diethyl ether given to mice 1 hour after a single-trial conditioning situation will not impair the retention of a response tested 24 hours after training. This observation, supported by the results of another study employing ether anesthesia in rats (*4*), leads one to infer that consolidation is complete between 20 and 24 minutes after training in this type of situation (*5*).

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References and Notes

1. C. Pearlman, S. K. Sharpless, M. E. Jarvik, *J. Comp. and Physiol. Psychol.*, in press; W. B. Essman and M. E. Jarvik, *Am. Psychologist* **15**, 498 (1960); unpublished data.
2. G. E. Müller and A. Pilzecker, *Z. Psychol. physiol. Sinnesorg.* **1** (1900); R. W. Gerard, *Science* **122**, 225 (1955).
3. W. B. Essman and M. E. Jarvik, unpublished data.
4. C. Pearlman *et al.*, unpublished data.
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Detection of Lycopene in Pink Orange Fruit

Abstract. Lycopene is shown to be the pink coloring pigment in Sarah—a pink sport of the Shamouti (Jaffa) orange—together with other unidentified carotenoids. This is a condition similar to that found in pink and red grapefruits, while the red pigments of blood oranges are anthocyanins.

Matlack (*1*) had suggested that the red coloration in blood oranges is caused by anthocyanins, which have quite recently been identified as cyanidin-3-glucoside and delphinidin-3-glucoside, dissolved in cell sap of juice vesicles of some blood orange varieties (*2*).

On the other hand, the pink and red color of some grapefruit and shaddock varieties has been found to be caused by plastid-contained lycopene and beta-carotene (*3*), which have been quite recently investigated by Lime *et al.* (*4*), Purcell (*5*), and others. As far as we are aware (*6*), no report of the presence of lycopene in oranges has been published to date.

Sarah, a pink bud sport of Shamouti (Jaffa) orange, which was first detected in the late 1930's and described in 1944 (*7*), presents at an even superficial examination many of the characters of pink grapefruits: (i) the filtered juice is almost colorless and does not present any pink tinge; (ii) the pink color is mainly present in the inner mesocarp, carpel walls, and vesicle stalks; and (iii) large concentrations of dark-yellow to pink plastids are detected especially around main conducting bundles and their anastomoses (*8*) even when fruit is fully ripe.

Carpels of ripe Sarah fruits were blended, extracted, and chromatographed on 1:1 W/W Magnesia-Hyflo Super Cel columns, as described under method A, by Lime *et al.* (*4*).

Two main bands were obtained, an upper red and a lower yellow-orange, which were eluted with 10 percent acetone in hexane and 5 percent methanol in hexane, respectively, into two separate fractions.

Spectral curves of both fractions were determined with a Beckman DU spectrophotometer. The curve obtained from the upper band was identical with that of lycopene in hexane, with peaks at 445, 470, and 503 mμ. This is in accordance with the situation found in pink and red grapefruits (*4, 5*). The second fraction which had been found to contain only beta-carotene in grapefruits (*4*) did not yield a curve identical with that of beta-carotene in hexane, since it has peaks at 440, 470, and 500 mμ instead of two peaks at 455 and 480 mμ (*4*); it seems to contain some unidentified carotenoids.

No anthocyanins could be detected in the aqueous and methanolic extracts of Sarah carpels or mesocarp portions. It is therefore concluded that the pink coloration observed is induced by substantial amounts of lycopene and not by anthocyanins as is usual in blood oranges.

Purcell (*8*) has pointed out that a carotenoid precursor must be assumed to enter fruit through the vascular system and to diffuse into the surrounding parenchyma where it produces pink coloration in pink and red grapefruits, especially before full ripeness is attained. It seems worth adding that this must be true for most citrus fruits. Concentrations of carotenoids can be seen easily around bundles, especially at the main fruit axis in many varieties, for example, Shamouti and Valencia oranges, Dancy tangerine, Eureka lemon, and Marsh seedless grapefruit, and especially so, because of the emphasizing pink tinge, in the Sarah orange.

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References

1. M. B. Matlack, *Plant Physiol.* **6**, 729 (1931).
2. B. V. Chandler, *Nature* **182**, 933 (1958).
3. M. B. Matlack, *J. Biol. Chem.* **110**, 249 (1935).
4. B. J. Lime, F. P. Griffiths, R. I. O'Connor, D. C. Heinzelman, E. R. McCall, *J. Agr. Food Chem.* **5**, 941 (1957).
5. A. E. Purcell, *J. Rio Grande Valley Hort. Soc.* **13**, 45 (1959).
6. J. F. Kefford, *Advances in Food Research* **9**, 285 (1959).
7. B. Ben-Ezer (Raab), *Hassadeh* **24**, 171 (1943/44).
8. A. E. Purcell, *J. Rio Grande Valley Hort. Soc.* **13**, 39 (1959).

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A World-wide Stratospheric Aerosol Layer

Abstract. An aerosol layer has been identified by a stratospheric balloon and aircraft aerosol collection program. Measurements of horizontal extension and vertical distribution indicate that this layer is a world-wide phenomenon, displaying little variation with time and latitude. The particles in this layer range in size between 0.1 and 2 μ in radius, are water soluble, and contain sulfur as the predominant constituent. It is most likely that they are formed within the stratosphere.

A program of stratospheric aerosol collection with high-altitude balloon equipment was started about 3 years ago and was recently supplemented by collection with high-altitude aircraft (*1*). The aim was to obtain basic information on a heretofore neglected subject of some importance to radioactive fallout and stratospheric circulation studies. The instrumentation was designed to study vertical profiles of number concentration of two particle size ranges, as well as the horizontal distribution, size distribution, and chemical composition of the particles. It is evident, from the results now available, that a large, persistent aerosol layer exists in the stratosphere at an altitude of about 20 km. This layer is composed of particles between approximately 0.1 and 2 μ in radius. Particles smaller than 0.1 μ are distributed with entirely different vertical profiles, the form of which indicates that they are of tropospheric origin and are brought into the stratosphere by mixing. On the other hand, a 2-μ radius appears to be a rather sharp upper limit, and almost no particles larger than this seem to be present. The characteristic features of this aerosol layer are listed below.

1) Vertical profiles obtained in middle north latitudes show a very broad maximum in number concentration at altitudes between about 18 and 23 km. The number concentration of particles at this maximum is about 1 per cubic centimeter, which is higher by a factor of 3 than that at the tropopause, and in most cases decreases rapidly above 24 km. The time variation at this maximum over a period of more than 2 years does not exceed a factor of 3. The shape of the vertical profile indi-

cates that it is most unlikely that these particles have penetrated into the stratosphere from the troposphere by vertical mixing.

2) Collections of these particles by aircraft at about 20 km over a wide range of latitudes between about 40°S and 70°N over a period of more than half a year show that the particle concentration is remarkably uniform with time and latitude. The combination of these aircraft data with the vertical profiles obtained in middle north latitudes suggests that the aerosol layer is a world-wide, persistent phenomenon.

3) The size distribution, dn/dr, of the particles between 0.1 and 2 μ in radius is of the form

$$dn/dr = kr^{-a}$$

with a being approximately 3; k is a constant. The particles are water soluble, have a tendency to evaporate to a spotty residue in the electron microscope, and show a structure and shape very much resembling those of spray aerosols produced from solutions of ammonium sulfate and some other soluble salts.

4) Analyses of the heavy deposits from long balloon and aircraft flights were performed with electron microprobe techniques and indicated sulfur to be the predominant element in the range of atomic numbers from magnesium (12) through zinc (30). The sulfur is deposited roughly in proportion to the visual density of the collection and has been present in every sample analyzed to date. Occasional samples contained aluminum, silicon, and iron. Some traces of chlorine, potassium, and calcium were found. Table 1 contains a summary of the average composition for both balloon and aircraft samples. We think that these particles consist mainly of ammonium sulfate and adduce, in addition to Table 1, the hygroscopicity of the collected particles and the electron diffraction pattern obtained by Friend (*2*), both of which indicate this compound. The few samples which have contained a significant amount of either silicon or iron, distributed throughout the collection, can be tentatively explained by a temporary fluctuation in micrometeorite influx. In no case was the concentration of either of these elements more than one-third that of sulfur on the same sample, which is in agreement with our identification of the persistent aerosol layer with a soluble sulfate. Since the vertical profile makes a direct tropospheric origin unlikely, and the composition makes an extraterrestrial origin unlikely, it appears that this aerosol must form within the stratosphere itself. The most plausible explanation at the present time is that these particles are formed by the oxidation of H_2S or SO_2 by ultraviolet radiation or ozone at the level where they are found. These gases, known to be present in the troposphere in sufficient quantity, can enter the stratosphere by mixing, without being removed very efficiently by washout in the upper troposphere.

Table 1. Chemical analysis of stratospheric particles from balloon and aircraft samples.

Balloon (0.1μ < particle radius < 1.5μ)		Aircraft (0.02μ < particle radius < 3.0μ)	
Element	Relative concn.*	Element	Relative concn.*
S	0.85	S	0.85
Si†	.08	Al†	.05
Fe†	.04	Si,Ca,K, Fe †	.01
Al‡	<.04		
Cl, K, Ca, Cr, Co, Ni, Cu, Zn ‡	<.01	Mg, P, Cl, Cr, V, Mn, Co, Ni, Cu, Zn ‡	<.01

* No allowance has been included in these figures for combined forms of elements of atomic number less than 12. † The concentration of these elements fluctuates from sample to sample. ‡ These elements were not generally present in detectable amounts.

This world-wide aerosol layer is most likely the one long sought for to explain the Purple Light (*3*). The conspicuous disk of red light above the point of sunset or sunrise has been observed for over a hundred years as a very regular phenomenon. The geometry of its appearance points to a thick aerosol layer in the stratosphere as the origin of the scattered light, although more precise calculations of the height of this layer, to be compared with our profiles, are still missing.

Thus far, our data have provided no support for the theory that rainfall is stimulated on a world-wide basis by the influx of extraterrestrial dust through the stratosphere into the troposphere. The particles of the stratospheric aerosol layer do not have the characteristics required by this theory. In addition, the presence of this aerosol layer seriously prejudices the identification of extraterrestrial dust collected at this altitude. We estimate that, in the size range below 2 μ in radius, the sulfate aerosol is about a factor of 1000 higher in number concentration than the cosmic dust, using Opik's estimate (*4*) for the latter and assuming sedimentation equilibrium in the atmosphere. It is very difficult, therefore, to detect the particles of extraterrestrial origin among the many indigenous ones. On the other hand, the concentration of particles of cosmic dust larger than 2 μ in radius is already so low that optimal sampling conditions provide an expected population of only 1 or 2 per square centimeter on the collection substrate, so that identification against background becomes a problem. If positive fluctuations of meteoritic influx in this size range exist, our data indicate that they must be rare, and it appears that a systematic aircraft collection program is the most promising method for the sampling of such swarms. Such a program is currently in operation through cooperation with the Defense Atomic Support Agency (*5*).

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References and Notes

1. C. E. Junge, C. W. Chagnon, J. E. Manson, *J. Meteorol.* **18**, 81 (1961); other reports in preparation.
2. J. Friend, Isotopes, Inc., Westwood, N.J., personal communication.
3. P. Gruner, *Handbuch Geophysik* (Borntraeger, Berlin, 1958), vol. 8, p. 432.
4. E. J. Opik, *Irish Astron. J.* **4**, 84 (1956).
5. We are grateful to the Defense Atomic Support Agency and its contractor, Isotopes, Inc., Westwood, N.J., for their cooperation, particularly to A. K. Stebbins III and J. Friend. We also are pleased to acknowledge the support of this work by E. A. Martell, Air Force Cambridge Research Laboratories, and J. Z. Holland, U.S. Atomic Energy Commission.

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Queen Honey Bee Attractiveness as Related to Mandibular Gland Secretion

Abstract. The termination of mandibular gland secretion by gland removal in living mated queen honey bees (*Apis mellifera* L.) caused approximately 85 percent loss of queen attractiveness to worker bees. The secretion of attractants in virgin queens increased with age. Old virgins were as attractive as mated queens. A rapid assay for queen attractiveness is described.

The queen bee is attractive to worker bees in the honey bee (*Apis mellifera* L.) colony. Worker bees constantly surround the queen, licking the abdomen, touching various body parts with their antennae, and offering food. Since dead queens or lipid extracts of queens are attractive to worker bees (*1*), chemical mediation of attractiveness is indicated rather than auditory, visual, or other communicative media.

It was observed in this laboratory that the contents of mandibular glands (*2*) removed from the heads of living queens were attractive to worker bees. These observations suggested that the mandibular gland secretion in living queens might be primarily responsible for queen attractiveness.

An experiment was conducted to assess quantitatively the contribution of the mandibular glands to the attractiveness of five classes of living queens (Table 1). Classes I and II were randomly chosen from normal colonies.