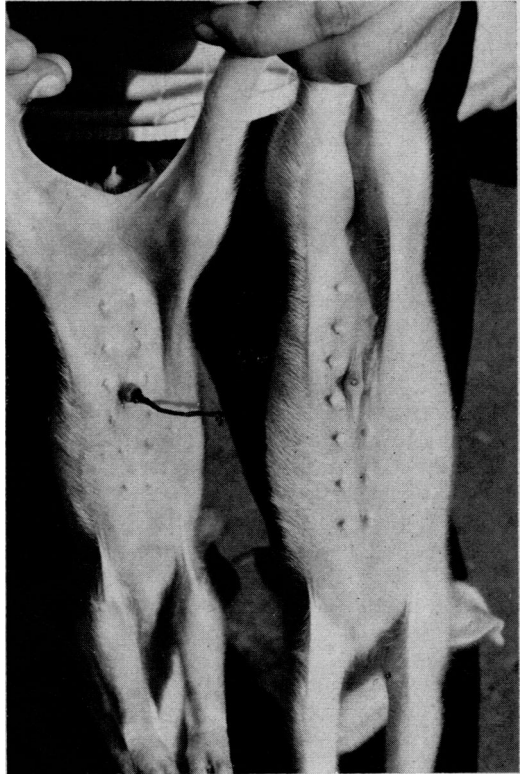


FIGURE 6. Two suckling piglets with enlargement of the mammary gland and vulva.

ficial cells were squamous in nature. The cells in the stratum germinativum had many epithelial invaginations (Figure 5), evidence of rapid proliferation.

The incidence of the condition was confined to groups of pigs being fed contaminated feed and was observed in all age groups including suckling pigs (Figure 6). Libido in mature boars was decreased markedly. In most instances the symptoms disappeared within two weeks after withdrawal of the contami-

nated feed from the ration. In one case a commercial feed was substituted but the signs of hyperestrogenism persisted until a second change in feed was made.

In all outbreaks corn was the principle grain in the ration and in most cases it was stored as shelled corn under good dry conditions. On one farm it was being stored unshelled in a damp area.

A random sample of corn kernels was incubated at room temperature in large plastic petri-dishes. The predominant fungus found in these incubated kernels was *F. graminearum*, although *alternaria*, *penicillium* and *mucor* were also identified.

#### Discussion

Estrogen-like substances of plant origin have been shown to cause severe economic losses in sheep and also to some degree in cattle (14, 16). In swine, although morbidity is usually high, mortality seldom occurs unless there is secondary infection as a result of a pronounced traumatised vaginal prolapse. Vaginal prolapses can be corrected by inverting the prolapse and fixing with a purse-string suture. The condition causes more serious losses where breeding females are affected as it can disrupt a breeding program. In one instance there were no conceptions for four months due to prolonged estrus in the females and lack of libido in the males. Further economic loss is incurred as the farmer has to purchase other feed for his breeding stock. The feed contaminated by *F. graminearum* may be diluted and fed to growing pigs.

Although prepuccial swelling and mammary development have been described in males, we did not observe this clinical feature (8, 10, 18). We did, however, see an outbreak where libido of mature boars was greatly reduced.

The vaginitis present in this condition appeared to cause some discomfort as the animals urinated frequently and many of them showed signs of tenesmus.

The vaginal epithelium was similar in appearance to that observed at the time of estrus (1, 2, 5). When estradiol was given to ovariectomised gilts, there was a marked proliferation of the vaginal epithelium (1, 9), a condition similar to that observed in the affected gilts.

We were unable to ascertain the period taken for clinical signs to appear after contaminated feed was fed initially. Experimentally it was shown that clinical signs appeared within ten days (6, 12, 17, 18). The clinical signs disappeared approximately two weeks after the contaminated feed was withdrawn from the ration. Some researchers described recovery within six days (3, 6, 15).

Most fungi of the genus *Fusarium* have estrogenic activity, only a few have no activity at all. *F. graminearum* and *F. culmonum* have the highest activity. Incubation time and temperature seemed to play a role in the estrogenic activity of the fungus, as it was

found that *F. graminearum* incubated at 25 to 28° C for 6 to 10 weeks had the highest estrogenic activity in female rats. It appeared that certain climatic conditions favoured the growth of *Fusarium* sp. as some outbreaks of hyperestrogenism were associated with warm, wet weather during harvesting (8, 11, 15).

Storage conditions of contaminated grain were varied and the condition was seen where both good and poor storage was used. The severity seemed to depend on the quantity of contaminated grain being incorporated in the ration.

The estrogenic compound produced by *Fusarium* sp. appears to be very heat stable as it has been isolated from autoclaved mouldy corn (4, 13) and from pelleted feed (4). It also appears that the compound can be excreted in the milk as hyperestrogenism has been described in suckling piglets (12, 15).

#### Summary

A number of outbreaks of hyperestrogenism in female swine due to feeding mouldy corn have been described. The affected animals ranged in age from one week to maturity. The females had signs of prolonged estrus and mammary development while the males had decreased libido. Although a number of fungi were isolated from the affected corn, *F. graminearum* was the predominant fungus. The histology of the vaginal epithelium from affected animals is described.

#### Résumé

On a déjà décrit un certain nombre de cas d'hyperœstrogénie chez des truies nourries avec du maïs mois. Leur âge variait d'une semaine jusqu'à la maturité. Ces truies présentaient des signes d'œstrus prolongé et du développement des glandes mammaires, tandis que les verrats subissaient un affaiblissement de l'instinct sexuel. En dépit du grand nombre de champignons isolés du maïs mois, *F. graminearum* prédominait. Les auteurs décrivent l'histologie de l'épithélium vaginal des truies affectées.

#### References

1. BOSU, W. T. K. The use of vaginal biopsies for the study of reproduction in swine. M.Sc. thesis. University of Guelph. 1969.
2. BRISTOL, F. M. Unpublished data.
3. BUXTON, E. A. Mycotic vaginitis in gilts. Vet. Med. 22: 451-452. 1927.
4. CHRISTENSEN, C. M., G. H. NELSON and C. J. MIROCHA. Effect on the white rat uterus of a toxic substance isolated from *Fusarium*. Appl. Microbiol. 13: 653-659. 1965.
5. DONE, J. T. Early pregnancy diagnosis in

- the sow by vaginal biopsy. *Vet. Rec.* 8: 64-68. 1968.
6. ERIKSEN, E. Oestrogene faktorer i muggent korn. *Vulvovaginitis hos svin.* *Nord VetMed.* 20: 396-401. 1968.
  7. FORGACS, J. and W. T. CARLL. *Mycotoxicosis.* *Adv. vet. Sci.* 7: 273-382. 1962.
  8. KEON, J. S. and H. C. SMITH. An unusual case of genital involvement in swine associated with eating mouldy corn. *Vet. Med.* 40: 131-133. 1945.
  9. KURTZ, H. J., M. E. MAIRN, G. H. NELSON, C. M. CHRISTENSEN and C. J. MIROCHA. Histologic changes in the genital tracts of swine fed estrogenic mycotoxin. *Am. J. vet. Res.* 30: 551-556. 1969.
  10. LEGENHAUSEN, A. H. Poisoning due to mould on corn. *Vet. Med.* 23: 29. 1928.
  11. McERLEAN, B. A. *Vulvovaginitis in swine.* *Vet. Rec.* 64: 539-540. 1952.
  12. McNUTT, S. H., P. PURWIN and C. MURRAY. *Vulvovaginitis in swine.* *J. Am. vet. med. Ass.* 73: 484-492. 1928.
  13. MIROCHA, C. J., C. M. CHRISTENSEN and G. H. NELSON. Estrogenic metabolite produced by *Fusarium graminearum* in stored corn. *Appl. Microbiol.* 15: 497-503. 1967.
  14. MOULE, C. R., A. W. H. BRADEN and D. R. LAMOND. The significance of oestrogens in pasture plants in relation to animal production. *Anim. Breed. Abstr.* 31: 139-157. 1963.
  15. PULLAR, E. M. and W. M. LEREW. *Vulvovaginitis in swine.* *Aust. vet. J.* 13: 28-31. 1937.
  16. SAMUEL, D. E. A review of the effects of plant estrogen substance on animal reproduction. *Ohio J. Sci.* 67: 308-312. 1967.
  17. STAMATOVIC, S. Z. LJSEVIC and S. DJURIC-KOVIC. O jednoj fungalnoj alimentarnoj intoksikaciji svinja. *Vet. Glasn.* 6: 507-510. 1962.
  18. STOB, M., L. S. BALDWIN, J. TUIITE, F. M. ANDREWS and K. G. GILLETE. Isolation of an anabolic uterotrophic compound from corn infected with *Gibberella zeae*. *Nature, Lond.* 196: 1318. 1962.
  19. URRY, W. H., H. L. WEHRMEISTA, E. B. HODGE and P. H. HIXY. The structure of zearalenone. *Tetrahedron letters* 27: 3109. 1966.

## BOOK REVIEW

*Principles of Radiation Chemistry.* J. H. O'Donnell and D. F. Sangster. Published by Edward Arnold and The Macmillan Company of Canada Limited, Toronto. 1970. 176 pages. Price \$16.00.

Radiation chemistry is a relatively young science. In spite of the importance of radiation application, the principles were not well established until recent years. However, a number of modern techniques have accelerated the growth of radiation chemistry. Electron spin resonance and pulse radiolysis techniques have particularly contributed to the recent development, revealing many basic facts of irradiation effect.

This book by O'Donnell and Sangster is written concisely for those who are not familiar with modern radiation chemistry, and will serve as a timely guide book. The subjects

and methods of radiation chemistry are multidisciplinary as stressed by the authors. The contents of the book are well organized systematically.

After a brief summary of the historical development, the authors started with general discussion about interaction of radiation with matters. Then basic and special techniques are followed by numerous applications to different systems, including organic, polymer, biochemicals and biological systems. The last chapter summarizes practical and industrial applications with up-to-date topics.

Two appendices in the book are particularly useful. One of them summarizes definitions, units and conversion factors which are often confusing for non-specialists. The other gives typical examples of calculations of dosimetry, radiation, decomposition rates, etc. *M. Fujimoto.*