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Cockayne Memorial Number

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EXAMINATIONS

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2. Intermediate Certificate in Horticulture.
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LEONARD COCKAYNE: HORTICULTURIST

Many tributes have been made to the work of Cockayne the botanist. The full extent of his services to horticulture has perhaps not been realised by all. From the days of his New Brighton garden onwards he corresponded with, and exchanged seeds with, the great botanical gardens and horticultural institutions almost the world over. Thus he made known the horticultural riches of our flora, so that, as has been said, "No one can visit the greater British and European gardens without seeing some evidence of his activities." No less true is this of America. We are privileged to publish some personal tributes indicating the happy relationships with horticulture abroad of our first Honorary Botanist.

Sir Arthur Hill, Director of the Royal Botanic Gardens, Kew, has written: "Cockayne was always modest as to his qualifications, and in his earliest letter we have at Kew, written to Sir W. Thistleton-Dyer in 1899, when sending a parcel of seeds in connection with his work on the seedling forms of New Zealand Phanerogams, he says, "I may say I am not a nursery gardener but merely a private individual who spends his whole time in the study of Botany." From thence onwards Kew has been enriched by consignments of seeds, living plants (including Tree and Filmy Ferns), and large numbers of herbarium specimens which he and his collaborators have most kindly sent home."

L. H. BAILEY, COLLEGE OF AGRICULTURE, CORNELL UNIVERSITY

"Leonard Cockayne was effectively associated with systematic botany, plant distribution and ecology, and service to horticulture. He was alert, positive and spontaneous. We looked to him for aid in many genera of New Zealand plants.

It was great joy to me to go with him to interesting plant associations in New Zealand and to hear his reasons. He was a philosopher of these situations, and he helped us to understand. The New Zealand flora is so peculiar that we have needed the guidance of such men as Cockayne, on the ground. It is good to know that you intend making a worthy testimonial in the Journal of the New Zealand Institute of Horticulture."

A corner in Cockayne's Ngaio garden.

CARL SKOTTSBERG; DIRECTOR, BOTANICAL GARDENS, GOTHENBURG, SWEDEN

"I never met Dr. Cockayne. After I had paid my first visit to the southern end of South America, I very much wanted to see New Zealand. Cockayne asked me to come, and my desire became stronger. But when I found it possible to cast loose again, duty told me to return to my old hunting-grounds. Now, as I look back on my botanical career, I know that I made a mistake. I should have gone to see him and work with him. The loss to me is irreparable.

I returned from the Antarctic voyage with a certain knowledge of the flora then generally called Antarctic. It is Antarctic of course, or at least part of it, in a genetic sense, but the greater part of the territory, now inhabited by this flora, is not Antarctic at all from a geographical or climatological viewpoint. I tried to make a subdivision of the whole area involved. I took up, and tried to define, the term "Subantarctic." In my juvenile zeal I was bold enough to discuss also the Neozelandic region. This put me into contact with Cockayne, and a correspondence began which lasted to his death. He sent me all his papers, he read and made comments on mine, supporting or criticising my views. He honoured me by asking my opinion. The more I saw of his work, the more I admired him for his sound ideas, logical treatment of his subjects, and vast knowledge in many fields of botany. When he supported me, I felt on safe ground.

He used to write long letters, and gradually I began to know him not only as a great botanist but as a remarkable personality. We became friends, and I could feel, across the seas, the firm pressure of his hand. I longed to meet him. And a day came when I needed his friendship more than ever, when I had to ask him to give his judgment on my work as a phytogeographer. He took the risk, and he was glad to do it. He went too far in his kind appreciation, and I told him so, but he stubbornly refused to take back anything or to admit any other interpretation of his words than a strictly verbal one.

To the scientific world, Cockayne became the outstanding representative of New Zealand botany. I think we can safely say that he inaugurated a new era of botanical resaerch in his country. He did not need to travel round the world and speak for himself. He stayed where he was, true to his mission, his work spoke for him, and the world honoured him. He deserved it all. It will be difficult to find, in our time, a botanist who has meant so much to his country as Leonard Cockayne did to New Zealand."

SIR W. WRIGHT SMITH; REGIUS KEEPER, ROYAL BOTANIC GARDEN, EDINBURGH

Many are the tributes which have been paid to the life and work of this great New Zealand botanist, since his death on July 8th, 1934. It befits me then to say little or nothing of the various branches of botany in which Cokayne interested himself in his study

New Zealand Plants in Gothenburg Botanical Garden.

of the New Zealand Flora, or of the many honours which were conferred upon him by various Societies throughout the world. Rather would I speak of him as a friend of the Royal Botanic Garden, Edinburgh; far more than any other Botanical Institution outside New Zealand did the Edinburgh Garden benefit by Cockayne's generosity and hard work.

I have the correspondence between Cockayne and the late Sir Isaac Bayley Balfour and later between Cockayne and myself—a correspondence which reached over almost 30 years, and which reveals the deep personal interest this botanist had for our Garden. On the 18th day of May, 1907, Sir Isaac wrote to Cockayne:—

"We have in our Herbarium specimens of the Flora of New Zealand known at the time of Hooker's exploration; and subsequently through Lauder Lindsay we received some additions; but it is far from being furnished in the many species and varieties that have been discovered in more recent times. I am now having it written up by the help of Cheeseman's Flora and find how faulty it is. Your kind offer of specimens is, therefore, one I gladly accept and any contributions you may send will be most highly appreciated."

Thus over the years did Cockayne augment our collection of New Zealand plants in the Herbarium by his excellent specimens. But more important still were his gifts to the Garden of seeds of interesting and in many cases uncommon New Zealand species. On May 1st., 1906, he wrote to Sir Isaac:—

"I am sending you to-day two packets of seed, both of which are, I believe, the first sent to Europe, viz:—Veronica salicornioides and Pittosporum patulum."

Many more are the plants which he introduced to the Edinburgh Garden and thus to Europe for the first time: Rubus parvus of the great scarlet fruits and metallic tinted leaves of autumn; several species of Raoulia and Helichrysum dimorphum to name but a few. Of the latter plant he sent seed even before he had described the species. On May 11th, 1907, he wrote of this plant:—

"Helichrysum dimorphum I have not yet described, not having seen flowers until a week or two ago, although it is some years ago since I discovered the plant. It is quite different from any other New Zealand plant, being a liane and one moreover showing a curious heterophylly. It climbs over the river terrace scrub of the montane region and has only been noted as yet in two adjacent localities."

Of very rare plants he sent many and his comments on the plants were always enlightening and penetrating. Of Pittosporum obcordatum he wrote on the 2nd of April, 1911.

"Only one tree is known. I found seedlings for the first time, wrote a brief, alas too brief, description then, and lost my specimens. Were the tree not in fruit one would never dream it to be a

Pittosporum. The seeding is absolutely different from the adult.

In the same letter he refers to seeds of Veronica odora and speaks of the plant in the following terms.

"If this is the real species, it is not yet in cultivation except in two private gardens in New Zealand. Until it was rediscovered in the Auckland Islands, neither Cheeseman nor myself believed there was such a plant. The seeds came from a plant collected in Stewart Island by a friend of mine. I have not yet sent a specimen to Cheeseman nor examined it critically myself, but in any case it is not V. elliptica nor any other species of Veronica, if it be not as identified here."

Two years later on January 23rd., he wrote:—

"Yesterday I received some seed of Pittosporum Dallii from my friend Mr. F. G. Gibbs of Nelson. The tree? was discovered some years ago by Mr. Dall, a collector for purposes of sale and he kept the locality a secret. Just before his death, however, he gave Gibbs a slight clue as to where it was to be found. A few days ago Gibbs went on the hunt and has returned with seed and flowering specimens, these having not been previously seen (Cheeseman described the plant in the Appendix to his flora from scanty material) and he reports the flowers are white and that the tree? is the handsomest of all the New Zealand Pittosporads. At any rate it is a most distinct plant. I shall have a specimen to send you, but have no time to-day to put it up. I shall also send a pinch of seed to Kew and shall sow some myself, as I think the seedling form may be of interest. Gibbs had just commenced to look for seedlings, but he noticed his fire, in the valley below, which he thought was safe, was beginning to spread and he had to run, not for his life, but for that of the vegetation. Happily he arrived in time and put the conflagration out. I am writing him for full particulars as to the habitat of the plant. All he told me was the locality, (the extreme N.W. corner of the South Island) and altitude 3000ft. From the latter fact, one might expect the plant to be hardy."

The story of Donatia novae-zelandiae makes interesting reading and throws much light on Cockayne's enthusiasm for collecting seeds and of having New Zealand plants established in European gardens. On March 31st., 1910, he wrote to Prof. Balfour:—

"Enclosed you will find a packet of Donatia novae-zelandiae containing a few seeds (very few) which I collected in the Dividing Range at 3000ft. altitude a few days ago. I would sow the seeds right on the surface soil in a small pot and give it some slight heat at first."

Later on May 16th., 1912, he exclaims:—

"I think you must have the most skilled seed-raiser in the world! It is not the specially easy seeds which are germinating but the most difficult, some of which like Donatia I had deemed impossible. I remember well gathering with numbed fingers the seed from the plants on the soaking wet ground of Arthur's Pass, and thinking it a most hopeless business. I am assured now that you are able to raise any of our seed and that they can travel quite well. But it is strange that none of the Raoulia species have germinated."

In this latter genus he was especially interested and held the species in high esteem as rock garden plants. He speaks first of them on June 30th., 1910.

"I intend to send you plenty of seed of the various species of Raoulia (excepting the "Vegetable Sheep" which it is hopeless to attempt. They take the place with us of the mossy saxifrages but I really think they are more beautiful and certainly are of more striking form and colour. Once raise one of them from seed and it is only a question of time and every alpine garden in Britain will grow them. But as far as I know, none are in cultivation as yet."

For some time, however, Edinburgh had no luck in the germination of the seeds of this genus. But on January 16th., 1913, he was able to write to Professor Balfour.

"Dr. Chilton, Professor of biology at our local University College has just returned from a visit to the Old Country and he tells me that he saw in the Edinburgh Botanic Garden a pot of seedlings of some species or other of Raoulia! After years of failure with my Raoulia seed, at I don't know how many gardens, you have succeeded at last. Perhaps you may be able to raise the "Vegetable Sheep." I do not think it impossible any longer. I must try this year to get you seed of one or other of the species. The only hope over here would be with seedlings. I don't think adult plants can grow for long, unless it be under the quite unnatural conditions of pot-plants in a green-house. But it is the species of Raoulia that make silvery circular patches that will be of importance for British Rock Gardens and that will vie with the mossy saxifrages. Raoulia australis, R lutescens, R. tenuicaulis, R. glabra and R. subsericea, will be the most important garden plants of the genus. And once established they can be raised vegetatively by thousands with the greatest ease."

The years have shown how sound was Cockayne's judgment of these plants, for all the species he names are now much prized rock garden plants. What might have been Edinburgh's fate in the germination of seeds of the "Vegetable Sheep"—Raoulia mammillaris —we shall never know for seeds of this species were never sent to the Garden.

Among the plants raised from the seed which was sent to us by Cockayne, perhaps the one we treasure most is Nertera Balfouriana, which he himself named in honour of his friend, the late Sir Isaac Bayley Balfour. This plant with its numerous pyriform, orange coloured fruits always does exceedingly well with us and was greatly prized by Sir Isaac. For one who worked so long on New Zealand plants Cockayne himself described comparatively few new species. On this subject he wrote:—

"I am giving Petrie all my new species, since I dislike describing plants and he loves it above all things."

Such then are but a few of the plants with which Cockayne enriched the Edinburgh Botanic Garden. Naturally in the later years of his life, he was unable to collect seed for us, but my correspondence with him never ceased for any length of time. My last letter from him, written on the 1st. of June, 1934, five weeks before he died, makes a suitable conclusion to this short note:—

"It was an extreme pleasure not only to receive from your hands the announcement that I had been elected an Honorary Fellow of your Botanical Soceity—a most rare distinction, but that I was once again in touch with yourself. You will see that this letter is not in my handwriting for the state of my eyesight makes it impossible for me to read or write (except my signature); nevertheless, I am attempting to keep on my botanical work and so keep the botanical flag flying as long as I may live (now nearly eighty) or my friends consider that my researches should best come to an end."

AN ARTIFICIAL SCREE IN A NEW ZEALAND GARDEN.

By J. Scott Thomson and G. Simpson.

INTRODUCTION.

"Although quite dry on the surface, at a few centimetres depth the substratum is damp, and deeper still, ample water, but icy-cold, is available for plants. The climatic features of the habitat depend upon extreme exposure to wind; strong radiation of heat from the stones; powerful heating of the stones themselves and, at times, very bright light. Within the space of a few hours the plants are frequently subjected to burning heat and considerable frost, or one hour they may be surronded by moist air and the next exposed to a strong, dry wind. Those which are evergreen bear a heavy weight of snow for four months at a time or more. Nor are occasional draughts unknown. It is obvious then that the ecological conditions of shingle-slip are distinctly those of desert, while in addition there is marked instability of surface. This latter character has, in part, led to the occupation of the ground not merely by certain peculiar life-forms but by 25 distinct species which do not occur in any other formation.

The formation is indeed distinct in itself and not a phase in the development of fell-field but a definite vegetation-entity the origin of which is wrapped in obscurity." (Vegetation of New Zealand. Ed. 2. L. Cockayne).

This arresting description of a New Zealand alpine *"shingle-slip" must impress the imagination of all who read it. Particularly does it appeal to the enthusiastic horticulturist who nevertheless

*A term used by high-mountain musterers to designate alpine scree slopes.

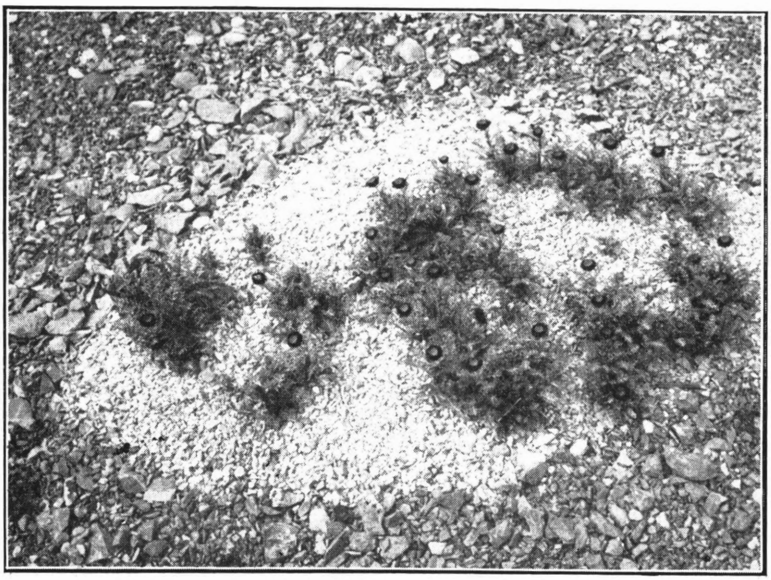
may be forgiven for wondering if any of these 25 remarkable species could ever be grown in captivity. At first glance it would seem impossible, but the writers hope to show that, with some measure of success at least, these obstinate plants and others equally obstinate may be made amenable to cultivation.

In this country the scree as an aid to botanical research and as a necessary part of any garden devoted to the cultivation of New Zealand plants, has seemingly in the past been either ignored or overlooked. The absence of many of our most striking rock, rock-debris, bog and other mountain species in public or private gardens is not due to the fact that attempts have not been made to bring these into cultivation; on the contrary, many have tried, time and time again, to successfully establish these rarities. Even such an experienced gardener as the late Dr. Leonard Cockayne frankly despaired regarding many of our species, and one has only to consult his book—The Cultivation of New Zealand Plants—to realise that all is not plain sailing. The following remarks, taken from the above publication, clearly illustrate the obstacles likely to be encountered by anyone who desires to possess a really representative collection:—Gentiana—"all most difficult to grow"; Pygmaea—"difficult"; Drapetes Lyallii—"difficult"; Haastia recurva—"extremely difficult"; Raoulia eximia and its allies (R. Buchanani, R. bryoides, R. mammillaris etc.)—"perhaps impossible in the open"; Leucogenes grandiceps—"rarely flowers in cultivation after the first season"; Myosotis—"some are difficult to maintain"; Phyllachne and Donatia—"unsatisfactory"; Ranunculus—"most are difficult to maintain" in a condition able to flower properly after the year of their introduction"; Raoulia Hectori—"not easy to grow"; Celmisia vernicosa—"very difficult"; bog cushion-plants—"certainly not easy to manage"; the species peculiar to unstable debris (Cotula atrata, Ranunculus chordorhizos, R. Haastii, R. Scott-Thomsonii etc.) "may be impossible."

Another noted grower, Mr. B. C. Aston, a keen enthusiast with a long and wide experience, makes the following comments (Journ. N.Z. Inst. Hort. No. 1. Vol. 3. 1931):—Vegetable Sheep (Raoulia eximia, R. mammillaris etc.).—"One would like to see these established on rock or moraine gardens, but the writer does not know of any attempt that has been successful"; New Zealand Gentians.—"the despair of all cultivators of New Zealand plants". Also (Journn. N.Z. Inst. Hort. No. 3 Vol. 2. 1930) he writes: "If anyone has successfully grown the larger Gentians of our mountains, . . . the Pleurophyllums, . . . Celmisia vernicosa, . . . , the rarer Ranunculuses (R. Haastii, R. Sinclairii and R. Buchanani) and the Coral Plant (Helichrysum coralloides) it is highly desirable that they should put their experience on record in this Journal for the benefit of others who would be glad to repeat their successes".

To the above lists of hitherto "impossible" or "difficult" species we could add more than a few, but enough has been said to

Leucogenes Leontopodium



Cotula atrata

show the problems that face the gardener who wishes to grow these interesting New Zealand plants.

The building of a scree on a more ambitious scale than the usual filling of a few pockets in the rockery with grit and leaf-mould has always appealed to the writers, and one of them, some two years ago, constructed in his garden a replica—as far as lay in his power—of a mountain "shingle-slip". Fortunately at the time the advice of Mr. D. Leigh, who has had a wide experience in building scree-gardens in England, was available, and many valuable hints were freely offered and thankfully taken. In the laying out of the scree no artistic effect was aimed at, utility being the main consideration.

DETAILS OF CONSTRUCTION.

For the benefit of those who may wish to try out this method of cultivating difficult alpines, the following particulars may prove useful. The site chosen has a slope of about 10 deg. to the south, and is situated in an open space surrounded by lawn and well away from overhanging trees. First of all, a large irregularly-shaped excavation was made to a uniform depth of 3 ft., the greatest length and breadth being respectively 27 ft., and 12 ft. On the bottom of the excavation, care was taken to keep a slight uniform grade leading down to the lowest part, and from this point a rough drain conducts away all superfluous water. The scree is so constructed that water from a hose placed in the top end of the scree will run freely out of the mouth of the drain—some 100 ft. distant—in less than 15 minutes after turning on the water. A further example may perhaps convey a better idea of the rapidity with which surplus water is conveyed away; after a fairly dry period, a rainfall of 0.3 inches spread over 15 hours was sufficient to cause the drain to function. The bottom of the pit was filled to a depth of 12 inches with large flattish stones, closely packed together on edge so as to afford rapid drainage. The narrow gaps between these stones were protected from possible blockage from above by a carefully placed thin layer of 2in. road metal, on top of which was placed an inch or two of Olearia hedge-cuttings: the effect of the foregoing was to make the lowest foot of the scree into a very effective sieve. From them on, the pit was filled with a mixture in equal proportions of 2in. bluestone road-metal, screenings, grit and leaf-mould, the final surface being about 6 inches above ground level. The excavated soil was discarded.

GENERAL.

The two bugbears of the gardener, weeding and watering, cause little trouble. Ordinary exotic weeds are practically non-existent but a word of warning is necessary regarding "stop-gap" species—those planted in the early stages to fill in the bare spots—as much trouble may be caused by prolific seeders or by those that increase rapidly by vegetative growth. Practically all species of Epilobium, for instance, should be rigorously excluded; E. brevipesearly became a great nuisance in the scree and, as mentioned elsewhere, Myosotidium nobile and Stilbocarpa Lyallii had to be removed. Strangely enough, the gentians—"the despair of all cultivators of New Zealand plants"—spring up from self-sown seed so readily that, given free play, they may well become scree weeds.

Watering is indulged in only when new plants are being installed or during periods of dry hot weather; the length of time that the main body of material retains moisture throughout its mass is remarkable. The mean annual rainfall at Dunedin is 36.35 inches, fairly evenly distributed throughout the year, and the average number of days in which rain falls is 160 per annum. The prevailing winds—from the south-west and north-east—are both moisture-bearing, but dry westerly and north-westerly winds are frequent enough. Perhaps influenced by these rainfall figures, many gardeners in other centres of the Dominion stoutly maintain that Dunedin is singularly favoured by its climate for the cultivation of alpine plants; this contention is equally stoutly denied by Dunedin gardeners who—whatever they may think privately—publicly prefer to place any credit for success to quite another source. Suffice to say that one of the writers grew a specimen of one of the vegetable-sheep (Raoulia Buchanani) in ordinary garden soil, where it flourished and flowered for 8 years before being accidentally destroyed. Also, after a 3 years' struggle, he succeeded in bringing to flower the rare Pleurophyllum speciosum; successes of this nature tend to breed unworthy suspicions that the Dunedin climate is responsible.

To North Island enthusiasts, who may fear that their northern conditions are inimical to scree plants, it is comforting to note that one authority has stated that a slope of only 5 degrees may be equivalent to a latitudinal distance of 300 miles; the Auckland gardener then—by merely grading the surface of his scree with mathematical precision—may reproduce at will something of the conditions prevailing at say Dunedin or even Campbell Island. We trust that this may be so; in any case a slope to the south has much to recommend it.

The scree was first planted some two years ago and even in that time the success attained has been both gratifying and phenomenal. The space of two years is, of course, too short a time in which to bring together a really comprehensive collection of the rare and difficult species; to obtain even a handful of these desirables often means a strenuous trip of many days—a fact often conveniently ignored by growers of New Zealand alpines in England and elsewhere—but enough have now been successfully established to warrant an extraordinary degree of optimism regarding the remainder.

A fairly complete list of the species present in the scree will be found below. Practically all have become firmly established, though nothing definite can yet be said concerning one or two which have been planted quite recently. So far, the only apparent failure was the pen-wiper plant (Notothlaspi rosulatum); specimens of this flowered abundantly the first year but died shortly afterwards. The species is probably biennial, but the plans lived long enough to show that some individuals possessed yellow flowers; they are not all white-flowered, as the "Manual" would have us believe.

It is worthy of remark that the scree, with a p H value of 6.6, can accommodate species such as Donatia novae-zelandiae and Gentiana Astoni which are confined in nature to widely divergent soils having p H values in the vicinity of 3.8 and 7.8 respectively.

Those marked "D" or "V.D." are—according to our experience—"difficult" or "very difficult" to maintain in such a condition that they flower after the first season. Quite a number can be kept long enough to flower once only, the real difficulty coming after their first season in the garden. Those not marked are but temporary occupiers of the scree and many will be replaced by "difficult" plants when these can be collected. Already Stilbocarpa Lyallii and Myosotidium nobile have had to be removed owing to aggressive rate of growth. Celmisia argentea and Herpolirion novae-zelandiae may probably share the same fate for the same reason.

List of species present in scree.

Aciphylla congesta. D. The small species of Aciphylla are striking rosette-plants, usually with erect rigid sharp-pointed leaves. A. congesta is found only in the mountains of Otago.

Aciphylla Dobsoni. V.D. Has numerous thick short leaves, smooth and shining. Forms small patches. Canterbury and Otago mountains.

Aciphylla Leighii, sp. nov. V.D. Very distinct; recently discovered by Mr. D. Leigh on the Mt. Madeline range, Otago.

Aciphylla Monroi. A well-known, easily grown spear-grass.

Anisotome capillifolia. D. A graceful little plant resembling a miniature crepe-fern. Otago mountains.

Anisotome imbricata. D. Said to occur from Nelson to Southland, but cultivation in the scree would reveal whether the forms of the north are really con-specific with those of the south or not.

Anisotome pilifera. Showy, with striking foliage. Occurs practically throughout the mountains of South Island.

Caltha obtusa. A curious species with upturned lobes almost as large as the leaf-blade. Large flowers.

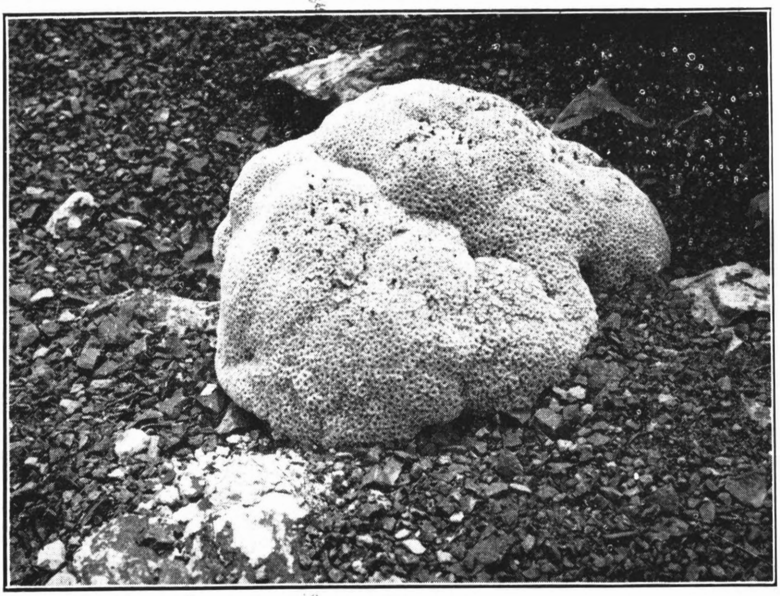
Celmisia argentea. Easily grown. A miniature rosette-plant forming large silvery cushions. Numerous flowers sunk amongst the leaves.

Celmisia bellidioides. Unusual; small fleshy green leaves.

Celmisia Gibbsii. V.D. A singular mountain-daisy with slender sparingly-branched stems.

Celmisia linearis. Easily grown. Rosette-plant probably of hybrid origin.

Celmisia sessiliflora. Similar to C. argentea but larger in all its parts.



Raoulia eximia.

Hebe linifolia

Celmisia vernicosa. V.D. An exceptionally beautiful celmisia with linear leaves like polished greenstone. Purple disc-florets; white rays. From Auckland and Campbell Islands.

Cotula atrata. V.D. A most distinct cotula, with much-cut leaves and large jet-black or dark-purple flower heads studded with golden stamens.

Coxella Dieffenbachii. Allied to the spear-grasses. From the Chatham Islands.

Crepis novae-zelandiae. A herb of odd aspect with yellow flowers.

Donatia novae-zelandiae. V.D. An extremely hard, densely-tufted mountain-bog cushion-plant. Numerous small white flowers.

Drapetes villosa. Well-known.

Drapetes Lyallii. V.D. A small compact moss-like cushion-species.

Earina mucronata. A common epiphytic orchid. Planted in scree for experimental purposes. Flowers regularly.

Forstera sedifolia. D. Dainty plant with small leathery recurved leaves and flowers perched on ends of long slender stalks.

Forstera tenella. D.

Gentiana Astoni. V.D. An attractive free-flowering gentian forming extensive mats. Does not resemble any other New Zealand gentian. Known only from Marlborough.

Gentiana bellidifolia. D. A common, though handsome, mountain species.

Gentiana corymbifera. V.D. Recently planted. The most imposing New Zealand Gentian.

Gentiana montana. V.D. One of the best of the gentians with long narrow leaves and dense clusters of large white flowers on long stalks. Seedlings produced in profusion in the scree.

Gentiana flaccida. D. A splendid garden plant.

Gentiana patula. D. A compound species of many forms.

Gentiana serotina. Of no particular merit.

Gentiana saxosa. An easily grown coastal gentian of decumbent habit. Flowers very freely under ordinary garden conditions.

Gentiana Townsoni. V.D. A desirable gentian with numerous fleshy leaves and dense umbels of large flowers.

Geum uniflorum. A noticeable plant with large solitary flowers.

Haastia pulvinaris. V.D. Recently planted. One of the "vegetable-sheep"; forms extensive light-yellow cushions.

Haastia recurva. V.D. A laxly-branched species of unusual aspect. Leaves densely covered with greyish wool. Peculiar large rayless flower-heads.

Haastia Sinclairii. V.D. Recently planted. A trailing plant with broad greyish woolly leaves.

Hebe ciliolata. Very distinct and easily grown.

Hebe dasyphylla. D. Prostrate and woody. Large terminal flowers and densely-leafy stems.

Hebe epacridea. Small rigid decumbent shrub. Recurved leaves, flowers packed in terminal heads.

Hebe Haastii. A well-marked high mountain hebe. Seeds freely in scree.

Hebe linifolia. Easily grown.

Hebe tetrasticha. D. Peculiar small much-branched shrub with square-stemmed branchlets. Flowers crowded near the tips of the branches.

Hebe uniflora. D. Similar to H. dasyphylla but smaller.

Hectorella caespitosa. V.D. A unique cushion-species from high-mountain localities in Canterbury and Otago. Flowers arranged in circles on the flattened ends of the branches.

Helichrysum coralloides. D. The justly-famous Coral Plant. Scale-like leaves—separated by layers of wool—closely pressed to the stems.

Herpolirion novae-zealandiae. The "grass-lily" of mountain swamps. Grass-like leaves and large blue or white flowers.

Leucogenes Leontopodium. This magnificent species resembles, but excels in beauty, the famous Edelweiss of Europe.

Leucogenes grandiceps. The common South Island "edelweiss," a silvery-leaved plant with large white bracst to the flower heads. Seedlings have already appeared in the scree.

Lycopodium australianum. D. Planted for experimental purposes.

Lycopodium scariosum. Planted for experimental purposes.

Myosotis albida. The common coastal "forget-me-not" of Otago and Stewart Island.

Myosotis decora. D. A beautiful mat-forming plant. Masses of flowers.

Myosotis macrantha. A graceful species wtih racemes of bronze-coloured flowers.

Myosotis pulvinaris. V.D. Forms soft rounded cushions, sprinkled with white flowers.

Oreobolus pectinatus. V.D. A hard dense cushion-sedge of mountain bog.

Oreobolus strictus. Planted for experimental purposes.

Ourisia caespitosa. A creeper with fleshy bright-green leaves and large flowers. Forms extensive mats.

Ourisia glandulosa. Forms broad colonies. Leaves provided with long jointed hairs. Large flowers.

Ourisia macrocarpa. An outstanding ourisia. Large thick leaves and whorls of large flowers.

Ourisia sessifolia. V.D. The most difficult and distinct of all the ourisias. Pale-green leaves covered with hairs. Large white flowers. Other species of Ourisia are also present in the scree but none of these are at all difficult.

Phyllachne clavigera. V.D. A singular cushion-species. Tips of leaves thickened and knobbed.

Phyllachne Colensoi. D. Cushion-plant Unusual at any time but very striking when in flower.

Polypodium pumilum. D. A high-mountain fern. Forms dense hard mats. Recently planted.

Polystichum cystostegia. Planted for experimental purposes.

Pygmaea ciliolata. V.D. The pygmaeas are all very difficult to establish. Leaves are minute and overlapping. Form excellent scree plants.

Pygmaea pulvinaris. V.D.

Pygmaea Thomsoni. V.D. It is with some diffidence that the pygmaeas have been named specifically. Undoubtedly the forms at present in the scree come under the present ideas of the species mentioned, but they possess characters which show the need for a thorough analysis of the group. Similar remarks also apply to some of the gentians listed.

Ranunculus Buchanani. D. A handsome Otago mountain buttercup. Equals in appeal the famous R. Lyallii.

Ranunculus Buchanani x Simpsonii. D. Planted for experimental purposes but makes an excellent show.

Ranunculus chordorhizos. D. A peculiar low-growing plant with greyish leaves and large yellow flowers. From mountains of Marlborough, Canterbury and Otago.

Ranunculus Lyallii. Planted for experimental purposes. Easily grown.

Ranunculus Buchanani x Lyallii. Planted for experimental purposes. Members of this group are conspicuous plants.

Ranunculus novae-zelandiae. A small-leaved creeping species confined to Otago.

Ranunculus sericophyllus. A neat little buttercup with silky leaves.

Ranunculus Scott Thomsonii. V.D. A rock-debris plant with coriaceous bluish-green leaves and yellow flowers. Confined to the Eyre Mts., Otago.

Ranunculus Simpsonii. D. A beautiful garden plant. Shining-green leaves and large orange-yellow flowers. Confined to the Fiord mountains.

Ranunculus Sinclairii. Small bog-buttercup with finely-cut leaves.

Raoulia bryoides. V.D. This and the following three species belong to that renowned group known as "vegetable-sheep". R. bryoides does not attain any great size. To see any of the "vegetable-sheep" flourishing in a garden is sufficient recompense for all the trouble of constructing a scree.

Raoulia Buchanani. V.D. The blue "vegetable-sheep" of Otago mountains. Grows to a great size and produces small scarlet flowers in profusion.

Raoulia eximia. V.D. Confined to the dry mountains of South Island. Forms immense cushions.

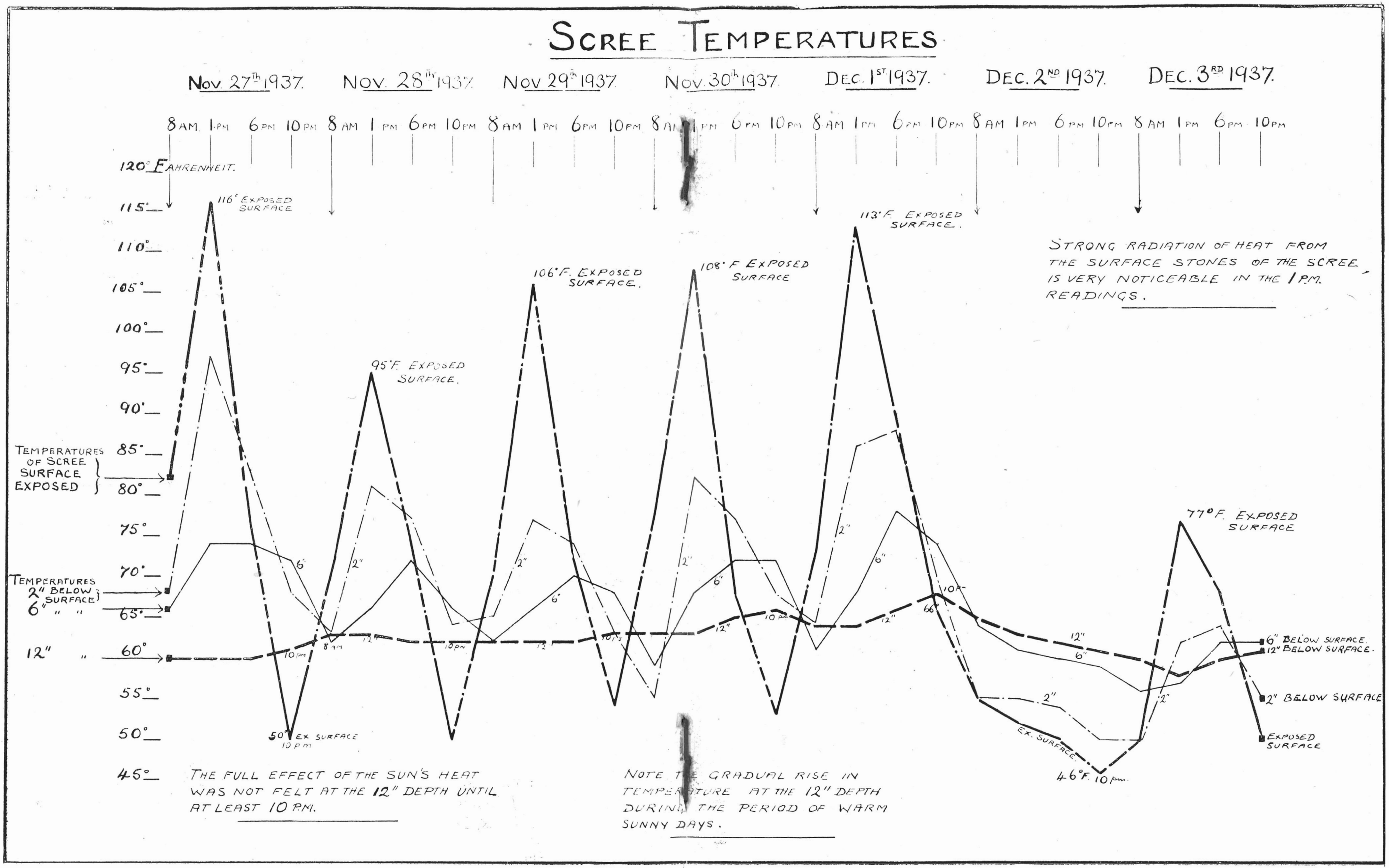
Raoulia mammillaris. V.D. Another of the above group.

Raoulia grandiflora. A small rosette-plant with silvery leaves and conspicuous flowers. Forms large patches.

Raoulia Hectori. D. Forms dense silvery carpets.

Senecio Lyallii. D. A noteworthy plant with long lily-like leaves and yellow flowers.

Wahlenbergia Matthewsii. The deservedly famous "Marlborough Harebell".



SCREE TEMPERATURES
Nov. 27th 1937.
Nov. 28th 1937.
Nov 29th 1937.
Nov 30th 1937.
Dec. 1st 1937.
Dec. 2nd 1937.
Dec. 3rd 1937.
8 AM 1 PM 6 PM 10 PM
120° Fahrenheit.
115°
110°
105°
100°
95°
90°
85°
80°
75°
70°
65°
60°
55°
50°
45°
Temperatures of Scree Surface Exposed
Temperatures 2" below surface
6" " "
12" "
116° Exposed Surface
95°F. Exposed Surface.
106°F. Exposed Surface.
108°F Exposed Surface
113°F. Exposed Surface.
77°F. Exposed Surface
50° Ex surface 10 pm
46°F. 10 pm.
Ex. Surface
6" Below surface.
12" Below surface.
2" Below surface
Exposed surface
Strong radiation of heat from the surface stones of the scree is very noticeable in the 1 P.M. readings.
The full effect of the sun's heat was not felt at the 12" depth until at least 10 P.M.
Note the gradual rise in temperature at the 12" depth during the period of warm sunny days.

As previously mentioned it is hoped to make further additions to the "difficult" and "very difficult" groups, and hungry gaps still exist for such fastidious species as Celmisia Macmahoni, Epilobium purpuratum, Gentiana cerina, Hebe Benthami, Myosotis capitata, Pleurophyllum speciosum, Pleurophyllum criniferum, Ranunculus crithmifolius and Ranunculus paucifolius, to mention only a few.

It is remarkable that many of our shingle-slip species are similar in colour to the stones amongst which they grow; much discussion has centred around this phenomenon but so far no satisfactory explanation regarding this peculiarity has been given. A further colour-peculiarity is that some of these rock-debris species, such as Ranunculus Haastii and R. Scott-Thomsonii, have the leaf-buds and the undersurface of the young leaves coloured purple; this changes into the glaucous hue when the leaves, approaching maturity, become further removed from the scree surface. The purple tint is also present in Cotula atrata, Epilobium purpuratum, E. pycnostachyum, Hebe Haastii and other species. In what manner, if any, this colouration helps the plant is still in doubt; only one fact—that the presence of the purple pigment tends to raise the internal temperature of the leaf—seems to have been definitely established.

TEMPERATURE VARIATION.

Detailed knowledge of the great extremes of temperature experienced by our alpine screes and the plants that inhabit them is apparently wanting in New Zealand. By way of a substitute we submit some readings taken in this artificial scree. It must be remembered, of course, that the degrees of heat and cold met with in a garden scree cannot compare in severity with the great range of temperatures engendered by mountain conditions.

The readings were taken 4 times a day—at 8 a.m., 1 p.m., 6 p.m., and 10 p.m.—for 7 consecutive days. The first 5 days were warm and sunny, a light rain fell for 15 hours on the 6th day, and on the 7th and last of the series the weather was sunny with frequent clouds. The temperatures—in degrees Fahrenheit—were registered by certified thermometers which agreed amongst themselves. The readings were taken on the surface of the scree (exposed and in shade) and at depths of 1in., 2in., 3in., 6in. and 12in. below the surface. For convenience in rapidly tracing the temperature variations at the exposed scree surface and at depths of 2in., 6in., and 12in., the reader may consult Fig. 1. Full details are to be found in Table A.

TABLE A.

Scree Temperatures.

	Nov. 27th, 1937.				Nov. 28th, 1937.			
	8 a.m.	1 p.m.	6 p.m.	10 p.m.	8 a.m.	1 p.m.	6 p.m.	10 p.m.
	deg.	deg.	deg.	deg.	deg.	deg.	deg.	deg.
Scree surface, exposed	82	116	76	50	70	95	74	50
,, in shade	64	77	61	—	60	63	59	—

1in. below surface	68	104	90	59	64	91	81	56
2in. ,, ,,	68	97	83	68	63	81	77	64
3in. ,, ,,	66	90	81	77	59	77	75	68
6in. ,, ,,	66	74	74	72	62	66	72	66
12in. ,, ,,	60	60	60	61	63	63	62	63

	Nov. 29th, 1937.				Nov. 30th, 1937.			
	8 a.m.	1 p.m.	6 p.m.	10 p.m.	8 a.m.	1 p.m.	6 p.m.	10 p.m.
	deg.	deg.	deg.	deg.	deg.	deg.	deg.	deg.
Scree surface, exposed	70	106	72	54	77	108	68	53
,, in shade	61	73	64	—	59	73	59	—
1in. below surface	64	86	73	57	59	92	77	62
2in. ,, ,,	63	77	74	63	55	82	77	68
3in. ,, ,,	59	68	72	68	57	73	73	73
6in. ,, ,,	62	66	70	68	59	68	72	72
12in. ,, ,,	63	63	63	64	63	63	65	66

	Dec. 1st, 1937.				Dec. 2nd, 1937.			
	8 a.m.	1 p.m.	6 p.m.	10 p.m.	8 a.m.	1 p.m.	6 p.m.	10 p.m.
	deg.	deg.	deg.	deg.	deg.	deg.	deg.	deg.
Scree surface, exposed	73	113	90	66	55	52	50	46
,, in shade	59	68	73	—	—	—	—	—
1in. below surface	59	93	86	68	55	55	53	48
2in. ,, ,,	59	86	88	70	55	55	54	50
3in. ,, ,,	59	72	81	72	59	57	55	52
6in. ,, ,,	61	68	78	74	64	61	60	59
12in. ,, ,,	64	64	66	68	65	63	62	61

	Dec. 3rd, 1937.			
	8 a.m.	1 p.m.	6 p.m.	10 p.m.
	deg.	deg.	deg.	deg.
Scree surface, exposed	50	77	68	50
,, ,, in shade	—	64	55	—
1in. below surface	50	63	64	54
2in. ,, ,,	50	62	64	55
3in. ,, ,,	50	56	62	60
6in. ,, ,,	56	57	62	62
12in. ,, ,,	60	58	60	61

The strong radiation of heat from the surface stones of the scree is very noticeable in the 1 p.m. readings, the maximum temperature noted during the duration of the experiment being 116 degs. F. It is of interest to note that the full effect of the sun's heat was not felt at the 12in. depth until at least 10 p.m. and in one case the 8 a.m. temperature at this depth was even higher than the 10 p.m. reading of the night before; the cool rain on the 6th day rapidly reduced the temperature throughout and its influence was felt at the 12in. depth until at least 1 p.m. on the next day. The high readings and rapid fluctuations at the 1in., 2in., and 3in. depths should also be noted, as it is at these depths that seedlings have to establish themselves. The scorching effect on seedlings just emerging through the surface must be very marked at high altitudes, and quite apart from other factors must have a prohibitive effect on the establishment of seedlings of many species.

Readings (Table B) were also taken in cultivated and lawn soils close to the scree and under the same conditions as regards aspect, slope, etc. As was to be expected the scree was warmer at all depths than either the cultivated or lawn soils.

TABLE B.

	6 p.m. Nov. 27th, 1937.			6 p.m. Nov. 30th, 1937.		
	Scree	Cultivated Soil	Lawn Soil	Scree	Cultivated Soil	Lawn Soil
	deg.	deg.	deg.	deg.	deg.	deg.
Surface, exposed	76	61	61	68	57	57
,, in shade	61	59	59	59	55	55
1in. below surface	90	66	66	77	62	62
2in. ,, ,,	83	67	64	77	62	62
3in. ,, ,,	81	67	64	73	62	61
6in. ,, ,,	74	62	60	72	61	60
12in. ,, ,,	60	54	54	65	57	57

The differences occurring between readings at the scree surface and those taken at the same time 6in. above that surface may be seen in Table C.

TABLE C.

Date	Scree surface	6in. above surface	Difference
	deg.	deg.	deg.
Dec. 14th, 1937	102	76	26
15th, ,,	88	64	24
20th, ,,	93	73	20
24th, ,,	115	90	25
Jan. 2nd, 1938	109	84	25
4th, ,,	111	88	23
11th, ,,	98	79	19
12th, ,,	109	84	25
15th, ,,	111	83	28
16th, ,,	115	86	29

SCIENTIFIC VALUE.

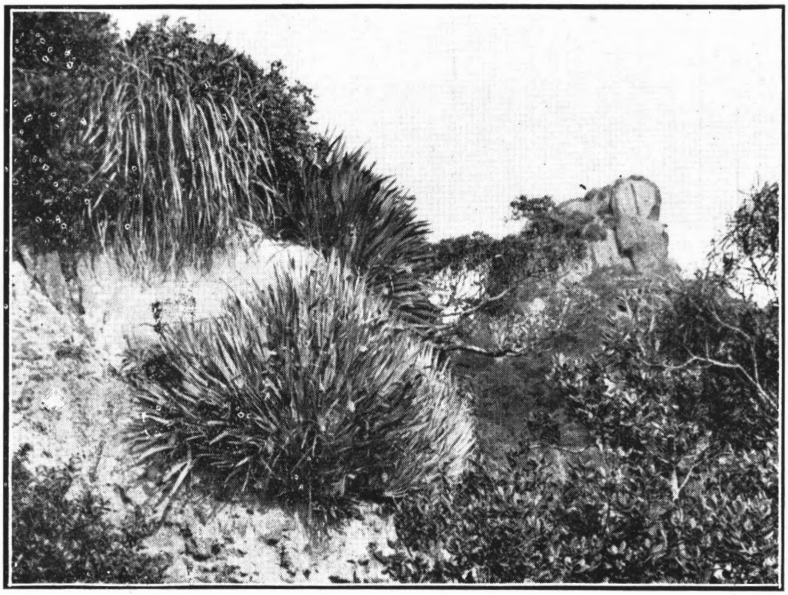
Of recent years taxonomists have shown an increasing appreciation of the value of garden cultures as an aid to plant discrimination. Critical species may be grown side by side and their full development watched. In place of (often imperfectly) dried specimens usually lacking in certain essential parts, one has complete material showing all stages of growth and in good condition for microscopic examination. It can be decided definitely whether a particular form has taxonomic rank or is an unfixed habitual state. Material can also be gathered for hybrid studies. Many of the genera most difficult botanically are among those that have hitherto resisted efforts to grow them, and it is here that the scree has its great value. By its aid the still unsolved question of specific differentiation in Gentiana, Pygmaea, Raoulia and Myosotis—to name a few—can be taken up with assurance of success.

HINTS ON COLLECTING AND PLANTING.

A few notes on methods of collecting and planting may be of interest. Quite equal to the pleasure of seeing a much-desired plant prospering is the enjoyment experienced when collecting it. The locality visited, of course, will depend on the particular species required. Many have quite a wide range in our mountains, others again are restricted to comparatively small areas. To obtain any means hard work, and generally speaking the really rare species cannot be collected without an output of energy commensurate with the rarity of the plant.

Beyond stating that weight must be kept down to a minimum consistent with efficiency, we will not go into the matter of equipment necessary as everyone has his own ideas on this debatable point. Huge lumps of soil around the plants are not necessary, but the roots must be as undamaged as possible and kept damp continuously until planted; well-dampened newspaper is an excellent medium for this purpose. Never collect large specimens; they are difficult to take out of the ground undamaged and are difficult both to carry and establish. Always take notes concerning the situations favoured by each species in its natural home; the placing, for instance, of Ourisia sessilifolia—a lover of damp and shade—under the shadow of a rock is well-nigh essential to success. Exceptions however are met with; who, for instance, would imagine that the alpine bog-plants could flourish in the driest part of scree? Cushion-plants should not be too small when collected. as larger pieces retain the moisture better both in transport and during the critical period of being established in their new home. To prevent damage during transport pack in light, strong boxes. If possible, always collect more than one specimen of each species; individuals can then be tried under different conditions of light and shade, or one can be copiously watered and the other not; in this way the requirements of each species can be rapidly determined without serious loss. It is important to carefully remove all the dead peaty leaves and leaf-sheaths just before planting; this enables the young roots to penetrate into the scree material as soon as possible, and often means the difference between success and failure. It is also necessary that the roots be very firmly packed when planting; short of damaging the plant, this can hardly be overdone. If the roots appear at all dry, a modicum of chopped-up sphagnum mixed with the scree material, will help to conserve moisture. Do not be afraid to water the scree; profuse and frequent watering has been purposely tried without damage to the plants or the scree itself.

In conclusion it is gratifying to note that since the completion of this scree, both the Dunedin and Christchurch Botanic Gardens have added similar additions to their New Zealand sections with great success, and several private enthusiasts are following suit.



Xeronema on Taranga Island.

XERONEMA: AN ISLAND LILY

By L. M. Cranwell and L. B. Moore

At hill-enfolded Ngaio, in the garden where Dr. Cockayne welcomed so many botanists, great and small, a Notospartium blooming mistily in January, told passersby this was no ordinary place. Hebes in every corner, Celmisia and Rubus in the rockery, Corokia and Coprosma berries gay in autumn all flaunted their contradiction of Samuel Butler's scorn of our wild flowers.

Here, as at Otari, every plant had a history, and from each the master sought to learn some share of Nature's secret. To the fire he kindled amongst visitors and readers alike is largely due the increasing use of native plants in gardens throughout the country. How very much more he hoped for can be gathered from "The Cultivation of New Zealand Plants." Among those still neglected but easily grown species whose claims he urged for decorative planting are the Renga lily (Arthropodium cirrhatum) and its dainty relative A. candidum, the dwarf Hibiscus trionum, the giant blue and white forget-me-not (Myosotidium hortense) from Chatham Islands, Colensoa physaloides with inky blue flowers and berries, and that noble lily, Xeronema Callistemon.

The last, Cockayne, in "The Vegetation of New Zealand, published ten years ago, placed in the highest class from a horticultural viewpoint. As it is still so little known we have collected and present here some details that may encourage readers to grow it. Our own field observations and garden experience we have supplemented with information given to us by other growers, foremost amongst whom we must mention Mrs. A. R. Pickmere of Whangarei.

Xeronema forms a comely tussock, as much as five feet high, and sometimes even more in diameter. Its smooth sword leaves are packed in close fans from whose bases rather meagre cord-like roots wander into the dry butts below. When alive the leaves are easily bruised, for all their militant appearance; when dead, the spongy tissues disintegrate and the veins remain, like bundles of pale dry threads, giving rise to the euphonious name for the genus (Xeros, dry; nema, a thread). The flowering stalk thrusts up from the centre of a fan, where it is protected at first by the curiously notched leaf bases. In early October it overtops the leaves, arching out at right angles so that each one of 200 or more coral red flowers is displayed on its upper surface. The slender petals curl down and back about the ovaries, while richly dyed pistils and stamens stand erect, the latter tipped by henna coloured pollen. Each flower is from two to three inches high and a brush may be 14 inches long: we can liken them only to torches when lit by sunshine in the beautiful islands where they grow.

An endemic of New Zealand, this striking plant is found nowhere on the mainland, but on certain islands off the eastern coast of North Auckland. There, its intrinsic beauty is enhanced by association with dark rocks, silvered by lichens, and bright sea and sky that seem forever blue. It was known to Mr. W. Fraser, Harbour Board Engineer at Whangarei (and ranger for these islands) and a very few others (who even called it "Fraser's Lily") before Dr. W. R. B. Oliver officially recorded it after a visit to the Poor Knights with Mr. Fraser in December, 1924. He identified it as belonging to Xeronema supposed to be a monotypic genus confined to the interior mountains of New Caledonia, and he gave it the specific name Callistemon because of the resemblance of the inflorescence to the Australian bottle-brush (Proteaceae).

Then in April, 1933, followed the surprise of its discovery by Mr. A. T. Pycroft on Hen or Taranga Island, some miles to the south. Hen Island has always, of course, seen more of collectors than the northern group, but neither was well known, the Poor Knights being really difficult of access. In both groups Xeronema tends to pick out tops and ledges or columns of rough volcanic rock, some of them hundreds of feet high. There, if seen at all, they must have been confused with Astelia Solanderi or Phormium and thus neglected during any hurried shore reconnaissance. Leonard Cockayne's visit to the Poor Knights in 1906 consisted of only "some two hours and a half . . . a considerable portion of which was occupied by sailing round much of the two main islands" in search of a landing place.

The Maoris, in their long occupation of both groups, must have known this showy plant, especially as it still grows near the wildest pa sites on the Poor Knights. There is a possible clue to it in the name raupo taranga, referring to a mysterious plant thought to occur on some of the northern islands.

On the islands the plant abhors wet or overshaded ground. Given good drainage and sunshine, it cares little about soil. It seems to grow fairly rapidly on cliff-faces, accumulating great masses of leaf-debris so that the clump may fall with its own weight, sometimes into the sea, or more often into dark coastal forest, where it fights a losing battle unless caught in some tree fork. Away from the sun like this, it rarely flowers. Seeds shaken from their capsules germinate only in crevices in the rock: they also need sunshine.

In February, 1937, we found it away from the cliff habitat on the plateau top of Tawhiti Rahi, the Northern Island of the Poor Knights, on porous and very hungry rhyolitic soil that bore only an open scrub of pohutukawa and manuka. Here Xeronema formed a dense undergrowth and seedlings were abundant.

Even a single fan can be established, because the thick leaf bases contain ample food reserves. Protection from excess moisture, burning by sun or frost is also important. The fan is, therefore, safest in a rockery, or even in a pot or tin. Plenty of stones below are more important than soil on top. Fans divide fairly rapidly: for example from two planted in one pot, one in 1924, and one in 1925, a large clump of 40 fans has now developed, producing in 1937, no fewer than six splendid inflorescences.

Early in January, the finely spinous black seeds are shaken from the angular capsules. They may be planted at once. Both sterile sand and an ordinary seed box mixture of sand, loam and leaf-mould, have proved suitable media for germination. Within two months the first small leaves appear and, at the end of a year, a fan of 3 or 4 leaves will be about ½in. high. Measured 5 year olds averaged about 10in., and had each from 3 to 9 fans. In the garden, some years would probably pass before such fans would flower, but on the Poor Knights, we have seen plants, little taller, in flower, especially near seabird-burrows. Their condition suggested senescence, however.

To gardeners who wait not impatiently for seedling daffodils to come to maturity, the time factor will be no great drawback, and a result similar to that in the illustration will repay any waiting.

With occasional additions from parties visiting the islands in the last few years, the plant has become established in a number of New Zealand gardens in Nelson, Wellington, Opotiki, Auckland and Whangarei, where Mrs. Pickmere has had unbroken success both with vegetative propagation and raising from seed. To her we owe the records of growth just quoted. Outside New Zealand we know of plants at Kew and in the late Lord Wakehurst's collections, and we have recently sent seed to the Gothenburg, Stockholm, Oslo and Berlin botanical gardens.

Some day it will be common in rock gardens: but never, we hope, at the expense of those island sanctuaries.

The Evolution of Cultivated Plants

The Banks Lecture For 1938.

By O. H. Frankel, (Geneticist, Wheat Research Institute.)

Two lines of research, working along different lines of approach, in recent years have shed considerable light on the problem of the origin and evolution of cultivated plants. Plant-geographical surveys, chiefly conducted by the Russian Institute of Plant Industry, have analysed the geographical distribution of genera, species, varieties and single characters. Experimental genetics and cytology have investigated the nature of variation in living organisms. We can now perceive, with ever increasing clarity, the ways and means which nature used, in evolving those organisms which are the foundations of our life and our civilization. And both, the plant material discovered in the course of these surveys, and the recent genetic discoveries, have opened up avenues for "directed evolution" under the influence of man.

THE ORIGIN OF CULTIVATED PLANTS.

THE GEOGRAPHICAL METHOD.

Professor N. I. Vavilov, the director of the Institute of Plant Industry, recognised that, in the past, plant-geographical surveys had shed little light on the origin of plants for the reason that crop plants had been treated **in toto,** irrespective of the botanical diversity occurring within each of them. What was required was an exhaustive collection of existing forms, and a subsequent minute description of all their characters. Vavilov then assumed that an area which exhibited the greatest diversity of forms, the "centre of varietal distribution," would be the locality in which the plant had chiefly evolved.

Expeditions were sent out to all parts of the world likely to possess a large diversity of forms of cultivated plants and their wild relatives. More than 300,000 specimens were collected—of wheat alone some 31,000—and most of them were grown in some of the fourteen branch stations of the Institute, depending on the climate required by the crop. A minute detailed observation and description, on systematic, morphological and physiological lines followed. Where necessary and possible, biochemical, genetic, and cytological methods were applied.

The general conclusions can be summarised as follows:—

(1) The existence of "centres of varietal distribution" was definitely established.

(2) These centres, of comparatively small size, are situated in mountainous districts in subtropical and tropical zones.

(3) As was to be expected, these areas are the sites of the most ancient agriculture, and further also the centres of origin of the races of domestic animals.

(4) A vast number of plants—and not only of cultivated plants—have their centre of origin in the same region. Only seven such regions have been established. (South-Western Asia, India, Eastern China, Abyssinia, Mediterranean Countries, Southern Mexico, and Central America, Peru, and Bolivia).

(5) One systematic unit may have originated in more than one of these centres; peas e.g. have originated in Abyssinia and in Eastern Asia.

Vavilov distinguishes between "primary cultures"—the very old cultivated plants which are unknown as weeds, such as wheat, barley, peas, and "secondary cultures," which have evolved from weeds occurring in "primary cultures." For the latter, the "centre of varietal distribution" lies in their "weed area." For rye, e.g., this centre is in South-Western Asia, where it is not cultivated but profusely occurs as a weed in wheat crops.

Many former errors were corrected by this method, such as the theory that cultivated wheat had derived from the wild wheat species, discovered in Syria and Palestine in 1906. It is now well established that the soft wheats originated in South-Western Asia, the hard wheats and their relatives in Abyssinia; and that the wild wheat of Palestine is merely a cast-off, isolated branch of the latter.

The most spectacular results were achieved with potatoes. The first two importations from South America occurred in the 16th Century. One went to Spain, the other, presumably by Sir Francis Drake, from Chile—the story of Sir Walter Raleigh's importation from Virginia is almost certainly a myth—went to England. No further effective importation was made for three hundred years. Salaman, based on genetic work, believes that the characters of all our varieties may have derived from these first two importations. The Russian workers, who collected potatoes in South and Central America found, and brought back with them, an amazing wealth of forms, comprising a vast number of previously quite unknown species and varieties. They exhibited a wealth of characteristics of high economic importance. It is impossible even to indicate their range. Suffice it to state that forms were found with extreme resistance to drought, to frost, to diseases; there was wide variation in chemical constituents, such as Nitrogen; some required no resting period so that three generations can be grown in one year.

The theoretical significance of these surveys is equalled by the practical value of the world collections of crop plants. They have been and will be a store of characters for breeding and combbination work. No serious plant breeder can afford to neglect the possibilities that these collections afford.

THE MECHANISM OF EVOLUTION.

The principle of evolution has been taken for granted throughout this lecture. Evolution pre-supposes variation, and the interpretation of evolution will depend on the interpretation of the biological nature of variation, i.e. of its relation to heredity. The occurrence of variation will be accepted by any horticulturist who is at all a close observer of nature. But it is essential that the biological nature of variation be clearly understood if ideals on the mechanisms of evolution are to be formed.

NON-INHERITED AND INHERITED VARIATION: LAMARCKISM AND DARWINISM.

The development of every living organism is determined by two factors: heredity and environment. Instinctively, we tend to assume that these factors influence each other—that hereditary influence plays a part in determining the individual's characteristics, and that in turn the influence of the environment is passed on to the progeny. We like to think that our own efforts will be of lasting benefit to our children; or that the special treatment awarded to plants or animals should not be lost to their progeny. We thus assume the "inheritance of acquired characters." Lamarck thought that evolution proceeded by means of adaptations to the environment. His pupils, even to our own day, endeavoured to demonstrate the inheritance of such "adaptations," of "acquired characters." It may be stated emphatically that not one single controlled experiment has proved the existence of such a mechanism of inheritance. It has therefore, by the vast majority of biologists,, been relegated to the wastepaper basket of scientific theories.

Darwin's theory of evolution is based on the assumption of a selection among "natural variants." We need not here consider the validity of the principle of the "survival of the fittest," on which Darwin's ideas of selection relied. In the evolution of cultivated plants, unconscious or conscious selection by the cultivator soon took the place of "natural" selection. The principle of selection, however, remains. What is required is the discovery of variants which may serve as raw material for selection. This has been largely achieved by recent research. Where Darwin had to assume variation as an innate characteristic of living matter, we now know a series of mechanisms of variation, which, combined, may be considered as the chief mechanisms of evolution.

(1) GENETIC RE-COMBINATION.—Crosses between related—and inter-fertile—varieties or species supply a more or less wide range of variants in their progeny, depending on the genetic differences between the parents. Hybridisation has played a very large role in bringing together valuable characteristics. It has played a large and important part in evolution and in deliberate breeding. It can however not be the **only** mechanism of evolution, as has been claimed by the late Dr. J. P. Lotsy and the late Dr. L. Cockayne, since it merely serves to re-combine existing genetic plants, but fails to explain their origin.

(2) MUTATION is the sudden alteration of one single genetic unit. Our knowledge of this process has been greatly increased in recent years by observations on the fruit fly (Drosophila melanogaster), on Antirrhinum, Datura, and other plants and animals. Its occurrence can be inferred in some horticultural plants, which have been cultivated for long periods without hybridisation or new importation. Thus the sweet pea (Lathyrus odoratus) was introduced to England from Sicily in 1699. All its numerous characters originated presumably by mutation. E.g. white flowers appeared in 1718, red flowers in 1731, black and scarlet in 1793, etc. Similarly, the Chinese primrose, introduced about 1820, presumably owes its varietal riches to a number of mutations.

Somatic mutations, i.e. mutations in embryonic body-cells which give rise to changed plant sectors, are famiilar to geneticists as well as to horticulturists. Some "bud-sports" no doubt are due to mutations. Thus the branch of nectarine on a peach tree, or a peach branch on a nectarine (the latter observed by Darwin), is due to a somatic mutation. Some bud-sports in apples are no doubt caused by the same phenomenon.

In recent years it has been shown that the rate of mutation—which ordinarily is comparatively low—can be largely increased by certain rays. X-rays and ultra-violet rays have proved highly effective. Quite recently cosmic rays have been shown to have similar effects. These observations are of the greatest importance for future research into the causes of mutations in nature; at the same time they may lead the way to a deliberate induction of mutations.

(3) CHROMOSOME CHANGES.—The mechanism of the distribution of chromosomal material—which is the main physical basis of heredity—is elaborately designed to insure regularity and permanence. At the same time exceptions from the regular behaviour are not infrequent. These have proved the most valuable sources of evolutionary variation. On the whole, when nature establishes a conservative element, it usually provides for mechanisms to break through the barriers of typical behaviour. Thus, evolution of plants has benefited greatly from the irregular processes of the multiplication of chromosome numbers and of the structural changes within the chromosomes.

POLYPLOIDY.—In plants it is a common occurrence to find that related species of the same genus have chromosome numbers, which are multiples of each other. Thus, in wheat we have species with 14, 28, and 42 chromosomes; in potatoes, 24, 36, 48, 60, and 72. In Hebe, a genus almost entirely endemic to New Zealand, there are species with 40, 80, and 120 chromosomes . It is legitimate to assume that polyploidy—which is the name given to this phenomenon—has some evolutionary advantages. Otherwise it would neither be as general, as in fact it is, nor would it be found amongst many of our cultivated plants, where, more often than not, the chromosome numbers of the most highly developed species are multiples of more primitive ones or of wild relatives.

Observation and experiment of the last few years have not only revealed the most important characteristics of polyploidy, but also the mechanisms by which it originates. We now know that polyploid species frequently have a cell size and organ size superior to that of their low-chromosome relatives. They often exhibit a wider range of distribution and variation, both conditioning a greater adaptability to changes in the environment. Finally, as we shall presently see, polyploidy affords the means of combining characters possessed by species—or even genera—which are distantly related, such as for example wheat and twitch (Agropyrum) but which are commonly separated by sterility barriers.

AUTOPOLYPLOIDY.—Polyploidy arises not infrequently by a simple duplication of the chromosome set. This may occur in the formation of sexual cells, or in some embryonic body cell, which then gives rise to a plant sector with twice the number of chromosomes in comparison with the rest of the plant. This has been found to occur in nature, e.g. in the thorn-apple (Datura Stramonium), in the Chinese primrose, etc. The variety "Telham Beauty" of Campanula persicifolia has originated in some such manner. If a young tomato plant is decapitated, a certain proportion of the shoots arising from the callus have doubled chromosome numbers.

The evolutionary value of autopolyploidy is, to start with, low, since the new organism merely possesses all the former hereditary material, but in doubled proportions. Only if mutation now sets in, resulting in a differentiation of the corresponding chromosomes, truly new systematic units are created. This process is inferred in many plant genera. In Hebe, e.g., it has probably given rise to a number of species and varieties, such as some forms of Hebe leiophylla, of Hebe salicifolia, and others.

ALLOPOLYPLOIDY.—Much more important from the evolutionary standpoint is another type of origin of polyploidy, which, when first discovered some ten years ago, was considered a rare exception, but now is held to be of frequent occurrence. On crossing distantly related forms—be it species of the same genus, or two related genera—it is often possible to obtain hybrids which, owing to the large differences between the chromosomes of the parents, remain sterile and therefore, from the standpoint of evolution, valueless. It has, however, been found in an ever increasing number of cases that such sterile hybrids occasionally give rise to a fertile branch; or that an entirely fertile plant is produced. On investigation it was found that the "fertile hybrid" possessed a complete set of both parents side by side; its chromosome number then was as large as that of both parents combined, and twice that of the "sterile hybrid." The oldest known example of that is Primula Kewensis. A sterile hybrid, produced from a cross of Primula floribunda X P. verticillata, suddenly produced a fertile branch. The chromosome number of each of the parents was 18, that of the sterile hybrid also 18, but the fertile sector—and all plants derived from it since for many generations—have 36 chromosomes. Karpechenko, a Russian geneticist, crossed radish and cabbage, each with 18 chromosomes, to produce—among many sterile hybrids with 18—a fertile one with 36 chromosomes . Among flowering plants one may mention a new fertile hybrid in the foxglove, named Digitalis mertonensis, with 112 chromosomes, which originated from a cross D. purpurea X D. ambigua, each with 56 chromosomes. It is not necessary for the parents to have identical chromosome numbers. E.g. Triticum vulgare, our bread wheat, with 42 chromosomes, crossed with rye (14 chromosomes), gave a fertile hybrid with 56 chromosomes.

The essential feature, about these new polyploid hybrid forms, is that they are entirely new systematic units, with all the features of true species—or genera—, with perfect fertility and with characters, which are entirely new. From the large number of instances, which have arisen in controlled experiments, it can be concluded that this mechanism has played a very important part in the evolution of plants. It is inferred, for example, that our bread wheats are such "Allopolyploids," possibly originated from crosses of more primitive wheats with a wild grass, Aegilops. Similarly, the loganberry has presumably originated from a cross between species with smaller chromosome numbers. Allopolyploidy can be inferred in many genera of agricultural and horticultural plants. In Hebe, it is presumably the mechanism which gave rise to such high polyploids as Hebe Traversii.

EXTRA-CHROMOSOMES.—Frequently chromosome numbers are found which are not simple multiples of one basic number. Such extra-chromosomes alter the balance of the set and constitute an important source of variation. In Hebe, apart from the "regular" series of 40, 80, 120, we find species with 42, 84, and 124 chromosomes.

STRUCTURAL CHANGES.—But there are not merely numerical changes which affect the constitution of the chromosome complement: the chromosomes themselves, their linear arrangement, is subject to variation. The genetic units are arranged longitudinally in these thread-shaped bodies. The genetic effect of any alteration in this arrangement is therefore profound. We now have definite proof that such changes occur, and that they have played an enormous role in the differentiation of plants and animals, in short, that they are an important mechanism of evolution. Chromosome sections may be "translocated" to other chromosomes, they may be "inverted," "duplicated." And every such change affects variation in the progeny, fertility with related forms, etc. With polyploidy, structural changes have played a major part in species differentiation.

To summarise, it can be concluded that mutation has played the fundamental role of creating new genetic units; that polyploidy and structural change have facilitated the establishment of major group differentiation; and that hybridisation has played the all-important part of facilitating the recombining, the reshuffling of genetic material.

THE PRODUCTION OF NEW FORMS.

From the foregoing paragraphs it is evident that man, by applying the mechanisms which Nature has used—and no doubt is using—in evolution, tremendous scope can be visualised for the production of new forms of plant breeding.

Plant breeding probably is as old as plant culture. There is more evidence of acute observation on the part of early agriculturists in some regions than there is in others. Vavilov concludes from his comparative observations that "the influence of such great sedentary ancient civilisations as that of China and the Mediterranean on the modification of initial primitive plants was extremely great. Giant forms have been obtained by selection of extreme recessives and mutations, not infrequently surprising in their contrast with wild primitives . . . Varieties of rice, barley, cabbage, fruits and radishes indigenous in China, Japan and the Mediterranean Countries indicate considerable creative work on the part of the plant breeders." On the other hand, plants from India, Afghanistan and South America "do not differ greatly from the corresponding wild forms."

Plant breeding as a planned, professional activity is barely more than a hundred years old. It owes its rapid progress chiefly to two men—Vilmorin, who discovered the principle of the progeny test, and Mendel, who formulated the fundamental laws of inheritance in hybrids.

Since 1900, when Mendel's laws were re-discovered, plant breeding has revolutionised agriculture and economics in many parts of the world. The re-combination of characters, belonging to different forms, in one variety, opened the door for previously undreamed of improvements. Space does not permit even the briefest outline of these achievements. In horticultural plants, much progress had been achieved by amateur breeders long before the scientific basis of plant breeding had been discovered. It is still largely in the hands of the non-scientific seedsman and gardener. Viewing their results—witness of which are the wonderful exhibits at National Flower Shows—one cannot but admire their intuition and power of observation. All the same, the time has come when scientific assistance could be usefully applied. In some Continental Countries, in the United States of America, in Great Britain, great institutions are devoted to the task of improving horticultural plants. Fruits, vegetables, flowering plants come into their orbit. In New Zealand, the creative horticulturist so far has lacked this assistance. One feels that—apart from eatable products of the garden and orchard—our flowers, objects not of subsistence but of beauty, could be brought into the sphere of the scientific breeder. Could not the New Zealand flora stimulate creative breeders to produce some new garden plants?

But it is rather with the thought of the plant breeding of the future than that of the present that I wish to conclude this lecture. In the past, plant breeding has mostly been content with selecting from variations found in Nature, and with hybridisation of related forms. A tremendous scope has been opened up by recent research. World collections of cultivated plants are now being established, facilitating the utilisation of previously unknown forms and characters. Induced mutations are likely to become a source of new variants. So far, they have yielded little practical help—they may prove more useful in asexually propagated crops such as fruits; but this field as yet has hardly been skimmed. Structural re-arrangement of chromosomes, induced polyploidy, hybridisation of distant forms without or with chromosome reduplication, are almost certain in future to produce entirely new crop plants. With very few exceptions, all our cultivated plants are hundreds or thousands of years old—or more. Is it not certain that man, deliberately imitating the methods applied by nature, will produce new plants, in accordance with his modern needs?

Our primary industries, under the attack of manufactured substitutes, will search in an increasing measure for new fields to conquer. The progressive exhaustion of certain mineral products, such as coal and oil, will set us new problems. One may imagine, for example, that New Zealand, instead of the costly hydrogenation of coal for the production of oil, will embark on a policy of producing power spirit. What would be more natural than to utilise the high tropical sun energy on the Pacific Islands? And if the plants producing a maximum of carbohydrates under these conditions at present are not good enough—better ones will have to be made. I strongly feel that, in the tremendous increase of material production of which we are capable, the plant breeder of the future will play an honourable part.

Institute Notes

Congratulations have been conveyed to Mr. J. W. Mawson, Town Planning Officer, Department of Internal Affairs, Wellington, on his election as a Fellow of the Institute of Landscape Architects of England.

Personal: At the April meeting of the Executive, six months leave of absence was granted to Mr. W. S. Mason, who is visiting the United Kingdom, Europe and the United States. Best wishes were extended for a pleasant holiday.

At a meeting of the Examining Board on the 12th April, the resignations of Messrs H. Baillie and W. S. La Trobe were accepted with regret.

With service dating from 1924 and membership of both the Executive Council and its Examining Board, Mr. Baillie has been a stalwart of the Institute.

Mr La Trobe was the representative of the Education Department and his wide experience of examinations and of the subjects included in the Institute's Schemes of Examination, made him an invaluable member.

A welcome was extended, at the same meeting of the Examining Board, to Mr. J. A. McPherson, Christchurch.

Educational: Mr. E. W. Campbell, who received his horticultural training with the Parks and Reserves, Invercargill, has been congratulated on his appointment to the London County Council Parks Department. It is expected that he will leave New Zealand about the middle of June.

Mr. G. H. Huthnance, formerly gardener at "Maranui," New Plymouth, has been congratulated on his appointment as first assistant at Pukekura Park and Brooklands.

The Christchurch Technical College's Syllabus in Horticulture, drawn up by the Canterbury District Council, was recently referred to the Executive by the Examining Board, "with an expression of hearty appreciation of the programme for the year." Mr. McPherson also mentioned the educational outings for students at weekends. "No doubt the Executive will be interested in seeing the nature of the work being carried out by the Canterbury District Council."

Appreciation has been conveyed to the District Council.

National Certificates in Florists' Art have been granted to: Mrs. V. V. Hill, Papatoetoe, Auckland; and Miss M. B. Collings, Wellington.

The Cockayne Gold Medal for the best Diploma Candidate at the 1937 examination has been awarded to Mr. F. J. E. Jollie, who is employed with Duncan and Davies Limited, New Plymouth. Congratulations to the winner are hereby recorded.

National Horticultural Week, 1939. The Joint Committee has tentatively fixed on the week commencing on Sunday, 5th February, 1939, or, failing that, the week commencing on the 29th January. The prospects for a successful National Flower Show appear to be very bright.

Condolence: The Institute has extended its sympathy on the death of E. C. Jack, Secretary of the New Zealand Forestry League and a member of the Institute.

BLEDISLOE (FRUIT) CUP COMPETITION

DEPARTMENT OF AGRICULTURE.
WELLINGTON, C.1.
5th May, 1938.

The Dominion Secretary,
N.Z. Institute of Horticulture,
P.O. Box 1237,
Wellington.

Dear Sir,

THE BLEDISLOE SILVER CHALLENGE CUP COMPETITION.

Wellington, Autumn Show, 27th April, 1938.

The following report on this Competition has been supplied by the Horticulturist, who judged the entries with the assistance of Mr. J. D. R. Carolin, of the Christchurch Office:—

"The Competition, held at the Town Hall by the Wellington Horticultural Society on Wednesday, 27th April, was for two cases of Jonathan Apples, packed and finished as though for export. Restricted to individual registered fruit-exporters. The awards were as follows:—

1. J. R. Laing, Riverside Orchard, Clyde, Otago .. 83%
2. A. C. Maisey, Redwoods Valley, Nelson 77%
3. H. Robinson, Rapaura, Marlborough 74%

There were three entries. All fruit was of the highest class, well packed in export style, and was very attractive. The nine points which divided the winners were chiefly concerned with size, wrapping and height. Optimum size for the variety in accordance with the rules for judging at fruit shows is no doubt a matter which should receive the careful consideration of competitors. Export printed wrappers have a decidedly better appearance than plain papers; but they must lie smooth and firm on the apple when the case is opened up. Good height is of the greatest importance, and was probably the deciding factor in the present competition; a surface that is slightly low or uneven is a serious fault in a competition of this class. To open up well after travelling the fruit must be well fitted and moderately tight.

This handsome trophy is probably the finest award here for competitive commercial packed apples, and is deserving of wide support with a view to encouraging emulation between the different packing shed staffs. If that is done it will then make a very handsome advertisement of the Dominion apple crop each year in a leading centre of population."

Yours faithfully,
J. A. CAMPBELL,
Director of the Horticulture Division.

New Zealand Institute of Horticulture

(INCORPORATED).

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