

a green center. The same percentage of colorless colonies developed after the application of pressure for 2 hours as after application for 20 minutes.

Of the cells streaked on agar plates after exposure to 500 atm for 1/2 hour or 2 hours, only 1 percent showed color mutation, indicating that the phenomenon is pressure-dependent though apparently not time-dependent. Further study is required however, before definitive conclusions can be drawn. Although the mutant colonies appeared white on agar, they appeared yellow-orange when grown in liquid, thus reflecting synthesis of carotenoids (10).

Two additional "pressure" mutants, designated PR-2 and PR-3, were isolated. Mutant PR-2 synthesized about twice as much carotenoid as did PR-1 or PR-3 on the basis of the dry weight of the cells. This relationship is based on the  $E_{1\text{cm}}^{1\%}$  (11) value of 2500 for  $\beta$ -carotene (12) measured from the absorption spectrum of the total carotenoids extracted in 95 percent ethanol. The carotenoids have not been isolated or identified.

Neither in Cattell's review (13) nor in the studies cited by Johnson, Eyring, and Polissar (14) are there references to pressure-caused mutations. Whether the effect reported here is a reflection of a chromosomal or cytoplasmic gene

change cannot be stated with certainty. However, there is evidence which suggests a lack of direct nuclear control over chloroplast formation. Furthermore, several studies show that both DNA and RNA are present in chloroplasts (15). Such evidence favors cytoplasmic mutation, rather than chromogenic mutation, as the probable mechanism upon which hydrostatic pressure acts. Also, Hedén's studies (16) suggest that nucleic acids are probably targets of hydrostatic pressure. It can be postulated that pressure acts on a stage of chloroplast formation in which there is an increase in volume (14) of either the structural organelle or some molecular phase vital to its development.

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#### References and Notes

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