

## Ergotism and Other Mycotoxicoses in Ancient Mesopotamia?

Robert D. Biggs

The Oriental Institute, University of Chicago

It is well known that the synthetic hallucinogen LSD (*d*-lysergic acid diethylamide) is derived from ergot, a fungus that grows on a variety of grasses. While the synthetic form is a relatively recent formulation and has inspired a scholarly literature of its own, the effect of ergot in human health has also been studied extensively in recent years<sup>1</sup>. When ingested in sufficient quantities, ergot produces a disease called ergotism which, in serious cases, has two variants, gangrenous and convulsive<sup>2</sup>. The designation "convulsive" does not refer to true convulsions when consciousness is lost. The symptoms of convulsive ergotism include tingling in the fingers, crawling sensations on the skin, headaches, vertigo, muscle spasms leading to epileptic type convulsions, confusion, delusions, hallucinations, vomiting, and diarrhea<sup>3</sup>. In connection with some of these manifestations, it is worth mentioning that there has been a serious suggestion that ergotism was a major factor in the infamous Salem witchcraft affair of 1691 and 1692<sup>4</sup>. It has also been implicated in *la grande peur* in France in 1789<sup>5</sup>.

We are all familiar with a number of fungi, which include mushrooms, molds, and mildews. We are also aware of the toxicity of some, especially mushrooms, but nevertheless a number of people each year are poisoned because they make a bad choice of which mushrooms to eat. Mushrooms, of course, are very visible fungi about which a great deal is published and about which many people consider themselves knowledgeable. Other groups of fungi also produce natural chemicals that are poisonous to humans. Many fungi we are conditioned to avoid because they smell, taste, or look "bad", whether or not they are toxic.

Many fungi affect grains, the most prevalent and best known being smut and rust. In fact, fungi are

1. An excellent summary, especially as applied to Eastern Europe and the British Isles, is Mary Kilbourne Matossian, *Poisons of the Past: Molds, Epidemics, and History* (New Haven and London, 1989).

2. The gangrenous form of ergotism was known in the Middle Ages as "St. Anthony's Fire" and was perceived as divine punishment; in extreme cases, it led to loss of limbs to gangrene.

3. *Ibid.*, Table I on pp. 11-12.

4. Linda R. Caporalet, "Ergotism: The Satan Loosed in Salem?", *Science* 192 (1976): 21-26. While the evidence is circumstantial, the case was so notorious even at the time that a great deal of evidence was gathered and is preserved. Her proposal seems now to have a measure of acceptance.

5. Matossian, *Poisons of the Past*, Chapter 6, "The Great Fear of 1789", pp. 81-87 and bibliography on pp. 171-173.

almost universally present in plant products, but toxicity seems to be the exception rather than the rule<sup>6</sup>. In this paper, however, we are concerned only with those that are toxic to humans or to domestic animals, particularly livestock, and which occur in cereal crops.

While it has been known for several centuries that ergotism is associated with contaminated cereal grains, it was not until the early 1960s that a substantial number of scientific researchers became concerned with toxic molds<sup>7</sup>. The catalyst for the research was the discovery of the toxic impact of molds in peanuts (initially in the "Turkey-X" disease in England when hundreds of thousands of turkey poults died).

Of the various fungi in this group, there is a genus known as *Claviceps* which has a seed-like form called a sclerotium<sup>8</sup>. While there are ten or more species of *Claviceps* (one source says there are more than fifty species), *C. purpurea* is the most common cause of ergotism in domestic animals and man<sup>9</sup>. This group of fungi, produced on crops in the field, is called ergot (the French word for the spur on a rooster's leg, which it somewhat resembles). The sclerotia contain alkaloids which can affect every system of the human body<sup>10</sup>. Among the chemicals which make up ergot are some which act as an abortifacient; others suppress fertility or stop lactation, thus obviously interfering with the production and sustenance of offspring<sup>11</sup>. Ancient evidence for ergotism is necessarily somewhat vague and uncertain. Rensburg and Altenkirk have pointed out that Pliny gave a reasonably accurate morphological description of ergot, with the environmental conditions for its development and some indications of its toxicity<sup>12</sup>.

A second group of fungi which have toxic effects is made up of molds produced by various species of the genus *Fusarium* that contaminate cereals. Best known and best documented is the one that causes alimentary toxic aleukia (ATA), responsible for many thousands of deaths in the Soviet Union during World War II and up to 1947 due to consumption of contaminated rye<sup>13</sup>. As the name implies, the disease affects the immune system. However, all cereal crops, and not just rye, are vulnerable to the various *Fusarium* molds, some species of which can produce toxins lethal to humans<sup>14</sup>. While ergot toxins and

6. Thomas D. Wyllie and Lawrence G. Morehouse, *Mycotoxic Fungi, Mycotoxins, Mycotoxicoses: An Encyclopedic Handbook*, vol. 3, *Mycotoxicoses of Man and Plants: Mycotoxin Control and Regulatory Aspects* (New York and Basel, 1978), p. 147.

7. Elmer H. Marth, "Mycotoxins", in Dean O. Cliver, ed., *Foodborne Diseases* (San Diego [and other cities], 1990), p. 139.

8. For an illustration showing it on rye and wheat, see Matossian, *Poisons of the Past*, p. 8, fig. 1. For a color photograph of *Claviceps purpurea* sclerotia, see W. F. O. Marasas and Paul E. Nelson, *Mycotoxicology: Introduction to the Mycology, Plant Pathology, Chemistry, Toxicology, and Pathology of Naturally Occurring Mycotoxicoses in Animals and Man* (University Park and London, 1987), pl. 1.

9. Thomas D. Wyllie and Lawrence G. Morehouse, *Mycotoxic Fungi, Mycotoxins, Mycotoxicoses: An Encyclopedic Handbook*, vol. 2, *Mycotoxicoses of Domestic and Laboratory Animals, Poultry, and Aquatic Invertebrates and Vertebrates*, (New York and Basel, 1978), p. 3.

10. More than forty alkaloids have been isolated from *C. purpurea* sclerotia. See Marasas and Nelson, *Mycotoxicology*, p. 21.

11. S. J. van Rensburg and B. Altenkirk, "Claviceps purpurea-Ergotism", in I. F. H. Purchase, *Mycotoxins* (Amsterdam, Oxford, and New York, 1974), p. 72, say that there is no evidence that ergot is truly abortifacient or that lactation is significantly suppressed in humans. On the other hand, Wyllie and Morehouse, *Mycotoxic Fungi*, vol. 2, p. 149, after citing a number of studies, state that the role of ergot in abortion remains an open question.

12. Van Rensburg and Altenkirk, "Ergotism", p. 69.

13. Matossian, *Poisons of the Past*, pp. 14-19 and, within a larger framework, her chapter "A Case Study: Russia and Its Neighbors", pp. 22-43. Cattle, horses, pigs, and dogs are also affected by the disease. See M. A. Crawford, "Epidemiological Interactions", in I. F. H. Purchase, ed., *Symposium on Mycotoxins in Human Health* (London, 1971), p. 238. For further details, see Abraham Z. Joffe in the section "Alimentary Toxic Aleukia", in the chapter "Effects of Fusariotoxins in Humans", *Fusarium Species: Their Biology and Toxicology* (New York, 1986), pp. 225-86. His chapter "Human Infections Associated with *Fusarium* Species", *ibid.*, pp. 293-98, gives details on various conditions, including ulcers, necrosis, and other lesions of the skin believed caused by *Fusarium* species.

14. Matossian, *Poisons of the Past*, pp. 14-15.

*Fusarium* toxins differ (the latter, for example, apparently cannot pass through the mother's milk<sup>15</sup>), their effects can be similar. *Fusarium* molds are produced during storage or when crops overwinter in the field.

In addition to products of the genus *Fusarium*, various other poisonous fungi – mycotoxins, to use the current terminology – have immunosuppressive capabilities as well. Aflatoxins<sup>16</sup> are produced by the molds *Aspergillus flavus* and *Aspergillus parasiticus* on a variety of grains and other agricultural commodities<sup>17</sup>. Generally, aflatoxins are produced during storage (warm temperature and a certain relative humidity are required for production of toxins), but at least *A. flavus* can invade some crops before harvest<sup>18</sup>. Someone who ingests this mold and does not die of acute poisoning can still die later as a result of another illness because of an impaired immune system. The term "aflatoxicosis" is now sometimes used to describe illness caused by this group of fungi.

Ergotism can be a lethal disease. Matossian points out that during ten epidemics recorded in Russia from 1832 to 1864, from 11 percent to 66 percent of those who became ill died, yielding a mean mortality rate of 41.5 percent<sup>19</sup>. Ergotism can occur at any time of the year since ergot alkaloids retain their toxicity for up to eighteen months, but epidemics occur most commonly after the rye harvest when ergot is most toxic<sup>20</sup>.

Ergotism – in the strict sense – is primarily associated with rye, especially in Europe. Nevertheless, ergot is still found in grain crops in the United States. According to United States Department of Agriculture standards, grain is ergoty if it contains more than 0.3% of *Claviceps sclerotia* by weight, and the sclerotia must be removed before the grain can be used for human food. Apparently no such standards apply to grain used for livestock feed<sup>21</sup>, and cases of livestock poisonings are documented in the quite recent past. There is at present very little evidence for the cultivation of rye in ancient Mesopotamia<sup>22</sup>. Yet it is known that other grass crops are affected by ergot as well.

In the discussion in this paper I sometimes use the term "ergot" or "ergotism" when perhaps the less specific terms "mycotoxin" and "mycotoxicosis" would be more appropriate, but with the impossibility of making such distinctions in an ancient society, it should be understood that the discussion is meant to encompass the entire range of possible poisoning by fungi associated with grain crops.

Ergot is unusually dangerous since it is not killed in the baking process and thus is consumed in bread<sup>23</sup>. In many societies, especially in low income groups or in times of limited food supplies, people

15. Joffe, *Fusarium Species*, p. 370.

16. Marth, "Mycotoxins", p. 138, gives an explanation of the term: "This material was given a trivial name by taking the 'a' from *Aspergillus*, the 'fla' from *flavus*, and adding 'toxin' to get 'aflatoxin'".

17. Muriel S. Palmgren and Alex Ciegler, "Aflatoxins", in Richard F. Keeler and Anthony T. Tu, *Handbook of Natural Toxins*, vol. 1, *Plant and Fungal Toxins* (New York and Basel, 1983), p. 299. They describe aflatoxins as "a group of structurally related secondary fungal metabolites that are carcinogenic, hepatotoxic, teratogenic, and immunosuppressive", *ibid.* In connection with the teratogenic effects, it seems to me probable that some of the malformed children and animals described in the Babylonian omen series *Šumma Izbu* are a result of consumption of aflatoxins by the mother. The standard edition of the omen series is Erle V. Leichty, *The Omen Series Šumma Izbu*, Texts from Cuneiform Sources, vol. 4 (Locust Valley, 1968).

18. Palmgren and Ciegler, "Aflatoxins", p. 301, but see the comments of Marth, "Mycotoxins", p. 150, on conditions governing aflatoxin production. See also Wyllie and Morehouse, vol. 3, p. 151.

19. Matossian, *Poisons of the Past*, p. 12.

20. *Ibid.*, p. 14. Rye is particularly vulnerable to *Claviceps* because, unlike other cereals, it depends largely on cross-fertilization and therefore opens its glumes in order to receive pollen from other plants – and consequently spores of *Claviceps* at the same time. See van Rensburg and Altenkirk, "Ergotism", p. 85.

21. Marth, "Mycotoxins", p. 141.

22. See Daniel Zohary and Maria Hopf, *Domestication of Plants in the Old World: The Origin and Spread of Cultivated Plants in West Asia, Europe, and the Nile Valley* (Oxford, 1988), pp. 63-71. There is ample evidence of rye (usually weedy varieties) in present-day Turkey and Iran. See especially *ibid.*, p. 69. See also Michael Zohary, *Geobotanical Foundations of the Middle East* (Stuttgart and Amsterdam, 1973), vol. 2, pp. 624-25.

23. Marth, "Mycotoxins", p. 142, states that toxins in grain are destroyed at or above 200° C, far higher than temperatures attained during the baking process. He makes this statement in connection with *Fusarium*, but I understand it to apply to all mycotoxins in grain.

tend to consume large amounts of bread and thus potentially harmful quantities of toxins. Bread containing as little as two percent ergot can cause a community-wide epidemic of ergotism<sup>24</sup>.

Because diseases caused by mycotoxins apparently occur in all parts of the world where climate and storage conditions are favorable for these groups of fungi to contaminate foodstuffs, it seems entirely likely that these diseases occurred in the ancient Near East. I have not seen in the scholarly literature any specific mention of the occurrence of ergotism in Iraq. While it may well be that the winters in southern Iraq are too mild to provide necessary climatic conditions for ergot, it seems probable that the colder areas in the north would be suitable. The other mycotoxicoses discussed here, however, occur throughout the world. I believe that there is evidence in cuneiform texts that there may have been frequent bouts – probably even epidemics – of ergotism or other mycotoxicoses in ancient Mesopotamia.

A striking example is to be found, I believe, in a recently published letter from Mari where several people in a single family died almost simultaneously. The passage in question is “The three children of PN have all died at the same time. On the first day when they got sick, PN sent to me (requesting) a diviner (to ascertain the cause of their illness); I sent a diviner. The second day, before nightfall, they had all died”<sup>25</sup>. This is at least consonant with Matossian’s statement that ergotism preferred the young as its victims and that it tended to affect many or all members of the same household more or less simultaneously<sup>26</sup>. She also comments that in the past – in fact until modern times – ergotism was often mistaken for an infectious and contagious disease<sup>27</sup>.

It is well known that both humans and domestic animals are affected by ergotism. As is equally well known, this is not the case with most diseases that afflict humans in an epidemic fashion. There are several passages in Mari texts that seem significant to me. “At GN the god has begun to consume cattle and humans; in a single day two or three people died”<sup>28</sup>. In other instances, it may be significant that specific mention is made of cattle being fattened<sup>29</sup>. “One prime fattened ox (intended for) an offering got very fat but (now) has gotten sick; he will not eat anything. Now I am afraid this ox is going to die”<sup>30</sup>. Among symptoms of aflatoxicosis in cattle are loss of appetite and emaciation<sup>31</sup>, clearly fitting this case. One authority specifically mentions feed refusal as one of the earliest signs of a mycotoxin problem<sup>32</sup>. Another passage from Mari is also relevant for our discussion: “one ox, a palace offering, has fleshed out and has gotten heavy, but when he (tries to) stand up, his feet get bloody and he cannot stand up, and toward his food he ...; he has to be forced to stand up; that ox cannot go to Mari”<sup>33</sup>. Bhat also discusses the problem of mycotoxins of silages, possibly relevant for our cases<sup>34</sup>. Interesting in this connection is that

24. Matossian, *Poisons of the Past*, p. 7. On p. 83 she gives one percent as an amount sufficient to cause a full-blown epidemic.

25. Jean-Marie Durand, *Archives épistolaires de Mari* 1/1, No. 280:5-11. In the discussion of Mari texts, I have benefited from Durand’s discussions in his chapter “Maladies et médecines”, *ibid.*, pp. 543-60, and some of the references I cite come from this chapter.

26. Matossian, *Poisons of the Past*, p. 12.

27. *Ibid.*

28. J. R. Kupper, *ARMT* 3, No. 61:9-13.

29. Akkadian *marû*. While the dictionaries do not make this explicit, I believe that animals designated by that term are confined and are being fed grain and fodder rather than being allowed to graze. This could have a significant bearing on the possibility of their suffering from poisoning by ergot or other mycotoxins.

30. M. Birot, *ARMT* 14, No. 5:5-9. The following letter also concerns the same sick ox.

31. Ramesh V. Bhat et al., *Health Hazards of Mycotoxins in India* (New Delhi, 1978), p. 12.

32. G. Paul Lynch, “Biological Effects of Mycotoxins on Ruminants”, *Interactions of Mycotoxins in Animal Production: Proceedings of a Symposium July 13, 1978 Michigan State University* (Washington, D.C., 1979), p. 97.

33. Charles-F. Jean, *ARMT* 2, No. 82:29-35. This is perhaps the gangrenous manifestation of ergot poisoning. See descriptions in Bhat et al., *Health Hazards*, p. 17.

34. Lynch, “Biological Effects”, p. 113.

studies have shown that the liver in sheep and goats can metabolize toxins better than does the liver in cattle<sup>35</sup>. Consequently, cattle are more likely to show overt signs of illness.

In view of the difficulty in distinguishing between infectious diseases and other epidemic diseases, I would not want to suggest that most, or even many, examples of death in epidemics are ergotism or mycotoxicosis, but I believe the indirect evidence goes beyond the letters cited above. One of the most noticeable results of the fungal poisoning being discussed here – even in mild cases – is miscarriages in both humans and domestic animals who consume contaminated grain. Studies have shown a statistically significant drop in fertility – that is, pregnancies brought to term – when pregnant women or animals consume such grain products. In the case of livestock, it has been shown that mycotoxins are responsible for infertility in a variety of ways<sup>36</sup>. Because of this known and documented correlation, it seems to me that when the astronomical diaries or the so-called astrological texts say “women had/will have miscarriages”, it may well reflect periods when the population was consuming quantities of tainted cereal crops, which would normally be when stored grains were being used.

I should like to cite several passages from cuneiform texts which could, in my opinion, refer to illness caused by mycotoxins. It must be remembered, however, that it was only in modern times that a definite connection between consumption of grain products and ergotism was established and that therefore no mention of the connection can be expected.

The Babylonian astronomical diaries, while their principal purpose was to record risings, settings, and conjunctions of heavenly bodies, weather phenomena, and such, also provide additional information on such matters as prices of staple products at Babylon in each month and levels of the Euphrates. Political events and other noteworthy events are also recorded. Among the latter are events affecting the population at large, such as swarms of locusts. Of interest to us here are reports relating to health matters<sup>37</sup>. I believe the following passages are particularly relevant. LÚ.GIG.ME AN.TI.LA *ina* KUR GÁ[L], “there was recovery for sick people”<sup>38</sup>; a similar passage is ITI BI LÚ.GIG AN.TI.L[A], which is surely to be interpreted as “that month sick people recovered”<sup>39</sup>. I believe this topos of sick people recovering may reflect recovery from ergotism or from other fungal toxins at a time of the year when large quantities of stored grain were no longer being consumed. Note that the month of recovery indicated in the astronomical diaries can be determined. Month III in 368 B.C. began on May 31; month II in 367 B.C. began on May 21<sup>40</sup>. By this time, the new barley crop would have been harvested and people would no longer be consuming the previous year’s stored grain. I believe that it is significant that one of the seventh century

35. Bhat et al., *Health Hazards*, p. 16. Nevertheless, the livers show pathological effects, suggesting yet another cause for anomalies in sheep livers examined by diviners in extispicy.

36. Lynch, “Biological Effects”, p. 109.

37. A. J. Sachs and H. Hunger, *Astronomical Diaries and Related Texts from Babylonia*, vol. 1, *Diaries from 652 B.C. to 262 B.C.* (Vienna, 1988). An example is p. 360, text –266, obv. 16 (month VIII, 267 B.C.) ITI BI LÚ.GIG.MEŠ MAH ŪŠ.MEŠ, “that month many sick people died”. However, month VIII began October 20, and I would doubt that the deaths in that month were associated with consuming tainted grains.

38. *Ibid.*, p. 126, text –368, rev. 8 (month III, 369 B.C.). The Akkadian reading of the first two words is uncertain, but note the passage from an eclipse omen *a-na* GIG AN.TI.LA and the Old Babylonian parallel to the same omen which has *a-na mu-ur-sa-ni ba-la-ti*, apparently meaning (assuming the entire relevant passage has been cited) “(favorable for) the recovery from illnesses”. See Francesca Rochberg-Halton, *Aspects of Babylonian Celestial Divination: The Lunar Eclipse Tablets of Enūma Anu Enlil*, AIO Beiheft 22 (Horn, Austria, 1988), p. 275 and now her review of the first volume of the astronomical diaries in *JAOS* 111 (1991), with the relevant Old Babylonian passages cited on p. 331. I am not convinced, however, that the parallel is not more apparent than real.

39. Sachs and Hunger, *Astronomical Diaries*, vol. 1, p. 130 text –366, A, col. ii 10 (month II, 367 B.C.). Note that this logographic writing is not merely one of the esoteric writings found in the Late Babylonian astronomical diaries. It is in fact found in a text of the seventh century B.C. to be cited next.

40. See the tables in Richard Parker and Waldo H. Dubberstein, *Babylonian Chronology 626 B.C.-A.D. 75*, 2d ed., Brown University Studies 19 (Providence, 1956).

astrological reports explicitly associates the identical phrase with a statement that women will carry their fetuses full term: GIG AN.TI.LA *ina* KUR GÁL.MEŠ SAL.PEŠ, MEŠ šà ŠĀ-ši-na *ú-šak-la-la*, "there will be recovery for sick people in the land, pregnant women will carry their fetuses full term"<sup>41</sup>.

I believe it is unlikely that the Babylonians or Assyrians had a single term for the diseases now recognized as mycotoxicoses – especially in view of the many and varied symptoms. Nevertheless, I will venture to suggest a term that may indicate the diseases in some of their manifestations. The following passage, making an explicit connection between a named illness or disease and miscarriages by pregnant women may be significant: *li-'bu ina* KUR *ú-la-'ib* SAL.PEŠ, MEŠ šà ŠĀ-ši-na NU SILIM.MEŠ, "there will be an epidemic of *li'bu*-disease in the country, pregnant women will not carry their fetuses full term"<sup>42</sup>. Other passages cited in *CAD* s.v. *la'ābu* might be cited, such as those saying the *li'bu*-disease will be epidemic in the land, passages connecting it with sorcery, or the passage in Ludlul II where it is said to make a body part shake. Such statements occur with too many other terms for illnesses, however, to carry any particular weight in this discussion<sup>43</sup>.

It has been suggested that *samānu* is an ergot-like blight on grain<sup>44</sup>. It is also the name of an illness affecting humans (numerous occurrences), and is once attested in a lexical text as affecting sheep; it is also the name of an insect. In my opinion, all passages connected with barley refer to an insect or a field pest and do not suggest identification with ergot – the harmful effects of which were not known until modern times.

There is no doubt that aflatoxins cause severe liver damage, especially when associated with protein malnutrition<sup>45</sup>. I suspect that this may help to account for the frequent mention of jaundice in the Babylonian medical texts<sup>46</sup>.

It has been suggested that mycotoxins might have been responsible for the plagues reported in Exodus and for the ailments of Job<sup>47</sup>, but I believe that there is a much more likely instance. It is Sennacherib's campaign to Judah, reported in 2 Kings 18:13-19:37, where in verse 19:35 the text says (citing the translation of the Revised Standard Version), "And that night the angel of the Lord went forth, and slew a hundred and eighty-five thousand in the camp of the Assyrians; and when men arose early in the morning, behold, these were all dead bodies". This passage has been discussed repeatedly by commentators, and attitudes have ranged from considering it entirely legendary to believing that there is a kernel of historical truth in it – at least to the extent of accepting that many of the Assyrian army died within a short time and that the army consequently withdrew to Assyria<sup>48</sup>. It certainly seems plausible that the army, probably dependent largely on cereals for nutrition, would have been vulnerable to a disease caused by contaminated grain.

41. R. Campbell Thompson, *The Reports of the Magicians and Astrologers of Nineveh and Babylon* (London, 1900), No. 207, rev. 4-5. A New edition of these texts is in preparation by Hermann Hunger, to appear in the series *State Archives of Assyria*.

42. Rochberg-Halton, *Lunar Eclipse Tablets*, p. 243:4. There are also many passages where the phrasing is different, using the verb *nadū*, one of whose meanings is "to have a miscarriage". An example is *e-ri-a-tum šà ŠĀ-ši-na ŠUB-di-a ACh* Sin 34:25. Other passages, some from extispicy texts, are cited in *CAD* s.v. *nadū*, meaning 1e-2.

43. See also passages cited in *CAD* s.v. *li'bu*.

44. *CAD* s.v. *samānu* B, discussion section.

45. Bhat et al., *Health Hazards*, pp. 14, 22, and 25. See also T. C. Campbell and L. Salamat, "Aflatoxin Ingestion and Excretion by Humans", in I. F. H. Purchase, ed., *Symposium on Mycotoxins in Human Health* (London, 1971), p. 271.

46. See passages cited in *CAD* s.v. *amurriqānu*, "jaundice" and *arqū* adj., "yellow", meaning 2.

47. R. Schoental, "Mycotoxins and the Bible", *Perspectives in Biology and Medicine* 28 (1984): 117-20.

48. See especially W. von Soden, "Sanherib vor Jerusalem 701 v. Chr.", *Antike und Universalgeschichte: Festschrift Hans Erich Stier zum 70. Geburtstag am 25. Mai 1972* (Münster, 1972), pp. 43-51. He rejects the idea that 185,000 men would be killed overnight, but suggests that even if a thousand men died over several weeks, it could still be grounds for an Assyrian withdrawal. In any case, the figure 185,000 is most unlikely, and many efforts have been made to arrive at a plausible number. On this question and others relating to this passage, see Mordechai Cogan and Hayim Tadmor, *II Kings*, Anchor Bible, vol. 11 (New York, 1988), p. 239. For comment on Herodotus's story of the role of mice in this episode, see Alan B. Lloyd, *Herodotus Book ii, Commentary 99-182* (Leiden, 1988), pp. 99-105, especially p. 104.

Other biblical passages where an epidemic caused by fungal poisoning of grain might be suggested would include the census plague in 2 Samuel 24:1-25<sup>49</sup>.

In summary, while one cannot prove the existence of ergotism or mycotoxicosis in ancient Mesopotamia beyond all doubt, I believe the circumstantial evidence cited here – and perhaps other evidence in ancient texts that I am not aware of – suggests that it is highly likely that one of the epidemics that humans and livestock suffered from on occasion was indeed ergotism or mycotoxicosis<sup>50</sup>.

49. See the commentary by P. Kyle McCarter, Jr., *II Samuel*, Anchor Bible, vol. 9 (New York, 1984), pp. 512-14.

50. I have not had an opportunity to consult Iraqi veterinary publications, but I suspect that studies have been carried out in Iraq as well, especially in view of the importance of the dairy industry in Iraq since the late 1950s.