

***Lycopodium* Spores used in Condom Manufacture: Associated Health Hazards¹**

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*The recommendation that condoms be used to limit the transmission of AIDS has resulted in their increased utilization. One major brand of non-lubricated condoms was demonstrated to be coated with *Lycopodium clavatum* spores, a product of known hazardous nature. Used previously in the manufacture of diverse products including hair powder, suppositories, and surgical gloves, these spores have caused allergic reactions ranging from hay-fever to more serious giant cell granulomas. This foreign-body response can simulate neoplastic disease, tuberculosis, or syphilis. Physicians should take note of the possibility that granulomatous masses on areas of the body that come in contact with condoms could be traced to these spores. These granulomas are non-lethal, do not lead to cancer, and are easily remedied; this is a relatively minor health problem compared to AIDS, a lethal, sexually acquired disease that might be contracted through sexual activity unprotected by condoms.*

*L'utilisation des Spores *Lycopodium* Dans La Fabrication des Préservatifs Provoquant des Problèmes de Santé. Le conseil d'utiliser le préservatif afin de limiter la transmission du SIDA, s'est traduit par une augmentation de leur emploi. Une des principales marques de préservatifs non-lubrifiés a démontré que ceux-ci devraient être enduits par les spores de *Lycopodium clavatum*, un produit originaire de notre nature reconnue comme dangereuse. Utilisés auparavant, dans la fabrication de multiples produits tels que la poudre pour cheveux, les suppositoires et les gants chirurgicaux, ces spores ont provoqué des réactions allergiques à un degré, s'échelonnant: de la Fiebre des foins vers de plus énormes et sérieuses cellules granulomas. Cette réaction au contact d'un corps étranger peut feindre soit une maladie néoplastique, la tuberculose ou la syphilis. Les médecins devraient considérer, l'éventualité pour ces masses granulomatous présentes sur les régions du corps, qui se révèlent en contact avec les préservatifs, auraient pour origine ces spores. Les granulomas ne sont pas mortelles, ne sont pas cancérigènes, et se guérissent aisément; il s'agit d'un problème de santé relativement mineur comparé au SIDA, une maladie sexuelle et mortelle qui serait contractée à la suite d'une relation sexuelle non-protégée par le préservatif.*

The prevention of the exchange of body fluids has been recommended as a means of limiting the spread of AIDS, and the utilization of condoms is one method of achieving that goal (Levine 1986). This recommendation has resulted in increased manufacture, sales, and use of condoms. The use of a potentially hazardous plant product in the production of one type of condom came to our attention after an inquiry from an industrial supplier of botanical products. The material, spores of the staghorn clubmoss (*Lycopodium clavatum* L., Lycopodiaceae), also known as vegetable sulfur (Reynolds 1982), is used as a dusting agent

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on at least one major brand of non-lubricated condoms to prevent the rolled latex from sticking to itself (Balick and Beitel 1988). A short communication (Balick and Beitel 1988) was the first report of our findings; the present article is intended to provide additional details on background information as well as on our study.

While we were investigating possible locations where additional supplies of this product might be obtained, it was discovered that the scientific literature contained numerous references on the use and hazardous nature of *Lycopodium* spores. The spores contain 50% of a fixed oil, as well as sucrose and phytosterol (Greenberg and Lester 1954). Due to the high proportion of oil, the spores are resistant to wetting, have emollient properties, and are highly flammable. Formerly, spores of *Lycopodium* species, including *L. clavatum*, were used for a variety of purposes: e.g., as a base for cosmetics such as face and hair powder; as dusting powder on surgical gloves to prevent sticking, and on pills and suppositories; as an absorbent in dry shampoos; in fireworks and flashpowder; and as "dry parting compound" in foundry work to prevent metal from sticking to wooden molds (Erb 1935; Greenberg and Lester 1954; Lambright and Albaugh 1934; Reynolds 1982; Salen 1951; Tobias 1932; Whitebread 1941; Windholz 1983). *Lycopodium* spores are also used in homeopathic medicine, as for example in the treatment of kidney stones (Reynolds 1982; Salen 1951).

Exposure to *Lycopodium* spores has caused allergic reactions ranging from dermatitis to severe asthma attacks and falling into several categories (Salen 1951): in pharmacists due to exposure during preparation of spore-coated pills and suppositories; in metal workers due to exposure to dry parting compound; in theater personnel and patrons due to exposure to face and hair powders; as hay-fever during the late summer due to exposure to spores released in nature; and in consumers using dry shampoos, face and hair powders, and spore-coated pills (Feldman 1934; Lambright and Albaugh 1934; Tobias 1932).

Of the most concern at present are the reports of *Lycopodium* spores causing adhesions on serous surfaces and foreign-body granulomas in soft tissue (Anonymous 1941; Antopol 1933; Antopol and Robbins 1937; Boyd 1955; Erb 1935; Whitebread 1941). In the earlier part of this century, *Lycopodium* spores were dusted on surgical gloves and other rubber supplies, and through this use, frequently introduced into wounds during surgery. Because of the ornamentation on the outer surface of the *Lycopodium* spore (Fig. 1), these bodies hold fast to moist tissue on contact and through manipulation can be forced beneath the surface. This led to the appearance, as a foreign body response, of lesions composed of granulation tissue arranged in the form of nodules. The granulomas—consisting of epithelioid cells, multinucleated giant cells, lymphocytes, and fibroblasts with areas of necrosis—are similar to the silicious granulomas produced by the magnesium silicate particles that make up talc (Antopol 1933; Boyd 1955; Erb 1935). They also simulate neoplastic disease such as cancer or infective granulomas caused by bacteria such as in tuberculosis or syphilis. The causative agent may be overlooked because the spores are poorly visualized in hematoxylin and eosin, but stain bright red and acid-fast in Ziehl-Neelsen preparation. These chronic postoperative reactions necessitated secondary operations as they either impeded the healing of the original condition or caused further complications. In animal experiments, granulomas are formed within 2–6 wk after exposure to *Lycopodium* spores (Antopol 1933). Such foreign-body granulomas are not desirable, and due

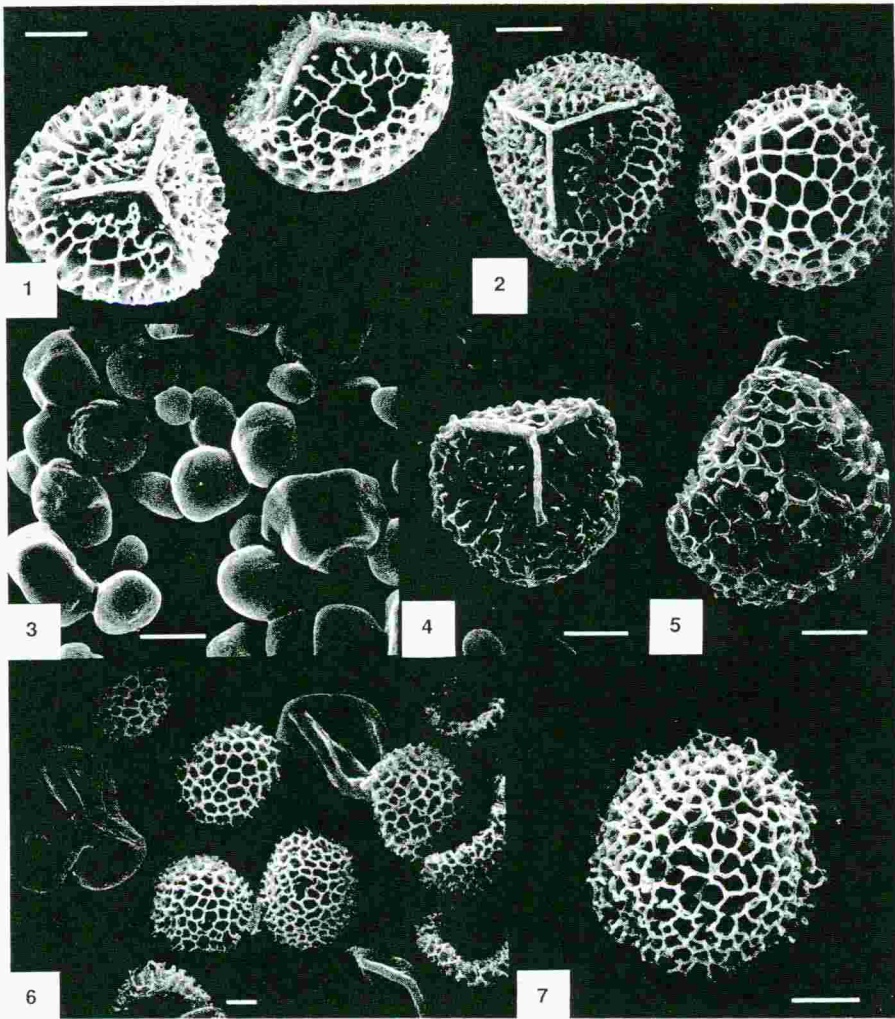


Fig. 1-7. SEM micrographs (scale bar, 10 μ m). **Fig. 1.** *Lycopodium clavatum*, spores from herbarium sheet, Canada, New Brunswick, Bathurst, *S. F. Blake 5421* (NY), proximal surface (left), equatorial view (right). **Fig. 2.** *Lycopodium* spores, "Lycopodium, Canadian," proximal surface (left), distal surface (right). **Fig. 3.** Dust-like material from condom, untreated, starch grains. **Fig. 4.** *Lycopodium* spore from condom, untreated, proximal surface with prominent trilete scar. **Fig. 5.** *Lycopodium* spore from condom, untreated, distal surface. **Fig. 6.** Dust-like material from condom, acetolyzed, *Lycopodium* spores (reticulations), unidentified pteridophyte spore (smooth walls). **Fig. 7.** *Lycopodium* spore from condom, acetolyzed, distal surface.

to the fact that the granulomas may resemble more serious diseases, surgeons using gloves dusted with this product were advised to clean them completely before use and to keep the air of the operating room free of spores in order not to expose the patient to unnecessary contamination.

One of the more disturbing case histories was a report of *Lycopodium* granuloma caused by the use of spore-covered anal suppositories (Antopol and Robbins 1937). *Lycopodium* granulomata were induced by the unintentional exposure of

a wound from an external hemorrhoidectomy to these spores on the exterior of anal suppositories that had been dusted by the pharmacist to prevent them from sticking to the wrapper. As soon as the granulomata were treated, and the use of the suppositories contaminated with spores discontinued (15 mo after the final operation), there was no recurrence of the granulomata.

The staghorn or wolf's-claw clubmoss, *Lycopodium clavatum*, is a circumboreal species (or complex of species) with isolated populations in tropical and subtropical mountain ranges of both the New and Old worlds (Beitel 1979). The spores of this species are light yellow, ca. 30 μm in diameter, tetrahedral in shape, with a trilete scar on the proximal surface of the spore as shown in Fig. 1 (Canada, New Brunswick, Bathurst, *S. F. Blake 5421*, NY). They are easily recognizable using the light microscope and/or scanning electron microscope. The proximal and distal surfaces are covered by high, narrow ridges that join to form a network (reticulum). Numerous windows are evident in the vertical walls of the reticulum. Spores (Fig. 2), labelled as "Lycopodium, Canadian," supplied by the industrial supplier as typical of those used as a dusting agent on condoms, appear identical to the spores of *L. clavatum*, although spores of several species of *Lycopodium* found in Canada have similar ornamentation (Wilce 1972). These include *L. annotinum*, *L. complanatum*, *L. digitatum* (= *L. flabelliforme*), *L. obscurum*, *L. dendroideum*, *L. sabinifolium*, *L. sitchense*, and *L. tristachyum*.

In a survey of three commonly sold brands of condoms at a local pharmacy, one (Ramses, non-lubricated) was identified as having been treated with *Lycopodium* spores. Examination under SEM of the dust-like material on the surfaces of a condom revealed numerous irregular polyhedrons of various sizes (Fig. 3). Acetolysis revealed two types of spores (Fig. 6), some identical to the spores of *L. clavatum* (Fig. 7), while some were an unidentified spore of larger size and smooth walls. The acetolysis treatment causes the spores to collapse (Wilce 1972). The polyhedrons in the untreated material, which disappeared after acetolysis, corresponded to the typical morphology for grains of corn starch (Fitt and Snyder 1984). The *Lycopodium* spores were evidently mixed with corn starch, which filled in much of the reticulation, shown in the non-acetolysed spores (Fig. 4-5). Because the spores are found on both the inside and outside surfaces of the condom, it is likely that *Lycopodium* spores would come in contact with membranes, both mucous and non-mucous, during use.

Because of the fact that condom use is increasing dramatically in response to the AIDS epidemic, physicians should take note of the possibility that granulomatous masses on any of the areas of the body that come in contact with condoms could be traced to the use of these products. These granulomas are non-lethal, do not lead to cancer, and are easily remedied; this is a relatively minor health problem compared to AIDS, a lethal sexually-acquired disease that might be contracted through sexual activity unprotected by condoms. Further research is needed to establish the range of contemporary products treated with these spores.

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LITERATURE CITED

- Anonymous. 1941. Items. *Science* 93(2413):10.
- Antopol, W. 1933. *Lycopodium granuloma*. Its clinical and pathologic significance, together with a note on granuloma produced by talc. *Arch. Path.* 16:326-331.
- , and C. Robbins. 1937. *Lycopodium granuloma* resulting from the use of anal suppositories. *J. Amer. Med. Assoc.* 109:1192.
- Balick, M. J., and J. M. Beitel. 1988. *Lycopodium* spores found in condom dusting agent. *Nature* 332 (14 Apr):591.
- Beitel, J. B. 1979. Clubmosses (*Lycopodium*) in North America. *Fiddlehead Forum, Bull. Amer. Fern Soc.* 6(5):1-8.
- Boyd, W. 1955. *Pathology for the surgeon*. W. B. Saunders Co., Philadelphia.
- Erb, I. H. 1935. *Lycopodium granuloma*. *Surg. Gyn. Obstet.* 60:40-44.
- Feldman, J. 1934. Industrial dermatoses. *Med. Rec.* 139:279-283.
- Fitt, L. E., and E. M. Snyder. 1984. Photomicrographs of starches. Pages 675-689 in Whistler, R. L., J. N. Bemiller, and E. F. Paschall, eds., *Starch: chemistry and technology*. 2nd ed. Academic Press, New York.
- Greenberg, L. A., and D. Lester. 1954. *Handbook of cosmetic materials*. Interscience Publishers, New York.
- Lambright, G. L., and R. P. Albaugh. 1934. Perennial hay fever from lycopodium. A case report. *J. Allergy* 5:590-591.
- Levine, J. 1986. The toughest virus of all. *Time* (3 Nov):76-78.
- Reynolds, J. E. F., ed. 1982. *Martindale. The extra pharmacopoeia*. Pharmaceutical Press, London.
- Salen, E. B. 1951. *Lycopodium* allergy. *Acta Allergol.* 4:308-319.
- Tobias, N. 1932. Cosmetics. *J. Missouri State Med. Assoc.* 29:63-69.
- Whitebread, C. 1941. Beware of "*Lycopodium*." *Amer. Fern J.* 31(3):100-102.
- Wilce, J. H. 1972. Lycopod spores, I. General spore patterns and the generic segregates of *Lycopodium*. *Amer. Fern J.* 62(3):65-79.
- Windholz, M., ed. 1983. *Merck index. An encyclopedia of chemicals, drugs and biologicals*. 10th ed. Merck and Co., Rahway, NJ.