V. s. in herb. Berol.; v. c. ex hortis Florent., Lips. et academiae technicae Carlsr.

Anm. Die Pflanze ist nicht „glaberrimum", wie Decaisne in Nouv. Arch. Mus. (2) II. 18 angibt, sondern in dem Blütenstande schwach behaart; allerdings fast kahl (inflorescentia puberula, subglabra).

L. Japonicum Thunb. Foliis coriaceis, corollae tubo calyce paulo usque $3^1/_2$plo, plerumque duplo, raro 3plo longiore, petalis minus acutis quam in specie antecedente. — Inflorescentia glabra v. puberula.

Japan. Nagasaki: Maxim. iter secund. (1863; floribus et fructubus), Oldham n. 539 herb. Götting. non herb. Berol., R. Oldham sine n. herb. Berol. — Ex Japonia sine locis: Teuter[?] leg.; herb. Lugd.-Bat. comm. — ? Yokohama: Maxim. iter secund. (a. 1863; specimen fructiferum, quod ob folia subcoriacea *L. ovalifolium* Hassk. non esse videtur).

V. s. in herb. Berol. et Götting. V. c. ex hortis Florent. et Lips.

Anm. Nach Forbes und Hemsley (l. c., siehe vorige Art) hat *L. Japonicum* Thunb., zu welchem sie aber auch *L. ovalifolium* Hassk. rechnen, folgende Verbreitung: China, Japan und Bonin-Inseln.

Karlsruhe, 12. December 1894.

The Sensitive Movements of some Flowering Plants under Colored Screens.

By

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Fully a year ago I delivered a lecture to the workers at the Woods Holl Biological Institute, entitled „Irrito-contractility in plants" (see Naturwissenschaftliche Rundschau. 1894. p. 379.) On that occasion I concurred in the view previously propounded by a couple of investigators in the same field of study, that the paraheliotropic movements executed by sensitive plants were due, chiefly or entirely, to the action of solar heat rays. Various observations and experiments, made during the past winter and spring, led me to conclude that the above interpretation was incorrect, and that certain of the light rays started the movements. Some of the experiments seemed further to indicate that the blue-violet or more refrangible rays of the spectrum were the exciting agents.

To test these points more exactly, studies were made during the past summer on different groups of sensitive plants, but in the present paper I propose dealing mainly with *Cassia nictitans, C. chamaecrista, C. Tora* and *Oxalis stricta.* The species of *Cassia* just named show sensitivity to external stimuli in the order in which they have been given; the first is markedly sensitive, hence the popular name of Wild Sensitive Plant, the second is decidedly less sensitive, and the third is least so.

C. nictitans and *C. chamaecrista* grow abundantly together in the sandy soil of New Jersey, and are greatly modified in growth according to environmental relations. If the seeds of the former germinate under the shade of shrubs or trees, there is formed a simple upright axis, or one bearing two to four short basal side branches. But if shaded for some hours and exposed to the hot sun for some hours the main axis remains relatively short, while more numerous and vigorous shoots than in the first are formed. If fully exposed to sunlight in a dry, sandy soil, the main axis remains short and bears numerous side branches which again branch, so that the entire plant assumes a dense, spreading, caespitose habit. Every transition type can be gathered between those now described, each indicating in habit a distinct relation to its environment.

Comparison of a lot of these plants that have grown under varying conditions of moisture and illumination, yield instructive results. During the hot season of July, August and the early part of September, when the thermometer registers 29—36° C during day, and rarely falls below 19—24° C at night, the leaflets recover from their nyctitropic state about 5 a.m. From then till 7 or 7:30 A.M. the leaflets are quite flat as a rule in all. But thereafter differences appear. If the morning is rather hazy, or if the plants grow for the time under shade, the leaflets remain flat till 10—10:30 a.m., even though the temperature has risen to 27° C. But if the morning sunlight be not obscured the leaflets of exposed plants will curve forward and upward in paraheliotropic movement, so that by 7:30—8 they will have moved through an angle of 18—20°, the thermometer it may, be meanwhile registering only 24—25° C. If, again, the plants are shaded by oak or other trees the temperature may rise during day to 37—38° C, and yet the leaflets will remain flat or nearly so. As a rule, however, it may be said that direct insolation, or reflection of light from a white surface when the temperature is 28° C, causes the leaflets to move within two minutes in *C. nictitans* and *C. chamaecrista.*

The above, and numerous similar observations led me to suspect that certain of the light rays, and not the heat rays, were the exciting agents. To verify this if possible, a series of colored glass screens were arranged so as to exclude all rays except those that each color of glass allowed to pass. Mr. Arthur T. Collins carefully tested the glasses with me by aid of his spectroscope, and the results are subjoined. One that to the eye appeared a rich violet proved, when tested, to be a dull glass that allowed only the less refrangible red rays and the violet rays to pass, and that absorbed the remaining rays of the spectrum. The results obtained with it are peculiar, but these will not be recorded in this paper. As the blue glass passed:- orange the violet rays, a fair index is got of the action of these on plants.

Red glass: — red and orange rays unobstructed, yellow almost cut out, green, blue and violet cut out.

Yellow glass — red slightly obstructed, orange and yellow unobstructed, yellow-green largely through, blue-green, blue and violet cut out.

Green glass: — red, orange and yellow cut out, green unobstructed, green-blue slightly through, blue and violet cut out.

Blue glass: — red, orange, yellow and green cut out, blue and violet through.

The experimental results recorded below were begun on September 4th and continued, with some interruptions, till October 3rd. They have been selected in preference to others made earlier in the season, as showing the behavior alike during high, medium, and rather low temperatures. It should be emphasized, however, that when the temperature falls considerably and pretty continuously below a given optimum the movements become quite unreliable. One illustration may be cited from a plant that has been extensively used during my inquiries. *Oxalis stricta* will grow and remain healthy looking for three or four weeks under a day temperature of 15—16° C, and a night temperature of 8—9° C, but the sensitive relations are then greatly disturbed and irregular. With a day temperature of 21—27° C and a night temperature of 17—18° C, the plant truly flourishes.

Cassia nictitans and *C. chamaecrista.*

One September 4th vigorous plants of each of the above were selected from others growing alongside, and covered with the colored screens already described. Except that it is less sensitive and therefore more sluggish in its response to stimuli, the latter species behaves fundamentally like the former, so that occasional reference only will be made to it. The plants were fully exposed to the sun's rays, and grew in a light sandy soil from whose surface the rays were strongly reflected.

At 2 p. m. on the above date the screens were arranged under a diffuse light but exposed to a temperature of 32° C in the brightest light, and 29.5° C in the shade. The high temperature but diffuse light was due to a hot sun attempting to shine through a smoke cloud, that had been blown down from fired forests in the interior of the State. The leaflets at 2 p. m. were almost flat. By 2:30 the leaflets of 1 and 2*) had inflexed through an angle of 45°, those of 3 through an angle of 15°, and those of 4 were unaltered. By 3:30 the leaflets of 1 and 2 were almost closed, those of 3 were inflexed 60°, those of 4 were unaltered. At 5 p. m. the leaflets of 1, 2 and 3 were closed, those of 4 were still unaltered. At 5:30 the leaflets of plants in the open began to show nyctitropic movement, as did those of 4 by 5:45. At 6:10 all had closed. The inflexion of plants 1 and 2 during daylight accords with Sachs' statements for *Mimosa pudica*; but the writer has since proved that had the plants been screened at 8 or 9 a. m., the

*) In speaking of screened plants hereafter those under red screen will be designated 1, under yellow 2, under green 3, and under blue 4.

leaflets would have recovered by early afternoon. In the case of *Mimosa*, recovery of a screened primary leaflet takes place within three to four hours.

September 5th. At 8:30 a. m. the sky was dull and the air cool. Screened and exposed plants alike showed fully expanded leaflets. At 9:30 the sun began to break through the smoke-cloud, and by 10 was shining brightly. The temperature at that tine was 35° C in the sun and in the shade 29° C. Then, and at 10:30 the temperature inside screen 1 was 37° C when the thermometer was exposed to the brightest red light. The leaflets were either flat or slightly deflexed*). Under 2 the temperature was 40° C and the leaflets were flat. The temperature under the green screen was 35.5° C and the leaflets were flat or very slightly inflexed. The temperature under 4 was 37° C, and the leaflets were inflexed through an angle of 35—40°. The unprotected plants around had their leaflets inflexed 20—35°, while plants under oak shade near by were flat or very slightly inflexed. The temperature steadily rose till 1:20, when it was 31.5° C in the shade. All of the plants remained unchanged, except that under the blue screen, whose leaflets formed an angle of 40—45°. Between 1:30 and 2 floating clouds pretty steadily subdued the light, and this went on till sunset. By 2:15 the leaflets under 4 were nearly flat, those under 3 were quite flat, those under 2 and 1 were chiefly deflexed through 5—7°. The leaflets of the exposed plants were inflexed 15—20° till near 3 p. m., but thereafter they gradually recovered till by 4:15 they were flat. By 4:15 many of the leaves of 1 had placed themselves in a peculiar and irregular position, some being strongly deflexed, others elevated at angles of 10—30°. At 4:30 its leaflets had started slight nyctitropic movement which went on till 5:15 when the leaflets were almost closed. At 4:50 the leaflets of 2 had started, and by 5:15 they were fully half closed. Not only did the leaves of 1 move irregularly; the leaflets of these, and to a less degree those of 2 closed irregularly; that is, while most curved steadily inwards, others were sluggish in action or scarcely moved, so that when the majority of the leaflets had fully closed, a few amongst them remained more or less expanded. At 5:15 those of 3 had slightly moved, and so had those of exposed plants. At 5:30 the leaflets of 3 were almost half closed, while those of 4 were flat. By 6:15 exposed plants, also 1, 2 and 3 showed perfect nyctitropism; at this time the leaves of 4 were fully half closed, and by 6:30 they had entirely closed.

September 6th. The day was dull and cloudy, though warm. At 9:30 a. m. the temperature inside the screens ranged from 30—32.5° but from this time on, the leaflets remained flat. Though somewhat retarded over the previous day, all showed nyctitropism in the order above given. As on the previous day,

*) The terms „inflexed“ and „deflexed“ are used here in an exact sense.

plant 1 and to a certain extent 2 presented irregular positions of the leaves, that were in striking contrast to the uniform position of those on plants 3 and 4 or on exposed leaves.

September 7th. The day throughout was clear and warm. At 7:45 a. m. the shade temperature was 25° C, but plants exposed to the sun had moved through an angle of 10—15°. The leaflets of screened plants were all flat. At 10:30 the shade temperature was 29° C, and under the screens was 34—35.5° C. Plants 1 and 2 had their leaflets mostly deflexed; a few only of the lower and older leaflets were flat, or nearly so. The leaflets of plant 3 remained quite flat, those of plant 4 had inflexed through an angle of 30—35°. These relative positions were maintained during the day till 4:15, when plant 4 gradually recovered its expanded state. At 4:10 plant 1 began to show nyctitropism, and by 4:50 the leaflets had closed. The same irregularity of leaf and leaflet movement was exhibited as on previous days. At 4:30 the leaflets of plant 2 had slightly inflexed on the younger leaves. and by 5:20 most of the leaflets were closed. At 5:10 plant 3 and likewise exposed plants had moved, and by 5:50 the leaflets were partly closed. At 5:40 the leaflets of plant 4 had started, but at this stage the observations were stopped.

Plants in pots were next set out, and alongside the screened ones were placed three as control specimens to indicate ordinary behavior under sunlight. One of the three was set against a white back-ground, the other two were set on grass. The plants were so situated that they received direct sunlight from 8:50 a. m. onwards. They were set out on the afternoon of September 10th, but from unavoidable circumstances observations could not be made till September 12th.

September 12th. The sky during the day was clear and the sunlight strong. At 7:30 a. m. the temperature was 19° C in the shade, and all of the plants had their leaflets fully exposed. By 10:15 the temperature in the sun was 33.5° C and in the shade 26° C, while under the screens it varied from 31—33° C. The leaflets of 1 were slightly deflexed, those of 2 were flat, those of 3 were flat in the older leaves, but slightly inflexed in the younger ones, those of 4 were inflexed 10—15°. At 11:30 the leaflets of 1 were deflexed 5—8°, a few of those under 2 were slightly deflexed, but most were flat, those of 3 had not sensibly altered, the leaflets of 4 were now inflexed from 35—40°. The last position corresponded with that of the leaflets placed against the white surface, and was greater by about 10° than that shown bythe plants on the lawn. The above relative positions were retained till 4:15, except that on three occasions rather dense, dull-white clouds floated across the sun's disc, and caused on each occasion expansion of the leaflets of 4 through 5—10°. The leaflets of I had begun to incurve at 4:15, those of 2 at 4:45, those of 3 at 5.5 and of 4 at 5:40. By 6:35 all had closed.

September 13th. The day was heavy and cloudy till about 1 p. m. Thereafter bright sunshine alternated at rather long intervals with cloud-shade. The leaflets of every plant remained open in the forenoon, but by 1:45 those of 4 were inflexed 10—15°. It had recovered by 4:20, and by that time plant 1 showed slight nyctitropic movement. For the remainder of the day observations could not be made.

September 14th. The sky was dull and leaden till 12 noon. From then till 1: 30 there was bright sunshine, but no observations could be made till 3: 30 when every plant showed expanded leaflets. At 3: 55 the leaflets of plant 1 began to inflect; at 4: 15 a flu on plant 2 had slightly moved, others were still flat; at 4: 30 those of plant 1 had moved through an angle of 65°, those of plant 2 through 40°. Plant 3 had just started at 4: 30, and a few leaflets of the exposed plants had also moved, though most were flat. At 5: 10 the leaflets of 1 were closed, those of 2 were fully two-thirds closed, those of 3 were fully one-third closed, and the leaflets of plant 4 were still expanded. At 6 p. m. plants 1 and 2, also those in the open were closed, plant 3 had almost closed, but the leaflets of 4 were flat except for a few at the ends of the younger leaves which had slightly inflexed. At 6: 30 the leaflets of 4 had all moved through an angle of at least 25°, some considerably more. At 8: 30 when next examined, all had closed.

September 15th. The day was bright and warm. As on previous days, the leaflets of plant 1 at 7: 30 were decidedly, and those of 2 slightly reflexed. Plants 3 and 4 had flat leaflets. At 9: 30 the sun temperature was 34° C, and the shade temperature 28.5° C. The screen temperature was 31.5—34° C. Plant 1 had reflexed leaflets, plant 2 flat or very slightly reflexed, plant 3 from flat to inflexed through 10° and plant 4 inflexed through about 30°, being intermediate in position between the plants on the lawn and that against white back-ground which indicated 40°. At 11: 30 plant 1 showed slight inflexion of its leaflets. Want of moisture would not account for this as all had been carefully watered on the previous evening. As the screen temperature was 36.5° C, it may be that a slight heat stimulus had taken effect here. The leaflets of plant 2 were flat; those of 3 were inflexed 10—15° on the older leaves, and 20—25° on the younger; those of plant 50—55° on the younger leaves.

At 2: 30 the sun temperature was 36.5° C and shade 30.5° C. The conditionsremained the same as above, except that a moderate re-expansion had taken place in the leaflets of plant 3. By 4: 30 plant 4 had re-expanded through an angle of 25°, and by 5: 15 the leaflets were flat. At 4: 10 plant 1 had begun to close, at 4: 40 plant 2, at 5: 15 plant 3, and at 5: 45 plant 4. By this time 1 and 2 were closed, and 3 was fully two-thirds closed. At 6: 30 the leaflets of 4 were nearly all closed.

September 16 th. A clear, hot day, with uninterrupted sunshine. Frequent observations made during the day essentially agreed with those given above, so that it is unnecessary to repeat the records.

September 17 th. The day was warm on the whole, but dull clouds greatly obscured the sun's rays till 12 : 45. Thereafter bright sunlight and cloud shade alternat ed till sunset. No observations could be made till 2 : 30, when the leaflets of plant 1 were reflexed, those of 2 slightly so or flat, those of 3 were also flat; those of 4 were inflexed 25—30°. From 2 : 50 till 3 : 15 heavy white clouds passed over, and at 3 : 10 the leaflets of 4 had almost recovered. Thereafter bright sunshine till 3 : 50 caused them again to close about 20°. Clouds again came over, and at 4 p. m. plants 1, 2, and 3 were uncovered.

When uncovered, the plants were left in position till next morning, but their relative periods of nictitropic movement were watched. The results are curious, but I attach little importance to them, till supported by several sets of similar observations. Instead of showing earlier nyctitropism than the exposed plants which were fully three-fourths closed at 5 : 50, plants 1, 2 and 3 were at that time fully expanded. At 6 : 20 plant 1 had slightly inflexed, 2 had inflexed 20°, 3 about 35°. Plant 4, which had recovered its flat state about an hour before, was beginning to close under the blue screen. It was then uncovered, and by 7 p. m. it and plant 3 were almost closed, but 1 and 2 only three-fourths. At 8 all were shut. On a priori grounds, one might have expected day-by-day a gradual return to the normal, in plants 1 and 2. These fragmentary observations are given, however, if only to stimulate research in the same line.

While the above studies were in progress, experiments were conducted to ascertain whether the paraheliotropic movement is solely determined by changes in the pulvinus cells, or is due to changes in the tissues of the leaflets that indirectly cause changes in the cells. Oltmanns' experiments by the use of a black screen decided this point for *Robinia* * But the usually flat position of leaflets when growing under the shade of trees decided me to use narrow strips of oak leaf. On a warm day, with sun temperature at 35.5° C, three strips, each about 2 m. m. in width and 35 m. m. in length were cut out of a leaf of *Quercus nigra*. Each weighed about 0.011 gramme. These were delicately placed along the pulvini of 2 leaves on one plant, and of one leaf on another, which had their leaflets inflexed 45—50°. In a few minutes the leaflets had rexpanded so as to form an angle only of 5—10°. Pieces of leaf were then placed as follows: 1) On the pulvini of the lower seven pairs of leaflets of a thirteen-paired leaf, 2) on the upper eight pairs of a sixteen-paired leaf, and 3) on the middle five pairs of a seventeen-paired leaf.

* Flora. 1892. p. 234.

Expansion of the partially covered leaflets followed, and caused a striking appearance in the leaves. That the weight of the oak leaf did not cause the movement, was proved by substituting strips of mica of like size, each weighing about 0.079 gramme. No visible movement followed.

Careful observations were then made on *Cassia nictitans* and *C. chamaecrista* to ascertain how soon, after shading, the change of position is evident. In the former species 1⅝ minutes, and in the latter 2¼—2⅝ minutes sufficed according to the age of the leaf. The relative rapidity of movement thus established is a pretty exact index to the relative sensitivity of the species. Thus *Strophostyles angulosa* which feebly responds to mechanical stimuli, and only slowly though markedly responds to sun stimuli, does not, when shaded, re-expand under 25—30 minutes.

Attempts were made with the leaves of *Cassia nictitans* to ascertain whether continuous exposure to bright light would injure them. Attached leaves were enclosed at 11.30 a. m. on a warm day between thin glass slips that pressed lightly against them. Within ten minutes minute droplets of liquid appeared over the upper and under surfaces of the leaflets, and this liquid steadily increased in amount, until after fifty-four hours, the leaves werequite drenched. The experiments were unavoidably stopped at this stage, but none of the leaves used had quite lost their sensitivity, though they had a very flaccid and slightly discolored appearance when left a few hours after. Prolonged and varied experiments are needed here.

Cassia Tora.

On September 17th at 5 : 30 p. m. young vigorous plants in pots were placed under the colored screens previously used. The succeeding day was wet and the sky was dense. The leaflets on all of the plants were fully expanded when examined at 9 : 15 a. m., but further notes could not be made until the succeding day at 4 p. m., when the leaflets were expanded. At 4 : 15 plant 1 began to show nyctitropism, at 4 : 40 plant 2, at 5 : 20 plant 3, and at 5 : 50 plant 4. Further observations could not be made till the following date:

September 21st. The day was clear and sunlight uninterrupted, though the temperature was not high. At 8 : 45 a. m. the leaflets in all were fully expanded. At 11 : 10 two exposed control plants showed leaflets contracted by paraheliotropism through 40—45°. The leaflets of 1 were almost fully expanded; those of plant 2 were mostly flat, though a few were reflexed. The leaflets of plant 3 were inflexed through 25—30°, and those of plant 4 through 50°. This condition persisted till 3 : 40 when the leaflets of 4 began to re-expand; by 5 : 20 they were flat. At 5 : 30 plants 1, 2 and 3 showed different degrees of nyctitropism, while 4 had leaflets expanded. At 6 : 30 plants 1 and 2 were closed, 3 was almost closed, and 4 had closed through 40°. At 7 : 45 plant 3 was closed, and 4 had moved through 75°. By 9 : 30 all had shut.

September 22nd. The day was clear and the sun was rather intense. At 7 : 30 a. m. the leaflets were flat in every plant. At 10 : 45 plants 1 and 2 showed flat or slightly reflexed leaflets, plant 3 had inflexed through 20—25°, and 4 through 45—50°. This state continued till 2 : 50, except that as the sunlight became more intense a further inflexion of 4 occurred, the temperature meanwhile being 35° C in the sun and 27.5° C in the shade.

At 4 : 25 plant 1 began nyctitropic movement, at 4 : 45 plant 2 followed, and 3 — which had not as yet recovered from the paraheliotropic — passed into the nyctitropic state, while 4 that recovered at 5.5 was nearly closed by 7 : 15.

September 23rd. The day was clear with warm sunshine, and the records were essentially like those just given. At 7 : 45 p. m. plant 4 was practically closed.

Observations could not be made on September 24th, and on the evening of that day the plants were removed. While under the screens specimens 1 and 2 had elongated greatly, specimen 3 slightly, and 4 not at all, judging from rough measurement.

Oxalis stricta.

Seven plants of this species were set out at 7 : 15 a. m. on October 2 nd. Three had been taken from a moist shady corner of my greenhouse, and four had been brought in some days before from a field. This may possible explain the rather varying results recorded below, buth the somewhat low day temperatures and the much lower night temperatures may have contributed to these results. The same screens were used as before for four of the plants, and three were used as control specimens.

By 8 a. m. the leaflets of 1 were deflexed *) through about 50°, those of plant 2 were barely one-third deflexed, those of plants 3 and 4 were flat. At 10 : 30 in a bright sun, plant 1 had leaflets deflexed through 65°, but in 2 the leaflets were re-expanding. The leaflets of 3 were now either flat or inclined upward, forming an angle of 100—105° with the petiole. Plant 4 showed insolation effects, the leaflets being deflexed 20—25°. At 11 : 30 the temperature was 26° C in the shade, hut the sunlight was intense. Plant 1 had leaflets deflexed through about 80°, plant 2 showed flat or in most cases slightly inflexed leaflets, plant 3 showed flat leaflets, plant 4 showed deflexion of leaflets through 60—65°. At 12 : 30 plants 1, 2 and 3 were unaltered, but the leaflets of plant 4 were deflexed through 75—80°. The observations were interrupted till 4 : 15, when all the plants except 4 were found to have the leaflets nearly or quite flat. Plant 4 now recovering from paraheliotropism was still deflexed through 25°, and at 5 : 20 its leaflets were flat, but at that time none showed nyctitropism.

At 5 : 30 plant 1 had slightly reflexed, and by 5 : 45 plant 2, as well as exposed specimens. At 6 : 30 plant 1 had closed,

*) It will be remembered that *Oxalis* leaflets fall backward or become deflexed as a result of stimulation.

plant 2 was almost closed, plant 3 and exposed ones were fully threefourths closed, plant 4 was barely one-third closed. At 7:45 the leaflets of 4 were deflexed throug 75°, and when next examined at 9:30 they were fully deflexed.

October 3rd. The sky was heavy and the atmosphere was very moist and dense till near 11 a. m. By 11:30 the sun had broken through at intervals. From 12:30 till 2:45 the sun was bright and pretty intense, but thereafter it was clouded over till 3:50; from then till sunset it shone brightly. At 12:45 plants 1, 2 and 3 showed flat leaflets, but those of 4 had already deflexed through 10°. At 1:30 p. m. 1, 2 and 3 were as before, but 4 was deflexed 45°. At 3:10 it had recovered to the extent of 10—15° in most of its leaflets, and at 4 it was deflexed only to 15° on the average. It continued to expand, though shone on by the slanting and subdued rays, till at 4:30 the leaflets were flat.

At 5 p. m. plant 1 showed slight nyctitropic movement, at 5:20 those in the open, and at 5:30 plant 2 moved. At 5:50 plant 3 had started, and at 6:20 plant 4. The full nyctitropic position was very slowly reached by 2, 3 and 4, for while exposed plants and 1 had deflexed through 90° or thereby by 6:20, plant 2 was deflexed 60°, plant 3 about 35°, and 4 had just started. At 8 p. m. 2 was deflexed, 3 was two-thirds and 4 was fully one third closed. At 9 all had closed. The rather sudden and considerable difference between the high day temperature (28° C at 5 p. m.) and that from 6 p. m .(23° C) onwards, in all probability explains the very sluggish nyctitropic movement just recorded, for the writer has since proved that under similar temperature conditions, the behavior is in no way different, but if the screened plants are brought into a warm greenhouse about 6:30 nyctitropic movement is at once accelerated.

Before summarising the abovedetails, referencene may bemade to certain histological conditions studied during the progress of the experiments. Some observers have held that loss of water is the primary cause of the paraheliotropic position, and it has been asserted that the stomata are then closed. Though Oltmanns', experiments and my own prove that the amovement is directly due to changes in the pulvinus cells, other weighty reasons can be advanced against the view that mere loss of water brings about the change. Plants growing in a dry place under tree shade at 29—32° C and fanned by a breeze might then be expected to show greater paraheliotropic movement than others in sunlight at 26. 5—29° C, and with the air still. But this is not so. Again while exposed plants at 26—29° C show decided movement in direct sunlight, others under red or yellow screens remain expanded at 35—38° C It seemed advisable, therefore, to obtain data as to the behavior of the stomata at different times and under different screens. Records will only be given at present for *Cassia nictitans* and *C. chamaecrista*. In the former, stomata are largely

confined to the lower epidermis, but a few occur, toward the base of each leaflet, near and parallel to, the veins on the upper surface. In the latter, stomata are most abundant on the lower epidermis, but are uniformly and pretty closely disposed over the upper.

On bright hot days, when the leaflets were paraheliotropic, numerous examples were studied in the fresh state and after fixing in alcohol, chromic acid, etc. The fresh specimens consisted of epidermis stripped and arranged under the microscope within a minute after the leaves had been removed from the plant, this work having been largely conducted in the field. In every instance, the stomata of the lower epidermis were either considerably or widely open. On the upper epidermis none were met with quite closed, but according to the degree of paraheliotropism the stomata ranged from wide open to three-fourths closed. The same principle applies to *Strophostyles angulosa* which has its stomata uniformly distributed over upper and lower epidermis, but in the proportion of one above to three below.

No continuous record was kept of the movements of the leaf stalks in the species studied, but such are regular and considerable in amount both in transverse and horizontal direction While the vertical motions are probably largely due to differences in tissue tension, the lateral ones seem to be determined by illumination, for their movements are such as to permit the leaflets to place themselves in a diaheliotropic relation when expanded.

(Fortsetzung folgt.)

Originalberichte gelehrter Gesellschaften.

Societas pro Fauna et Flora Fennica in Helsingfors.

Sitzung am 6. April 1889.

Herr **John Lindén** sprach:

Ueber seine 1888 in Süd-Carelien vorgenommene Reise.

Das Gebiet, welches sich zwischen 60° 43′ und 61° 13′ N. Br. 3° 50 und 5° o. L. (Helsingfors) erstreckt, zerfällt in zwei in botanischer Hinsicht wesentlich verschiedene Theile: in das an Pflanzen reichere, durch viele Linden charakterisirte „Vuoksen-Gebiet", von der Krümmung des Flusses nach Osten bis zu dessen Mündung im Ladoga, und in das innere, durch eine verhältnissmässig dürftige Vegetation ausgezeichnete, an das südliche Savolaks und Ladoga-Carelien grenzende Gebiet.

Die Artenzahl der im Gebiete beobachteten Gefässpflanzen beträgt 528, von denen 250 allgemein, 118 hier und da zerstreut und 160 selten sind oder eine unsichere Verbreitung haben. Von diesen verdienen *Epipogon aphyllus*, *Cirsium heterophyllum* × *palustre* und *Calamagrostis Hartmaniana* hervorgehoben