POST-FIRE REGROWTH OF *ADENOSTOMA FASCICULATUM* H. & A. AND *CEANOTHUS CRASSIFOLIUS* TORR. IN RELATION TO ECOLOGY AND ORIGINS

GEORGE F. HOWE*

Regrowth of two important chaparral shrubs ***(Adenostoma fasciculatum*** *H. & A.—chamise, and* ***Ceanothus crassifolius—*** *buck brush) has been studied after five different fires in the vicinity of Newhall, California. It is clear that chamise seedlings are regularly important in regeneration of chamise populations after fire, even though preexisting chamise plants can resprout from their crowns. It is found, on the other hand, that populations of buck brush frequently do not regenerate after fire despite the great buck brush potential for seedling growth. This problem is briefly examined although no immediate explanation is apparent.*

The Problem Stated

Certain evolutionists maintain that chaparral genera which resprout from the old plants, as well as producing seedlings *(Adenostoma,* for example), routinely have fewer taxa because they have reproduced vegetatively by sprouting, thus resisting the microevolutionary changes which accompany the sexual life cycle involving new seedling generations. They also claim that speciation and specialization have been hastened in those shrub genera in which certain species are unable to sprout after fire *(e.g. Arctostaphylos* and *Ceanothus).*

However, it is shown here that *Adenostoma* (a genus which experiences widespread and vigorous seedling regrowth and survival) possesses only three taxa. Thus it is concluded that some genera have numerous taxa *(Ceanothus)* and others few *(Adenostoma)* depending upon factors other than seedling versus crown sprout reproduction, such as:

1. the fact that "splitters" in taxonomy have dignified certain types to taxon status with binomial names when such groups are really only parts of one major cenospecies.
2. some genera may have had gene systems which predispose them to rapid "speciation".
3. the Creator may have distributed more taxa in certain genera for very practical reasons which scientists must yet discover. Several avenues of further research are suggested.

Introduction

Two shrubs distributed widely throughout the chaparral of Southern California are the chamise *(Adenostoma fasciculatum* H. &A., Figure 1) and the buck brush *(Ceanothus crassifolius* Torr., Figure 2). Chamise has two different modes of regrowth after fire—by old plants sprouting from swollen, charred crowns, and by seeds which germinate forming a carpet of new plants. Burned buck brush plants, on the other hand, are unable to regenerate by crown sprouting and are thus limited to seedling reproduction. In fact, certain whole sections of the genus *Ceanothus* are unable to crown sprout while other sections of the same genus can.[1]

In their studies of regrowth after fire in the chaparral of the San Jacinto Mountain region, Richard Vogl and Paul Schorr found that seedling mortality in chamise was high and they concluded that chamise seedlings seldom contribute to mature chaparral cover.[2]

Philip Wells noted that chaparral genera which regenerate by both crown sprouting and seedlings *(e.g. Adenostoma)* contain relatively few taxa.[3] Conversely, Wells reported that genera in which certain species are unable to reproduce by crown sprouting (such as *Ceanothus* and *Arctostaphylos)* are found in many taxa. Wells concluded that the tempo of evolution in *Arctostaphylos* and *Ceanothus* was quickened by: ". . . abandonment of the conservative, crown-sprouting mode of reproduction in favor of a non-sprouting, obligately-seedling response to recurrent fire that results in a greater frequency and intensity of selection."[4]

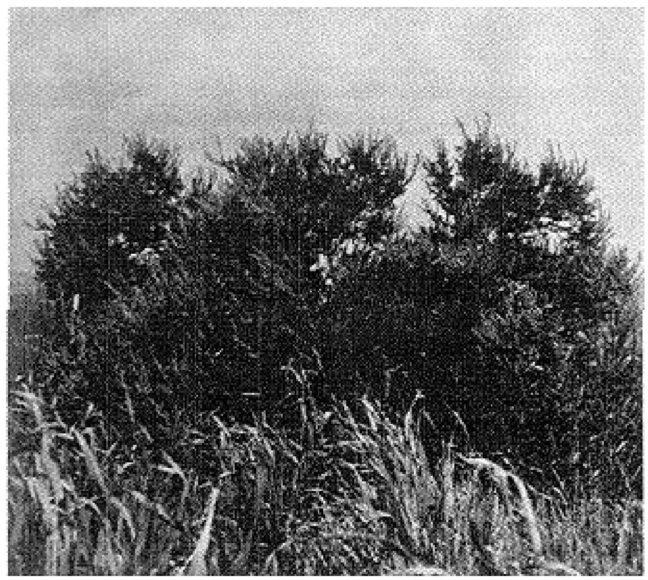

Figure 1. The chamise *Adenostoma fasciculum* H. & A. so common to the chaparral of Southern California.

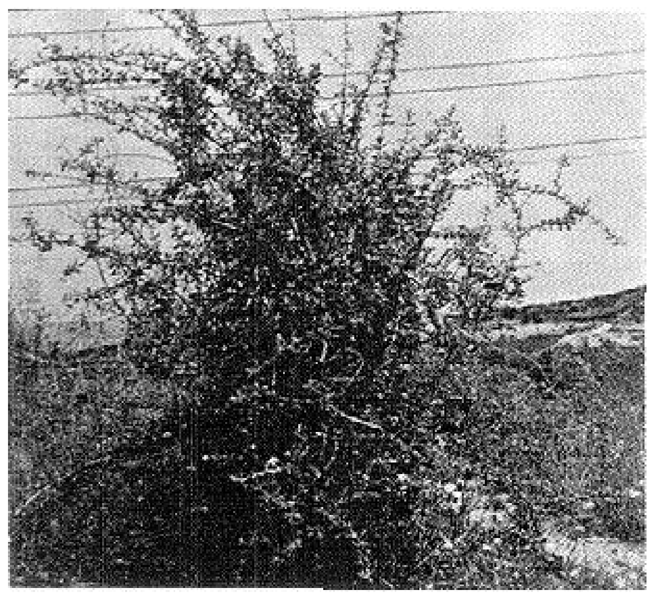

Figure 2. The buck bush *Ceanothus crassifolius* Torr., widely distributed throughout the chaparral of Southern California.

*George F. Howe. Ph.D., is professor and chairman, division of natural science and mathematics, Los Angeles Baptist College, Newhall, California 91321.

Figure 3. Dead charred stumps of buck bush showing alternating pattern of branch arrangement.

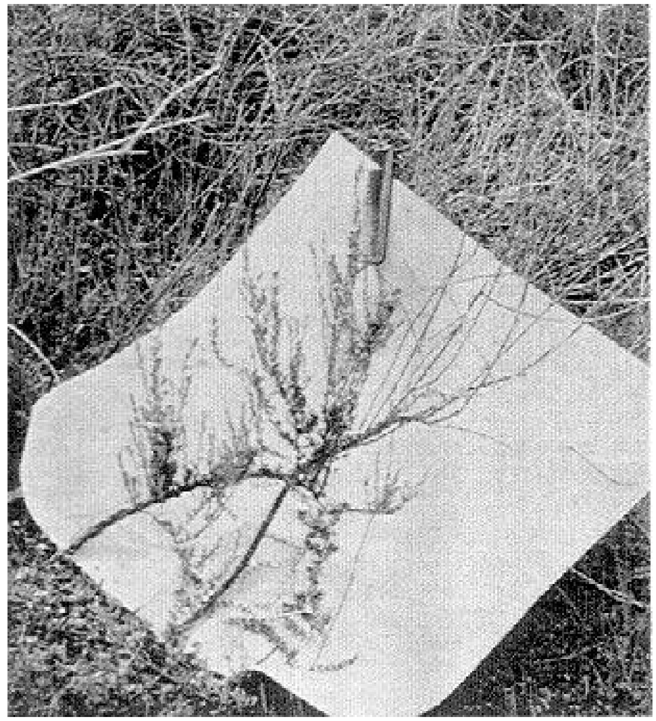

Figure 4. Chamise seedlings. Note absence of charred stem or burl at ground level. Seedlings are near pen and camera.

In the present paper, field observations of seedling behavior are reported from five different fire sites in the Newhall, California region. These observations are discussed in relation to Vogl and Schorr's belief that chamise seedlings seldom contribute to the mature chaparral cover. The evolutionary concepts of Wells are likewise evaluated in the light of field data.

Observations

Regrowing populations of chaparral shrubs have been observed at the site of five different fires over a period of several years following each burn. These fires occurred in communities generally located on the north and/or south facing slopes of ridges that run east and west. Extensive reports on other facets of regrowth will be presented in subsequent papers but attention is drawn presently to chamise and buck brush.

It is possible to estimate the original pre-fire composition of the chaparral in most of these areas by studying adjacent unburned portions of each ridge. In the burn, stumps of buck brush have an alternating pattern of branch arrangement and are unmistakeable even in the dead, charred condition (Figure 3).

Seedlings of chamise can be distinguished easily from old crown-sprouted specimens. A seedling is narrower and has no charred stem or burl at ground level (Figure 4) while a crown-sprouted plant almost always manifests charred stumps amid the new branch sprouts—evidence of its existence before the previous fire (Figure 5). Crown-sprouted plants are invariably larger than seedlings during the first decade of development. Crown sprouts form on burned plants in just a matter of weeks after the fire and shoots over 12 inches tall exist before the first rainy season begins. Likewise crown-sprouted plants have a fully developed root system right after the fire whereas seedlings generally do not begin growing until the rains arrive—anywhere from two to four months or more after the fire.

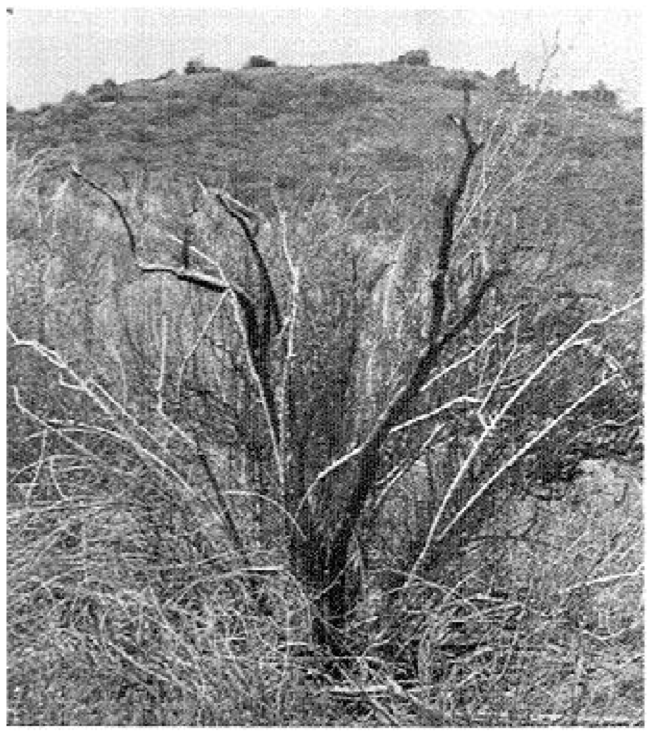

Figure 5. A crown-sprouted chamise as evidenced by presence of charred stumps amid new branch sprouts.

Table 1. Observations of chamise and buck brush regrowth at the sites of five different fires, Newhall, California.

Fire name and date	Original condition	Location and topography	Restudy date(s)	Condition chamise population	Condition buck brush population	Rainfall, inches during first season
Placerita Canyon Road, August 1962	Chamise and buck brush, clumps.	South slopes of east-west running ridge south of and parallel to road.	3-21-73	Seedlings few. Crown-sprouting of scattered individuals.	Scattered goves in grass community. Major groves from before fire destroyed.	———
Oak Orchard Lane, 6-2-69	Mixed stand of chamise & buck brush.	North-facing slope of east-west running ridge north of and parallel to road.	April '69 5-2-70 4-11-75	Thick regrowth seedlings throughout, Fig. 4. Crown sprouts few and only at lower portion slope, Fig. 5.	Largely destroyed. Burned stumps remain, Fig. 3.	27.70 (very high)
Peachland Avenue, 10-4-70	Mixed stand buck brush & chamise, chamise clumped.	North and south facing slopes of west running ridge south of terminus, Peachland, Avenue	3-21-73	Sparse regrowth of chamise seedlings. Crown sprouting common.	Only 7 seedlings on south facing slope and a few on north facing slope where thick stand prevailed before fire.	15.09 (average)
Castaic or Lake Hughes Road, Autumn 1970	(?) Possibly near pure stand chamise.	Gentle, south facing slope about 300 yards east of Lake Hughes Road, above Castaic Lake.	April '74 March '75	Mostly seedlings with scattered crown sprouted plants, Table 2.	———	15.09 (average)
Wildwood Canyon Road, 8-28-73	Mixed stand chamise and buck brush.	North and south and west facing slopes of small east-west ridges leading into main north-south ridge.	8-6-74 3-24-75 4-10-75	Vigorous seedling growth and substantial crown sprouting. See Figs. 6, 7, and 8.	Dense germination and survival of seedlings evident on all slopes.	13.24 (low average)

Dates of the various fires are reported either from personal observation or from records kept at the Newhall Station, Los Angeles County Fire Department. The growing season corresponds to the rainy season which may extend from November to May. Thus seedlings observed in April of 1975 would have experienced two growing seasons following a fire in autumn of 1973, for example. The data for the various fires are summarized in Table 1 and then various additional observations on certain fires are indicated thereafter.

Wildwood Canyon Road Fire

On a west-facing slope in this study seedling growth is being recorded at five charred telephone poles which serve as reference points for circular quadrats spaced at intervals along the slope. Each quadrat consists of a circle three feet in radius (approximately 28 sq. ft.) around each pole. The perimeter of the circle is judged in each observation by use of a yard stick. A complete account of these quadrat studies will be published after several more years of observation. At this time (spring, 1975) two growing seasons have occurred in these quadrats following the 1973 fire.

As seen in Table 2, of the three quadrats which orginally manifested chamise seedlings surviving in 1974, two still had chamise seedlings present during the second growing season, 1975. From analysis of these quadrats and marked areas on ridges nearby, there is reason to believe that the seedlings will persist and play a significant role in the regeneration of chamise cover at the Wildwood burn (Figures 6-8).

Table 2. Survival of seedlings at pole quadrats in the Wildwood Canyon Road burn, Newhall, California.

Pole Quadrat and Date	Adenostoma fasciculatum (chamise)	Ceanothus crassifolius (buckbrush)
1; 8-6-74	0	0
1; 3-24-75	0	0
2; 8-6-74	3	5
2; 3-24-75	0	4
3; 8-6-74	10	6
3; 1-17-75	3	4
4; 8-6-74	0	100
4; 3-24-75	0	30
5; 8-6-74	13	25
5; 3-24-75	13	13

Although only an average amount of rain fell in the first season following the Wildwood Canyon Road fire, there has been profuse germination and survival of buck brush seedlings (see Figure 7). This was not true of the other fires in this study (see Table 1). In the Peachland Avenue burn, for example, extensive buck brush cover was destroyed by the fire and only a few scattered seedlings survived.

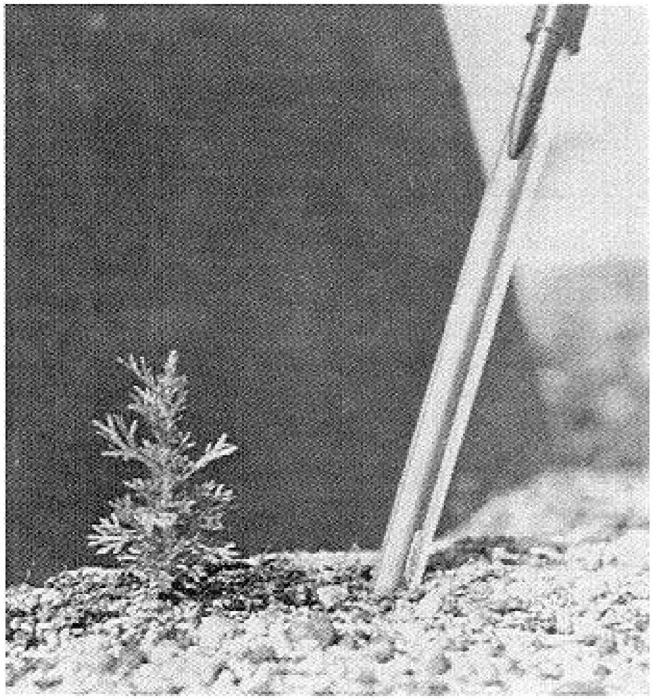

Figure 6. Typical chamise seedling surviving in Wildwood Canyon in 1974 after 1973 fire.

Figure 7. Well established buck bush seedling in Wildwood Canyon. Seedling is located to right of pen in center.

Figure 8. Portion of a quadrat at Wildwood Canyon showing multiple chamise seedlings (to right of pencil and camera) surviving in 1974 after 1973 fire.

Castaic – Lake Hughes Road Fire

In April of 1974, approximately 44 months after this fire occurred, a chamise chaparral south-facing slope territory east of Lake Hughes Road was examined to determine what proportion of chamise plants were crown sprouted individuals as opposed to seedlings. Four 12 by 12 foot square quadrats were randomly marked off and the number of seedlings versus crown sprouted chamise plants was determined. (see Table 3).

On this slope it is clear that seedling growth was more important in regrowth of chamise cover than crown sprouting by old plants. A sequel to this research will be completed since the same region burned again in the autumn of 1974.

Placerita Canyon Road Burn

In late August of 1962 there was a large chaparral fire on the south-facing sloped of a ridge south of Placerita Canyon Road. Study of this area was not begun until 1968. Whole groves of buck brush were eradicated by that fire and were not replaced by subsequent seedling growth.

Discussion

Chamise Seedling Contribution: Substantial growth of chamise seedlings along with crown sprouts was observed after several different fires in the vicinity of Newhall - Oak Orchard Lane, Castaic, and Wildwood Canyon Road at intervals of six and one half, four, and two years after burning, respectively. In each case the seedlings were making an important contribution to the new chamise population. Seedling survival of chamise has been a vigorous adjunct to crown sprouting in the Wildwood Canyon Road burn. Surviving chamise seedlings far outnumber crown sprouted specimens on the north facing slope of the Oak Orchard Lane fire and likewise on the south facing slope of the Castaic burn. It may be concluded that seedlings are definitely involved in the perpetuation of chamise populations after fires in the Newhall area. These results certainly conflict with the hypothesis of Vogl and Schorr:

> We strongly suspect the *Arctostaphylos* and *Adenostoma* seedlings seldom contribute to mature chaparral cover . . . We hypothesize that a suspected preferred attraction of animals to seedlings allows the resprouts to grow relatively undisturbed particularly with high herbivore densities.[5]

Additional research is necessary to determine if chamise seedlings respond differently in the San Jacinto Mountains than in the Newhall area or if Vogl and Schorr's conclusions were premature.

Buck Brush Regrowth Patterns: Buck brush appears in many pure shrub stands and mixed with chamise or other chaparral species. In three of the four buck brush fires observed here (Oak Orchard Lane, Peachland Avenue, and Placerita Canyon Road) the buck brush plants did not return as densely after burning as before. A similar demise of *Ceanothus* was reported by Horton and Kraebel in their study of the Barranca Canyon burn, north of San Bernardino.[6] They attributed the lack of *Ceanothus* regrowth to the fact the the Barranca fire occurred in the spring (March, 1942), possibly destroying the parent *Ceanothus* plants before that year's seed crop had ripened. But they found that fires in the fall were followed by a reverse situation: "However, it should be stressed that the summer and fall fires in the studied areas were followed by an increased number of *Ceanothus* shrubs."[7]

Table 3. Comparison of the number of seedlings and crown-sprouted plants on the Castaic (Lake Hughes Road) burn, Newhall, California area. Data were gathered in April, 1974. Since then the area has been burned again.

Quadrat Number	Chamise Seedlings	Chamise Crown-sprouted Plants
1	3	1
2	3	2
3	10	3
4	20	5
Totals	36	11

While a fire in the spring may be more destructive to *Ceanothus* populations, fires which occur in the autumn can likewise demolish cover of *Ceanothus crassifolius* (buck brush), as in the Peachland Avenue fire and Placerita Canyon Road fire. The June fire in this series (1968, Oak Orchard Lane) was also followed by a substantial decrease in the buck brush cover. In one August Wildwood Canyon Road fire, however, the buck brush seedlings have undergone dense growth and are apparently replacing the buck brush component originally present. Thus in distinction to Horton and Kraebel's results in the San Bernardino area, most of the summer and autumn fires studied in Newhall led to a demise of buck brush populations rather than a vigorous recovery.

It may be concluded that buck brush recovers vigorously after some autumn fires but is nearly demolished after others. There is no apparent correlation of survival and total rainfall during the first season after fire because there was poor regrowth of buck brush on the Oak Orchard Lane area following an unusually heavy rainy season and excellent regrowth along Wildwood Canyon Road after an average rainy season. Possibly the distribution of the rain—in November and December, for example, instead of largely in March and April—has some bearing on the survival or demise of buck brush seedlings. This problem should be studied further.

Speciation and Non-Sprouting: The theories of Philip Wells[8] deserve extensive discussion in the light of the present research. Among the 20 genera listed on Wells' Table I, the two genera which have non-sprouting taxa (*Arctostaphylos* and *Ceanothus*) also possess a relatively large number of subsidiary taxa—75 and 58, respectively. Wells relates that among the other 18 genera, all of which regenerate by both sprouting and seedling activity after fire, the number of taxa per genus ranges downward from *Quercus* with 12 taxa to genera like *Pickeringia* (chaparral pea) and four others which have only one taxon per genus.

A large number of taxa in a genus apparently correlated with the propensity to reproduce by seedlings only, and a low number of taxa per genus correlates with ability to reproduce by both crown sprouting and seedling activity throughout the genus, as Wells has pointed out. Wells also believes that "loss" of the crown sprouting characterisitc leads within a genus to greater rates of speciation and a greater degree of specialization in species formed because of an enhanced frequency and intensity of natural selection (consult quotation given above).

If it be granted for the sake of discussion that all taxa in each chaparral genus did arise from one common ancestral taxon, it would not be apparent as to which trait was "ancestral"— the ability to reproduce by both seeds and sprouts or the ability to reproduce by seedlings only. Because crown sprouting is found in at least some taxa of all the 25 woody chaparral genera and because the ability to crown sprout is ". . . widespread . . . among woody dicotyledons",[9] Wells assumes that the ability to crown sprout in any genus was always "ancestral" or "primitive". Furthermore, he holds that ". . . loss of the sprouting faculty is indeed a specialized development in perennial dicotyledonous plants."[10]

But there are no absolute criteria by which to verify such an assumption and the opposite assumption might even be more logical for the evolutionist. Since the greater number of taxa in *Arctostaphylos* and *Ceanothus* are unable to sprout, perhaps the ancestral taxon in each of these genera lacked the ability to crown sprout and thus underwent considerable speciation. Accordingly, taxa with crown sprouting are outnumbered in both genera because the pace of speciation slowed or even stopped in those lines in which sprouting developed—a derived condition. This alternative should be discussed and researched.

Even if all the taxa in the genus *Ceanothus* descended from one common ancestral taxon, this would not constitute "evolution" on the grander scale but would simply be an example of speciation. Thus when Wells speaks of a "quickening of the tempo of evolution . . ." he is, like so many other authors of papers published in the journal *Evolution*[11], dealing only with "microevolution" or "special evolution" rather than the "general" evolution or the "ameba-to-man" continuum which is so often implied by the use of the word "evolution".

Implicit in Wells' argument is the unstated assumption that within each genus studied all taxa arose from one common ancestral group. Wells presents no evidence to support this assumption and substantiation is generally unavailable because in most cases the origin of the taxa has not been observed through "speciation". Thus the speciation discussed is usually assumed and inferred speciation rather than demonstrated speciation, and alternative views should be considered.

Some of the 58 taxa designated within the genus *Ceanothus*, for example, may represent separate kinds created on day three of the creation week (Genesis 1:9-11). Other taxa in the genus may represent particular genotypes which the Creator established directly and rapidly after the flood with no recourse to speciation but in keeping with a model proposed by Walter Lammerts.[12]

Many of the so-called taxa in the genus *Ceanothus* may be insignificant groups which should not have been given taxonomic status as Van Rensselaer and McMinn have strongly asserted:

> From observations made upon garden and field hybrids and other variations, the writer believes a comprehensive study of the genus *Ceanothus* based upon experimental methods would result in the acceptance of fewer species (ecospecies of the experimentalist) than we now represent by binomials in this volume and in other studies of the genus. It is the prediction of the writer that many of the forms now accepted as distinct species on morphological and geographical data would not prove to be true biological species (ecospecies of the experimentalist) if they were tested by putting them through the biological sterility sieve advocated by Clausen, Keck, and Hiesey (Table 2).[13]

Since *Ceanothus* is divided into only three sections and the species in each section undergo some hybridization with other species in the same section, it might be reasonable to assert that there are really only three taxa or cenospecies in the whole genus *Ceanothus*.

Yet a more serious problem centers on Wells' belief that when a taxon can reproduce by both means, crown sprouting will consistently be more important than seedling survival in the establishment of a new population after fire:

> The crown-sprouters, on the other hand, tend to reproduce successfully mainly by vegetative regeneration, as they usually grow in dense, laterally proliferating colonies. Although their dormant or suppressed seeds also germinate readily after fire, seed production is often lower among crown-sprouters (particularly *so* in *Arctostaphylos)*. In any event, the root systems of established individuals have an overwhelming growth advantage over small seedlings, and rapidly recoup the initial monopoly of the shrubby canopy. Hence, not only the frequency, but also the intensity of natural selection is greater with the non-sprouting, obligately seeding strategy in fire-swept vegetation.[14]

Likewise, Vogl and Schorr asserted in the abstract of their report of post-fire studies in the San Jacinto Mountains that they suspected manzanita and chamise seedlings seldom contributed to mature chaparral cover.[15] However, results in the present paper are noticeably different. In all areas where chamise was present, seedlings were contributing significantly to the restoration of chamise cover. Horton and Kraebel also reported that chamise seedlings were still surviving and had reached a height of 31.9 inches 25 years after a fire in the chaparral near San Bernardino.[16] Wells readily admits that ". . . chamise possesses an equally superb capacity for reproduction by crown-sprouting or by seed (Sampson, 1944) . . ."

If chamise can and does reproduce vigorously by seedlings, and if widespread seedling survival is a key factor enhancing speciation and production of many taxa, then *Adenostoma fasciculatum* populations would present extensive opportunity for natural selection to occur. Thus it is by no means clear why *Adenostoma* possesses only three subsidiary taxa. Evidently some plants like chamise have very few taxa despite the fact that they routinely and vigorously reproduce by seedlings after fire. Seedling activity after fire does not always yield speciation and specialization. Since *Adenostoma* has so many seedlings, there is evidently nothing inherent to speciation in the survival of seedlings after fire and students of origins must look elsewhere to explain how one genus *(Adenostoma)* has only three taxa and another genus *(Ceanothus)* has 58 taxa. In both cases seedlings contribute extensively to regrowth after fire.

Further Research and Reconsideration

Several areas which have appeared as settled in the literature deserve to be studied again. Additional study of the extent and character of hybridization between taxa in the genus *Ceanothus* ought to shed light on which taxa are valid groups and which are the products of overzealous taxonomy. Genetic studies in *Arctostaphylos* and *Ceanothus* might reveal some other causes such as peculiar gene systems which might predispose those populations toward reproductive isolation more readily than do the gene systems of other genera. Since it has been shown here that *Adenostoma* seedling development is vigorous, each of the other 18 genera which Wells assumed to reproduce largely or only by crown sprouting after fire should be reexamined to see if each genus has a great potential for seedling regrowth.

In the regrowth of vegetation after fire by crown sprouting mechanisms and by seedling survival the creationist sees the providence of God as recorded in the book of Job, chapter 38, verses 25-27:

Who hath cleft a channel for the waterflood,
Or a way for the lightning of the thunder;
To cause it to rain on the land where no man is;
On the wilderness, wherein there is no man;
To satisfy the waste and desolate ground,
And to cause the tender grass to spring forth?

Acknowledgements

The author gratefully acknowledges the able assistance of Douglas Faucette in the area of processing and printing the photographs appearing in this paper.

References

1Van Rensselaer, Maunsell and Howard E. McMinn 1942. *Ceanothus*. Santa Barbara Botanic Garden, Santa Barbara, California, p. 162.

2Vogl, Richard J. and Paul K. Schorr 1972. Fire and manzanita chaparral in the San Jacinto Mountains, California, *Ecology* 53(6): 1180.

3Wells, Philip V. 1969. The relation between mode of reproduction and extent of speciation in woody genera of the California chaparral, *Evolution* 23: 264-267.

4*Ibid*., p. 266.

5Vogl and Schorr, *Op. Cit*., p. 1186.

6Horton, J. S. and C. J. Kraebel 1955. Development of vegetation after fire in the chamise chaparral of Southern California, *Ecology* 36(2): 258.

7*Ibid*., p. 258.

8Wells, *Op. Cit.*

9*Ibid*., p. 264.

10*Ibid*., p. 265.

11Moore, John N. 1973. Retrieval system problems with articles in *Evolution, Creation Research Society Quarterly*, 10(1): 110-117.

12Lammerts, Walter E. and George F. Howe. 1974. Plant succession studies in relation to micro-evolution, *Creation Research Society Quarterly*, 10(4): 208-228.

13Van Rensselaer and McMinn, *Op. Cit*., p. 154.

14Wells, *Op. Cit*., pp. 265-266.

15Vogl and Schoor, *Op. Cit*., p. 1186 and 1179.

16Horton and Kraebel, *Op. Cit*., p. 252.

A NOTE ON SPECIATION IN *CEANOTHUS* AND *ADENOSTOMA*

WALTER E. LAMMERTS*

Editor's Note: Since Dr. Lammerts has grown two large populations of ***Ceanothus*** *seedlings from hybrid plants, it is pertinent for Dr. Lammerts to write on speciation in* ***Ceanothus*** *in relation to the previous article by Dr. George F. Howe.*

The genus *Ceanothus*, as Dr. Howe suggests, certainly does form strikingly different variations where seedlings of hybrids are grown, variants which in other genera might easily pass for species. Thus "La Primavera" appeared in 1935 at the Santa Barbara botanical garden[1] among seedlings of some garden gathered seeds of *C. cyaneus*. Though similar to *C. cyaneus*, this variety bloomed one month earlier and had a sturdier root system.

Maunsell Van Rennsselaer, then director of the Santa Barbara botanical gardens, kindly gave me open pollinated seed. I obtained mature shrubs from 807 seedlings. Among these 156 looked like *C. cyaneus*, 130 like *C. spinosus*, 178 like *C. griseus*, 225 like *C. arboreus*, 106 like *C. impressus*, and seven like *C. nomeanus*. Most important was the fact that five looked like *C. tomentosus olivaceus*, even though this species was not growing anywhere near the garden where "La Primavera" was located!

No doubt much of this variation was the result of crossing with the various species all of which, with the exception of *C. tomentosus olivaceus*, were growing in the vicinity. Such statistics do show the great potential for variation carried by *only one plant*, due to prior hybridization and compatability of the gametes produced by it with those of other species.

Similarly in March of 1970 I planted seed of the variety "Theodore Payne", obtained 450 seedlings, and set them out in the spring of 1971. The astonishing variation among seedlings is seen in Figure 1, where the branch held at the right has small leaves in comparison with another seedling plant, at the left, with much larger leaves. In fact, no two plants were identical, as described in my article on the origin of Gentian Plume.[2] This new variety combines the very large flower clusters of "Theodore Payne" with the dark blue flower color of Julia Phelps, which possibly is a hybrid of a species similar to *C. papillosus.*

So then quite evidently if these species did come from a common ancestral type they still have so much similarity that crossing among them occurs naturally.

To me it would seem that Wells exaggerates the monotypic nature of the chamise. Thus Jepson lists two species of the genus *Adenostema*: the chamise, *A. fasciculatum*, and the ribbonwood, *A. sparsifolum*. The chamise (or greasewood) has one listed variety, with bluntish leaves called *obtusifolium.*

Actually botanists for some reason pass over the great amount of variation shown in the chamise. Probably because the flowers are white, it does not have the potential for color variation possessed by genera with colored flowers such as the genus *Ceanothus*. The leaf variation, as may be seen from Figures 2 and 3, is considerable. Not only does the color of the bark vary, but the leaves do also. The variety in which the leaves have three small forks at the ends of most of them would be given varietal status in *Ceanothus* if combined with a different flower color.

The question as to why these variations in *Adenostoma* have not become greater as time went on, whereas they have in *Ceanothus*, is one for evolutionists to answer. No clearly evident survival value has been linked with any given leaf type in *Ceanothus*. Yet radically distinctive leaf forms are found, many very lovely from the horticultural viewpoint. Oddly enough, though having the potential, the chamise never developed widely distinctive or lovely leaf patterns. Such differential behavior over a given period of time poses a real problem for evolutionists.

*Walter E. Lammerts, Ph.D., operates Lammerts Hybridization Gardens, Box 496, Freedom, California 95019.