or less pure types to appear even when the parents differ. Consequently, if all the blondes disappear the family may become brunet and of approximately pure type. We cannot assume amalgamation, but merely an alloy in which one metal distills off.

My investigations so far show that climate evolves type and that migrants survive or perish according as they settle in a climate similar to or different from the ancestral one. When there is a marked difference it is a bar to eugenic development. Moreover, if the adverse factor can be discovered, it may be a simple matter to guard against it and produce healthy, vigorous posterity of the brainy race of northern Europe. Of course, all hope of increasing the size of the brain by selection of proper mates must be abandoned as absurd, and in addition some of the best thinkers are physical defectives, unfit for procreation. Bizarre suggestions to select mates and breed up a physically better type may result in handsome imbeciles. A selection so far found practicable is that based upon property and has been in successful operation a long time in Europe among the upper classes. The only thing we can do is to allow the young to marry whom they please—a thing they will do anyhow—and then prevent the destruction of the offspring by avoidable factors in the environment, and the most deadly of these are climatic. An enormous birth rate has hitherto been necessary to supply material for *human natural selection*, but it is too expensive. We must utilize what the more frail modern woman can produce—a woman who would promptly perish were she to bear children as often as her ancestors. Eugenics then must devise means of rearing a higher percentage of infants, for at present the death rate among them is still appallingly high.

[Presented by the Committee on Eugenics.]

REPORT OF COMMITTEE ON BREEDING NUT AND FOREST TREES.

GEO. B. SUDWORTH, *Chairman.*

This Committee on Breeding Nut and Forest Trees has, within the last few years, fully surveyed in its annual reports the field of tree breeding and pointed out its possibilities and limitations. The work now before the committee is to follow the course outlined, and to report from time to time the progress made and the results obtained.

It is only natural to expect that more rapid progress will be made in the breeding of nut trees than in the breeding of forest trees, as is shown by the papers of individual members of the committee accompanying this report. The results obtained are presented in detail in these papers. In the case of nut trees the improvement sought is in the form and quality of the nut, a fruit produced either annually or at short intervals, and, therefore, more responsive to human influences. The establishment of new varieties of nut trees can be brought about more readily by grafting and budding than by a selection of seed. In the case of forest trees the improvements sought are chiefly in the physical properties of the wood, or in the production of species or varieties resistant to drought, insects, and fungous diseases. If these qualities are to be produced alone by breeding, they can not be secured except by the long, tedious process of seed-selection, which may require several generations of trees. Since, however, the breeding of forest trees is still in its infancy in this as well as in older countries, no results can be expected within a short time. Progress, though, has actually been made along this line by the creation of the necessary means of carrying on such long-time experiments in the form of two forest experiment stations. One is located at Flagstaff, Ariz., and known as the "Coconino Experiment Station." The other is on Pikes Peak, near Manitou, Colo., and is known as the "Fremont Experiment Station."

As a preliminary step toward such experiments at these stations a study was made last season of the differences in the size, weight, and vitality of tree seeds of the same species, obtained from individuals grown under different conditions of climate and elevation. Perhaps the most interesting results along this line were those obtained with older and younger Western Yellow pine (locally the young trees are known as "black jack"). Tests of seed from old trees ranging in age from 280 to 425 years gave an average per cent of germination of 68.4; while seed from young trees, ranging in age from 125 to 145 years, gave 83.2 per cent of germination. These results demonstrate the superior value of young Western Yellow pine for seeding purposes. If to the inferiority of old yellow pine be added the greater danger of being thrown by wind, one can appreciate the importance of these results for forestry, particularly in timber forest planting. In the table of germination tests (page 188) there have been brought together the results of seed tests of nine different species of

native conifers obtained from thirty-eight widely separated localities in the western half of the United States.

Samples of seed of *Pinus ponderosa* have been received from eighteen Forests; these Forests are so scattered that the samples may be taken as fairly representative of the variations met with in the seed of this species. While only one sample, that from the Datil Forest, was stated to be of the variety *scopulorum*, it is quite probable that several others were in reality this variety, and one or two are perhaps mixtures of the pure species with the variety.

In two characteristics the samples of *Pinus ponderosa* vary to a remarkable extent, namely, in size or weight of seed (number of seeds per pound) and in rapidity of germination (shown by the germination per cent at different times). Furthermore, these two characteristics are apparently correlated, for the light seed usually germinates much more rapidly than the heavy seed. Again, there is a distinct connection between these characteristics and the region from which the seed comes. The light quick-germinating seed comes from the eastern slope of the Rockies and from the south, while the heavy, slow-germinating seed comes from farther north and west. This connection between the characteristics of the seed and the region from which it comes has been noticed by European purchasers of American seed (Rafn); it was also pointed out in the 1907 Forest Service circular on "Germination of Pine Seed."

By means of these characteristics of the yellow pine seed, it is possible to divide the National Forests into three definite regions. The first includes the eastern part of District 1, all of Districts 2 and 3, and the southeastern part of District 4. Here the seed is usually small (it varies greatly in size, however, especially in Arizona) and germinates very rapidly. The second region includes the western part of District 1 and the northern part of District 4. Here the seed is large and usually slow (but somewhat variable) in germination. The third region is the Pacific Coast, District 6, and probably the northern part of District 5 (no samples of *P. ponderosa* have been received from California during the past winter). Here the seed is very large and very slow and irregular in germination.

The sample from the Helena Forest appears to be intermediate in character between the samples of the first region mentioned above and those of the second. The seed is considerably larger than any of the samples from the former, yet it germinated (in soil) more rapidly than any other of the eighteen samples.

Germination tests of nine different species from thirty-eight widely separated localities.

Species.	National Forest.	Germination per cent.								Number of seeds per pound of sample that may germinate.
		Two weeks.		Four weeks.		Six weeks.		Present time.		
		Chamber.	Soil.	Chamber.	Soil.	Chamber.	Soil.	Chamber.	Soil.	
<i>Larix occidentalis</i>	Blackfoot.....	17.5	15.5	37.0	29.5	42.5	34.5	45.0	40.5	53,340
Do*.....	Flathead.....	12.5	9.0	29.5	11.5	34.0	19.0	37.0	27.0	33,800
Do*.....	Helena.....	18.5	4.5	33.0	5.5	39.0	12.5	39.5	17.0	22,720
Do*.....	Lolo.....	9.0	7.5	23.5	13.5	27.0	15.5	27.0	26.0	16,760
<i>Pinus murrayana</i>	Deerlodge.....	26.0	73.5	37.5	77.5	42.0	78.0	48.0	78.0	95,350
Do.....	Helena.....	7.0	13.5	13.0	16.0	16.5	18.0	16.5	18.0	24,350
Do.....	Shoshone.....	47.5	27.5	65.0	61.5	69.5	61.5	70.5	61.5	54,300**
Do*.....	Leadville.....	16.0	60.0	42.0	65.0	57.0	67.5	57.0	68.0	78,100
Do.....	Medicine Bow.....	13.5	49.5	21.0	64.0	28.0	69.5	46.0	69.5	65,750
Do.....	Bonneville.....	30.0	50.0	51.5	73.0	55.5	74.5	61.0	74.5	62,500
<i>Pinus ponderosa</i>	Targhee.....	39.5	76.5	60.0	86.0	65.5	86.5	65.5	86.5	88,000
Do*.....	Cabinet.....	20.5	40.5	38.0	61.0	53.0	67.0	68.5	78.5	6,780
Do*.....	Coeur d'Alene.....	11.0	24.0	41.5	50.0	57.5	67.5	73.5	81.5	7,700
Do.....	Helena.....	48.0	70.0	57.5	71.5	62.5	71.5	63.5	71.5	7,320
Do.....	Sioux.....	78.0	80.5	86.0	84.5	87.0	86.0	87.0	86.0	13,660
Do.....	Black Hills.....	35.5	59.0	43.5	61.0	44.5	61.5	44.5	62.0	11,800
Do.....	Medicine Bow.....	24.0	30.0	39.0	40.0	42.5	42.0	42.5	42.5	7,700
Do.....	Pike.....	65.0	69.5	73.0	76.0	75.0	77.0	75.0	77.0	14,050
Do*.....	Boise.....	0.0	2.5	15.5	26.0	33.0	44.5	61.0	76.5	6,060
Do.....	Payette.....	10.5	12.0	23.0	27.0	47.0	43.0	80.0	56.0	5,020
Do.....	Pocatello.....	7.5	8.5	40.5	45.0	61.5	63.5	70.0	74.5	6,870
Do*.....	Weiser.....	3.5	5.5	18.5	16.0	22.5	25.5	33.5	39.5	3,800
Do*.....	Columbia.....	1.5	1.5	4.5	8.5	17.5	23.5	44.0	58.5	4,830
Do*.....	Colville.....	3.0	19.0	16.0	32.5	35.5	49.5	49.0	74.5	5,480
Do*.....	Umatilla.....	9.5	13.5	28.5	34.0	54.5	56.0	53.0	81.0	6,240
<i>Pseudotsuga taxifolia</i>	Wenatchee.....	5.5	13.0	28.5	38.0	42.5	56.0	73.0	73.0	5,270
Do.....	Asaroka.....	44.0	34.0	53.0	39.0	58.0	43.0	59.5	43.5	16,440
Do.....	Helena.....	30.0	24.5	46.5	30.5	40.0	41.0	49.5	43.0	20,770
Do.....	Medicine Bow.....	18.0	10.0	23.5	12.5	25.5	12.5	26.0	12.5	7,160
Do.....	Boise.....	5.5	3.5	14.5	18.0	18.0	20.5	22.5	20.5	7,420
Do.....	Pocatello.....	47.0	11.0	64.0	50.5	72.0	61.0	76.0	62.5	17,450
Do.....	Targhee.....	10.0	6.5	20.0	17.5	21.0	20.5	21.0	22.0	6,720
<i>Pinus edulis</i>	Crook.....	.....	2.5	.....	4.0	.....	4.0	.....	4.0	62
<i>Pinus coulteri</i> *.....	Angels.....	.....	0.0	.....	6.0	.....	21.5	.....	44.5	490
Do*.....	Morse Seed Co.....	.....	0.0	.....	9.5	.....	32.0	.....	67.5	940
<i>Pinus lambertiana</i> *.....	Plumas.....	.....	0.0	.....	0.0	.....	3.0	.....	22.0	870
<i>Picea sitchensis</i>	Olympic.....	6.5	5.5	21.5	48.5	26.0	51.5	26.5	51.5	96,000
<i>Cupressus arizonica</i>	Chiricahua.....	12.5	6.5	12.5	7.0	12.5	7.0	12.5	7.0	9,760
<i>Picea sitchensis</i>	Snoqualmie.....	0.5	8.5	1.5	16.5	1.5	19.5	1.5	21.0	39,700

** This figure is calculated on the basis of the chamber test; the soil test was damaged by insects.

Samples of seed of *Pseudotsuga taxifolia* have been received from thirteen Forests, located chiefly in Districts 2 and 4. The quality of the seed varies so much, however—many of the samples containing large percentages of empty seeds—that the number of seeds per pound gives little clue to the weight of the filled seeds. Furthermore, the germination per cent is mostly so low that the rapidity of germination can hardly be stated. It appears, however, that seed from Idaho takes considerably longer to germinate than seed from Colorado. It may eventually be possible to separate a quantity of filled seeds from each sample and thus obtain more useful figures.

Of the twelve samples of *Picea engelmanni* (shown in the first report), eight came from Colorado, and it is quite probable that the one sample from Montana is mixed with seed of *P. canadensis*. Thus no definite statement can be made regarding this species.

The nine samples of *Pinus murrayana* show considerable variation in size, but very little in rapidity of germination. While the samples from the Targhee and Shoshone Forests are much larger than any other, it is hardly possible to outline definite regions from this characteristic.

Some other characteristics of the seed, which are not brought out in the tables, are worth mentioning. The seed of some species appears to have two periods of germination: the majority of the viable seeds will germinate, and then, after a pause, a further number will do so. This is most noticeable in *Larix occidentalis*, all four samples of which have behaved in this way. The samples of *Pinus ponderosa* from Washington and Oregon, and one or two from Idaho, show signs of the same habit. This behavior is sometimes seen very clearly in seed which has been stored for a long time; stored samples of *Pinus ponderosa* and *P. attenuata*, tested during the past winter, have shown it in a marked degree.

The behavior of *Pinus monticola* is as yet uncertain. It is quite evident that the seed is very slow to germinate, so slow that no report on the germination of the samples can yet be made. The seed from the Coeur d'Alene Forest, sent for storage experiments, has germinated 40 per cent in twenty-two weeks. Various methods of germination are being tried, with good promise of success.

The importance of these results for planting are obvious.

The next step at these stations will be to start next spring plantations with seed obtained from different sources as to region, elevation,

age, and soundness of mother trees, and to record for the next several years the growth in height, the root development, the weight, the date when new foliage appears and the old is shed, etc. The species to be experimented with at the Coconino station will be chiefly the Western Yellow pine (*Pinus ponderosa*). Seed of this pine has already been gathered from one hundred different individual trees. Each tree receives a separate number and a description including the following points:

Tree number; height (feet); diameter breast high (inches); age (years); yield in cones (bushels); condition of cones; condition of tree; clear length; condition of crown; whether fire-scarred; whether spike-top; other peculiarities; site—slope, ground cover, stand.

At the Fremont Experiment Station the species to be tried are the Engelmann spruce, Douglas fir, Western White pine, and Western Yellow pine.

These experiments will enable us to choose intelligently just the right kind of seed for a given locality and thus save the inevitable disappointment and loss of time and money which come from the use of seeds not adapted to given soil and climatic conditions. Definite results can not be expected in less than five years.

The practical importance of such experiments will become apparent when one realizes that during the last year the national government alone has gathered about 14,000 pounds of tree seed, while the amount of seed to be used in the next five to ten years will be many times this amount. Upon the choice of this seed will depend the character and quality of the future forest that will come from it.

The improvement, however, of our forest resources does not need to be delayed altogether until we can secure, by gradual selection, species and varieties that will meet our economic needs better than the species on hand. There are other means of improving the quality of our forests besides breeding. The introduction of exotics and silvicultural treatment of the forests are two methods which may bring about identical results, and in a much shorter time than would be possible by breeding alone. The introduction of new blood and the improvement of the stock on hand are requisites for the accumulation of qualities for transmission by breeding. The introduction of exotics and silvicultural treatment must, therefore, be considered as essential parts of the general plan of breeding new varieties of forest trees, and progress has been made along these lines.

INTRODUCTION OF EXOTICS.

During the last year an actual trial was made with the following 53 exotic species, of which 39 are eucalypts :

<i>Pinus sylvestris</i> ,	<i>Pinus chinensis</i> ,	<i>Pinus canariensis</i> ,
<i>Pinus austriaca</i> ,	<i>Casuarina equisetifolia</i> ,	<i>Cedrus libani</i> ,
<i>Pinus gerardiana</i> ,	<i>Picea excelsa</i> ,	<i>Cedrus deodara</i> ,
<i>Morus alba tartarica</i> ,	<i>Pistachia chinensis</i> ,	
<i>Eucalyptus amygdalina</i> ,	<i>Eucalyptus siberiana</i> ,	<i>Eucalyptus trabutii</i> ,
<i>Eucalyptus diversicolor</i> ,	<i>Eucalyptus saligna</i> ,	<i>Eucalyptus microtheca</i> ,
<i>Eucalyptus globulus</i> ,	<i>Eucalyptus almenoides</i> ,	<i>Eucalyptus paniculata</i> ,
<i>Eucalyptus goniocalyx</i> ,	<i>Eucalyptus bicolor</i> ,	<i>Eucalyptus pulverulenta</i> ,
<i>Eucalyptus longifolia</i> ,	<i>Eucalyptus boristoana</i> ,	<i>Eucalyptus resinifera</i> ,
<i>Eucalyptus leucoxylon</i> ,	<i>Eucalyptus botryoides</i> ,	<i>Eucalyptus rudis</i> ,
<i>Eucalyptus marginata</i> ,	<i>Eucalyptus cornuta</i> ,	<i>Eucalyptus siderophloia</i> ,
<i>Eucalyptus melliodora</i> ,	<i>Eucalyptus corynocalyx</i> ,	<i>Eucalyptus sideroxylon</i> ,
<i>Eucalyptus mulleriana</i> ,	<i>Eucalyptus crebra</i> ,	<i>Eucalyptus tereticornis</i> ,
<i>Eucalyptus obliqua</i> ,	<i>Eucalyptus deanci</i> ,	<i>Eucalyptus viminalis</i> ,
<i>Eucalyptus pilularis</i> ,	<i>Eucalyptus gunnii</i> ,	<i>Acacia melanoxylon</i> ,
<i>Eucalyptus polyanthema</i> ,	<i>Eucalyptus hemphloia</i> ,	<i>Syncarpia laurifolia</i> ,
<i>Eucalyptus punctata</i> ,	<i>Eucalyptus hemphloia</i>	<i>Quercus suber</i> .
<i>Eucalyptus regnans</i> ,	<i>albens</i> ,	
<i>Eucalyptus rostrata</i> ,	<i>Eucalyptus masculata</i> ,	

This list does not, of course, include all of the exotic species which can be tried. The following additional species are selected for trial in the near future :

<i>Pinus laricio</i> ,	<i>Pinus excelsa</i> ,	<i>Abies pindrow</i> ,
<i>Pinus pallasiana</i> ,	<i>Picea morinda</i> ,	<i>Larix leptolepis</i> ,
<i>Pinus pinaster</i> ,	<i>Picea orientalis</i> ,	<i>Larix curilensis</i> ,
<i>Pinus pinea</i> ,	<i>Picea alcoquiana</i> ,	<i>Larix siberica</i> ,
<i>Pinus halepensis</i> ,	<i>Abies pectinata</i> ,	<i>Cupressus sempervirens</i> ,
<i>Pinus bungeana</i> ,	<i>Abies cephalonica</i> ,	<i>Chamaecyparis obtusa</i> .
<i>Pinus cembra</i> ,	<i>Abies nordmanniana</i> ,	

If these prove adaptive to given local conditions, they may in themselves form a valuable addition to our forest resources, or by hybridizing with native species furnish material for further selections and breeding. Of these introductions the most interesting will be the sowing next spring of over 3,000 pounds of Austrian pine. This species may enable us to extend in the Southwest the lower timber line further down into the foothills, where our native yellow pine stops at an elevation of about 5,000 feet, giving way below this level to a scrubby growth of oaks and other chaparral species.

IMPROVEMENTS BY SILVICULTURAL TREATMENT.

The quality of the wood and the growth of forest trees in a stand depend, as every observer knows, upon the way the stand has grown, that is, whether in an overcrowded, dense, or open stand; whether the leaf litter was regularly burned or otherwise removed, or allowed to remain and form a humus; whether the existing stand began under dense shade and remained suppressed for a long time, or started in dense shade of older trees, comprising trees of all ages and sizes, or whether it started in an opening and made a uniform, even-aged stand. It is empirically established that, in the case of broad-leaved species, rapid growth, all other conditions being equal, means, as a rule, a straighter grain and stronger and more serviceable wood; while slow growth means brittle, twisted, and less useful wood. The biological reason for this difference in the quality of wood of the same species grown at different rates, lies in the fact that every decrease or increase in the width of the annual ring means a decrease or an increase of the summer or winter wood, while the kind of wood formed early in the season and known as "spring wood" remains, as a rule, approximately the same in both rapid-growing and slow-growing trees. The summer or winter portion of the annual ring contains few fibro-vascular bundles, is less porous, has thick-walled wood-elements, the presence of which, in larger or smaller quantities, always determines the relative strength of the wood as a whole. Therefore, for broad-leaved trees, the wider the rings, or the more rapid the growth, the stronger the wood, while the narrower the rings, or the slower the growth, the weaker the wood.

In the wood of coniferous trees the reverse is true, owing probably to the simpler structure of their wood, less marked periodicity in the appearance of the foliage, and less transpiration.

It is entirely within the power of the forester to stimulate the growth of trees in the stand by proper and timely thinnings, to produce clear or knotty timber, and thus by silvicultural treatment to control the quality of the timber grown. To what extent improvement of the wood thus brought about may be transmitted by heredity through breeding is still an open question. If, however, as we already know, the size of the seed has an undisputed influence upon the stock produced from it, and the size of the seed varies with the position of the tree in the stand, whether it is dominant or suppressed

—a condition which may be produced artificially in any forest—it may be expected that seed obtained from cylindrical straight-boled trees will stand a better chance of producing wood of more desirable qualities than seed from suppressed knotty, crooked trees. The proof of this, however, can and will be obtained only through the experiments to be started on the relation of the source of the seed and the resulting trees.

SUMMARY.

To sum up, there are three important problems before us:

- (1) Selection of tree seeds which are to produce our future forest.
- (2) Improvement of the present forest by silvicultural treatment, thus creating better trees capable of transmitting the qualities brought about by such treatment.
- (3) Introduction of exotics into regions which either do not support tree growth at all, or, have trees of inferior quality, thus adding directly to the forest wealth of this country and furnishing new material for hybridization and further selections.

Of these three problems the one which promises definite results within a short time is the selection of tree seeds.

This committee considers it most essential at present to lay down principles and methods of tree seed selection for the guidance of foresters and other tree seed collectors in whose hands rests the future of our timber forests.

REPORT OF COMMITTEE ON ANIMAL HYBRIDS.

This committee recently addressed a letter to each of the experiment stations asking for a statement concerning the animal hybridization work at those institutions. The following experiment stations report more or less work of this character, either now in progress or recently so: Indiana, New Hampshire, South Dakota, Arizona, Florida, South Carolina, North Dakota, Georgia, Michigan, Illinois, New York, Oklahoma, Iowa, North Carolina, Wyoming, and California.

At some of these stations Mendelian phenomena in the crosses between the breeds are being studied, and in most of them the aim of the work is the establishment of new types or breeds. The follow-