spread among the Curculionidae, it seems unlikely that it would serve the same function in all species. Its presence or absence does not appear to be correlated with any obvious biological or ecological attribute, and since "no particularly logical arrangement of the Curculionid subfamilies has been proposed" (*6*), it cannot be identified with any taxonomic categories. In general, however, its adaptive value is probably related to visual (photokinetic) orientation, to regulation of daily activity patterns, to entrainment of circadian rhythms, to measurement of light intensity, or to analysis of light quality.

The exact function of the cephalic filter has been explored most extensively in the alfalfa weevil. Since this insect's action spectrum had already been found to coincide with the reflectance spectrum of alfalfa, *Medicago sativa* (*7*), the possibility of a link between the red head capsule filter and host plant recognition was examined in more detail.

A behavioral bioassay originally developed to evaluate the relative importance of visual and olfactory cues in remote sensing of host plants (*8*) was modified to determine whether or not adult weevils need the red filter to locate living alfalfa. Groups of starved weevils, placed in the bioassay chamber, were offered an option of moving toward either a greenhouse flat of live alfalfa or a similar flat of dead alfalfa sprayed with a green paint which lacked the strong infrared reflectance of living alfalfa. A control group of untreated weevils were able to discriminate between the two choices: 73 percent moved toward the living alfalfa (Table 1). However, weevils in a second group, whose red filters were occluded (*9*) by an opaque mixture of lampblack and white (clear) shellac, were more random in their choice of direction and showed a statistically significant decrease in the visual response to alfalfa (Table 1).

This change in the response cannot be an artifact of the shellac mixture because a third group of weevils, which received a coat of white (clear) shellac over the same part of their heads, were able to locate the living alfalfa as well as the unpainted weevils (Table 1). A final group of beetles, whose compound eyes were covered by the opaque lacquer, became much more sedentary and seemed reluctant to move. When placed in the bioassay chamber they generally remained stationary and showed no definitive response to either the alfalfa or the control flat.

The normal pattern of host plant recognition, therefore, seems to require functional compound eyes as well as transmission of light through the red head capsule filter. These sensory inputs are presumably integrated by the brain or nervous system as the alfalfa weevil evaluates the suitability of potential food sources.

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10. I thank E. M. Raffensperger and K. Adler for assistance in various phases of this research.
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Anomalous Temperature Dependence for a Partial Vapor Pressure

Abstract. *In a limited temperature range the partial pressure of gallium subsulfide (Ga_2S) above gallium sesquisulfide (Ga_2S_3) increases when the temperature is decreased. The anomaly in the partial pressure is caused by changes with temperature in the equilibrium compositions of two solid phases that coexist at 1228° ± 3°K. At this temperature the solids differ in sulfur content by 0.4 atomic percent sulfur.*

In the course of a mass spectrometric study of the vaporization of gallium sesquisulfide (Ga_2S_3), we were surprised to find that near 1220°K decreases in temperature caused increases in the partial pressure of one of the two principal vapor molecules, gallium subsulfide (Ga_2S), (Fig. 1). In other temperature ranges, decreases in temperature caused normal exponential decreases in the partial pressures. The anomaly near 1220°K was reproducible and large; the partial pressure increased about 50 percent when the temperature was lowered 25°K instead of decreasing 50 percent as was expected from the variations of partial pressure with temperature in other temperature ranges.

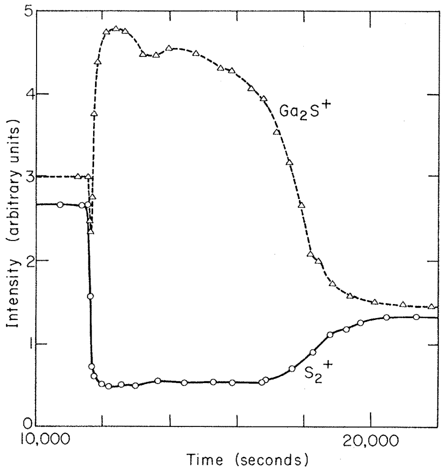

Fig. 1. Variation of the partial pressures of Ga_2S (proportional to Ga_2S^+, dashed line) and S_2 (proportional to S_2^+, solid line) with time. At about 11,700 seconds the temperature was lowered from 1230° to 1203°K.

After about an hour under our experimental conditions, the anomalously high partial pressure decreased over a similar time span to values that were consistent with interpolations of pressures from higher and lower temperature ranges. The anomaly could not be dismissed as arising from purely kinetic factors; it must have a thermodynamic basis because partial pressures can only change, even during reactions, in directions that increase the total thermodynamic stability of the system.

The key to explaining the partial pressure anomaly lies in recognizing that two-component solids such as Ga_2S_3 have variable compositions (*1*). The vaporization of Ga_2S_3 occurs by dissociation,

$$\mathrm{Ga}_{(2+2\epsilon)}\mathrm{S}_{(3-\epsilon)}\,(\mathrm{s}) = (1+\epsilon)\,\mathrm{Ga_2S}\,(\mathrm{g}) + (1-\epsilon)\,\mathrm{S_2}\,(\mathrm{g}) \quad (1)$$

where ϵ takes small positive or negative values that depend upon conditions of preparation and subsequent treatment of the sample. When heated to some fixed temperature in a crucible from which the vapor can escape through a small orifice into a vacuum, the solid loses either Ga_2S or S_2 preferentially. The preferential loss shifts the composition of the remaining solid in a direction that reduces the partial pressure of the more volatile vapor molecule and increases the partial pressure of the less volatile vapor molecule. A steady state is reached when the average composition of the vapor that escapes through the orifice is the same as the composition of the solid (*2*). This composition, called the composition for congruent vaporization, can vary with temperature. However, the variation is small for solids and it had apparently never been measured for a solid such as Ga_2S_3, in which the ratio of the elements present can be varied by, at most, a few atomic percent.

Variations in the composition for congruent vaporization can be measured for Ga_2S_3 with a mass spectrometer. When Ga_2S_3 is heated in alumina or graphite crucibles, Ga_2S^+ is the principal ion product from the collision of 70-ev electrons with Ga_2S molecules and S_2^+ is the principal ion from S_2. The proportionality constant between each ion intensity and molecular flux was calculated from the steady state ion ratio Ga_2S^+/S_2^+ of a congruently vaporizing solid (*3*) for which the composition (*4*) and total pressure (*5*) were known. We calculated changes in composition by correcting the known composition of a known weight of solid for the time integrals of the total Ga_2S and S_2 molecular fluxes (*6*). That pressures measured even under nonsteady state conditions were close to equilibrium values is demonstrated by the observation that pressures measured at all compositions and temperatures were unchanged when the areas of the orifices were changed by as much as a factor of 20.

The sulfur content of the congruently vaporizing Ga_2S_3 decreased linearly with temperature by very small amounts, less than 0.002 atomic percent per degree Kelvin, except on heating through 1228° ± 3°K where it decreased discontinuously by 0.4 ± 0.1 atomic percent. The discontinuous change, which is reversible with temperature, must arise from a phase transition between a low-temperature form of solid Ga_2S_3, which we will call ℓ-Ga_2S_3, and a high-temperature solid form, which we will call h-Ga_2S_3 (*7*).

Figure 2 is a schematic partial phase diagram that is consistent with the observed temperature dependence of the composition for congruent vaporization. In constructing the diagram we were guided by the knowledge that, although high- and low-temperature modifications of a two-component solid phase are often ascribed the same fixed composition, they actually can coexist over at least a small range of compositions and temperatures (*1*). Phase boundaries for both solid phases at 1228°K were determined from discontinuities in a plot of composition for congruent vaporization versus temperature (dashed line, Fig. 2). The boundary for a low-temperature phase at 1203°K (point c, Fig. 2) was determined from variations in the partial pressure with composition. Partial pressures for two-component systems are independent of composition when two condensed phases are stable, but they vary with composition in one-phase regions (*2*). The boundary of the h-Ga_2S_3 phase at 1203°K was drawn to be consistent with a calculation described below.

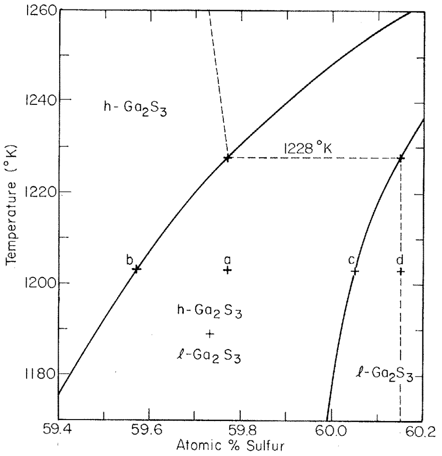

Fig. 2. Schematic partial phase diagram showing details of the transition between h-Ga_2S_3 and ℓ-Ga_2S_3. The dashed line shows the variation of the composition for congruent vaporization. Data of this report fix the phase boundary compositions at 1228° and 1203°K. The curvature of the boundaries is expected from our theoretical analysis.

The changes in partial pressures with time (Fig. 1) can be correlated with the partial phase diagram (Fig. 2). When h-Ga_2S_3 of a composition for congruent vaporization at a temperature T_1 infinitesimally above 1228°K is first quenched to a temperature at which the two solid modifications can be brought to equilibrium, say, 1203°K, the h-Ga_2S_3 first supercools at an essentially unchanged composition to point a, where at equilibrium a mixture of h-Ga_2S_3 of composition b and ℓ-Ga_2S_3 of composition c would exist. During this cooling at constant composition the partial pressures of both vapor molecules decrease. Then ℓ-Ga_2S_3nucleates, and the untransformed portion of h-Ga_2S_3 shifts toward higher gallium content. As the gallium content increases, the Ga_2S partial pressure rises and the S_2 partial pressure continues to fall. When the compositions become those at which the two solids can be at equilibrium at 1203°K (points b and c, Fig. 2), the partial pressures of both gases become constant for about an hour under our experimental conditions, while preferential loss of Ga_2S reduces the quantity of h-Ga_2S_3. When no h-Ga_2S_3 remains, the composition of the ℓ-Ga_2S_3 phase and the partial pressures of the two vapor molecules again shift simultaneously until the composition (point d) for congruent vaporization of ℓ- Ga_2S_3 at 1203°K is reached. The product of the Ga_2S and S_2 partial pressures, which is a measure of the molar free energy of the condensed phase or phases, is constant to within our limits of measurement during the isothermal pressure changes.

These partial pressure variations are unusual only in that the partial pressure of Ga_2S that is in equilibrium with the two solid phases is higher at 1203°K than it is at 1228°K. The pressure of a gas molecule that is in equilibrium with two solids of different composition is called a decomposition pressure. Decomposition pressures usually decrease exponentially with decreasing temperature. But for at least two different liquid-solid decomposition reactions (*8*), the changes in the compositions of the condensed phases along their phase boundaries with temperature are sufficient to cause reversals in the sign of the temperature dependence of the decomposition pressures. Composition changes almost certainly also cause the anomalous temperature dependence of the Ga_2S decomposition pressure.

The overall change in the partial pressure P of Ga_2S as a consequence of a change in the temperature T of the decomposition reaction is given by

$$P_2 - P_1 =$$

$$\int_{T_1}^{T_2} \left(\frac{\partial P}{\partial T}\right)_X dT + \int_{X_1}^{X_2} \left(\frac{\partial P}{\partial X}\right)_T dX \qquad (2)$$

where X is the mole fraction of gallium in one of the solids at its equilibrium phase boundary composition, and the subscripts 1 and 2 identify the initial and final states. For h-Ga_2S_3 at 1228°K, X has the same value indicated by point a of Fig. 2. Because the composition for congruent vaporization changes very little with temperature in the single-phase regions, the value of the first integral can be obtained for h-Ga_2S_3 by a conventional Clausius-Clapeyron extrapolation of Ga_2S partial pressures measured above 1228°K. With T_1 = 1228°K and T_2 = 1203°K, the value of the integral is $- 1.0 \times 10^{-5}$ atm. We made two measurements of the variation in partial pressures with composition over a range of 0.04 atomic percent sulfur at 1237°K by quenching a sample from higher temperatures and measuring the variations in ion intensities with time until the congruent composition was reached. Both partial pressures varied linearly with the mole fraction of gallium. The two values measured for $(\partial P/\partial X)_T$ were 2×10^{-2} and 3×10^{-2} atm per mole fraction of gallium. The average of these values, corrected by means of the Clausius-Clapeyron equation to 1203°K, is 1.0×10^{-2} atm per mole fraction of gallium. Values for all quantities in Eq. 2 have now been determined except the limit X_2; we calculate $X_2 - X_1 = 0.002$ for the change in the mole fraction of gallium along the h-Ga_2S_3 phase boundary when the temperature changes from 1228° to 1203°K, compared to a measured change of 0.001 for the ℓ-Ga_2S_3 phase boundary. We calculate from the phase boundary compositions a heat and an entropy of transition that are well within the ranges of values found for transitions between low- and high-temperature modifications of solid phases (*9*).

Our analysis depends on measurements of differences in temperatures, pressures, and compositions. These differences can be measured with higher precision than the absolute values. The composition changes are probably uncertain by no more than a factor of 2. Our measurements appear certainly precise enough to justify the conclusions that a decomposition reaction of a high-temperature form of Ga_2S_3 has a partial pressure which increases with decreasing temperature and that the increase is a consequence of changes in the compositions of the equilibrium solids.

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Myasthenic Immunoglobulin Accelerates Acetylcholine Receptor Degradation

Abstract. *Degradation of acetylcholine receptors by cultured rat skeletal muscle cells was determined from the release of* ^{125}*I from bound* ^{125}*I-labeled α-bungarotoxin. Addition of immunoglobulin from patients with myasthenia gravis to the culture medium accelerated the degradation rate to a mean of 8.51 ± 0.44 percent per hour, compared with the mean control rate of 3.97 ± 0.14 percent per hour* ($P << .001$)*. A similar mechanism may possibly be involved in the autoimmune pathogenesis of myasthenia gravis in man.*

Myasthenia gravis (MG) is a neuromuscular disorder characterized by weakness and fatigability of muscles. Recent evidence indicates that there is a decrease of available acetylcholine (ACh) receptors at the neuromuscular junctions of myasthenic patients (*1*), sufficient to account for the typical clinical and physiological manifestations (*2*). Several lines of evidence suggest that the pathogenesis of this abnormality involves an autoimmune attack directed against ACh receptors: (i) An experimental model analogous to MG has been produced by immunizing various animals with purified ACh receptor (*3*). (ii) The serums of patients with MG contain antibody for ACh receptor, which has been demonstrated by several different methods (*4*). (iii) Immunoglobulin G (IgG) from myasthenic patients has been shown, when passively transferred to experimental mice, to reproduce the typical features of myasthenia gravis (*5*). Thus, a humoral immune process appears to play an important role in the pathogenesis of the human disease. However, the mechanism by which the antibody affects the ACh receptors is not yet known. In this study, we have examined the effects of immunoglobulin from myasthenic patients on mammalian skeletal muscle cells in culture. The findings indicate that the immunoglobulin from MG patients produces an increase in the rate of degradation of ACh receptor by the cultured cells and reduces the total number of available receptor sites.

Cultures of rat skeletal muscle were prepared by conventional methods (*6*). The limb muscles of 16- to 18-day fetuses from Sprague-Dawley rats were minced, and trypsinized for 1 hour in Hanks balanced salt solution without divalent cations, containing 0.25 percent trypsin. The cells were strained through bolting silk, centrifuged, resuspended in culture medium, and plated for 30 minutes in a Falcon 75-cm^2 plastic flask for selective removal of the rapidly adhering fibroblasts. The nonadhering cells, predominantly myoblasts, were transferred to a second flask and cultured for 48 hours. The cultures were trypsinized and replated in gelatin-coated 35-mm Falcon plastic petri dishes. Cultures were grown at 37°C in Eagle's minimum essential medium (MEM) with Earle's salts, supplemented with 10 percent fetal calf serum, under an atmosphere of 10 percent CO_2. Large numbers of dishes were prepared simultaneously, so that the cultures would be at the same stage of development and have closely comparable numbers of ACh receptors.

Degradation of ACh receptors was measured by an indirect method that depends on the specific labeling of the receptors with ^{125}I-labeled α-bungarotoxin (α-BuTx) and the release of radioactive material derived from degraded receptors into the culture medium (*7*). Sets of identical 7- to 8-day-old cultures were first saturated with ^{125}I-labeled α-BuTx for 30 minutes [0.05 μg (6.25×10^{-12} mole) in 1 ml; the specific activity was 3×10^4 to 5×10^4 c/mole], and the unbound toxin was removed by washing four times with culture medium (modified by omission of phenol red). At several intervals from 2 to 40 hours, the medium and a single washing were removed for counting of released radioactivity, and fresh medium was added to the culture dishes. At the end of the experimental period (usually 40 hours), the cultures were extracted with two washings of 1 ml of 1 percent Triton X-100 in phosphate-buffered saline, *p*H 7.2, to solubilize the remaining cell-bound complexes of ACh receptor and