substance P could also be ruled out as the stimuli concerned. Contractions induced by 0.1 μg of 5-HT exhibited short latencies and fast relaxations, and blocking of 5-HT responses of uteri by lysergic acid or dihydroergotamine (*4*) did not change the effects of the extracts. The insensitivity of the rat colon to the extract is also in agreement with this evidence (*5*). Substance P is known to occur in extracts of brain and intestine of some mammals and to induce slow contractions of a number of smooth muscle preparations (*6*), but it is insensitive to heat, is dialyzable, and stimulates rat colon. Active roach extracts were found to be nondialyzable through cellophane (Fig. 1), and to be destroyed by heating above 50°C for 10 min, although stable for at least 24 hr at *p*H 5, 7, or 8 at room temperature.

Smooth muscle stimulants with prolonged effects somewhat resembling those of the roach gut extract have been reported from several tissues. Dalgliesh *et al.* (*5*) extracted from the small intestine of the horse a material designated substance C, which caused long contractions of guinea pig ileum. Various workers (*7*) have reported the production, during anaphylaxis, of a smooth muscle stimulating substance which has been called "slow reacting substance." A nondialyzable, heat-labile extract from the abdomen of the garden tiger moth, *Arctia caja*, has been found to cause constriction of bronchial smooth muscle when given intravenously to guinea pigs (*8*). It is not yet known whether the activity reported here might be due to high concentrations of any of those substances in roach gut and blood (*9*).

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References and Notes

1. L. Barton Browne, L. F. Dodson, E. S. Hodgson, J. K. Kiraly, *Gen. Comp. Endocrinol.*, in press.
2. J. Sternburg and J. Corrigan, *J. Econ. Entomol.* **52**, 538 (1959).
3. J. H. Gaddum, W. S. Peart, M. Vogr, *J. Physiol.* (*London*) **108**, 467 (1949).
4. I. H. Page, *Physiol. Rev.* **34**, 563 (1954); E. Fingl and J. H. Gaddum, *Federation Proc.* **12**, 320 (1953).
5. C. E. Dalgliesh, C. C. Toh, T. S. Work, *J. Physiol.* (*London*) **120**, 298 (1953).
6. B. Pernow, *Acta Physiol. Scand.* **24**, 97 (1951); W. W. Douglas, W. Feldberg, W. D. M. Paton, M. Schachler, *J. Physiol.* (*London*) **115**, 163 (1951).
7. C. H. Kellaway and E. R. Trethewie, *Quart. J. Exptl. Physiol.* **30**, 121 (1940); N. Chakravarty, *Acta Physiol. Scand.* **46**, 298 (1959); ———, *ibid.* **48**, 167 (1960).
8. G. W. Bisset, J. F. D. Frazer, M. Rothschold, M. Schachler, *Proc. Roy. Soc.* (*London*) **B152**, 255 (1960).
9. This research was supported in part by grant No. E-2271 from the National Institutes of Health, U.S. Public Health Service, and by the U.S. Educational Foundation in Australia.

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Succession in Desert Vegetation on Streets of a Nevada Ghost Town

Abstract. Vegetation was sampled on the old street system of Wahmonie, Nevada, and on a less disturbed area immediately adjacent. The vegetation on the denuded upland site showed a large increase in bunch-grass and an invasion by pioneer shrubs which ordinarily are chiefly confined to dry washes.

Muller (*1*) and Shreve (*2*) have concluded from studies in the Chihuahuan and Sonoran deserts that plant succession is essentially lacking in desert vegetation. According to Shreve (*2*), if a desert plant community is destroyed, the earliest stage in the return of the vegetation will be the appearance of young plants of the former dominants. "Not only do the same species appear at the outset, but their first individuals ultimately constitute the restored community." Nevertheless, on the Nevada Test Site of the U.S. Atomic Energy Commission, in the northern Mohave Desert, there are a number of shrubs, sub-shrubs, and herbs which are unimportant on undisturbed upland sites in the desert, but which are ubiquitous weeds where the original vegetation has been destroyed by man. Many of the invading plants are natives of naturally disturbed desert habitats, chiefly dry washes; a few are weedy exotics, like *Salsola*. The Nevada Test Site is exceptionally well endowed with disturbed sites. Besides areas devastated by the detonation of nuclear devices, there are a variety of sites from which vegetation has been denuded by more prosaic, mechanical means. Unfortunately, most of the disturbed areas are of rather recent origin, dating from the past 10 years, or else are of indeterminate age. However, the discovery of horn silver in the Tertiary volcanics east of Jackass Flat in 1928 has fortuitously provided a quasi-experimental plot 33 years old. On the bajada south of Lookout Peak, Nye County, the townsite of ephemeral Wahmonie, Nevada, was platted as eight streets and five avenues (unpaved, ungraded), which are still in evidence, although buildings have long since disappeared. According to Murbarger (*3*), "automobile-borne miners began pouring out of Tonopah toward

Table 1. Comparison of desert vegetation on an abandoned street system 33 years old with that of an adjacent, less disturbed site. Density is given as plants per acre and frequency as percentage.

Streets of ghost town	Density	Frequency	Adjacent site	Density	Frequency
Stipa speciosa Trin. & Rupr.	1050	96	*Grayia spinosa* (Hook.) Moq.	1082	100
Ephedra nevadensis Wats.	378	86	*Lycium Andersonii* Gray	565	96
Lycium Andersonii Gray	351	74	*Larrea divaricata* Cav.	344	80
Thamnosma montana Torr. & Frém.	153	48	*Ephedra nevadensis* Wats.	264	70
Hymenoclea Salsola T. & G.	108	32	*Coleogyne ramosissima* Torr.	201	42
Salazaria mexicana Torr.	81	20	*Stipa speciosa* Trin. & Rupr.	138	44
Grayia spinosa (Hook.) Moq.	45	20	*Thamnosma montana* Torr. & Frem.	21	8
Acamptopappus Shockleyi Gray	32	8	*Acamptopappus Shockleyi* Gray	5	2
Larrea divaricata Cav.	18	6	*Eurotia lanata* (Pursh) Moq.	5	2
Coleogyne ramosissima Torr.	14	6	*Krameria parvifolia* Benth.	5	2
Dalea Fremontii Torr.	4	2	*Opuntia acanthocarpa* Englem. & Bigel.	5	2
Eurotia lanata (Pursh) Moq.	4	2	*Yucca brevifolia* Engelm.	5	2
Aplopappus Cooperi (Gray) Hall	4	2			
Krameria parvifolia Benth.	4	2			
Lepidium Fremontii Wats.	4	2			
Total	2250		Total	2640	

the new bonanza, and in April, 1928, two months after the original strike, the town had a population of 1500, the Gilbert brothers had installed an electric light plant and numerous stores and cabins had been built. Almost before it was possible to say 'Wahmonie, Nevada,' the boom collapsed." The townsite is located at an elevation of 4300 feet on a gentle south-facing slope, on unsorted alluvium typical of fans in this area, but free of major drainageways. The soil has a gravelly, granular, sandy-loam texture with lag gravel on the surface, the whole derived from the lavas and tuffs of the adjacent mountains. The platting of the townsite apparently amounted to little more than clearing of the shrubs from the street system, but the "streets" are still conspicuous because of the peculiarity of the vegetation which has become established on them in the course of 33 years. The perennial vegetation was sampled on the streets and on the less disturbed portion of the bajada immediately adjacent, which was taken as the best available "control." A distance method similar to the quarter method of Curtis and Cottam (*4*) was used, but ten individuals were recorded per point. Fifty points were taken, giving a total sample of 500 individuals for each site. The results are presented in Table 1.

Clearly, there have been pronounced changes in the physiognomy and floristic composition of the vegetation in Wahmonie. In fact, an open stand of bunch-grass has partially replaced the desert shrub community, because of the large increase of *Stipa*. On the whole, invasion by shrubs has been slow, and the species composition has changed both quantitatively and qualitatively. Of the dominant shrubs on this portion of the bajada, only *Ephedra* and *Lycium* are present on the townsite in large numbers, and it happens that both of these are species which sprout vigorously from underground parts when the tops are destroyed. It is significant that *Thamnosma, Hymenoclea,* and *Salazaria,* which are characteristic shrubs of naturally disturbed desert habitats, such as drainageways and actively eroded bedrock areas, should appear in large numbers on a man-disturbed site. This establishes a pioneer or weedy character for certain plants of dry washes, which have been regarded as an *ad hoc* climax. Shreve (*2*) concluded: "Each habitat in each subdivision of a desert area has its own climax, which must not be given an elastic definition and must be interpreted as having a genetic relation to any other climax." Since the word climax, as applied to vegetation, conveys an idea of relative stability, it seems scarcely applicable in the case of desert washes, which are periodically scoured by floods carrying great quantities of coarse detritus. The average wash presents an extensive open surface favorable for invasion by pioneer plants possessing the requisite adaptations for efficient seed dispersal, celerity of growth, and early maturation. One might suppose that all plants of this habitat have a greater water requirement than plants of upland sites and for this reason are restricted to naturally irrigated areas of the desert. However, the present study shows that several shrubs of dry washes can become established in abundance on the more xeric upland portions of an alluvial fan when the competition of the dominant upland shrubs is largely removed. Obviously, these pioneer plants of the desert play a role similar to that of successional plants of more humid regions (*5*).

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References and Notes

1. C. H. Muller, *Ecology* **21**; 206 (1940).
2. F. Shreve, *Carnegie Inst. Wash. Publ. No. 591* (1951).
3. N. Murbarger, *Ghosts of the Glory Trail* (Desert Magazine Press, Palm Desert, Calif., 1956).
4. G. Cottam and J. T. Curtis, *Ecology* **37**; 451 (1956).
5. This report is based upon investigations at the Nevada Test Site performed under contract No. AT(29-2)517 between the U.S. Atomic Energy Commission and New Mexico Highlands University.

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Biosynthesis of Stigmasterol in Tomato Fruits

Abstract. The presence of stigmasterol in tomato fruits was demonstrated. Labeled mevalonic acid was incorporated into this sterol, while sodium acetate was not. The identity of the isolated product was established by rigorous purification to constant specific activity, melting point determinations, and infrared spectrum.

The biosynthesis of steroids in plants has only recently begun to receive attention, in contrast to the large volume of work on the biosynthesis of animal steroids (*1*). In 1958 Sander and Grisebach (*2*) reported the incorporation of labeled acetate into tomatin in tomato seedlings. Guseva *et al.* (*3*) have studied the biosynthesis of the steroidal alkaloids chaconine and solanine in potato sprouts, finding that mevalonic acid is no more effective as a precursor than acetate. Ramstad and Beal (*4*) injected labeled mevalonic acid into *Digitalis lanata* plants, from which they then extracted radioactive digitoxigenin. On feeding radioactive mevalonic acid or sodium acetate to *D. purpurea* plants, Gregory and Leete (*5*) found that, while both were incorporated into digitoxigenin, only the acetate was incorporated into the side chain. Recently Nicholas (*6*) showed that β-sitosterol is synthesized from labeled mevalonic acid by *Salvia sclarea*; the sterol from the flowers had higher radioactivity than that from other parts of the plant.

Table 1. Purification and radioactivity of stigmasterol. Melting points were taken on a Kofler block and are corrected. Radioactivity was determined to ±0.9 error.

Treatment	mp (°C)	Count/min mmole
	Stigmasterol acetate	
A	142–144	3200
B	142–145	1870 ± 90
C	143–145	1280 ± 70
D	143–145	913 ± 68
E	143–145	840 ± 68
	Stigmasterol	
F	168–170	733 ± 49
G	168–170	766 ± 58
H	169–171	770 ± 54

In our first work on the biosynthesis of plant steroids (*7*), we incubated *Dioscorea floribunda* tuber homogenates with labeled acetate and mevalonate; acetate was incorporated into diosgenin, but mevalonate was not. While it is probable that the steroid nucleus is formed in the same manner in plants and animals, more information is needed concerning the origin of the side chain in typical plant steroids. The present study was initiated by a separate investigation of the biosynthesis of carotenoids in *Lycopersicon esculentum* fruits from mevalonic acid (*8*), in which a highly radioactive sterol fraction was discovered.

Preliminary experiments were carried out on "Snowball" tomatoes (*9*). By injection of radioactive mevalonic acid by the technique described by Purcell *et al.* (*8*) and use of the separation procedure described by Heftmann *et al.* (*10*), we isolated pure stigmasterol, which had an infrared spectrum identical with that of an authentic sample. The yield of the sterol fraction was low, however, and the radioactivity was not high enough to allow dilution with carrier material. Accord-