Proceedings of the American Physical Society

MEETING AT ROCHESTER, NEW YORK, JUNE 23–24, 1944

THE 261st meeting of the American Physical Society, being the 1944 Summer Meeting in the East, was held in Rochester (New York) on Friday and Saturday, June 23 and 24. Our meeting was held conjointly with one of the American Association of Physics Teachers, and comprised the inaugural meeting of our own Division of High Polymer Physics. To that Association and this Division belongs most of the credit for arranging an excellent threefold meeting, with 238 registrants and 180 in attendance at the dinner. The Association had a symposium, "Essential physics for a naval career," and another, "The training of physicists for industry," in which we were graciously allowed to join as co-sponsors; it had also two programmes of contributed papers. We had two programmes of contributed papers (the abstracts follow) and an invited paper, "Ultraviolet spectra of biologically important molecules," by G. A. Anslow. The host institution was the University of Rochester, and to Professor F. C. Fairbanks and his department and secretarial staff warm thanks are expressed. The weather was merciful for the season. The dinner of Friday evening at the Hotel Seneca was followed by brief speeches by A. J. Dempster, L. McDowell, J. H. Dillon, and L. A. DuBridge, and an address, "The new world and the scientist," by C. E. K. Mees.

The Division of High Polymer Physics of our Society made its debut with an inaugural programme of four scientific sessions comprising twenty-one invited papers. The titles of these papers are printed below; abstracts and in some cases complete texts are to be published elsewhere. This programme was arranged by J. H. Dillon, M. L. Huggins, W. J. Lyons, and H. F. Mark, who with W. F. Busse served as chairmen. A draft of by-laws was evolved and adopted by the Division in business session and by the Council of the Society, and in accordance with its stipulations the Council appointed an initial executive committee of seven members to serve until the 1944 Annual Meeting of the Society. These seven are: R. B. Barnes, W. F. Busse, P. Debye, J. H. Dillon, J. P. Elting, W. J. Lyons, and L. A. Wood. The Division of High Polymer Physics is now launched and fully equipped and ready to proceed under its own steam. Communications should be addressed to its Secretary Dr. W. J. Lyons, 2100 Robert E. Lee Boulevard, New Orleans 19, Louisiana.

Other actions by the Council at its meetings of Friday and Saturday included the appointment of a "steering committee" of three members (K. K. Darrow, A. J. Dempster, R. S. Mulliken) to guide the formation of the Division of Spectroscopy authorized at the April meeting, with power to add other members to the Committee and to arrange symposia; and the appointment of a committee of six (S. Dushman, T. A. Read, F. Seitz, W. Shockley, S. Siegel, R. Smoluchowski) to arrange a symposium and take other steps to promote a Division of Physics of the Solid State.

The Council elected four candidates to Fellowship (one had previously been a Member) and fifty-five candidates to Membership; their names are subjoined.

The Society has lost through death four of its Fellows: S. Ballantine (Ballantine Laboratories), N. A. Kent (Boston University), Margaret E. Maltby (Barnard College), and O. M. Stewart (University of Missouri).

Elected to Fellowship: J. Hillier, H. F. Mark, E. Ott, E. M. Purcell.

Elected to Membership: Bartnoff, Shepard; Barton, David Maxwell; Brody, Selma Blazer; Brown, Barremore Beverly; Budd, Chester B.; Burns, Preston; Claassen, Howard H.; Clark, Orrin H.; Ellis, James; Ferguson, Jasper N.; Gibson, Kenneth Alvin; Gilbert, Edgar N.; Graves, J. Dentler; Halteman, Eber K.; Harth, Erich M.; Hook, Alonzo Lohr; Jastrow, Robert; Kaufmann, Stefan G.; Kessler, Myer; Kinnaird, Richard F.; Labin, Edouard; Lanzl, Lawrence H.; Levine, Samuel; Lewin, Gerhard; Lopes, Jose Leite; Madansky, Leon; Maiden, Robert M.; Mathieson, Raymond L.; McCarthy, Edward L.; Munier, John Hammond; Pardee, Otway O'Meara; Perkin, Richard S.; Pleasonton, Frances; Plew, Herman E., Jr.; Prather, Robert W.; Proskauer, Eric S.; Rall, Waldo; Rich, Joseph Anthony; Schwartz, Don L.; Schwarz, Edward Robinson; Sharer, William W.; Shaw, Morton R., Jr.; Sreb, Jules H.; Stephenson, John; Strong, Guy E.; Tallmadge, Francis K.; Thomas, Benjamin W.; Vogel, Charles P.; Weltmann, Ruth N.; Wetmore, Warren L.; White, Donald W., Jr.; Woods, Frank R., Jr.; Wundheiler, Alexander; Urquhart, Robert Cameron; Ziomek, Joseph S.

KARL K. DARROW
Secretary

Symposia of the American Association of Physics Teachers and the American Physical Society

Essential Physics for a Naval Career

Introduction. COMMANDER F. K. ELDER, USN (Ret.), *Head of Physics Committee, U.S.N.A.*
Vectors. LIEUTENANT COMMANDER J. A. TIEDEMAN, USNR, *Instructor in Physics, U.S.N.A.*
Mechanics. LIEUTENANT COMMANDER L. E. KINSLER, USNR, *Instructor in Physics, U.S.N.A.*
Gyroscopes. LIEUTENANT COMMANDER J. D. RIGGIN, USNR, *Instructor in Physics, U.S.N.A.*
Sound. LIEUTENANT E. R. PINKSTON, USNR, *Instructor in Physics, U.S.N.A.*
Optics. LIEUTENANT (J.G.) R. A. GOODWIN, USNR, *Instructor in Physics, U.S.N.A.*

The Training of Physicists for Industry

Postwar Training of Physicists for Industry. SAUL DUSHMAN, *General Electric Company.*
Training for the Small Industrial Research Laboratory. H. L. MASON, *Taylor Instrument Companies.*
Training of Physicists for the Optical Industry. BRIAN O'BRIEN, *University of Rochester.*
Observations on the Training of Physicists. M. N. STATES, *Central Scientific Company.*
Discussion, opened by J. T. LITTLETON, *Corning Glass Company.*

Invited Papers of the Inaugural Programme of the Division of High Polymer Physics

Systems with Superimposed Viscous and Elastic Behavior. A. TOBOLSKY, *Princeton University.*
Transition Phenomena in High Polymers. W. O. BAKER, *Bell Telephone Laboratories.*
A Contribution to the Kinetic Theory of Rubber Elasticity. T. ALFREY, *Monsanto Chemical Company.*
A Recent Development in the Theory of Rubber Elasticity. HUBERT M. JAMES AND E. GUTH, *University of Notre Dame.*
Electrostatic Properties of Rubber and GR-S. R. S. HAVENHILL, H. C. O'BRIEN, AND J. J. RANKIN, *St. Joseph Lead Company.*
Speed of Retraction of Rubber. R. B. STAMBAUGH, MARGARET ROHNER, AND S. D. GEHMAN, *Goodyear Tire & Rubber Company.*
Rise of Temperature on Fast Stretching of Butyl Rubber. S. L. DART AND E. GUTH, *University of Notre Dame.*
Limiting Law of the Reinforcement of Rubber. HUGH M. SMALLWOOD, *U. S. Rubber Company.*
Relations Between Stress, Strain, and Temperature in a Pure-Gum Vulcanizate of GR-S. FRANK L. ROTH AND LAWRENCE A. WOOD, *National Bureau of Standards.*
Some Low Temperature Properties of Elastomers. F. S. CONANT AND J. W. LISKA, *Firestone Tire & Rubber Company.*
Physical Properties of Elastomers at Low Temperatures. T. L. LOUGHBOROUGH, H. E. GREENE, AND C. W. HARRIS, *B. F. Goodrich Company.*
Molecular Weights and Weight Distribution of High Polymers Determined from Light Scattering. P. M. DOTY, B. H. ZIMM, AND H. MARK, *Polytechnic Institute of Brooklyn.*
Theory of Filler Reinforcement. E. GUTH AND HUBERT M. JAMES, *University of Notre Dame.*
Some Factors Influencing the Brittle Point of High Polymers. R. S. SPENCER AND R. F. BOYER, *The Dow Chemical Company.*
Kinematic Errors in Bobbin Drives on Roving Frames. S. L. GERHARD, *United States Rubber Company.*
Control of Elongation in Highly Stretched Tire Cord. H. J. PHILIPP AND C. M. CONRAD, *Southern Regional Research Laboratory, U. S. Department of Agriculture.*
The Influence of Velocity-Gradient on the Relation Between Viscosity and Concentration in Cuprammonium Solutions of Cellulose. W. J. LYONS, *Southern Regional Research Laboratory, U. S. Department of Agriculture.*
Orientation of Hydrophile Xerogels in an Electric Field, Part II. S. E. SHEPPARD AND P. T. NEWSOME, *Eastman Kodak Company.*
Determination of Molecular Weights of High Polymers by Solubility Methods. D. R. MOREY AND J. W. TAMBLYN, *Eastman Kodak Company.*
Comparison of the Structures of Stretched Linear Polymers. M. L. HUGGINS, *Eastman Kodak Company.*
Fractionation, Viscosity, and Osmotic Pressure Studies on Cellulose Esters. J. W. TAMBLYN, R. L. TICHENER, D. R. MOREY, AND R. H. WAGNER, *Eastman Kodak Company.*

Abstracts of Contributed Papers

A1. X-Ray Coincidences From Te^{121} (125 Days).* ROSALYN S. YALOW AND M. GOLDHABER, *University of Illinois.*—Te^{121} (125d) which decays by K-electron capture into Sb^{121} can be produced by deuteron bombardment of antimony-The radiations emitted by Te^{121} are very complex, consist. ing of x-rays, internal conversion electrons, and γ-rays. By critical absorption and fluorescence studies, O'Neal and Scharff-Goldhaber found not only the $K\alpha$ lines of Sb but also x-rays of somewhat shorter wave-length ("tellurium like"). They interpreted these x-rays as due to a transition in the Sb atom after both K electrons had been removed, one by K-electron capture and the other by a succeeding internal conversion of a γ-ray. We have obtained further evidence strengthening this interpretation by observing Geiger counter coincidences between the x-rays emitted during the decay of Te^{121}. The X-X coincidence rate observed was about 10^{-3} per x-ray counted in a single counter. When the x-ray rate in a single counter is reduced to about half by interposing different absorbers of suitable thickness between the Te sample and the counters, it is found that Cd foils, which absorb preferentially the shorter wave-length member of the x-ray pair, reduce the coincidence rate more strongly than either Ag or Al foils. From the relative intensity of the "double hole" x-ray transition to that of the "single hole" x-ray transition, one may obtain an estimate of the absolute mean lifetime of internally converted nuclear excited states by using for comparison the mean lifetime for which a hole in the K-electron shell exists. This time can be calculated from the known widths of x-ray lines. One may conclude that the excited state of the Sb^{121} nucleus which gives rise to strong internal conversion lines has a mean lifetime $\lesssim 2\times10^{-17}$ sec.

* Read by title.

A2. Slowing Down of R Neutrons into C Neutrons in Lead. C. O. MUEHLHAUSE AND M. GOLDHABER, *University of Illinois.*—When fast neutrons are slowed down inside paraffin they pass through an energy region above the Cd absorption limit where they may be referred to as R neutrons. After a few further collisions with protons they become C neutrons. It is of interest to study with what probability R neutrons can be slowed down into C neutrons by interaction with heavy elements. A previous attempt to detect this transformation was unsuccessful. With a more sensitive arrangement we have now been able to detect such an effect in lead and other elements. Its magnitude depends to some extent on geometrical and other factors. With one arrangement the slowing down effect from R into C neutrons per lead atom was found to be 5 percent of that observed per hydrogen atom. It is unlikely that more than a small part of the effect is due to hydrogen contamination in the lead. The effect appears to be too large, however, to be accounted for by excitation of lattice vibrations alone. No effect was observed with our arrangement with either Ra-α-Be or Ra-γ-Be sources when no paraffin was present to slow down the primary neutrons into the R region.

A3. Nuclear Excitation of Cadmium. MARCELLUS L. WIEDENBECK, *University of Notre Dame.*—By x-ray irradiation of self-quenching argon-ether counters having cadmium cathodes, the excitation curve for this element was obtained up to 2.9 mev. The half-life[1,2] was found to be 48.7 ± 0.3 minutes. The threshold for the excitation is 1.25 ± 0.03 Mev and activation levels were found at 1.68 Mev, 2.08 Mev, and 2.56 Mev. The electron excitation curve shows the same threshold and activation levels which were found by x-ray excitation. Absorption of the conversion electrons by aluminum foils indicates that the energy of the metastable state is 195 kv.

[1] Dode and Pontecorvo, Comptes rendus **207**, 287 (1938).
[2] J. R. Feldmeier and G. B. Collins, Phys. Rev. **59**, 937 (1941).

A4. The Electron Affinity of Bromine and a Study of Its Decomposition on Hot Tungsten. P. M. DOTY AND J. E. MAYER, *Columbia University.*—The electron affinity of bromine has been measured by determining the ratio of ions to electrons leaving a hot tungsten surface in contact with bromine gas at low pressure. The value obtained is 80.5 ± 0.4 kcal./mole. The measurements, which extend over a range of 700° in temperature and 80-fold in pressure, show no trend in the electron affinity and demonstrate that the decomposition of bromine under these conditions is a first-order reaction. The assumption of unit accommodation coefficient is shown to be correct. The agreement between the value here obtained and the value calculated from energy cycles substantiates the improved method of calculating lattice energies.

A5. Analysis of the Raman Spectrum of a New C_5H_8 Compound. FORREST F. CLEVELAND AND M. J. MURRAY, *Illinois Institute of Technology.*—Murray and Stevenson[1] recently reported Raman frequencies and relative intensities for a new C_5H_8 compound and presented five possible structures for the molecule. The method of preparation as well as the values of the C−H stretching frequencies indicated that the compound was spiropentane. In the present investigation, the depolarization factors of the Raman lines have been obtained and the expected number of polarized and depolarized frequencies, both for the entire molecule and for the carbon skeleton ($\Delta\nu$ less than 1050 cm^{-1}), have been worked out for each of the five structures by use of the group theory formulas. If it is assumed that all lines involved in accidental degeneracies have been resolved, the structure giving the best correlation with the experimental results is one having the symmetry D_{3h}. However, if unresolved accidental degeneracies do exist, as seems quite probable for the spiropentane structure since there are a number of similar groups in the molecule, the spiropentane structure of symmetry C_{2v} would give the best correlation. A calculation of the frequencies would aid in deciding between the two structures. The large number of approximate coincidences between the Raman and infra-red frequencies is additional evidence in favor of the spiropentane structure.

[1] Murray and Stevenson, J. Am. Chem. Soc. **66**, 314 (1944).

A6. The Formation of a Zone Plate by Newton's Rings. ROBERT AYRES WOODSON, *Eastman Kodak Company.*—The approximate equation for the radius y' of the Nth ring of a zone plate is: $y'^2 = Nf\lambda = Ny_1'^2$, where f = focal length, λ = wave-length, y_1' = radius of first ring. The approximate equation for the radius y'' of the Nth Newton ring is: $y''^2 = N\lambda/n(C_1 - C_2) = Ny_1''^2$, where λ = wave-length, n = index of refraction of thin film, C_1 = curvature of one surface of thin film, C_2 = curvature of other surface of thin film, y_1'' = radius of first ring. Since the radius of the Nth ring is proportional to $\sqrt{N}$ for both the zone plate and Newton's rings, it occurred to the author to use Newton's rings for the formation of a zone plate. On combining the above equations, we obtain for the power P of such a zone plate, $P = n(C_1 - C_2)$, or for an air film between the lens surfaces, $P = C_1 - C_2$. For the combination of a plano-parallel plate and the convex surface of a zero-power meniscus lens, the focal length is equal to the radius of the convex surface.

A7. Some Basic Thermodynamic Considerations. J. L. FINCK, *College of the City of New York.*—In previous papers the writer has endeavored to show that from a phenomenological point of view there is justification for including metastable states within classic thermodynamics, particularly if catalytic phenomena are considered. In doing so, a much broader view may be taken of the thermodynamic behavior of systems. However, criteria based exclusively on the first two laws of thermodynamics define equilibrium in such manner that metastable states are excluded. In the present paper a critical examination is made of development of the second law, and a fallacy is found wherein the metastable states are excluded from the very start—in the treatment of Carnot's cycle. Logical approach requires that we establish the independent variables in advance, and it is found that in general an equation of state should include more than two independent variables. Such an equation will include metastable, as well as ordinary equilibrium states, and will apply to systems consisting of one or several phases. In enlarged systems it is shown that entropy is no longer an integrable function, and therefore cannot play the role it does in classic thermodynamics. It is suggested how an enlarged equation of state may explain thermodynamically the catalytic behavior of systems where intermediate products are formed.

B1. Knudsen Type Vacuum Gauge in Technical High Vacuum Work. A. F. TURNER AND O. A. ULLRICH, JR., *Bausch & Lomb Optical Company.*—The Knudsen vacuum gauge has not found widespread application. Apparently the principal objection hitherto has been the need for a vibration-free support. This restriction can be materially relaxed in the design of DuMond and Pickels[1] by the addition of a small auxiliary internal damping vane moving in a horizontal plane between permanent magnets. External permanent magnets damp the impact vane. Gauges so constructed and mounted rigidly on the base plates of large bell jar systems have given satisfactory performance in evaporation work under adverse floor vibration conditions. The gauge is practically linear through the 10^{-5} mm Hg range using a sensitivity of 1×10^{-5} mm Hg per cm deflection at 23-cm scale distance. Operation in higher and lower ranges is obtained by changing the heater temperature. The gauge is not harmed if accidentally turned on at atmospheric pressure—a definite advantage in a technical instrument. The performance of the gauge during the evaporation of some metals and salts will be described.

[1] Jesse W. M. DuMond and W. M. Pickels, Jr., Rev. Sci. Inst. **6**, 362 (1935).

B2. Solution of the Diffusion Equation Applicable to the Edgewise Growth of Pearlite. W. H. BRANDT, *Westinghouse Electric & Manufacturing Company.*—The diffusion equation is transformed to a set of coordinates moving with the pearlite interface and a solution applicable to the problem obtained in the form of an infinite series of terms. Using the first three terms, the edgewise velocity of pearlite growth is calculated for a plain carbon eutectoid steel using data most of which are obtained by extrapolation. The values obtained show reasonable agreement with values for the rate of pearlite nodule growth determined by Hull, Colton, and Mehl.* The velocity increases with decreasing temperature, as expected, and it is shown that this is due to the change in the solubility of ferrite and cementite in austenite with temperature. The theory predicts curved ferrite and cementite interfaces and the carbon concentration in austenite is shown to vary across each of these interfaces.

* F. C. Hull, R. A. Colton, and R. F. Mehl, Trans. A.I.M.E. **150**, 185 (1942).

B3. The Mechanics of the Metal Cutting Process. II. Oblique Straight-Edged Tool and Continuous Chip. M. EUGENE MERCHANT, *Cincinnati Milling Machine Company.*—The principles employed in the derivation of the mechanics of the simple case previously discussed[1] have been extended to an analysis of the geometry of chip formation and of the force system occurring in the more general case of a straight-edged tool with cutting edge oblique to the direction of relative motion of tool and workpiece. It is found that the direction of chip flow and the direction of shear are no longer perpendicular to the cutting edge as they are in the simple case. As a result the force system is three-dimensional. However, it is again possible to obtain simple relationships between the readily measurable force components and geometrical variables, and such basic quantities as strain in the chip, friction between chip and tool, shear strength of the metal, etc., thus making possible the analysis of actual machining operations in terms of these basic quantities.

[1] M. E. Merchant, Bull. Am. Phys. Soc. **19**, No. 2, 7 (1944).

B4. Experimental Investigations of the Mechanism of Friction. B. W. SAKMANN, *Massachusetts Institute of Technology.*—In all friction experiments material is exchanged between the sliding surfaces even under small loads of a few grams. This fact seems to indicate that such an exchange of matter might be of fundamental importance in all frictional phenomena. The development of a radioactive tracer method made it possible to investigate this transfer of matter. Spherical riders were slid over an activated base surface and were tested for the presence of radioactive material. The amount of material transferred depends upon various parameters. The amount of base metal adhering to

the rider was found to be proportional to the normal load and the distance traveled. The transferred material increased with the surface roughness if the rider was harder than the base. If, on the other hand, the rider was softer than the base, surface finish was of minor importance. For steel samples the deposited material was inversely proportional to the Brinell hardness. For riders of different metals of the same hardness and surface finish the amount of transferred material increased with the solid solubility of the base metal in that of the rider. The exchange of metal was reduced by lubrication. The reduction depended on the normal load and, for the same load, on the material of the rider.

B5. Tensile Strength of Liquids. ALLEN KING, *Dartmouth College.*—When a tension is applied *slowly* to a liquid column, rupture occurs with the formation of a cavity. The critical tension for rupture probably fluctuates about a mean. The smallest cavity in which vapor can exist in equilibrium within a liquid at absolute temperature T may be assumed to have a diameter equal to the average distance between molecules of vapor at the vapor pressure for this temperature. This cavity is in unstable equilibrium. If q represents the critical tension (tensile strength) in atmospheres, then $q=14.6\gamma(p/T)^{\frac{1}{2}}$, where γ is the free surface energy in ergs per cm^2 and p is the vapor pressure in cm of Hg. At 20°C q has a value of 194 atmos. for water, 80 atmos. for ethyl alcohol, and 132 atmos. for diethyl ether. According to this relation q increases with temperature to a maximum value.

B6. Ponderomotive Forces on Matter in Electric and Magnetic Fields. FELIX EHRENHAFT, *New York City.*—In a recent Letter to the Editor of *The Physical Review* it was stated that beside the force of gravity and the magnetic action of electric currents (Oersted, Biot-Savart, H. A. Lorentz), $f_e=D+1/c[v_e, H]$, there is a third general force, the electric action of magnetic currents, $f_m=B+1/c[v_m, E]$. However, if one adds to the electrodynamic equations the term of the magnetic current, following the conception of Stefan and Heaviside, it seems that the forces f_e and f_m cannot explain all the observed movements. If there is no angle between the direction of the electric current and the magnetic field, and no angle between the direction of the magnetic current and the electric field, the second terms of the above equations become nil. But it has been observed that, when the homogeneous electric and magnetic fields are parallel and in action simultaneously, there can be a circular movement of matter. One suspects that some of the phenomena reported by S. P. Thompson and others are of the same type, although the homogeneity of the fields they employed was not considered by them. Experiments in gases as well as in liquids will be described where these movements are to be seen in homogeneous fields. Conclusions can only be drawn under the preliminary assumption that there is no interdependency between H and E other than that expressed in the equations mentioned above.

Read by Title

T1. The Electrical Resistivity of Alpha-Phase Copper-Zinc Alloys at Low Temperatures. H. A. FAIRBANK, *Yale University.*—A systematic investigation of the resistivity (ρ) of the copper-zinc alpha-phase solid solution system has been made in the temperature range 14.3°K to room temperature. Measurements were taken on two sets of one millimeter diameter wires. The first was annealed at 700°C and quenched; the second, cold-drawn through a 75 percent reduction and left in the hard-drawn state. For the annealed set, the resistivity varied linearly with the temperature above 70°K and with a higher power of T at low temperatures, approaching a constant value below 20°K. Above 70°K, $d\rho/dT$ was found to increase linearly with atomic percent solute in variance with Matthiessen's rule. The residual resistivity increased with percent added zinc, but not in agreement with Nordheim's theory,[1] unless it be assumed that the effective number of free electrons per atom increases with added solute atoms or that the specimens were not true random solid solutions. The hard-drawn specimens showed properties similar to the annealed group except for an increase in the resistivity due to residual strains.

[1] L. Nordheim, Ann. d. Physik **9**, 664 (1931).

T2. The Electrical Resistivity of Alpha-Phase Copper-Tin Alloys at Low Temperatures. H. A. FAIRBANK, *Yale University.*—An investigation similar to that described in the previous abstract for the Cu-Zn alpha-phase alloys has been carried out for the Cu-Sn alpha-phase alloy system in the temperature range 14.3°K to room temperature. The dependence of the electrical resistivity on temperature and on percent added tin was similar to that found for the Cu-Zn system. However, the cold work produced some unexpected effects. Although the expected increase of resistivity with residual strain occurred in the higher percentage tin specimens, the wires of zero to three atomic percent tin, which were hard-drawn through a 75 percent reduction and left in the strained state, showed a lower resistivity at low temperatures than did the corresponding annealed, quenched specimens. This anomaly increased as the temperature was lowered. This unusual behavior may be due to order in the Cu-Sn specimens of about two atomic percent tin, induced either during the cold working process or during the air cooling which followed the anneal at 750°C prior to the 75 percent reduction. It is also possible that a phase separation may have occurred as a result of the extensive cold work. Further investigation appears highly desirable.