used instead of Ringer solution. They were inoculated intravenously through the orbital branch of the anterior facial vein. The absence of mediastinal thymic tissue was verified microscopically at necropsy.

A large-plaque strain of polyoma virus, derived from the LID-1 strain and maintained on C3H mouse embryo cells, was injected subcutaneously into 4- to 6-day-old mice. Each mouse received 2×10^6 plaque-forming units of the virus.

The thymectomized mice failed to gain weight normally, showed a reduction in the number of lymphocytes in the peripheral blood and lymphoid organs, and had a reduced capacity to form hemolysins to sheep erythrocytes. Most of these thymectomized mice developed tumors of the parotid gland, unilateral or bilateral, and all were dead 3 months after operation. When syngeneic spleen cells were administered, all except 3 of 44 thymectomized mice were restored and 25 of these remained tumor-free and in good condition at 8 months (Table 1). The lymphoid system of the tumorous mice in the group treated with syngeneic cells showed at necropsy no depletion of lymphoid elements, whereas there was a depletion of lymphocytes in the blood and lymphoid organs of their neonatally thymectomized littermates. The presence of parotid gland tumors in 36.6 percent of these treated mice probably results from the early introduction of virus (at 4 to 6 days of age) before adequate restoration of immunologic faculty. More recent data indicate that induction of tumors by polyoma virus is almost completely prevented in C57BL mice treated with spleen cells when the virus is inoculated at a later time (10 to 12 days).

Among the 37 animals that received a sham operation for thymus removal or among the control littermates only one developed a parotid gland tumor; this tumor was unilateral (Table 2). The primary neoplasm in all of the tumorous mice in this study appeared to arise in the parotid gland(s); other salivary glands showed varying degrees of neoplastic foci. Rarely were sites outside of the salivary gland area involved in neoplastic transformation.

The response of a small group of (C57BL × C3H) F_1 mice to the LID-1 strain of polyoma virus was similar to that of parental C57BL mice. Intact mice completely resisted the oncogenic effects of virus while those F_1 mice thymectomized within the first 24 hours were strikingly susceptible. Mice in these groups were 6 to 8 days old when inoculated with the polyoma virus. In one group, grafted at 1 to 3 days of age, thymuses from 1-day-old C57BL donors reestablished the capacity to resist oncogenesis (Table 2).

These data show that thymectomy within the first 24 hours of life of C57BL (and F_1) mice leads to abrogation of resistance to the oncogenic activity of polyoma virus. Though wasting, lymphoid depletion, and impairment of immunologic competence resulted in the mice that were thymectomized shortly after birth, it is known from previous work (*9*) that nonspecific factors affecting the health of the animal and inadequate antibody response to polyoma virus do not contribute to this susceptibility. Treatment of neonatally thymectomized C57BL mice by spleen cell inoculations, which ensured normal growth and immunologic development, also leads to a restoration of resistance. Such supplementation by lymphoid cells is known to result from "seeding out" of these immunologically competent adult cells which have benefited from the presence of thymic tissue. Thymic tissue per se is therefore a necessary antecedent of resistance to polyoma virus to the extent that it provides maturation of the immunologic faculty and consequently prevents the progression of neoplastic clones induced by polyoma virus.

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Spore Discharge in Basidiomycetes: A Unified Theory

Abstract. *Olive's demonstration that a bubble bursting at the basidiospore apiculus breaks the connection between spore and sterigma convincingly explains the mechanism of severance; but it does not explain spore discharge, because the bursting force is not applied in the appropriate direction. The form of the developing spore and sterigma shows that the spore is forcibly abstricted while the membrane is still fluid. If the abstricting force persists until the fracture of the sterigma, it provides a mechanism whereby the spore is reliably discharged.*

The demonstration by Olive (*1*) that the "droplet" formed at the apiculus of a basidiospore, just before its discharge, is in fact a bubble indicates that the tip of the sterigma is fractured by the blow transmitted through the spore when the bubble bursts. Thus, after 75 years of speculation, this structure can finally be assigned a functional role. However, the bubble seems to deliver its blow transversely or diagonally, and it is difficult to believe that it supplies the main propulsive force, which acts along the axis of the sterigma. What is this force?

Theories of jet discharge are invalidated by the fact that the sterigmata preserve their turgor. Buller (*2*) suggested that surface forces on the droplet provide the impetus, but this was no explanation, for no one could suggest how such forces might operate. Prince (*3*) noted a double septum in the sterigma tip of *Gymnosporangium* and proposed that, as the intervening sterigma wall ruptures, these septa evaginate against each other and flip the spore away. However, the combined travel of the two septa could at most be about 0.2 μ, too short to allow them to reach a useful velocity. A stronger objection to Prince's explanation is that the mechanism demands absolutely synchronous fracturing of the full circumference of the apiculus wall; for, if one part held for an instant longer than the rest, the spore would discharge laterally or tip sideways without discharging, whereas almost all spores are discharged directly away from the hymenium (along the axis of the sterigmata) with impressive regularity. The

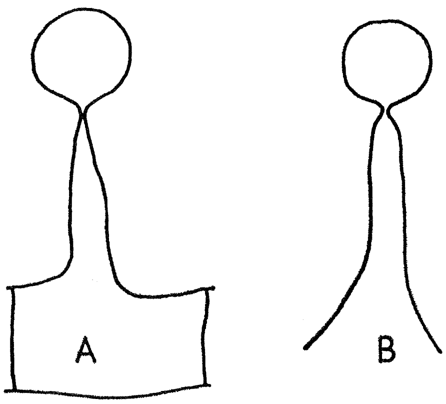

Fig. 1. Visible results of surface tension acting against an abstricting force. (*A*) Sterigma and young basidiospore of *Melampsora epitea* (camera lucida drawing from cytological preparation). (*B*) Late phase of splash in milk, droplet separating (*6*) (not to scale).

transverse blow from the bursting bubble must cause the near side of the sterigma to break first, which further invalidates Prince's explanation. The conidia of Entomophthoraceae are discharged by essentially the mechanism proposed by Prince, but under very different circumstances. The septum is very broad in proportion to the spore diameter, and the mechanical advantage is consequently relatively enormous. The broad base must also limit the directional error imposed upon a conidium by uneven rupturing of the conidiophore wall. Moreover, imperfect discharge in Entomophthorales, whose conidia are exposed to such secondary means of transfer as wind, rain, or insects, is much less serious than it would be in most higher basidiomycetes, whose undischarged spores are sheltered by folds, teeth, tubes, or gills.

Ten years ago, in another context, I published (*4*) drawings of a sterigma and young basidiospore of the rust *Melampsora epitea* beside a tracing of one of Edgerton's photographs of a droplet being abstricted from splashing milk (Fig. 1). The curves of minimal area exhibited by spore and sterigma—visible results of surface tension operating against an abstricting force—prove that the spore does not grow from a rigid sterigma but is thrust from a fluid one. Only when the ultimate shape has been achieved is it made permanent by deposition of a rigid wall in both spore and sterigma. Active streaming, which must either induce or be caused by electrical potential, occurs during spore formation; and the abstriction may be caused by like charges centered in the spore and below the base of the sterigma. If the repulsion that must exist during spore formation persists until the bubble bursts, we have an accurately directed discharge that satisfies requirements. When I stumbled on this possible explanation 2 years ago I discussed it with colleagues in several disciplines, in the hope of devising a method of testing it. (My mortification at needing 8 years to make this modest deduction is partly assuaged by the apparent failure of anyone else to make it.) Failure to devise a test and the fact that my explanation, like previous ones, did not account for the supposed droplet discouraged me from publishing. However, if we combine the bubble and repulsion mechanisms we have a unified theory that seems to fit the observed facts: the sterigma tip is snapped by abrupt bending, and the spore is regularly discharged in the appropriate direction and, in tube and gill fungi, for an appropriate distance. This discharge mechanism is so reliable that it has become the most distinctive feature of a large and ecologically important group of fungi.

The testing of the repulsion theory presents a challenge. A charge on the falling spores might be detected by observing their deflection in falling through an electric field, as was attempted by Buller (*2*); but as John Hart has pointed out to me, demonstration of a residual charge is inconclusive; for separation of a spore (with a membrane or polar molecules) from its sterigma would probably induce a small charge upon it.

In many Basidiomycetes the hymenium lines slender vertical tubes or covers closely spaced gills. It is important that the spores should not be thrown too far and should not drift laterally before they fall free of the hymenium. A persistent charge of the same sign as that upon the hymenium would help to prevent such accidents.

One inevitably wonders how such an elaborate mechanism arose. When the fungi first left their ancestral aquatic habitats it was vital to replace their now largely functionless motile spores with effective dispersal agents (*5*). At first the spores were probably dispersed largely by rain or spray; but, if the fungi were to penetrate all terrestrial niches successfully, air-borne spores were essential; and forcible discharge is strongly adaptive in facilitating aerial dispersal. The repulsion mechanism is thus an expected extension of the process of spore formation on a slender sterigma. It is not so simple to visualize the evolution of the bubble mechanism. Gas may have been originally a chance metabolic byproduct, which occasionally burst irregularly through the primary membrane of the spore. If the rupture even occasionally served to break the sterigma tip, perfection of the bubble mechanism by further mutations would be expected; for maintenance of the repulsive charge consumes energy, and a device that ensures more prompt release of the spores at maturity than enzymatic dissolution of the wall could provide would be highly adaptive.

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Glutathione as an Inducer of Feeding in Ticks

Abstract. *Ticks engorged solutions containing reduced glutathione as readily as blood, provided that the tonicity of the solutions was adjusted to that of plasma. Among substances tested this effect was specific for the tripeptide. Glutamic acid inhibited the feeding response.*

The tick *Ornithodoros tholozani* (Laboulbene and Megnin) is the vector of Asiatic human relapsing fever in the Near East. Its hosts are various mammals, both wild and domestic, as well as man. From the first nymphal stage the tick normally feeds every few months and can survive several years of starvation. Since blood is the only fluid imbibed by ticks, the question arises as to what substance or substances initiate the feeding response.

Ornithodoros tholozani can be easily fed on blood through an artificial membrane made of parafilm stretched on a glass ring. The ticks probe through the membrane into the solution provided it is warmed to 38°C, but they do not im-