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*Observations upon the Germination and Growth of Species of
Salvia in the Garden of Thomas Hanbury, Esq., F.L.S.,
at La Mortola, Ventimiglia, Italy.* By PHILIP SEWELL.

(Read 12th June 1890.)

The following observations upon certain of the species of *Salvia* grown in Mr Hanbury's garden at La Mortola, have been made during a period of more than five months, from November 1889 to April 1890. Observations of a similar nature have been made upon species of other genera, with which, in a subsequent paper, it is my wish to make certain comparisons. At present I have contented myself with the attempt to give, in as detailed a manner as appears necessary, facts regarding the germination and early growth of the selected species, which may be of service in adding to our knowledge of life histories of Phanerogams, and in aiding us to elucidate the significance of ordinary morphological features; perhaps, also, they may be useful, when supported by further observations of a like nature, because of their bearing upon horticulture, in connection with the raising of plants from seed.

In the following pages attention is confined to external morphology; for, with such observations as may be made in a garden like Mr Hanbury's, it appears out of place to devote much attention to details of minute anatomy. Should it appear likely that histological data would be of value in explanation of any of the points raised, or have any bearing upon the classification of the species, they may be subsequently attempted.

The notes thus collected have reference especially to the following points:—The species capable of being grown in the open air at La Mortola; the rate and success of germination amongst these; the nature of the nutlets; the appearance, shape, texture, &c., of the cotyledons as also of the plumule and subsequent leaves; the relation of these to the cotyledons; transitions in shape, texture, &c.; general habit, and rough classification based upon early characters; movements of leaves in young plants; possible significance of special

characters indicated by readiness or reluctance to germinate successfully, &c. &c.

The species of *Salvia* sown on the 6th of November 1889 were as follows :—

<i>S. albo-cærulea</i> (see Nich. Gard. Dict.),	Mexico, . .	Perennial.
<i>S. aurita</i> , Thunb.,	Cape,	„
<i>S. canariensis</i> , Linn.,	Canary,	„
<i>S. ceratophylla</i> , Linn.,	Asia Minor, . .	Biennial.
<i>S. confertiflora</i> , Pohl,	Brazil,	Perennial.
<i>S. Dominica</i> , Linn.,	Italy, Syria, . .	„

Also sown under the synonym *S. graveolens*.

<i>S. Forskohlei</i> , Linn.,	Asia Minor, . .	„
<i>S. gesneræflora</i> , Lindl.,	New Granada, .	„
<i>S. Greggii</i> , Gray,	Mexico,	„
<i>S. Heeriana</i> (See Nich. Gard. Dict.),	Peru,	„
<i>S. hispanica</i> , Linn.,	West Indies, . .	Annual.
<i>S. interrupta</i> , Schousb.,	Tangiers,	Perennial.

It is probable that the seeds sown under the name “*S. candelabrum*,” and described in the following notes as *interrupta* “*cand.*,” belong to this species. A mature plant, so named in Mr Hanbury’s collection, is apparently a form of *S. interrupta*, with loose paniced inflorescence, instead of a verticillate inflorescence, which characterises the form of *S. interrupta* sent from Kew.

<i>S. lantanæfolia</i> , Marts. Gal.,	Mexico,	Perennial.
var. <i>limbata</i> .		
<i>S. Linkiana</i> , Roem et Schult.,	Asia Minor, . .	„
<i>S. lyrata</i> , Linn.,	Mexico,	„
<i>S. mexicana</i> , Linn.,	„	„
<i>S. nutans</i> , Linn.,	Asia Minor, . .	„
<i>S. obovata</i> , Elliot,	North America, .	„
<i>S. polystachya</i> , Orteg,	Mexico,	„
<i>S. porphyrata</i> , Dene,	Texas,	„
<i>S. pratensis</i> , Linn.,	Europe,	„

Sown under the names *S. Tenorii* and *S. variegata*, by which they are described in the following notes :—

<i>S. purpurea</i> , Marts. Gal.,	Mexico,	Perennial.
<i>S. runcinata</i> , Linn.,	Cape,	„
<i>S. triangularis</i> , Thunb.,	„	„

In addition, the following species are grown in the open air by Mr Hanbury :—*Salvia argentea*, Linn.; *S. aurea*,

Linn.; *S. Benthellii*, Hort.; *S. bicolor*, Desf.; *S. boliviana*, Planch.; *S. cacaleæfolia*, Dec.; *S. calycina*, Sibth. Sm.; *S. "camphorata";* *S. coccinea*, Linn.; *S. carduacea*; *S. "columnii";* *S. crassifolia*, Desf.; *S. cretica*, Linn.; *S. discolor*, H. B. K.; *S. "dulcis";* *S. farinacea*, Benth.; *S. "fruticosa";* *S. gigantea*, Desf.; *S. glutinosa*, Linn.; *S. Grahami*, Benth.; *S. grandiflora*, Ettling.; *S. ianthina*; *S. involucrata*, Cav.; *S. leonuroides*, Glox.; *S. leucantha*, Cav.; *S. napifolia*, Jacq.; *S. nilotica*, Vahl.; *S. "oxylepis";* *S. paniculata*, Linn.; *S. patens*, Cav.; *S. pseudo-coccinea*, Jacq.; *S. pulchella*, Dec.; *S. purpurea*, Cav.; *S. "Regeli";* *S. "reginæ";* *S. ringens*, Sibth. Sm.; *S. "sanguinea";* *S. semiatrata*, Zuccar; *Salvia splendens*, Sellow; *S. "Verschaffelti";* *S. virgata*, Ait.

The above list is extracted from Mr Hanbury's carefully compiled and remarkably full catalogue of plants grown at La Mortola. Where the specific name is placed in inverted commas, no authority can be found for it in the botanical or horticultural works to which we have access. It is probable also that some are incorrectly named.

The *conditions* under which the seeds were germinated were as nearly as possible identical. They were sown on the same day in 4-inch pots, two species sharing one pot in almost every case. From November 6th to November 28th the pots were placed in a somewhat shaded position in the open air. They then were exposed to the morning sun. Owing to injuries to some of the seedlings from the attacks of slugs, the pots were removed to an equally shaded position, where they were, however, more exposed to drying winds. On the 7th of December they were placed under glass in a cold frame, facing the south. The effect of this protection was, of course, quickly noticeable; but after a few days, during which the frame was kept "close," air was freely admitted throughout the day, the frame serving essentially as a protection against the considerable variations of temperature recorded at nights, when frosts even were registered at rare intervals in certain parts of the garden.

The rainfall was very slight before March. During that month, however, more than half the total average rainfall for the year fell. This average is 25 inches. From October

24th to November 25th rain only fell on one day, and that in slight amount; indeed, the greater number of days during the winter might be described as almost cloudless; only on twenty-three days, from October until the end of April, was rain recorded.

The averages of temperature, taken three times every day, are given for periods of six days; also the maxima and minima for these periods.

Date.	Average of 18 Readings.	Maxima.	Minima.
Nov. 8 to Nov. 15	12·0	16·0	6·5
„ 16 to „ 21	9·0	11·0	6·25
„ 22 to „ 27	9·5	11·75	6·0
„ 28 to Dec. 3	4·75	11·25	2·0
Dec. 4 to „ 9	5·0	8·5	1·0
„ 10 to „ 15	5·5	9·0	2·5
„ 16 to „ 21	6·0	8·5	4·0
„ 22 to „ 27	9·0	11·75	5·0
„ 28 to Jan. 2	7·0	11·0	3·5
Jan. 3 to „ 8	10·0	12·0	7·0
„ 9 to „ 14	10·0	11·75	6·5
„ 15 to „ 20	10·0	11·25	6·5
„ 21 to „ 26	12·5	15·5	7·75
„ 27 to Feb. 1	9·5	14·0	6·0
Feb. 2 to „ 8	8·0	11·0	3·5
„ 9 to „ 14	7·0	10·0	3·5
„ 15 to „ 20	13·0	17·5	6·5
„ 21 to „ 26	12·0	18·5	7·25
„ 27 to March 5	7·5	12·5	1·5
March 6 to „ 11	12·0	16·25	7·5
„ 12 to „ 17	13·25	18·0	13·5
„ 18 to „ 23	13·25	16·5	8·0
„ 24 to „ 29	15·0	17·5	10·0
„ 30 to April 4	17·0	19·0	12·0
April 5 to „ 10	16·25	19·0	11·0
„ 11 to „ 16	15·0	18·5	8·75
„ 17 to „ 22	14·0	17·25	10·0
„ 23 to „ 28	17·0	19·5	11·5

THE NUTLETS.

In the foregoing species, and in the others in Mr Hanbury's collection, there is not much variation in the size, shape, or nature of the surface of the nutlets. A few species (*S. interrupta* and *S. argentea*) may be described as possessing large nutlets, of which the following dimensions may serve as illustration:—

Mm. $3\cdot75 \times 3\cdot3 \times 2\cdot75$ in *S. interrupta*.

But by far the greater number attain an average size as follows :—

Mm. $2\cdot5 \times 1\cdot8 \times 1\cdot65$ in *S. Tenorii*.

Mm. $2\cdot2 \times 1\cdot7 \times 1\cdot6$ in *S. Forskohlei*.

A few amongst those in Mr Hanbury's collection having a more compressed or triquetrous shape, differ somewhat in size ; e.g., *S. gesneræflora*, *S. Greggii*, *S. Heeriana*, *S. mexicana*, *S. sanguinea*, *S. triangularis*.

Mm. $3\cdot2 \times 2\cdot3 \times 1\cdot5$ in *S. Heeriana*.

Mm. $2\cdot75 \times 1\cdot25 \times 1\cdot0$ in *S. sanguinea*.

S. purpurea may be instanced as considerably the smallest seed in the collection.

Mm. $1\cdot75 \times 1\cdot0 \times \cdot75$. in *S. purpurea*.

It will be evident from the preceding dimensions, that the nutlets are not large ; most commonly they have an elongate appearance, inasmuch as they are more or less evidently compressed or even triquetrous.

They are described in the 'Genera Plantarum' of Hooker and Bentham as "*Nuculæ ovoideo-triquetræ vel compressiusculæ, læves*;" and Bentham in Decandolle's 'Prodromus' characterises them as "*Siccæ, glabræ plerumque lævissimæ*." Their specific characters are of little importance, nor in the last-mentioned work are they again referred to in classification, presenting but slight dissimilarity one with another.

The surface of the persistent carpellary coat is, as a rule, slightly roughened or pitted. The greater number (I speak with reference to those in Mr Hanbury's collection) are black or dark-brown in colour ; a few are lighter or very distinctly yellow. *S. canariensis*, *S. dominica*, *S. hispanica* may be instanced as examples of the species with darker coloured nutlets. Those which are lighter coloured are commonly also distinguished by their more elongated shape ; whilst they are somewhat smoother in texture ; e.g., *S. confertiflora*, *S. farinosa*, *S. nutans*, *S. Heeriana*, *S. mexicana*, *S. purpurea*.

In most species the walls of the cells of the outer coat break down into mucilage when they are placed in water or in a damp place, a commonly noticed phenomenon amongst the seeds of many families of plants ; it perhaps serves as a

remarkable adaptation for fixing the nutlet in a position where it shall have a chance of germinating to advantage, or it may afford aid in the actual process of germination by retaining moisture in close proximity to the seed. This production of a thick mucilaginous envelope is very quickly recognised upon the immersion in water of nutlets of a full black colour; it is not long, however, before it appears in those species with lighter coloured or even shining coats to the nutlet.

In *S. interrupta*, which we noticed as possessing the largest and most spherical nutlets of all the species, no production of mucilage can be induced even by immersion in boiling water.

GERMINATION.

The following tables have been drawn up to shew the observed difference in the rates and results of germination of the various species.

In some there was evidently a second period of germination, when conditions were more favourable, after the pots had been placed in the frame. For the most successfully germinated species we have added the total percentage of individuals observed, but it is not probable that data on this point are absolutely correct.

It is natural for us to enquire whether we can account in any way for these observed differences, either by reference to the countries to which the plants are native, or by reference to their peculiar habitats, or from some other cause evident in the nutlets themselves.

We must refer to the list previously given for information regarding the countries of which the various species are natives, but we do not think that much can be learnt from reference to the native country without much more detailed information as to the exact habitats preferred by the species. Unfortunately, such information is not forthcoming in many cases. We believe, however, that definite morphological characters may be associated with successful or unsuccessful germination under different conditions of treatment, and these morphological characters have, doubtless, direct relationship to the plant's special habitat.

We shall later refer in more detail to the seeming relation between general habit, together with the nature of the young leaves, to the percentages of successes and failures to produce healthy plants; at present we may point out some more evident facts regarding distribution and germination, which are not, however, of much value apparently.

Thus, the first four species to germinate are natives of the South of Europe, Asia Minor, or the Canaries, where, doubtless, the conditions of climate in the open air are very similar to those at La Mortola. Again, the species which have not germinated at all are from Brazil, New Granada, and (actually!) Italy. The fact that *S. Dominica* (grown under that name, and in another pot under the synonym *S. graveolens*) should not have germinated, although the experiment has been made in the country where the plant is indigenous, is just one of those facts which shew us of how little value it may be to judge as to a plant's requirements, without reference to exact habitat or to the nature of the plant itself. It is, of course, possible that the seed of this species has been faulty, but more likely the conditions under which it was attempted to germinate it have been different from those of its habitat; perhaps an overplus of watering may afford an explanation. We imagine also that we have detected a connection between the nature of the coat of the nutlet and the amount of success in germination. It appears as if those of smaller size, with shining or smoother coats, had germinated less readily; certainly less successfully, as measured by the total percentage out of the fifty or one hundred seeds sown in each case.

This, which we put forward as little else than a speculation at present, does not seem so unnatural to us when we think of the vastly different habitats—the margin of a lake or the slope of a hill-side, where the species naturally scatter their seeds.

Yet we may point out that, although in the same species when germinated under the different synonyms of *S. Tenorii* and *S. variegata*, there was close agreement in response to the environment in which they were placed for germination, yet in the two forms of *S. interrupta* there was a difference of forty days in the time of germination.

Similarly, confining our attention to the percentages which

germinated (as far as the attacks of slugs at an early period would allow us to determine with exactitude), whilst in the two forms of *S. interrupta* there was close agreement in the totals, in *S. pratensis* the form *S. variegata* only produced 20 per cent., whilst *S. Tenorii* produced 55 per cent.

So great differences within the limits of what are single species (again with the proviso that the seeds as supplied to us are correctly named in these cases) does not warrant the forming of many inferences.

The following tables show dates of germination, total percentages successfully germinated, dates upon which maximum number of individuals was first observed in each species:—

I. The following germinated before *ten days* had elapsed after the date upon which the seeds were sown:—

	Total.	Max. observed on
<i>S. Forskohlei</i> ,	80 per cent.	16th day.
<i>S. canariensis</i> ,	30 „	16th „
<i>S. pratensis</i> (<i>S. Tenorii</i>),	55 „	16th „

II. The following germinated on dates between the 10th and 15th days:—

	Total.	Max. observed on
<i>S. pratensis</i> (<i>S. variegata</i>),	20 per cent.	60th day ?
<i>S. hispanica</i> ,	45 „	32nd „
<i>S. aurita</i> ,	65 „	45th „
<i>S. ceratophylla</i> ,	4 „	30th „
<i>S. Heeriana</i> ,	20 „	50th „
<i>S. interrupta</i> (<i>Kew</i>),	20 „	50th „
<i>S. obovata</i> ,	8 „	16th „

III. The following germinated between the 30th and 40th days:—

	Total.	Max. observed on
<i>S. purpurea</i> ,	2 per cent.	32nd day.
<i>S. triangularis</i> ,	45 „	50th „ ?
<i>S. porphyratea</i> ,	55 „	75th „ ?

IV. The following between the 50th and 60th days:—

	Total.	Max. observed on
<i>S. interrupta</i> ? (“ <i>S. candelabra</i> ”),	25 per cent.	50th day. ?
<i>S. runcinata</i> ,	20 „	70th „
<i>S. mexicana</i> ,	4 „	70th „
<i>S. lyrata</i> ,	30 „	50th „

V. The following after the 70th day :—

	Total.	Max. observed on
<i>S. albo-cœrulea</i> ,	2 per cent.	70th day.

VI. A few seeds germinated in each of the following at very different dates, but the seedlings have failed to develop :—

S. Dominica.

S. Greggii.

S. nutans.

S. Linkiana.

VII. The following had shown no signs of germination by the 130th day :—

S. confertiflora.

S. gesneræflora.

S. graveolens.

We may note, in conclusion of this part of our subject, that out of the twenty-five species sown only six produce more than 40 per cent. of seedlings, only half of the total number produce 25 per cent., whilst more than a quarter produce a smaller percentage, of which only one or two individuals survive in most cases. In three species no germination has been observed.

THE COTYLEDONS.

Just as we have observed but little difference in the sizes of the nutlets, so among these species of *Salvia* there was not much variation in the size of the cotyledons at the time when they first made their appearance above the soil.

The seeds being exalbuminous, the size of the cotyledons, as they emerge from the coats of the nutlet, has strict dependence on the character of the nutlet; they are longer or broader, according as we have noticed the seed to be longer or broader; thus they entirely fill the seed, having only towards their base a minute radicle and plumule, which together lie sunk in a tiny depression. The coats of the nutlet are ruptured at the base by the convergence of the radicle; they split as the cotyledons enlarge, and are thrown off when these are below the soil. When the free cotyledons make their appearance through the soil, pushed up by the straightening of the somewhat stout hypocotyl, the apex of

the cotyledons is uppermost; they are perhaps three times as long and three times as broad as they were when enclosed within the seed. Thus the actual measurements of *S. Forskohlei*, when first noticed above the soil, were 3 mm. $\times$ 3 mm.; nor were there other species noticed that differed much from these dimensions, *S. interrupta*, the largest of the nutlets, having perhaps dimensions 4 m. $\times$ 4 m.

All the species were characterised by thick, almost fleshy, cotyledons, which remain appressed only for one or two days, as a rule, after emergence through the soil; in all the colour is light, and they are generally smooth, in only a very few instances appearing pubescent on the upper or under surfaces.

In the case of *S. interrupta*, which we must again notice, on account of other peculiarities, the cotyledons remained appressed for a number of days. Commonly, in favourable circumstances, the cotyledons spread their upper surfaces to the light quickly, after which a considerable increase in size and shape, and ultimately the development of petioles, may be noticed.

The ordinary phenomena of the growth to be observed in these species of *Salvia* are as follows:—

After the cotyledons are no longer in contact with their upper surfaces, they lie at first inclined to one another, subsequently in the same plane, or again inclined according to their position with regard to the amount of light to which they are exposed. They are commonly symmetrically opposed the one to the other; but in exceptional circumstances one may grow nearer to the other, if thereby it gains advantage from a better exposure to light. This ability in the cotyledon to place itself so that it is exposed to a greater amount of light is dependent mostly upon the growth of the cells in the petioles, but also in some species upon growth or variation in the turgescence of cells situate about the point of union of petiole and lamina; alteration at this point allows the lamina to lie in the same plane as the petiole, or to be at a greater or less angle to it. This variation in the inclination of the lamina, as distinct from the petiole, was noticeable most distinctly in those species where there is an abrupt transition from petiole to lamina.

The maximum increase in the size of the lamina occurs

within the first eight to ten days after the expansion of the cotyledons; it is not, however, the case that all alteration in size or shape takes place within that limit of time. In some cases, even after forty or fifty days, a slight change in shape was noticeable, by which the cotyledons of every species assumed more or less an emarginate character. This might be due to enlargement of cells as distinguished from actual increase in the number of cells composing the lamina; certainly it was a character assumed at a later time apparently than when the growth of the lamina or petiole was most apparent.

The growth of the petiole was not noticeable for some days after the time when the laminae had spread themselves out in a more or less horizontal position. The petioles developed simultaneously with the development of the plumule, which in most cases was not to be seen, unless with the aid of the microscope, until ten to fifteen days had elapsed after the cotyledons first appeared above the soil.

The time which elapsed between the first appearance of cotyledons and the first appearance of the plumule might, however, vary considerably, according to the time of year and the conditions under which the seeds were germinated. Where such facts have been observed they have been inserted, more with a view to future comparison than on account of any suggestions which they afford at present.

The cotyledons persisted in most species until the leaves subsequently developed cut off their supply of light, or pressed them upon the surface of the ground. Where the subsequent leaves and the cotyledons were very evidently petioled, they persisted for a longer period than was otherwise the case.

The following table allows of comparison as to the sizes attained by the cotyledons of various of the species when they were mature; the amount of spread from the top of one cotyledon to the top of the other is also indicated in most cases at its maximum, but as much variation was observed in the latter measurements, we shall refer to them subsequently:—

	Maximum Length of Petiole and Lamina in Single Cotyledon.		Max. Breadth of Single Cotyledon.	Area of Lamina (approx).	Max. Measure- ment from Tip to Tip of Pair of Cotyledons.
	Petiole. mm.	Lamina. mm.	mm.	Sq. mm.	mm.
<i>S. albo-cœrulea</i> .	4 +	6	7	42	19
<i>S. canariensis</i> .	7 +	6	6	36	26
<i>S. ceratophylla</i> .	4 +	5	5	25	22
<i>S. Forskœhlei</i> . .	5 +	7	5	35	25
<i>S. Heeriana</i> . . .	8 +	6	6	36	26
<i>S. hispanica</i> . . .	3 +	5	4	20	13
<i>S. interrupta</i> , var. "Cand."	18 +	9	11	99	38
<i>S. interrupta</i> (Kew)	15 +	10	14	140	52
<i>S. lyrata</i>	6 -	8	9	72	...
<i>S. obovata</i> . . .	5 +	7	8	56	...
<i>S. porphyrata</i> .	10 +	9	12	108	...
<i>S. runcinata</i> . .	6 +	6	7	42	22
<i>S. Tenorii</i> . . .	5 +	5	7	35	25
<i>S. triangularis</i> .	7 +	8	9	70	28
<i>S. variegata</i> . .	2 +	6	6	36	18

Perhaps the fairest comparison which may be made among the species from the above data is that given by the approximate areas of the laminae. As has been already pointed out, the inclination of the cotyledons, one to another, may vary very considerably at different times. Hence the amount of spread from tip to tip gives but little information as to the sizes attained by them. The specimens measured have invariably been the largest among the batch of seedlings; in a few cases the results of competition with the other seedlings of the batch has been to produce cotyledons of considerably different dimensions from the above. Such a case was observed in *S. Tenorii*, where the petiole of one individual was 8 mm., and the lamina 4×4 mm.; whilst in another the petiole was 4 mm., the lamina 7×5 . Again, in *S. porphyrata* the growth of the cotyledons was considerably increased after the growth of the first pair of ordinary leaves. Thus, whilst on the 58th day after germination, the lamina is 6×6 mm. and the petiole 3 mm., on the 110th day the dimensions of the lamina are 9×8 mm., whilst the petiole has increased to 6 mm. In general it has been attempted to give the dimensions of the largest healthily-grown (and not "drawn") seedlings. We may consider in a more detailed manner such further observations as we have made regarding the shape and texture of the

cotyledons, and as to those features which may be considered as especially characteristic of particular species.

As may be seen by reference to the foregoing table, the shape of the lamina of the cotyledon is approximately rounded, but generally somewhat broader than long. In some species there is a slightly emarginate apex, a feature more or less shown by all when mature.

The base of the lamina alters considerably in most of the species as they develop. In some species it is a transition from a slightly cordate base to one which merges gradually into the petiole. In most the transition is such as may be observed in the leaves subsequently developed, and is towards a form with a broader base at a later period. *S. obovata* and *S. variegata*, *S. Forskohlei* and *S. Tenorii* were decidedly cordate when the cotyledons expanded; *S. Heeriana* and *S. runcinata* retained abruptly straight bases; *S. interrupta* shewed a peculiar thickening of the base of the lamina, causing a slight projection beyond the edge from the under surface.

These variations in shape of the cotyledon have probably reference to the variations in shape of the cauline leaves, an abrupt base or an attenuate apex, a long or a short petiole, being frequently seen both in cotyledons, and, at least, in some of the earlier subsequent leaves in certain of the species.

More distinct than such variations in shape are the few exceptions to the ordinary smooth type of cotyledons. *S. interrupta*, in its two forms, possesses almost hirsute cotyledons, in contrast to all the other species, just as it shewed a larger nutlet and one without a mucilaginous development in contrast with the rest of the species observed. The cotyledons of *S. interrupta* possess long petioles, and have much more the appearance of ordinary leaves than have most, having an almost recognisable midrib or line of venation through the fleshy lamina, in continuation with the petiole. The cotyledons persisted in this species for a longer time than was commonly the case amongst the others.

The cotyledons of *S. triangularis* and *S. Heeriana* also appeared somewhat pubescent, a fact which shows us again that characters distinguishing the mature plant make their appearance in the cotyledon, inasmuch as when mature these are the most pubescent of the species here considered.

The margins and under surface of many species were provided with minute, perhaps glandular, hairs, the purpose of which is apparently to prevent the passage of water between the expanding cotyledons, or to retain, as was actually observed, a film of air between the delicate cells of the young cotyledons and the moisture from the ground where they had germinated. Such hairs were also found upon the hypocotyls, and much more conspicuously and invariably upon the petioles of the cotyledons, where they often attained to a very considerable size. Their occurrence upon the petioles must assuredly be regarded in the light of a protection for the young leaves of the plumule, over which they met when the petioles were nearly approximated in the youngest stages of plumular development. In *S. lyrata* these hairs gave a markedly hirsute appearance to the petioles, although the lamina was ordinarily smooth.

As to the development of the petioles, we may further remark that the length of these in the greater number of instances did not exceed that of the laminae. A glance at the foregoing table will show that they do not often exceed the length of the lamina. They commence to grow only after the laminae have been visible for a considerable time, and, we presume, may vary very much in length, according as they are exposed to a greater or less amount of light.

In some cases a great difference was to be observed in the lengths of the two petioles in one individual, phenomena generally, but not always, to be accounted for by the position in which the seedling was growing. As a rule, the petioles are stout rather than attenuate. They attain their greatest length in those species in which the subsequent leaves have the longest petioles.

The growth of the hypocotyl is hardly evident in any of the species we have here considered. As will be observed later, the general habit of the greater number of these species is an appressed one, hence it is of *S. Heeriana* only that we have any note upon the development of the hypocotyl. Of this species, on the 75th day after germination we have noted, a "distinctive feature is, that whilst the seedlings are not crowded together, nor in a position where they are liable to be 'drawn up,' they have longer hypocotyls than any of

the species in which 'a drawn' condition is not evident." Even in *S. Heeriana* the hypocotyl was only 11 mm. long. The great development of internodes which, at an early stage characterises this species among those which have germinated successfully, is sufficient explanation of the presence of the hypocotyl.

THE DEVELOPMENT OF THE PLUMULE.

The plumule in all the species of *Salvia* which we have examined is exceedingly small when the cotyledons expand above the surface of the soil. In *S. Forskohlei* and *S. Tenorii*, for instance, it could not be seen without the removal of a petiole and cotyledon, nor did it exceed 0.5 mm. until a few days after the cotyledons had emerged.

In the above-mentioned species it was not until the 16th day after the seed had germinated that the first two leaves of the young plant could be seen distinctly. Sixteen days later, in these two instances, the extreme measurement from tip to tip of these first leaves was only 4 mm. But the growth of the plumule in many species which germinated later was much more accelerated by the, we presume, more favourable conditions of temperature under glass. Nevertheless, among species which developed at the same time—*e.g.*, the two species we have instanced and *S. canariensis*—there was observable a very different rate of growth under the same conditions. By the 30th day the plumule of *S. canariensis* was more than twice the size it was in the other two species. At a later stage the mature leaves were much longer in this species. The growth of *S. triangularis* may be instanced, in which there was produced a first pair of leaves of the same size as those of *S. ceratophylla*, in half the time taken by the latter. In this case, however, the subsequent development was different, inasmuch as *S. ceratophylla* rushed ahead very quickly.

The sizes attained by the first leaves seemed to have no relation, either when mature or at the earlier period of their growth, to the sizes attained by the cotyledons.

Instances of this were frequent, where individuals of one species, with smaller cotyledons, would possess larger first

and second leaves than others which at the first appeared the most vigorous by reason of their larger cotyledons.

This was noticed both in *S. Forskohlei*, where the individuals were crowded together, and in *S. interrupta*, where they were grown quite free from one another.

The first appearance of the ordinary leaves was as a wrinkled semi-equant pair, having a greatest length in some species in a vertical direction, and in others (which ultimately showed a more lowly habit) in a horizontal direction.

Although the leaves were thus produced in pairs, it was almost always evident in early stages that one was grown more favourably than the other, either by reason of its position with relation to light, or from an actually earlier development. Just as one leaf in a pair seemed, at the first, to have the pre-eminence, so it was not long before the much greater growth in size of the later pairs made itself evident. A difference in size between the first and succeeding pairs was less marked in species with a considerable development of internodes.

The shape and texture of these early leaves differed considerably within the limits of single species, to facts under which head we may now refer.

CHANGE OF SHAPE IN LEAVES OF THE SAME SPECIES.

In the detailed tables which we shall give of the dimensions of leaves, as observed at different dates and when mature, we shall be able to make rough comparisons as to such changes in shape as are brought about by increase in breadth in proportion to length, or *vice versa*; at present we may notice a few of the more general changes in shape.

In many species an increase in breadth towards the base of the lamina in the later leaves was clearly marked. Thus, in *S. Forskohlei* and *S. Tenorii* the first and second leaves which were produced were distinctly spatulate or obovate. Subsequent leaves were more oblong, some were oblong-lanceolate, due to the crowded manner in which the individuals were grown together, whilst others grown in a less crowded position produced broader and less lanceolate leaves.

The leaves of *S. ceratophylla*, which in many respects closely resembled the above in the earliest stages of the plant's development, although increasing very conspicuously in length, also became relatively broader; they change from lanceolate to ovate, the petioles subsequently elongating so as to free the lower earlier leaves from an overdue shading by the coarser uppermost ones. The leaves of *S. variegata* similarly pass through the same change, from an approximately spatulate to a more oblong-lanceolate shape, although it does not possess petioles in its earliest leaves.

A very distinct form of leaf, such as that of *S. canariensis*, is in general outline much the same in all the youngest leaves. It is some time before leaves are developed which show an evidently hastate base, although this is a characteristic feature of the leaves of the fully-developed plant.

Similarly, the first leaves in *S. hispanica* and *S. aurita* are more rotund than are the typical leaves; it is not until the third or fourth leaf that any indication is given of the lyrate or lobed character of the leaves of the fully-developed plant.

The pinnate leaves of the mature plant in *S. interrupta* are not produced in the pairs immediately succeeding the cotyledons. In some seedlings the third or fourth leaf showed a minute leaflet situate on the petiole at some little distance from the terminal leaflet. Also, in a note taken of this species on the 120th day, we have remarked that the lamina of the first leaf of the plumule resembles the cotyledon in that it is abruptly united to its petiole; the lamina and petiole of succeeding leaves are less bluntly united. The fifth and sixth leaves have each a pair of leaflets 6 mm. from the terminal leaflet and 15 mm. across on the above date.

Comparison may be made between the dimensions previously given of the leaves of *S. interrupta* and those taken on the 175th day, when fourteen leaves had been developed. The dimensions of the leaves of a mature plant are also given:—

175th day—Total length, . . . 100 mm.; lamina, 55 × 35.
 „ Leaf from mature plant, 250 „ lamina, 110 × 60.

It is perhaps hardly worth while to notice in any detail the changes in size to be observed between the leaves of an

early date and those of the more mature plant. Regarding changes in shape, perhaps no general statement can be made, except that it is at times a change from a simple leaf to a compound one—that a simple leaf always precedes a lobed or finely-divided one. This is seen not only in the young plants as they develop from seed, but it is shown in almost every mature plant on the different axes, where the simplest forms of leaves are those produced earliest; that is, those outermost in the bud.

Examples come to mind of the change that may be noticed in countless Leguminosæ, in *Scabiosa*, in *Cineraria maritima*, and others.

Perhaps, more distinct than such alteration in shape is the very evident alteration in the nature of the surface, especially in those species which are of appressed habit. This change, in general, is one from an almost characterless to a specialised leaf, from one without more than a light-coloured depression for midrib, with a few large veins given off on each side, to a leaf which is rugose, with a closely-netted venation and coarse veins on its under surface, and a wavy, crenate, or serrate leaf margin.

The features of most marked description of which we must now take notice are those which give to the plant its *general habit*; by this we shall roughly classify our species, calling attention to certain correlated or, at least, accompanying characters.

The *roots* of the species we have examined are all very much alike, in most species the primary root thickening very evidently, and from this small, wiry, secondary roots are given off in the upper part, and longer, somewhat more vigorous fibrous roots from lower down. In some species, as *S. Forskohlei*, the upper part of the primary root is very much thickened, giving the appearance of a tap root at first; in general it is wiry and branched at a distance of sixty to eighty mm. from the "crown."

S. canariensis apparently formed much less vigorous roots in comparison with the size of its leaves than any other species; the secondary roots were more wiry than was observed in other species. *S. lyrata* and *S. obovata* possessed roots in which the primary root was not so evidently thickened, others of almost equal size arising from its upper

TABLE, allowing Comparison as to Rate of Growth, as shown by the *Number and Sizes of Leaves produced by*
130th and 175th days.

SPECIES.	Number of Seedlings in each Pot, Competition indicated by a + sign.	Deduct Number of Days before Species Germinated.	Number of Leaves protruding, omitting those of a size under 2 mm., measured in Pair from Tip to Tip.	Size in mm. of First Leaf, Total Length, Length and Breadth of Lamina being given.	Size in mm. of Largest Leaf Produced.		Number of Leaves produced by 175th Day. [After having been planted out.]	Size in mm. of Largest Leaf produced by 175th Day.	
					Total.	Lamina.		Total.	Lamina.
<i>S. carabophylla</i> . .	2	16	12	35 25 × 10	95	85 × 35	18 (also buds and flowering axis)	140	95 × 55
<i>S. Forskolei</i> . .	25 +	6	10	30 20 × 10	50	? × 18	10-12	50	? × 18
<i>S. Tenorii</i> . .	16 +	8	10	30 20 × 10	62	47 × 20	10-12	62	47 × 20
<i>S. Heertana</i> . .	7	16	10	(the largest leaf)	55	37 × 26	12 (buds very small still)	94	64 × 45
<i>S. interrupta</i> , "cand."	3	52	8	(the largest leaf)	55	35 × 18	12	74	40 × 22
<i>S. interrupta</i> . .	4	16	6	32 14 × 12	77	45 × 31	14	100	55 × 35 (terminal leaflet)
<i>S. hispanica</i> . .	2	15	8	24 17 × 12	25	19 × 16	10	42	32 × 23
<i>S. aurita</i> . .	16 +	16	8	36 20 × 20	48	30 × 25	12	55	35 × 25
<i>S. lyrata</i> . .	14 +	50	6	(the largest leaf)	33	26 × 15	8	60	45 × 30
<i>S. elovata</i> . .	4	16	6	(the largest leaf)	15	13 × 9	8	37	32 × 20
<i>S. variegata</i> . .	7	12 [? 40]	6	... 15 × 6	...	17 × 8	...	...	...
<i>S. canariensis</i> . .	11 +	8	8	20 11 × 8	75	44 × 16	12	80	50 × 27
<i>S. triangularis</i> . .	18 +	38	4	(the largest leaf)	30	18 × 16	8	56	30 × 21
<i>S. porphyratea</i> . .	14	40	4	(the largest leaf)	31	12 × 12	6	34	18 × 16
<i>S. lantanefolia</i> . .	1	16 [? 50]	2	(the largest leaf)	...	15 × 11	8	20	17 × 11
				(3rd and 4th only just showing)					

part. A few secondary roots of a stouter and more vigorous nature were produced in many of the larger growing species, which may be compared in appearance with runners, but which had not developed sufficiently to allow a definite opinion being formed as to their nature.

GENERAL HABIT OF VARIOUS SEEDLINGS.

A most evident distinction may be drawn amongst such a collection of young seedlings as we have undertaken to examine, based upon their general habit.

Of the several species which produced healthy seedlings before the 120th day, the following may be characterised as of a "squat" habit, *i.e.*, they produced rosettes of radical leaves, which, as they matured, assumed a horizontal position, oftenest being appressed closely to the ground :—

TABLE A.

	"Drawn up."	Day when Germinated.	120th Day. Height to Apex of Largest Leaf.
<i>S. ceratophylla</i> . . .		16	5 mm.
<i>S. Forskohlei</i>	+	6	...
<i>S. Tenorii</i>	+	8	...
<i>S. lantanæfolia</i> . . .		16 [? 50]	3 "
<i>S. lyrata</i>	+	50	6 "
<i>S. obovata</i>		16	3 "
<i>S. polystachya</i> . . .		18	4 "
<i>S. variegata</i>		12 [? 4]	3 "

Opposed to these were the following, in which internodes were developed to a greater or less extent :—

TABLE B.

	"Drawn up."	120th Day.	120th Day.
<i>S. aurita</i>	+		23 mm.
<i>S. candelabrum</i> . . .		52	63 "
<i>S. hispanica</i>		15	14 "
<i>S. mexicana</i>		50	...
<i>S. triangularis</i> . . .	+	38	21 "

The following were not so evidently to be distinguished as of one class or the other. They may be considered as an

intermediate group, in which, although the species possess no evident internodes, yet the leaves are long, petioled and erect :—

TABLE C.

	Day.	120th Day. Height to Apex of most erect Leaf.
<i>S. canariensis</i>	8	75 mm.
<i>S. interrupta</i>	16	83 „
<i>S. porphyrata</i>	40	26 „

That a better comparison may be made as to this difference in habit, we have given the heights in millimetres, as measured on the 130th day, to the tip of the most erect leaf in every case. Where drawn out because of competition among the individuals, we have placed a mark (+) after the name; and in order that comparison may be clearer, we have inserted the number of the days which elapsed till each species germinated.

The difference in height is very apparent between the species enumerated in Table A. and those of Table B. Seedlings of *S. Forskohlei* and of *S. Tenorii*, growing near the edge of those which were crowded together in the pots, possessed leaves as closely appressed to the surface as was the case in *S. ceratophylla*. It was otherwise with the individuals of these species which were crowded together.

Although *S. interrupta* and *S. canariensis* (on Table C.) appear to have the most conspicuously erect habit of all the species, their excessive height is due to the greater development of their leaves and leaf-stalks, the internodes in *S. interrupta* developing somewhat later. Often, indeed, where internodes were developed, the leaves were borne almost horizontally, and on this account the measurement of "heights" is fallacious.

Intimately associated with this development of internodes was the *development of buds* in the axils of the leaves, and even in the axils of the cotyledons of certain species, at an early stage of the plant's growth.

In *S. aurita*, although the second pair of leaves of the primary axis were but 6 mm. in length, these were conspicuous in the axils of the cotyledons on the 50th

day of germination ; whilst, on the 130th day after the seeds were sown, when the elongated character was particularly noted, these axillary buds had developed leaves of some size as compared with the leaves of the primary axis.

In *S. Heeriana*, similarly, the leaves of the secondary buds were well developed on the 130th day after the seeds were sown, or the 114th after the germination of the species was recorded.

In *S. triangularis* secondary buds were developed in all the axils, some shewing two pairs of leaves well developed.

In *S. hispanica* they were evident, but perhaps their appearance in *S. interrupta* was the most remarkable. Hardly more than ten days previously we had noticed this species as of the intermediate class, C. ; whilst on the 130th day, or the 114th after germination, the last node was 20 mm. from the bases of the petioles of the cotyledons, whilst buds appeared in the axils of the first and second leaves, as well as in the axils of the cotyledons.

Clearly the development of internodes, so conspicuously related to the appearance of secondary buds, had a certain advantage in raising the leaves of the primary axis out of the way of the secondary buds so as not to interfere with their growth.

The truest comparison as to the total amount of growth within the same limit of time and under the same conditions is, however, best afforded by the data previously given as to the sizes of the leaves. It is not, however, a profitable thing to make here such comparisons at any length. The conditions were somewhat different, owing to the crowding of the individuals together ; but it appeared as if those of "squat" habit (Table A.) grew most quickly, producing the largest amount of leaf surface within the given time. The biennial, *S. ceratophylla*, developing horizontally-placed leaves of an exceedingly coarse nature, was of all the most remarkable, on account of the vigorous rate at which it grew. The annual, *S. hispanica*, shewed no such zealous haste to develop.

It might be suggested that the rosette of horizontal or cauline leaves is a saving of time and perhaps material to the plant, but this is hypothetical. Some, or most, of the species here considered shewed evidently an amount of

natural difference in their rate of growth, just as they did in their morphological features.

Did we know more as to the exact habitats in which these species are found naturally, we might certainly with more justice attempt to understand the peculiar distinctions of habit between one and another; at present we must content ourselves with calling attention to certain other distinctions which were very evidently correlated to these of general habit.

COLOUR AND HAIRINESS OF LEAVES CORRELATED TO HABIT.

When we had grouped by themselves those of our seedlings which showed very evidently the "squat" habit, it was noticeable that they were also distinguishable from the remaining seedlings by the darker green of their foliage and the general absence of hairiness upon the leaves.

That we might be the more sure that such a correlation was evident, we showed the batch of seedlings to one of Mr Hanbury's boys, who was with us at the time, and asked him whether he noticed any very distinct differences between the two groups.

He almost immediately indicated the much darker colour of the seedlings of "squat" habit, and, when questioned further, observed the greater abundance of hairs upon the leaves of those species which were distinguished by their lighter green colour.

We think that there is a clear suggestion from the above facts, that certain morphological characters may justly be linked to special conditions of habitat; and, in consequence, we may presume, special cultural conditions for the most successful germination. There would need to be a closer scrutiny as to the conditions of ripeness in which the seeds were gathered—the depths at which they were sown in the soil, &c.—before any very clearly substantiated proof of this could be laid down, but with our present data we may fairly make a few observations on this point.

From tables which have been given earlier in this paper, we have shown that there were very considerable differences in the total number of seedlings which, in one species and another, germinated successfully.

The extent to which this correlation is carried may be most clearly indicated by the following Tables:—

I.—HABIT.	II.—COLOUR.	III.—HAIRS.
Group A.—“ <i>Squat</i> ” :—	<i>Dull bluish green</i> :—	<i>Absent entirely</i> :—
<i>S. ceratophylla</i> .	<i>S. ceratophylla</i> .	<i>S. ceratophylla</i> (except a few sickly hairs on midrib and petiole).
<i>S. Forskohlei</i> .	<i>S. Forskohlei</i> .	<i>S. Forskohlei</i> .
<i>S. Tenorii</i> .	<i>S. Tenorii</i> .	<i>S. Tenorii</i> .
<i>S. lantanæfolia</i> .		<i>Present chiefly on youngest leaves</i> :—
<i>S. lyrata</i> .		<i>S. lyrata</i> .
<i>S. obovata</i> .		<i>S. obovata</i> .
<i>S. polystachya</i> .	<i>S. polystachya</i> .	<i>S. polystachya</i> .
<i>S. variegata</i> .	<i>S. variegata</i> .	<i>S. variegata</i> .
Group B.— <i>Erect</i> :—	<i>Generally a brighter yellow green</i> :—	<i>Absent entirely</i> :—
<i>S. aurita</i> .		<i>More or less abundant</i> :—
<i>S. candelabrum</i> .		<i>S. aurita</i> (sparsely distributed on matured leaves).
<i>S. hispanica</i> .		<i>S. candelabrum</i> .
<i>S. mexicana</i> .		<i>S. hispanica</i> (more on under surface).
<i>S. triangularis</i> .	<i>S. interrupta</i> .	<i>S. mexicana</i> .
<i>S. albo-cerulea</i> .	<i>S. candelabrum</i> .	<i>S. triangularis</i> .
	<i>having a dull although yellowish green colour</i> .	<i>S. albo-cerulea</i> .
Group C.— <i>Intermediate</i> :—		<i>S. aurita</i> (sparsely distributed on matured leaves).
<i>S. canariensis</i> .	<i>S. interrupta</i> .	<i>S. hispanica</i> (more on under surface).
<i>S. interrupta</i> .	<i>S. candelabrum</i> .	<i>S. mexicana</i> .
<i>S. porphyrata</i> .	<i>S. albo-cerulea</i> .	<i>S. triangularis</i> .
	<i>S. lyrata and obovata are exceptions</i> .	<i>S. albo-cerulea</i> .

Such differences form the basis for the practical knowledge gained by the clever gardener, who asserts with confidence that such and such species are easily raised from seed, others not so. For anything that we know, there may be practical men who could run over the species of *Salvia* here enumerated, and assert of one species or another that it would be easy to grow in gardens in Britain or on the Riviera, or the reverse. Perhaps it is from lack of leisure, or from the idea that generalisations on the subject would always be useless and uncertain, that such men, who are the most practical observers, never attempt to make more than suggestions *why* some species succeed and others do not. But we are almost confident that series of careful observations of such a kind as we have brought forward would do much to establish in our minds clear ideas of cultural requirements as evidenced by the external morphology of the plants we attempt to grow; or, what is the same thing, *the external characters may, we believe, be associated definitely with the habitat preferred by the species.*

Unfortunately for us, in this particular instance there is very little information as to exact habitats, in such botanical works at least as we have had access to, to guide us in making a full comparison. We are also aware how difficult it is for a traveller during a short visit to distinguish in a very precise way as to what are the exact habitats affected by plants collected. It is work, nevertheless, which will repay persistent and careful research.

The facts given in tables earlier in the present paper show us, that as carefully as we can ascertain, with such observations as have been recorded, out of the total number of seeds sown, among species with glabrous and dark coloured leaves, 33 per cent. have germinated successfully; 25 per cent. have germinated amongst those species with lighter coloured leaves, which are but sparsely covered with hairs; 15 per cent. only of the seeds of those species with very distinctly pubescent or hairy leaves. We would wish to avoid anything like a hasty rushing to a conclusion; but it would appear that in this case, and, as a rule, glabrous-leaved plants suggest a damper habitat than that suggested by hirsute or pubescent leaves; damp-loving plants would, we think, fare better under such conditions as those in which

the species of *Salvia* have been grown. But we might observe that of the five species with most distinctly hairy leaves, three were the last to germinate; also they germinated at a time when an altered temperature and position tended to keep the pots in which the seeds were sown in a drier position.

Perhaps there is nothing more in our first statement than is indicated by the common remark of the gardener—that such and such a species is one that “grows freely,” or that is “coarsely growing.” But what may rightly be described as “coarsely growing” wherever placed in an English garden might not be likely to prove so everywhere on the Riviera. In such a case we need more exact determination as to what are the requirements best suited to one kind of plant or the other. Comparison of plants requiring the same conditions will surely lead us to associate features such as those we have instanced—glabrous leaves or hairiness, with habitat and with the requirements of the plant for successful germination or growth.

It is of interest to make some slight comparison between the resemblances which, so far, we have detected among the various species here considered, and the natural affinities which have been recognised after systematic study of the genus.

Thus, in the groups to which we have called attention on account of the difference in texture of the leaves, the group in which hairs on the leaf are sparsely distributed, and in which the colour is a more lively green, contains—*S. triangularis*, *S. aurita*, *S. runcinata*, *S. lyrata*, and *S. obovata*—all of which belong to the section *Heterosphace* of Bentham.

This early resemblance in character is possibly only due to the fact that the species are herbaceous; if it is anything more, it may be regarded as evidence of relationship in the nature of the leaves and early growth, supporting the recognised relationship based upon the nature of the flowers. *S. lyrata* and *S. obovata*, which are very closely allied species, show their intimate relationship in a peculiar manner in their earliest stages—in that they are the only species observed in which the leaves are very strongly coloured: the colour was reddish-purple.

The above is perhaps the most evident instance, those species with dull and glabrous leaves being from several sections ; as also those with a low growing habit in their earliest stages.

Note upon the Movements of Young Leaves of Salvia Species probably attributable to the Effects of Dry Air and consequent Evaporation.

Jan. 21, 1890, 11 P.M.—A pot of seedlings of *Salvia canariensis* which had remained for some hours in a dry warm position in a dwelling-room showed five seedlings out of nine, with the second pair of leaves (cotyledons excluded) in more or less close contact ; each was about 16 mm. long, and had been separate from the other before the plants were brought into the room. The young leaves were closely pressed, one against the other, towards the base, but the tips of the leaves were generally somewhat reflexed. All the seedlings would, in all probability, have so responded to the stimulus, of whatever nature it might be (dry air probably), but the crowding together in the pot caused petioles or laminae of one or another seedling to interfere with the movements of its neighbours.

In one case the third pair (larger) were developed, and they were closely appressed for the greater part of the extent of the lamina, the species being only 5 mm. apart. The petiole did not appear to move much, if at all, nor did both leaves move towards each other equally ; the lamina of one would incline towards the lamina of the other, making an angle with its petiole, whilst the lamina and petiole of its opposite leaf might be curved much in the same direction throughout.

Jan. 22, 10 A.M.—The seedlings having been kept in the same position since they were last observed showed a *separation* of the leaves of those pairs, which, before, were observed to have been in partial or complete contact. In only one case was there any contact of the lamina of one leaf with that of its opposite leaf.

The following were the measurements of the distances between the tips of the various leaves :—

In the largest individual,	.	.	42 mm.
In average sized,	.	.	20 „
In the smallest,	.	.	10 „

Jan. 22, 2 P.M. Of one seedling it is noticed that it has drawn its young leaves together by 14 mm.

Jan. 22, 6 P.M. After having been out in the open air during the afternoon, the seedlings were brought into the warmer, drier air of the room; all showed the leaves widely separated. In selected seedlings the distances apart from tip to tip were as follows :—

A. (largest seedling.)		B.	
3rd and 4th leaves,	42 mm.	3rd and 4th leaves,	20 mm.
1st and 2nd leaves,	46 „	1st and 2nd leaves,	43 „
cotyledons,	18 „		

C.

3rd and 4th leaves,	25 mm.
1st and 2nd leaves,	44 „

Jan. 23, 8 A.M.—The measurements of the above were :—

A.		B.	
3rd and 4th leaves,	28 mm.	3rd and 4th leaves,	25 mm.
1st and 2nd leaves,	46 „	1st and 2nd leaves,	42 „
cotyledons,	18 „		

C.

3rd and 4th leaves,	20 mm.
1st and 2nd leaves,	43 „

It is probable that we have an explanation of the movements at first recorded, in the fact that on the morning of the 23rd the exhibited movement was less evident, indeed, hardly noticeable. The plants had, on this occasion, been placed in a cooler place in the room, and not, as before, within a couple of feet of a wall, where was a flue of hot air.

The movements of the leaves of *S. canariensis* may be compared with the movements exhibited in *S. interrupta*, the seedlings of which species were only twenty-five days

old ; those of *S. canariensis* were seventy-five days old ; both were placed in identically similar conditions.

S. interrupta.—Jan. 21 :—

A.	1st and 2nd leaves apart,	21 mm.
B.	” ”	18 ”
C.	” ”	19 ”

Jan. 22, 10 A.M. :—

A.	1st and 2nd leaves apart,	26 mm.
B.	” ”	21 ”
C.	” ”	22 ”

Jan. 22 and 23, at 6.30 (after exposure in open air) :—

	(22nd)	(23rd)
A. 1st and 2nd leaves apart,	29 mm.	22 mm.
cotyledons,	38 ”	38 ”
B. 1st and 2nd leaves apart,	23 ”	23 ”
cotyledons,	32 ”	32 ”
C. 1st and 2nd leaves apart,	30 ”	25 ”
cotyledons,	26 ”	26 ”

Further comparison in both species shows that if they are placed out in open air they assume positions in which the leaves are further and further apart—due to growth in relation to light ; but, whenever the above species, and also various others are brought into the drier air, and the greater darkness of the room, they exhibit movements such as we have indicated. Thus, the tips of leaves in *S. canariensis* moved from a position, 40 mm. apart, to a position of close contact, one leaf extending a little beyond the summit of the other, however.

It is perhaps not worth while to record these movements at greater length. Some leaves, especially when very young or old, being either too much appressed or too much recurved, exhibited no movement ; thus, within two days, leaves of *Tenorii* moved from 57 mm. apart to 30, and back to 34, whilst younger leaves retained the more fixed position, 11 or 12 mm. apart. Some seedlings also exhibited greater divergence than others.

Although we have considered that this movement is brought about in many instances by altered conditions of

moisture in the air about the plant, we cannot say whether it is a movement commonly to be observed in nature with a view to protect the tender leaves of the bud. The movements of the leaves may readily be so influenced by too great drought, when the soil in the pot becomes dry. We attempted to ascertain whether in mature plants of these and other species growing in the open air there was evident movement, but our observations were perhaps too limited in time to allow us to detect such.