POSTFIRE STRATEGIES OF TWO CHAPARRAL SHRUBS (CHAMISE AND CEANOTHUS) CAST LIGHT ON ORIGINS

George F. Howe*

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How do you start with survival of shrubs after fire and end up discussing origins models? This is what Wells did when he claimed that Ceanothus evolved rapidly because its species could not resprout after fire but had to use the seedling mode of reproduction thereby being forced to undergo mutation, selection, and speciation more rapidly than plants like chamise that resprout.[2] This paper contains a review of some of the data that conflict with Wells' evolutionary hypothesis.

The problem of how a plant could have originally gotten the ability to resprout after fires is discussed in terms of the neodarwinian microevolutionary model, the newer evolutionary concept of "punctuated equilibria", and the scientific creation model. Keeley has proposed a "stochastic fire hypothesis" that fits quite well with our field data in particular and with the scientific creation origins model in general. Keeley argued that resprouters like chamise are well adapted for growth in areas where fires are frequent and that obligate seeders like Ceanothus have an advantage wherever fires come after long fire-free periods. The idea that both patterns of shrub growth after fire are advantageous under different circumstances supports creation scientists' belief that there is a plan in nature.

On first consideration it might seem that anything as prosaic as shrub survival would have little connection with the exciting controversy about origins presently raging between scientific creationists and mega-evolutionists. Yet the very presence of two groups of bushes (chamise—which botanists call *Adenostoma fasciculatum* and a number of species of mountain lilac—genus *Ceanothus*) thriving throughout the chaparral shrublands of western North American poses serious problems for advocates of the various megaevolution origins models, as we shall see.

Figure 1. Chamise stems are woody with narrow, needle-like leaves clustered into little bundles. These leaves are evergreen and up to 1/2 inch long. Not knowing otherwise, someone might mistake chamise for some type of strange little spruce or fir plant. Both green leaves and stem burn violently in chaparral fires; hence the other common name for this plant is "greasewood".

Meet the two Shrubs—Chamise and Ceanothus

Chamise is a member of the rose family even though its little evergreen leaves resemble miniature needles of spruce or fir, clustered along thin, dry, woody stems (Figure 1). A new section of stem and leaf growth appears each year during January and February. When chamise blooms a few short weeks later in May or early June, its dense clusters of small, cream-colored flowers clearly betray its rose family affinities and brighten the tip of every upper branch, causing the whole shrub to stand out against a backdrop of other dull grey-green bushes, yellow dried grasses, and brown soil (Figures 2-5). In fact, during the spring season, each species of shrub in the chaparral blooms at a slightly different date so that for a period of about two months the flowers highlight different shrubs producing a kaleidescope of light and color that makes every hillside more beautiful than a chalk artist's picture under "black-light."

Chamise flowers soon fade to a rich brown color and the seed ripens, falling to the soil nearby. This cycle of growth, flowering, and seed production continues year by year but the bushes themselves seldom get much taller than two meters because older branches bend downward. In mature chamise forests that go for decades without burning, thick old stems and fallen branches produce a brittle pile of tinder that will burn with intensity during the next fire (Figure 6). Chamise is so highly flammable that is has also been called "greasewood" because the shrubs erupt into flame as if they were torches full of pitch or grease (see Figures 7-9). It is not a matter of "if" that next fire will come but simply "when" since every square inch of chaparral ultimately burns. The chaparral actually experiences senescence but it becomes a more diverse, productive, and rejuvenated ecosystem after fire. Generally, the longer a chaparral forest thrives before the next fire, the hotter and more devastating that fire will be.

Newcomers to Southern California understandably dream of owning a home right up in the beautiful brushy chaparral forests but soon discover that such a plan would put their home in constant fire jeopardy. Fire departments and insurance firms require owners of

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*George F. Howe is Professor and Chairman, Division of Natural Sciences and Mathematics, Los Angeles Baptist College, P.O. Box 878, Newhall, California 91321; and President of the Creation Research Society.

Figure 2. Chamise flowers seen clustered at the tips of branches during May demonstrate that these plants belong in the rose family. The one-meter tape lends size perspective. Chamise plants produce many seeds, most of which lie dormant for years until the next fire burns the forest.

Figure 4. Chamise plants sometimes grow apart from other shrubs, like this one seen along Pico Canyon Road, Newhall, California. In the foreground are dried mustard plants and a live-oak woodland in the background. There are only four taxa (taxonomic groups) in the genus *Adenostoma.*

structures in the chaparral to remove all shrubs from a broad zone around each building every year before fire season.

After the fires, chamise plants have the ability to send forth fresh stems and leaves from the burned crown at or just above the soil level (Figures 10-11). Within two or three weeks following the burn, these tender shoots we shall call "resprouts" are visible on many of the

Figure 3. Chamise stems, leaves, and flowers can be seen here silhouetted against the sky. Old stems and lower sections of chamise plants become brittle, serving as a ready reserve of tinder just waiting for the next fire.

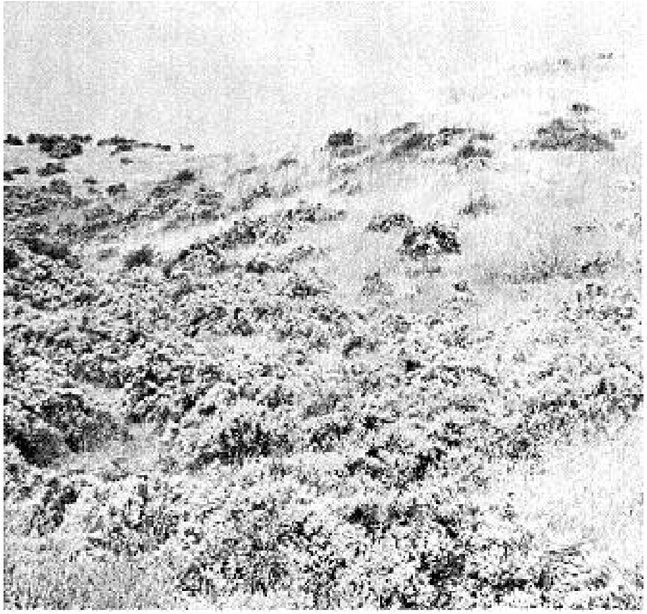

Figure 5. Chamise more often grow in dense clusters with other chamise as seen here, or mixed together with shrubs like mountain lilac, manzanita, and scrub oak. Chamise plants make up a large percentage of the chaparral brush cover in southern California. Here they are seen in full bloom on a slope opposite a stand of weedy grasses including ripgut and wild oats.

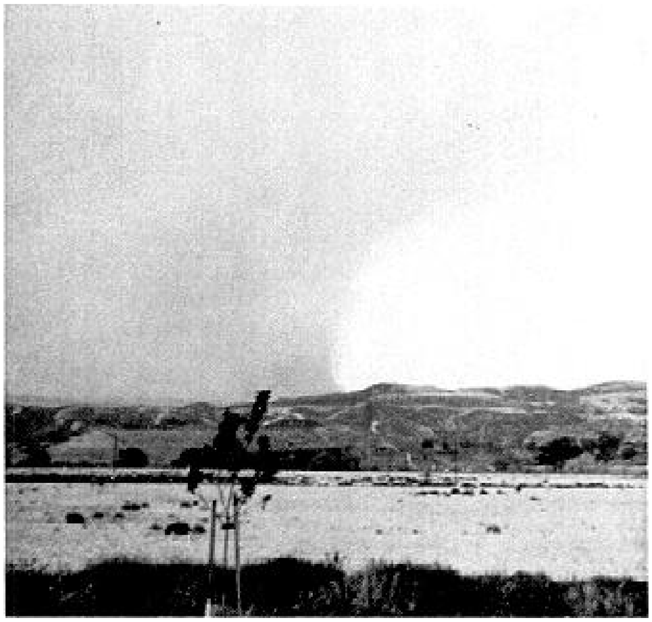

Figure 6. When chamise and other shrubs burn, a column of smoke can be seen for many miles.

chamise shrubs beneath a dead skeleton of the former shoots.

During the next rainy season following the fire, seeds also of chamise generally germinate in large numbers, producing tiny seedlings on the charred ground. But since the chamise resprouts begin growing almost immediately after the fire (earlier than these seedling which wait for rain) and since the resprouts arise from a root system which provides them with large quantities of stored food, the resprouts generally get taller sooner

Figure 7. In August 1973, a thick stand of chamise mixed with *Ceanothus crassifolius* and other shrubs near Middlebank Road, Newhall, California, burned. A helicopter and fire crew are seen on the ridge top with a series of burned poles below. These poles were used as site locations for successional studies I reported in 1976—see reference 5. If a long time elapses between fires at any spot, plants like *Ceanothus* which produce large numbers of seedlings have an adaptive advantage, according to Keeley and Zedler.

Figure 8. With the Middlebank Rd. chaparral fire well under control, a crew of fire fighters is seen mopping up a few remaining hot-spots. Many of the burned chamise shrubs in the background resprouted after the fire. None of the *Ceanothus* plants resprouted; but *Ceanothus* produced numerous seedlings. Keeley has asserted that wherever fires come quite frequently, resprouters like chamise will have an adaptive advantage—see references 8 and 9.

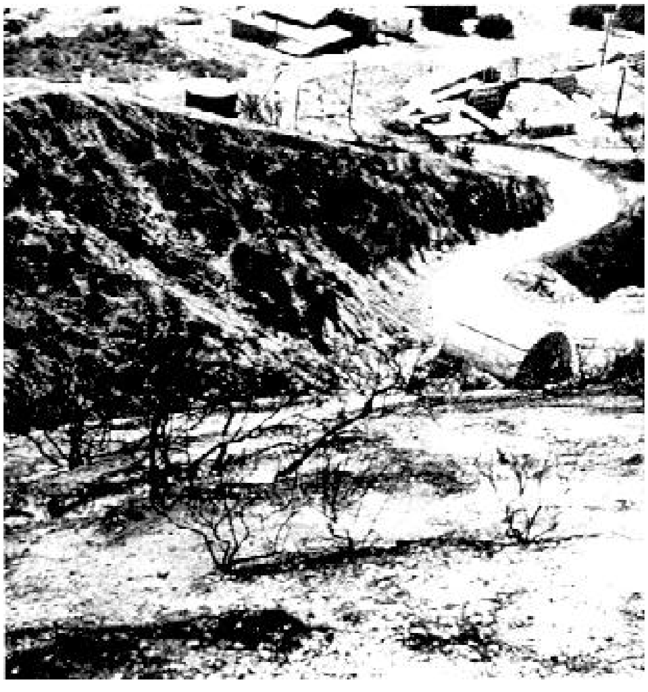

Figure 9. After a chaparral fire burned stumps of shrubs remain. Broad zones of brush must be cleared to enable fire fighters to save structures.

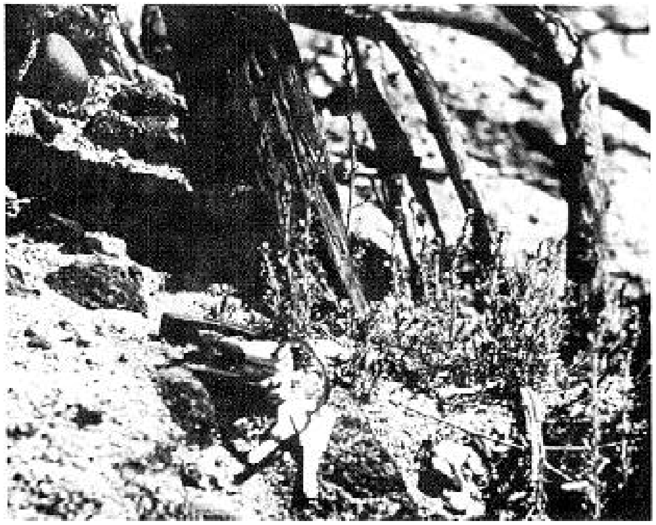

Figure 10. Just eight weeks after the fire Seen in figure 9, chamise stumps had produced sprouts up to 6 inches long. The keys give perspective.

than do the seedlings (Figure 12). During the first growing season after a fire, the ground is also covered with a profuse display of wild flowers. In many cases these are species like California poppy *(Eschocholzia californica),* the lupine *(Lupinus succulentis)* and others like the beautiful chocolate-lily *(Fritillaria biflora)* (Figures 13-14). Such a display as this is usually not seen again in that locality until a year after the subsequent fire.

Mountain lilac shrubs which are members of the buckthorn family, have leaves that are larger and broader than those of chamise, the shape varying widely among the 58 taxa (species and varieties) of this genus *(Ceanothus)* (Figures 15-17).

Figure 11. After the Middlebank Road fire, chamise plants resprouted vigorously as seen here (note pen for perspective). Slightly to the right and up from the pen is a cluster of *Ceanothus crassifolius* seedlings. This is one of the species of *Ceanothus* that cannot resprout from old plants but is an obligate seeder. Wells (see reference 2) suggested that this inability to form resprouts is what forced *Ceanothus* to reproduce sexually by seeds and thereby to yield many more taxa (categories) than chamise.

Figure 12. A resprouted chamise plant can be seen at the upper left, about 10 months after the fire at Middlebank Road area. Wells (see reference 2) argued that resprouts play the major part in restoring a chamise population after fire and hence he felt that plants like chamise have undergone much less speciation than *Ceanothus.* But in the foreground here, near the pen, are several chamise seedlings growing vigorously 10 months after fire. They are still alive (1981) and contributing to the present population in that locality and others 8 years and more after the fire. Although such seedlings got a slower start, they produced an average of 86% of the new chamise plants on our postfire quadrats (see reference 4). We concluded from these results that chamise should have produced just as many taxa as *Ceanothus* and that Wells' evolutionary model cannot explain how chamise got only 3 taxa and *Ceanothus* 58.

Can Evolutionists Explain why Chamise has only Three Taxa while Ceanothus has 58?

Why does the genus of chamise *(Adenostoma)* have only three subgroups (taxa) within it—only two actual species? Certain workers assumed that new chamise forests would arise after fire primarily from resprouted plants and not from seedlings because it was believed the seedlings would nearly always die in months or years ahead.[1,2] Based on this, Wells[3] reasoned that there would therefore be little or no chance for microevolution of chamise to occur because resprouting plants would have a vegetative restoration of the same old individuals after fire and the sexual basis for recombination, mutation, and speciation would be bypassed because the seedling did not survive.

The presence of many more taxa (58) in the genus *Ceanothus* Wells attributed to the fact that most *Ceanothus* species are unable to produce resprouts and therefore the old plants die. In such *Ceanothus* species

Figure 13. After a chaparral fire there is generally a glorious display of annual wildflowers as seen here with California poppies, blue dicks, and many other species. During the second growing season after a fire there are not nearly so many flowering herbs and the population will not recur in these proportions until the next fire.

all new plants must start from seeds formed by sexual processes, This obligate seedling link between-populations of *Ceanothus,* Wells reasoned, has caused considerable selection, mutation, and speciation which resulted in the production of many more taxa within that genus. But the basis for Wells' evolutionary argument is somewhat nebulous, as we shall see.

Linn Carothers and I[4] found that at three different fire locations near Newhall, California, large numbers of chamise seedlings grew so well that in our quadrats they outnumbered resprouted individuals 86% to 14% after several years. On this basis we concluded that chamise seedlings certainly do survive and contribute substantially to the regeneration of populations after fire.

If such seedling survival is a key factor in enhancing evolution (as Wells asserted) then *Adenostoma* populations would also present widespread opportunity for speciation and they should have produced large numbers of taxa instead of only three. Wells' model thus falls short and we are left without an evolutionary explanation of why chamise has only three taxa and *Ceanothus* has 58.

Creationists Alternatives Regarding why Adenostoma has only three Taxa, and Ceanothus 58

In my 1976 paper[5] I suggested some alternative ideas from the creation vantage as to how *Ceanothus* might have gotten 58 taxa and chamise only three:

1. The Creator may have established many distinct "kinds" of *Ceanothus* at the time of creation and only three types of *Adenostoma.*

Figure 14. This amazing growth of lupines *(Lupinus succulentis* occurred after a 1970 fire west of Interstate-5 in Newhall, California. Lupine is one of those plants whose seeds must undergo high temperature treatment or scaring before germination will occur. This high-temperature-requirement looks like another design system preadapting certain plants like lupine to flourish after chaparral fires and then to lie as dormant seeds for decades until the next fire.

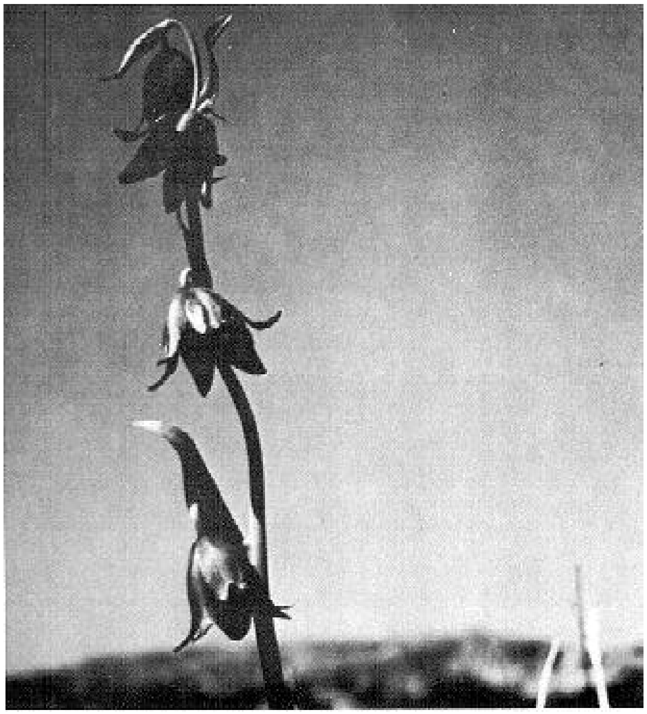

Figure 15. Chocolate lily *(Fritillaria biflora)* also known as mission bells can be found growing in the profuse stands of wildflowers subsequent to fire.

Figure 16. Leaves of most Ceanothus species are broader and larger than those of chamise. Here Lammerts holds one of the many *Ceanothus* plants in his very productive hybridization garden. Certain varieties of *Ceanothus* developed by Lammerts and others have become ideal landscape plants because of their spectacular flower display coupled with drought resistance. Various kinds of *Ceanothus* plants are suitable for hedges, ground cover, or individual plantings in yards and gardens. *Ceanothus* plants which cannot resprout are assumed by Keeley to have a distinct advantage after fires that come infrequently. The large number of seedlings will survive readily in the many open spaces found in the wake of such a burn. Creationists use Keeley's ideas as a tribute to design engineering evident in nature.

2. The Creator may have produced many more groups of *Ceanothus* rapidly after the flood without recourse to speciation—a general idea of Divine postflood activity that Lammerts has repeatedly suggested.

3. Many of the so-called "taxa" in the genus *Ceanothus* may be insignificant groups not worthy of the name "species" and allowed in current taxonomy.

In addition to these three, readers may be able to devise other creation alternatives to Wells' evolutionary hypothesis. Numbers 1 and 2 above rest on the concept of created design while number three relates to man's imperfect attempts to establish a valid species concept among plants. While none of these creationist alternatives can be "proved," only an overriding antisupernatural bias would prevent a worker from evaluating, testing, and teaching them as legitimate counterparts to evolutionary models which have themselves been shown inadequate up to this time.

What Makes Plants Able to Resprout After Fire, Anyway?

Any plant capable of resprouting after fire must be able to produce buds near soil level, buds that will resist death during the holocaust. To the best of my knowledge, no detailed study has been made of the physiological, developmental, and genetic basis for such resprouting. The mechanism for all of this probably hinges on the integrated action of several systems of genes located at various positions on chromosomes of the resprouting species. If so, all the genes necessary to produce the end result (resprouting) would be required at once in order that regrowth occur. But as with the origin of so many other complex systems, it is difficult to imagine how such an all-or-nothing collection of genes would arise by neodarwinian natural selection over long periods of time. If a particular plant had all the genes required for resprouting, there would be a definite advantage such that old plants would thrive after fire. But if any of the essential genes were lacking, presumably none of the other intermediate stages would be of any help to the plant in terms of physiology or selection. It would be hard to envision how such partial combinations of genes would ever have been preserved against the selection process and therefore it seems unlikely to this author that any plant would develop the ability to resprout by natural selection.

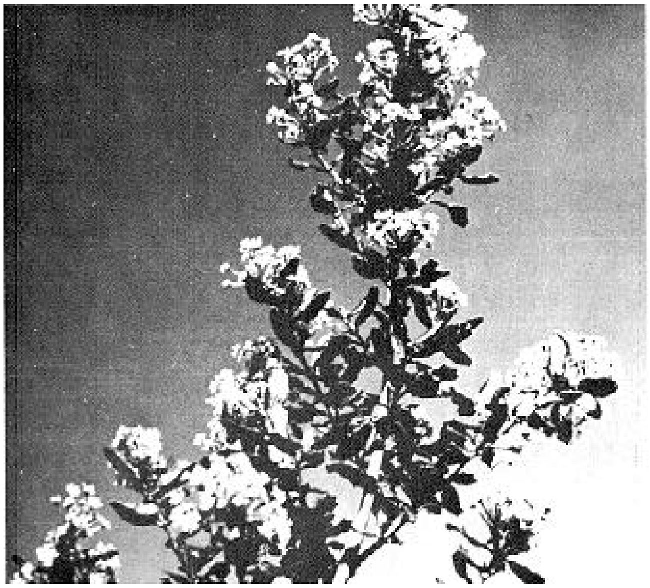

Figure 17. A stem of *Ceanothus crassifolius* known as the hoary-leaved *Ceanothus* or buckbrush is seen flowering here in silouette against the sky. This species of *Ceanothus* is one of those which cannot resprout but must reproduce by seedling after fire. Far from being a disadvantage, this strategy seems to enable *Ceanothus* to flourish after fires that follow long fire-free periods.

If it should turn out in future analysis, however, that this whole resprouting phenomenon is indeed a change in just one or two gene pairs (a very unlikely proposition) then creationists would see this as another example of what we call "variation within the kind" and it would have no bearing on ultimate origins or megaevolution. This whole area of finding out just why some plants resprout and others don't would be a fine domain of study for some ambitious workers skilled in genetics, plant breeding, and physiology.

Would Evolution by Saltation, Jump Evolution, or Evolution Involving Punctuated Equilibria Help Explain How Plants got the Ability to Resprout?

Currently some evolutionists have suggested that major evolutionary changes must have occurred rapidly at certain special periods in geologic time. Such outbursts of evolution came, they believe, as punctuations in long periods of quiescence or equilibrium. The punctuated equilibrium model is tempting in that it could explain the gaps found throughout the entire fossil record. Likewise, it would seem to account for the rapid origin of intricate systems such as this mechanism for resprouting of shrubs that we have been discussing. By this view, one could assume that the entire genetic apparatus for resprouting after fire must have come quickly and as a complete package-deal, perhaps being functional from the very onset.

The saltation model falters, however, in precisely the same manner that Goldschmidt's "hopeful monster" or "macroevolution" concept failed. There has been no means discovered in field or laboratory by which these infrequent outbursts of rapid evolutionary development could have produced complex adaptations quickly. In his marvelous review, Ouweneel[7] showed that saltation certainly could not rest on what geneticists have called "macro-mutations" or "homeotic mutations" as evidenced in the vinegar fly, *Drosophila.* Thus it seems that the saltation concept must be considered dead for lack of a genetic mechanism. In the creation model alone is there a reasonable understanding of how the necessary parts of a complex mechanism could arise at once so that the system would be operative and advantageous from the onset—direct creative action. Although the Creator's work cannot itself be studied scientifically, its results stand as clear testimony supporting its occurrence.

Design Significance for Resprouting and Non-Resprouting Adaptations

Keeley[8] has also criticized Wells' evolutionary idea that *Adenostoma* somehow got few taxa because its crown sprouting pattern circumvented evolutionary mechanism. Keeley wrote that such ideas were ". . . not overly compelling" because the ". . . nonsprouters do not appear to have any such obvious advantage; sprouting species are very successful." Since both the sprouters (like *Adenostoma*) and the nonsprouters (like *Ceanothus* species) are "successful" after fire, Keeley decided to evaluate the possible advantages that each pattern of regrowth might have in its own right. He developed a "stochastic fire hypothesis" to explain how the obligate seeders and the sprouters might each manifest an adaptive advantage under different fire circumstances.

While Keeley did not bring up the topic of Divine control in origins, creationists would assert that this is exactly what might be predicted from the scientific creation model—that each pattern of regrowth after fire would have a specific design function of its own under certain circumstances. This is similar to the situation in animal anatomy where creationists have predicted that each of the so-called "vestigial organs" would have its own design functions in the body of the particular animal, and these predictions have been proving true as more research on organ physiology is undertaken. With shrubs then, creationists would predict that under particular fire conditions resprouting and non-resprouting species would each have an advantage. Let's see how such a prediction is borne out in Keeley's hypothesis.

Non-Sprouters Have the Advantage where Fires are Infrequent

On the basis of an extensive series of their own experiments and reports of others, Keeley and Zedler[9] argued that obligate seeders such as *Ceanothus* species would possess a distinct advantage wherever there has been an especially long fire-free period before the burn. After such a long interval between fires, they reasoned, the resprouting individuals such as chamise would be few in number because old plants died in the stand before fire and because of a high percentage of total killing during the fire as a result of its great intensity (large amounts of accumulated fuel). Under these circumstances, Keeley and Zedler proposed that ". . . the longer the fire-free period, the larger the opening after fire." Since seedlings are well equipped to survive in large openings, the obligate seeder adaptation is proposed to be of advantage where fires are infrequent.

Resprouters Have the Advantage where Fires Come Often

On the other hand, they concluded that sprouting reproduction is advantageous where there has been a short length of time between fires. They reasoned that such a situation ". . . would be only slightly damaging to the sprouting species, and reproduction could be safely deferred or reduced for the first years after fire and all energy dedicated to growth." In fact, little or no seed may be produced by the very young seedling or resprouted shrubs for several years following fire. If another fire were to come very quickly, one would expect fewer seedlings surviving as a result of low seed numbers. Our own data fit the stochastic fire hypothesis at this point quite well because Carothers and I found that where two fires came within four years of each other on a gentle slope near Castaic Lake, California, many seedlings grew and survived after the first fire but we could find no seedlings (only resprouted plants) surviving after the second fire.[10]

The creationist sees this as evidence that the resprouter species were designed to fare well when fires are frequent and the non-sprouters (which ultimately funnel much of their energy into seed production) were geared to have the distinct advantage after long fire-free periods. In either case the end result is that the vegetation is efficiently restored—a tribute to a plan in nature.

But in the evolution models, how could these two different patterns of regrowth be expected to "evolve" at the same time in the same geographic region, and in response to the same factor—fire? It would seem too much to ask that natural selection produce just one pattern for survival after fires—resprouting, for example. To ask that it produce two different but very successful survival modes which respond to subtle differences in the length of the fire—free intervals seems even more unlikely. It will be more satisfying philosophically and scientifically for many workers to assert that these adaptations are evidence for design action by the

Creator. Accordingly, He formed some obligate seeders (like certain species of *Ceanothus*) for vigorous survival after intense fires where resprouters may have largely died. Conversely He formed some resprouters to restore vegetation efficiently after fires that come with greater frequency. In this case fewer seeds have been produced (because of lack of time) and the fire has been of lower temperatures so the resprouters flourish. It reminds one of a failsafe engineering system whereby regrowth will occur no matter what fire conditions prevail.

What at first seemed to be a dull study of two groups of little southern California shrubs has turned out to be crucial ground for testing creation research against evolutionary idealogies. It appears at this writing that the scientific creation model is superior.

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DOES CHROMOSOMAL REORGANIZATION REALLY LEAD TO THE ORIGIN OF NEW SPECIES?

WALTER E. LAMMERTS*

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Some people have appealed to chromosomal reorganization as a way of getting large changes in a hurry, as is needed according to the notion of punctuated equilibrium. It is shown here that there is no evidence that such changes will really lead to anything which is new, viable, and improved. Punctuated equilibrium is still a hypothetical process, for which no mechanism can be found.

Stephen J. Gould in his article entitled: "Is a New and General Theory of Evolution Emerging?[1]" states that "the most exciting entry among punctuational models for speciation in ecological time is the emphasis, now coming from several quarters, on chromosomal alterations as isolating mechanisms." Then he quotes the work of Carson with great approval. So let us see what Carson proposes in his paper entitled: "The Genetics of Speciation at the Diploid Level."[2] He states that "Indeed, the origin of the genetic basis of species differentiation appears as an important unsolved problem of evolutionary biology." (introductory paragraph.) After pointing out that often it is difficult to decide where the species line can be drawn between two gene pool communities, he then proposes new criteria for the determination of species boundaries and how they might have originated. Contrary to the usual basic assumption of neo-Darwinism that the effects of mutation and recombination by meiosis and syngamy can reach into every corner of the genome (or gene pool of the species) and shake it up, Carson maintains that part or even most of it is essentially closed to that process in natural populations. In fact he claims that in every species there are two systems of genetic variability, the "open" and the "closed" system.

In the open system mutants are either codominants or simple recessives. Both homozygotes tend to be fully viable. He is of the opinion that these genes tend to have a superficial or possibly even a trivial effect, at least in their individual action. These he believes respond readily to either artificial or natural selection. Quantitative traits would come under this category. However, as I have pointed out in various articles, there has been as yet very little proof that any mutations are of value to the organism as regards survival and actually most are actually defective under the usual environment of the species. This has been fully discussed in my article: "Mutations Reflect the Glory of God's Handiwork.[3] As to their responding to natural selection we have yet to see any demonstration. Thus even the classical case

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*Walter E. Lammerts, Ph.D. is a Founding Member, Fellow, Past President, and Past Editor of the Creation Research Society. He runs Lammerts Hybridization Gardens, P.O. Box 496, Freedom, California 95019.