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LINCOLN NEBRASKA

BIOLOGY

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I.—On the Movements of Petals

BY ESTHER PEARL HENSEL

INTRODUCTION

The following paper has to do with an investigation of the physical causes which bring about opening and closing movements, periodic or otherwise, of certain flowers. With that end in view, seven different species of flowering plants have been experimented upon directly, a much larger number being simply observed with respect to the nature, time, etc., of their anthotropic movements.

Movement consists in the corolla taking upon itself either the open or closed position for certain periods of the day or night; for example, the morning glory (*Ipomoea purpurea*) opens early in the morning (from 4:00 to 5:00 A.M., in the greenhouse) and closes from 11:00 A.M. to 2:00 P.M., or even 5:00 P.M. on cool days, while the common dandelion (*Taraxacum taraxacum*) opens from 7:00 to 8:00 A.M. and closes from 5:00 to 6:00 P.M.

In the closed position, the petals or florets may assume practically the same position as that of the bud, as in the gentians, asters, dandelions, etc.; often, however, the edges of the petals only touch, forming a dome inside of which the stamens and pistil are well protected, as in the wild rose and in the tulip. In

some genera, as in *Mentzelia*, the sepals may stay reflexed after the first opening.

For convenience, flowers which are influenced in their opening and closing by the amount of heat present may be grouped into four classes as follows:

I. Day-bloomers.

1. Those that open only during the day, but for two or more (sometimes several) days in succession (hemeranthous).
2. Those that open only during one day or part of a day, then the corolla withering, deliquescing, or dropping at once (ephemeral-hemeranthous).

II. Night-bloomers.

3. Those that open only during the night, but for successive nights (nyctanthous).
4. Those that open for only one night or part of one night (ephemeral-nyctanthous).

All flowers not included in these types open at any time of the day or night and stay in this condition through day and night until the end of their existence, irrespective of the amount of heat present. Whether a flower is a day-bloomer or a night-bloomer seems to depend upon nothing so much as habit, the conditions surrounding the plant, its environment, in no way influencing this aspect. The purpose of this paper is to explain the causes of opening and closing in any type by means of experiments.

The form of the corolla and its physical condition when mature, i. e., dry shriveling, deliquescing, deciduous when yet fresh, etc., do not seem to influence the kind of movement; any type, for instance day-bloomers, may have the extreme variety of forms of corolla, from undivided, as in the morning glory, to divided, as in the tulip; the corolla itself may vary in its physical characteristics, e. g., in ephemeral day-bloomers from dry shriveling in the spring lily (*Erythronium albidum*) to deliquescing in the spiderwort (*Tradescantia bracteata*) and deciduous

in flax (*Linum usitatissimum*). The corolla may also change in color upon withering, as in the evening primrose (*Pachylophus caespitosus*), the waxy white petals turning a dull pink upon withering.

The life of an individual flower varies from a few hours, as in the ephemeral species, to many days. According to Kerner and Oliver, the range is from 3 hours (in *Hibiscus trionum*) to 80 days (in *Odontoglossum rossii*). Whether the length of life of an individual flower and the closing at certain hours have anything to do with the pollination of the flowers by certain insects is not a question to be discussed here, however interesting it may be. The two are closely connected but are not cause and effect.

Following is a list of plants which show these movements, those preceded by a * having been experimented upon directly; the others were simply observed. The list is very small when compared with the cases actually known, since it simply includes those coming under personal observation within the last two or three years:

I. Day bloomers.	DAYS	OPEN A.M.	CLOSED P.M.
1. Opening and closing repeatedly.			
<i>Agoseris greenii</i> , (Gray) Rydb.	1-2	7:00- 8:45	2:00-3:00
<i>Claytonia virginica</i> L.	2	8:00- 9:00	6:30-7:30
<i>Crocus vernus</i> All.	12	9:00-10:00	4:00-5:00
<i>Erigeron flagellaris</i> Gray	2	9:30-10:30	5:00-7:30
<i>Gentiana acuta</i> Michx.	4	8:00-10:00	5:00-6:00
<i>Gentiana frigida</i> Haenke	4	8:00-10:00	5:00-6:00
<i>Gentiana parryi</i> Engelm.	4	8:00-10:00	5:00-6:00
<i>Lactuca scariola</i> L.	2+	8:00- 9:00	3:00-4:00
<i>Machaeranthera aspera</i> Greene	4+	7:00-10:00	4:00-6:00
<i>Rosa woodsii</i> Lindl.	4	6:00-10:00	7:00
* <i>Ta. axacum taraxacum</i>	2-5	6:00- 8:00	5:00-7:00
<i>Tulipa gesneriana</i> L.	5-7	9:00-10:00	5:00-6:00
2. Opening and closing but once, 1 day or less.			
<i>Epilobium adenocaulon</i> Haussk.		9:00	3:00-5:00
<i>Erythronium albidum</i> Nutt.		8:00- 9:00	6:00-7:00
<i>Specularia perfoliata</i> (L.) A.DC.		7:00- 8:00	3:00-7:00
* <i>Linum usitatissimum</i> L.		5:00- 8:00	10 A.M.-2
* <i>Oxalis stricta</i> L.		8:00- 9:00	3:00-4:00
<i>Portulaca oleracea</i> L.		10:00-11:00	3:00-4:00

	OPEN A.M.	CLOSED P.M.
<i>Sisyrinchium angustifolium</i> Miller	9:30-11:00	5:00-6:45
<i>Tradescantia bracteata</i> L.	5:00- 6:00	4:00-5:00
II. Night bloomers.	OPEN P.M.	CLOSED A.M.
3. Opening and closing repeatedly.		
* <i>Mentzelia nuda</i> (Pursh.) T. & G. 4-5 days	3:00-5:00	5:00- 6:00
4. Opening and closing but once. 1 day or less.		
<i>Allionia linearis</i> Pursh.	5:00-6:00	8:00- 9:00
<i>Allionia nyctaginea</i> Michx.	4:00-5:00	9:00-10:00
<i>Cereus grandiflorus</i> Mill.	8:00-9:00	2:00- 3:00
<i>Datura stramonium</i> L.	5:00 6:00	8:00-11:00
* <i>Ipomoea purpurea</i> (L.) Roth.	4-5 A.M.	10:30 a.m.-3 p.m.
* <i>Mirabilis jalapa</i> L.	6:00-9:00	10 A.M.-4 P.M.
<i>Onagra biennis</i> (L.) Scop.	5:00-6:00	9:00-10:00
* <i>Pachylophus caespitosus</i> (Nutt.) Raimann	5:00-8:00	9:00-11:00
<i>Silene hallii</i> Wats.	5:00-7:30	9:00-12:00

All flowers not included in the previously stated types stay open through the day and night during their period of existence. Such flowers do not open because of temperature changes but because they have reached a certain period of growth; the largest number of flowers belong here. Of the other classes, a very large number are day bloomers, a smaller number night bloomers.

Ephemeral flowers behave much as those flowers which open and close for several days, that is, they are influenced by temperature variations; in their opening, however, they show a close relation to the large number of flowers which open only once and stay open until they die (generally after several days); the chief difference is that the ephemeral species are more regular in the time at which this process occurs.

HISTORICAL REVIEW (FROM 1686 TO 1905)

So much has been written on the subject of flower movement, and with such different views as to its cause, that it seems advisable to give a rather detailed account of the work of the different investigators.

Pfeffer reports Cornutus as having said as early as 1686 that heat caused, or at least hastened, the opening of the anemone.

Whether this was a theory or had really been found out from experimentation, I am not able to ascertain, as I do not have access to the original paper.

Linné in 1751 gave many instances of flower movement. He made a list of forty-six species with the time of opening and closing of each. These he called "sun flowers" ("solares flores") and divided them into (a) those which the conditions of shade, humidity of the air, and atmospheric pressure affect directly ("meteorici"); these do not open during cloudy or rainy weather; (b) those that open in the morning but close before evening, at different times according to the light ("tropici"); (c) those that open and close at a certain hour of the day ("aequinoctiales"). These last he grouped into his "Floral Clock" according to the hours of the day at which they open and close their flowers, every hour being represented by two or three opening or closing flowers; composites were also included here since the ray florets act much as the petals of simple flowers. It is quite significant of the importance of the subject that it should have been known even thus well over two hundred years ago.

According to Royer, Duhamel (a contemporary of Linné's) attributed opening to heat and turgescence, but said that heat rarified the cell sap, quite contrary to the later view that turgescence is due to an excessive flow of liquids to certain regions.

Dutrochet in 1836 gave as the cause of the opening and closing of four-o'clocks (*Mirabilis jalapa* and *Mirabilis longiflora*), the morning glory (*Ipomoea purpurea*), and the dandelion (*Taraxacum taraxacum*) turgescence and the filling of the fibrous tissue with oxygen. He attempted to explain the process in this way: on the external side of the corolla nerves, parenchymatous tissue is arranged in longitudinal rows, while on the internal side there is fibrous tissue, the two tissues tending to curve in opposite directions and thus draw along the other tissues surrounding them. Opening and closing result from the alternately predominant action of one or the other tissue. The parenchymatous tissue tends to curve outward by filling with water, thus causing opening in flowers of *Mirabilis*; the fibrous tissue curves outward by the chemical action of the oxygen in the water, causing closing

of the flower. The reason that *Mirabilis* closes earlier than *Convolvulus* is because it is easier for *Mirabilis* to fill its fibrous tissue with oxygen under the influence of light and heat. In the case of flowers opened and closed for several days, as the dandelion; etc., the fibrous tissue becomes gradually filled with oxygen during the day when the flower is open. At the same time, the sap current is diminished because of the decreasing light, thus decreasing turgescence; in consequence, the cellular tissue curves inward and the flower closes.

Hermann Hoffmann (1850) brought together results showing that temperature was the all-important factor in opening and closing, light influencing the processes only as it contained heat rays. His experiments were conducted upon foliage leaves of *Oxalis tetraphylla* and *Mimosa pudica*, and the flowers of *Tolpis barbata*, *Oenothera lindleyana*, *Onagra biennis*, *Lotus peregrinus*, *Ipomoea purpurea*, and *Eschscholtzia*. These were the principal species experimented upon; several others, however, were used to help disprove that sleep movements are caused by moisture in the air, electricity, or the expansion of gas within the plant—causes to which opening had been ascribed. He further proved that opening can be caused artificially at the hour of most profound sleep by simple increase of heat without the aid of light, but that the prolongation or excess of heat caused sleep. He stated also that the dilatation of the sap by the action of heat could not cause the daily expansion of a flower, since water expands only $1/22$ of its volume between 0° and 100° C.

Royer (1868) affirmed that variations of heat and turgescence—complements of each other—were the cause of all flower movements. *Taraxacum taraxacum*, *Crocus*, *Tulipa gesneriana*, *Ficaria ranunculoides*, and *Bellis perennis* were experimented upon by him as examples of sleeping flowers, i. e., those that open and close several times. He made a close distinction, however, between sleeping flowers and ephemeral ones, such as *Convolvulus arvensis*, *C. sepium*, *Glaucium flavum*, *Stellaria media*, and several *Veronicas*, which sleep only in appearance and close only when their existence is ended. These latter, he said, could be transformed into sleeping flowers by humid earth, shade, late

flowering, etc.; and, vice versa, sleeping flowers could be made ephemeral by increased heat and dryness, or when the whole flow of sap toward the flower was hindered. In his opinion, turgescence and heat caused opening and closing by the unequal dilatation of the faces; without heat there was no dilatation, without turgescence no elasticity. The internal face, on account of its position, was less exposed to the action of the air and dilated more than the outer, causing opening. Prolonged and abundant transpiration diminished turgescence, and sleep occurred; then the internal face was shortened and the outside became plane and convex.

De Candolle, a contemporary of Royer, has been stated by the latter as having emphasized light as the factor causing opening and closing movements.

Light and moisture, and a certain law of periodicity, were stated by Balfour (1875) to be the cause of sleep movements of flowers, periodicity (or habit) being given almost first place.

Darwin (1881), as we should expect, held to the latter view, saying that movement was a quality inherited by both plants and animals. He agreed with Pfeffer that nyctitropic movements of flowers are caused by unequal growth of the two sides of the petals due to temperature changes.

Gustav Zacher (1881) ascribed floral movement of *Lotus ornithopodiodes* to light, but more especially to the variability of the amount of water in the water vessels.

Pfeffer reports Hofmeister to have said that temperature changes caused movements in garden tulips.

According to Sachs (1882 and 1887) light was the all-important factor; temperature and humidity were given a secondary place, it being only occasionally, as in *Tulipa* and *Crocus*, that they were the important factors. However, Pfeffer's experiments (1876) were mentioned by him, and he certainly considered them valuable. Pfeffer's experiments on *Tulipa*, *Crocus*, *Adonis vernatus*, *Ornithogalum umbellatum*, and *Cochicum autumnale* make heat the most important element. He considers opening and closing mere growth movements; heat and light, as they diminish at night, cause the outer surface to grow faster

than the inner, and the flower closes, or, in the case of flowers remaining open at night, meteoric influences affect the internal and external surfaces in the opposite way.

It is due to Anton Hansgirg, first in 1890, and then later, that we have such exhaustive lists of plants possessing what he calls "gamotropic" and "carpotropic" movements, principally the latter. Under the former term he includes movements that serve to protect the ovary and stamens and to make cross-fertilization easy; under the latter, those growth movements of flower stems by which the flower is placed in a certain position at one period of its growth, and in a different one at a later period; for example, the morning glory bud and flower are erect, while the fruit is pendulous. Movements of the calyx, involucre, etc., to protect the fruit, are also included under "carpotropic" movements. The real cause of what he terms "gamotropic" movements, those serving to protect the ovary, stamens, etc., he does not state directly, but in a later paper he remarks that carpotropic nutation movements are not so dependent upon the daily change of light as the nyctitropic and gamotropic appearances. He also makes the statement that carpotropic movements must be distinguished from those similar to nyctitropic and gamotropic ones which occur through epinasty and hyponasty—the merely passive movements without growth. In a still more recent article (1892) he adds a few facts on the subject, but offers no explanation, saying that it is yet to be proven whether periodic opening and closing are caused by changing epinastic and hyponastic growth of flowers. He states that such movements are inconstant in different genera of the same family. The same lists of species were continued in 1896 when he assigned to gamotropic and to nyctitropic movements light and heat as causes. He divides gamotropic flowers into: (a) those periodically opened and closed, (b) ephemeral, day or night, (c) those that open only once and stay thus until withering (agamotropic), and (d) those that are pseudocleistogamous and hemicleistogamous. Light is given importance, for ephemeral flowers can be made to become two-day flowers if deprived of light. In 1902 still further additions were made to these lists of species possessing types of car-

potropic and gamotropic movements. Here, as in earlier publications, he concludes by saying that the exact causes are unknown.

In a paper published in 1890, Hermann Vochting treats of the influence of temperature upon the flower movements of *Anemone stellata*—those of the flower pedicel especially—but he also mentions that the opening and closing are connected with the unequal growth of the upper and under sides of the basal portion of the floral leaves.

Friedrich Oltmanns (1895) gives to light the most important place in causing nyctitropic movements of flowers, the more intense the light, the earlier the closing or opening, a certain quantity of light being necessary for the withering of ephemeral flowers or the closing of periodically moving ones. He makes the statement that Royer, De Candolle, Dutrochet, and Meyen have all thought light an important factor, while Pfeffer considers that heat works with light in causing flowers to open in the morning.

Kerner and Oliver (1895) say that the opening of flowers is promoted by sunshine, but whether it is light or heat is to them a question. Kerner says that the amount of pollen produced and the number of flowers on a plant directly affect the length of time a flower stays open. As to the physical cause, the sun's rays affect the tension of the tissues, but just how is not known. The movement of flowers—the change in the position of the petals—is only another expression of heat energy. The author suggests that, since anthocyanin converts light into heat, if the petals or sepals are white on the inside, the under surface must be tinged red, violet, or blue in order to cause opening.

From Strasburger and Schimper (1898) it is to be inferred that light and temperature variations are the cause of opening and closing. The same two factors are said by Ludwig Jost (1898) to cause nyctitropic movements. They work together, the two sides of a petal reacting in an opposite manner due to internal causes. His experiments were made principally upon tulip and dandelion flowers. He gives three possibilities as to the growth of the two sides. The first is Pfeffer's: the growth of the concave side is hindered by the growth of the convex side,

i. e., the concave side is passive. It is affected, later, as much by temperature changes as the convex side. The second (the most probable according to the author) is that the opposite sides react in an opposite manner to temperature changes, the restraint of the concave side being recognized as an active retardation in growth. The third possibility is that the concave side is not usually influenced by temperature changes.

Reynolds Greene's view (1900) as to the nervous mechanism of a plant is especially interesting, although flower movement is not discussed by him in his *Vegetable Physiology*, in which the former discussion is given. He says that a plant has a nervous mechanism, and that stimuli are conducted from cell to cell through the connecting strands of protoplasm which pass through the cell walls, and contrasts this with the nervous system of animals. The root tip, at a short distance from the apex, the three hairs on the leaf of "Venus' Fly Trap," etc., are special sense organs or regions, which, however, are not anatomically differentiated. The protoplasm in those parts receives the stimulus due to the physiological differentiation of the protoplasm; hence plants can respond to a more delicate stimulus than animals. The lack of coordination, however, may cause the stimulus to produce a harmful effect on the plant.

J. Bretland Farmer, in an article which appeared in the *New Phytologist* for March 19, 1902, refuses to accept the theory that epinasty and hyponasty cause opening and closing of the tulip flower. He attributes movement to a localized irritable tissue (as in *Dionaea*) on the outer surface of the petals. This area consists of active cells capable of altering their state of turgescence, or, at any rate, their size, more readily and effectively than the cells which form the more internal tissue layers. The intercellular spaces are large in these perianth leaves, and the cells so arranged that they give a certain amount of shearing action without damaging the cells themselves. One experiment, made by Farmer, is to put a median longitudinal section in dilute KNO_3 solution, which causes the petals to straighten out (open). To prove that there is an irritable tissue, he puts the petal in water, when it closes, or, rather, curves in, then in alcohol to kill

it, and finally in water or salt solution, when it straightens out again. He considers that this shows that movement is due to the life and activity of the protoplasm.

Detmar, in his recent *Plant Physiology* (1903), devotes some space to nyctitropic movements of flowers, citing a few experiments with *Leontodon hastilis*, *Tulipa gesneriana*, *Crocus vernus*, *Adonis vernalis*, and *Taraxacum taraxacum*. Those with *Leontodon* heads show, as he thinks, that light variations are very important in the opening and closing, while in the experiments with all the others, temperature variations alone cause the movements. His experiment, cited for *Leontodon hastilis*, was about as follows: he cut off during the day several stalks possessing open flowers and put them in water in the dark. They closed as usual in the evening and opened again the next morning (in the dark). The following night they closed, but would not open the next morning until placed in the light. In the evening they closed again, thus proving to his satisfaction that light in no way affects opening.

The view held by Ludwig Jost in his recent *Plant Physiology* (1904) is that not all flowers act nyctitropically to temperature variations; some react to light variations. I infer from his statements that it is variations in light that cause opening and closing in composite heads, while in *Crocus* it is temperature. He states that darkness has the same effect on composites as coolness has on *Crocus*, and that light has the same effect as heat. He adds that, generally in nature, it is the receiving of light accompanied by a rise in temperature, or the taking away of light with lowering of temperature, that causes these movements.

In the Prantl-Pax *Lehrbuch der Botanik* (1904), rising temperature and light are said to cause the inner side of floral leaves (such as *Tulipa*, *Crocus*, *Adonis*) to grow more than the outer; hence the flower opens. Lower temperature and light cause the outer to grow more, and the flower closes. There is a caution not to confuse these movements with those of ephemeral flowers. The author seems to make two divisions of floral movement: those caused by outside forces (autonomous), and those caused by internal forces, turgor changes, brought about by stimuli acting on the protoplasm and influencing growth (paratonic).

It is to Pfeffer more than to any one else that we owe the most of our knowledge on the subject of plant movement, more in respect to leaves than to flowers, however. Temperature, according to his view, causes the flowers of *Crocus* and *Tulipa* to open and close by certain variations. A sudden rise opens them. They then turn gradually back to a lesser opening, which position is kept constantly while the temperature remains stationary. When the temperature is lowered a similar reaction occurs. The flowers of *Crocus luteus*, *C. vernus*, and *Tulipa gesneriana* react in a few minutes, he says, to a rise of $\frac{1}{2}^{\circ}$ C. The flowers of *Adonis vernalis*, *Ornithogalum umbellatum*, and *Colchicum autumnale* react less strongly, while those of *Ranunculus ficaria*, *Anemone nemorosa*, and *Malope trifida* respond to changes of 5° – 10° C. Flowers of *Oxalis rosea*, *Nymphaea alba*, and *Leontodon* show only a common thermonastic movement with this change (5° – 10° C.).

In volume I of his *Plant Physiology*, Pfeffer states that osmotic pressure varies with temperature according to the same laws that influence gaseous pressure, and hence, by a rise in temperature of 15° C. the pressure is only raised from 100 to 105.5. Thus temperature can never exercise any marked direct effect upon turgor in plants.

The most recent publication on this subject is by Walther Wiedersheim (1904). Movements of petals are said by him to be caused by variations in temperature. The flowers experimented with were *Tulipa* and *Crocus*. Burgerstein and Farmer say that the movement in these flowers is a variation movement that occurs, not on account of growth, but by the changing, lengthening, and shortening of certain tissue complexes. Jost, Schwendener, the author, and Pfeffer consider them to be growth movements, the latter saying that growth produces movement by a change in the force of expansion occurring "simultaneously and equivalently" in the two halves, but unequally fast. The other three agree in saying that growth, one phase of it, either opening or closing, occurs as a result of light or temperature stimulus but unequally, the second movement, the counter-reaction, occurring from interior causes, due to the stimulating action set up by increase in growth of the first side.

The foregoing summary of the work done on this problem since 1686 shows how very varied have been the theories as to the cause of the movement of floral leaves, and the great need for further investigation. Many of the articles which support good theories show evidence of a small or inexact amount of experimentation. This, I have tried to avoid by endeavoring to prove all statements by actual experiment, so that the final result should be conclusive. As to the exact processes which are carried on within the flower, or plant, to bring about movement, there is yet much to be done.

EXPERIMENTAL METHODS.

Information as to the cause of floral movements was sought in two ways: first by means of field observations, and second by means of experiments performed either in the field or greenhouse, mostly the latter because of the greater ease with which the surrounding conditions could be controlled. The aim was to eliminate the possible physical factors, such as light, humidity, etc., one after the other. For example, in order to prove that humidity could not cause the opening of the flowers of the morning glory, light, heat, and the water-content of the soil were made the same in three instances: in one of these the air was made very dry, in another very moist, and in the third it was kept normal. The procedure was the same for the elimination of the other factors. The apparatus used for these experiments was very simple. For example, in the humidity experiment cited above, two large bell jars, thermometers, a psychrometer, calcium chloride for absorbing moisture, and a piece of sheet rubber to tie around one flower pot were used. Water-content and light require tin cans for soil samples, thermometers, photometers, and a shade tent. To ascertain whether heat influences opening and closing of flowers, several simple pieces of apparatus were necessary. A tin box, 2 x 2 x 2 ft., collapsible like the small tin dinner boxes, was constructed to be used in field work, but was also found useful in indoor experiments. The top and one side were made of glass; a hole $\frac{3}{4}$ of an inch in diameter was cut in

another side to admit a cork for holding the thermometer in place. Two alcohol lamps were also found necessary, one to heat the box in which the plants were placed, the other to heat water in a retort, and thus pass water vapor into the box and produce a moist atmosphere. Self-registering thermometers and psychrometers were of great aid in taking readings of control conditions. Besides taking advantage of low temperatures in the open, or in cold rooms, double-walled bell jars packed with snow or ice were used to obtain low temperatures.

In all the experiments, strong, healthy plants were used, and no experiments were performed with flowers cut off from the plant. Wiedersheim, in his researches of 1904 on the crocus and tulip, and also Pfeffer and Jost, have affirmed that they have obtained the same results with flowers cut off from the plant as with those on the plant. Wiedersheim has even performed experiments successfully with all but one perianth leaf removed. However, unless this fact is thoroughly proved as in the instance just mentioned, it is much safer to work with the plant intact.

Unless otherwise stated, all observations apply to flowers in the greenhouse.

EXPERIMENTS

The plants directly experimented with were the common dandelion (*Taraxacum taraxacum*), the cultivated four o'clock (*Mirabilis jalapa*), the cultivated morning glory (*Ipomoea purpurea*), the evening star (*Mentzelia nuda*), the large evening primrose (*Pachylophus caespitosus*), and the common flax (*Linum usitatissimum*). Four of these are ephemeral types, one hemeranthous (the dandelion), and one nyctanthous (the evening star).

Hemeranthous and nyctanthous flowers open and close because of temperature variations, and temperature variations alone. They undergo a resting period, they sleep, while ephemeral flowers in closing end their existence, and therefore temperature variations only prolong or hasten this process with them. Hemeranthous and nyctanthous types can be made ephemeral, or at least shorter lived, by the addition of more heat than

is normal. This is shown by the difference in the actual life of a flower blooming in the spring or in midsummer: the common dandelion lasts three to five days in the spring, while in midsummer two days is normal, on account of the more intense life of the flower at that time. On the other hand, ephemeral flowers can be made longer lived by the opposite process, the life processes going on less intensely than normal, as numerous experiments with the morning glory have shown.

The dandelion, four o'clock, morning glory, and flax were experimented with in the greenhouse, the plants being grown from seed, and the evening star and evening primrose in the open, since it was impossible to grow them in the greenhouse either from seeds or by transplanting the young seedlings. The difficulty probably lay in the fact that the change of climate, altitude, etc., was too great, from 9,000 ft. above the sea at Halfway, Colorado, to 1,200 ft. at Lincoln. At any rate, it was impossible to grow them at all from seeds, even when these were seasoned. The young seedlings of *Mentzelia*, transplanted in the fall from the mountains in Colorado to the university greenhouse at Lincoln, grew for a short time, but soon died, while those of the evening primrose grew fairly well during the whole year but showed no tendency to flower.

The experiments which follow seem to me to prove quite conclusively that variations in the amount of heat present are the causes of opening and closing movements among hemeranthous and nyctanthous types which are not ephemeral, and also secondarily in the latter. It is the sudden variations within a few hours which cause flower movement. Seasonal variation in temperature effects opening and closing scarcely at all, even in types of flowers (ainthous) which bloom throughout an entire season or more as the dandelion. In May it opens between 7:00 and 8:00 o'clock in the morning, in July between 5:00 and 7:00, in August between 7:00 and 8:00, and in September between 7:00 and 9:00. The plant accommodates itself gradually to these changes, and opening and closing occur regularly with, perhaps, only a few hours difference in time.

The reason why cloudiness has been considered by some investigators as an important factor in movement is probably because a reduction in the amount of light (cloudiness) is nearly always accompanied by a lower temperature. The factors have not been carefully separated.

Movement can not be brought about by an increase of turgor within the cells, for with a rise of 15° C. the pressure is only raised from 100 to 105.5, and this, according to Pfeffer, could not cause a movement. Fifteen degrees of temperature, Centigrade, are, in no case that I know of, necessary to effect opening, and hence sufficient power could not be obtained in this way. Experiments were made with flowers cut off from the plant to determine whether turgescence was efficient in closing them. Some were immersed in water, others in different per cents of sugar solutions—all with the same results—opening and closing at the usual times.

It seems not at all probable that the expansion of the gases in the plant could increase turgidity by the rise of temperature, and hence cause opening, since, as far as temperature is concerned, gaseous pressure and osmotic pressure are governed by the same laws. Moreover, how can night blooming flowers be explained by this theory? Lack of time prevented experimentation on such an improbable cause.

That the protoplasm of the cells within the plant could be stimulated by temperature is the last and only plausible explanation. Just how this is done can not be understood, but that flowers are positively or negatively thermotropic to certain temperature extremes seems evident. Why a certain flower is ephemeral while others are hemeranthous or nyctanthous seems to me to be only partially answerable. It is doubtless true that the character is inherent, but the original causes must have been climatic, a flower closing for biological reasons, such as protection of pollen against unfavorable weather conditions, etc., and loss of water by excessive heat. An attempt was made by Dutrochet in 1836, and Farmer in 1902, to explain movement by means of the corolla (of *Taraxacum* and *Mirabilis* in the case of the former, and of *Tulipa* in that of the latter). Dutrochet gives tur-

gescence as the cause. Farmer gives to a localized tissue on the outer face of Tulipa petals the power of causing the perianth to open as a result of irritation. He says the opening is, however, due to the stimulus (he does not state what, but denies epinastic and hyponastic growth here) affecting the protoplasm and producing movement. Sections that I have made through the nerves of the corolla of Mirabilis do not show the differences in structure, indicated by Dutrochet, sufficient to cause opening and closing. He states that the cellular tissue on the outside would tend to curve out by filling with water in excess—opening, the fibrous tissue on the inner side tending to curve in by oxidation—closing. Cross-sections through the nerves of the corolla of Mirabilis show about this proportion of the different tissues: $145\ \mu$ of parenchyma on the outside of the nerve, exclusive of epidermis, $72\ \mu$ of fibrous tissue, and on the inner side, $102\ \mu$ of parenchyma, exclusive of the epidermis. We could scarcely expect movements such as Dutrochet speaks of to occur as results of turgescence of the parenchymatous tissue when it is present on both sides of the fibrous tissue and in such proportions. He states also that the morning out-curving of parenchymatous tissue (opening) of the dandelion is brought about by a strong rise of sap under the influence of light, causing turgescence. The closing, he says, is due to the diminution of this force, and to the gradual filling of the fibrous tissue with oxygen during the day. This could not occur, since the osmotic pressure of the cell sap is increased only 5 per cent with a rise in temperature of 15°C ., and the temperature never need change this much to induce closing; hence, some other cause must be sought.

HEMERANTHOUS TYPE

Experiments with Taraxacum taraxacum. The flowers of the dandelion open from 7:00 to 8:00 A.M. in the greenhouse or in the open in May, and close from 5:00 to 6:00 P.M. On cool, cloudy days they may not open at all, and in a sudden lowering of the temperature, usually accompanied by cloudiness, as upon the approach of a storm, they may close at once. Temperature

is in all cases, however, the cause of movement, light and the humidity of the air in no way influencing it except in so far as they are necessary to the continued growth of the plant. The composite head acts as the simple flower.

Experiments showing that light does not influence opening and closing. Plants with buds that were ready to open, or that were open for the first time, were at 6:00 P.M. put into shade tents made of black cambric and of sufficient darkness so that there was not the slightest coloration of solio paper at 3:00 P.M. after 5 minutes exposure, when the sun was shining brightly upon the tent. The next morning, the flowers in the shade tents were open as wide as those in normal sunlight. In other experiments, the same results were obtained; in nearly every case, the temperature in the shade tent was the same as in the sunlight, or a little higher.

Experiments showing that humidity has no direct effect upon flower movement. Plants with flowers open one day only were used. At 5:00 P.M. after the flowers had closed, one plant, well watered, was placed in a bell jar with the sides of the bell jar wet with water and the pot standing in water. A thermometer was suspended in the jar. Another plant was placed in a bell jar, which had been dried by lying on its side in a very dry room with an air temperature of 23° C. and a relative humidity of 25 per cent. The pot was wrapped in rubber cloth so that there could be no evaporation from the pot or soil, and a flat dish filled with calcium chloride placed beside it to absorb any moisture given off. A thermometer was suspended in this jar also. The following morning, both flowers were open at 8:00 A.M., as were those left in normal conditions. The temperature in the dry jar was 27.6° C., in the moist one 25.6° C., and in the normal one 21° C. with a relative humidity of 54 per cent. The same results were obtained several times, so that this experiment also seems to prove conclusively that opening is not dependent directly upon the humidity of the air.

Experiments showing that variations in temperature produce opening and closing. I have been able to open and close dandelion flowers before the usual time by varying the amount of heat.

present, but never to make the flowers stay open longer than usual by increasing the amount of heat to a little more than normal. The point at which opening occurs seems to be from 15° to 18° C., in the greenhouse, generally nearer the higher limit.

In the experiments which follow, relative humidities will usually accompany the temperatures, simply as additional proof that they are not influential in causing movement. For convenience, different parts of the greenhouse in which experiments were performed will be indicated, especially in those cases where the plants are transferred from one part to another to obtain the different conditions present there, thus: south house, north house, east house, middle house. The situation of plants placed out of doors will be indicated as *open*, that of those placed in the tin box with increased temperature as *warm chamber*, those placed in double walled bell jars packed with snow or ice, *cold chamber*, those in bell jars with saturated air, *moist chamber*, those in dry bell jars, *dry chamber*, while that of those in the compartment made of black cambric will be indicated as *shade tent*.

Flowers which do not open at the usual time in the morning because of low temperature, can be opened in from fifteen minutes to an hour by placing the plant in the warm chamber described on page 13.

Date	Hour	SOUTH HOUSE			WARM CHAMBER		
		Condition	Temp.	Rel. Hum.	Condition	Temp	Rel. Hum.
Mar. 25, 1904	10:45 A.M.	½ open ...	15.5°C.	67.4%	½ open...	.....	.....
Mar. 25, 1904	11:00 A.M.	¾ open ...	.....	.....	Wide open	36.5°C.	39.4%
Mar. 25, 1904	12:00 M.	Wide open	21.8°C.	26%	.....	.....	.....

On March 30, 1904, a cloudy day, dandelion flowers remained closed all the morning in the greenhouse. When the temperature was artificially increased in the warm chamber, in dry air or with vapor, opening occurred as in the several cases cited below.

Date	Hour	SOUTH HOUSE			WARM CHAMBER		
		Condition	Temp.	Rel. Hum.	Condition	Temp.	Rel. Hum.
Mar. 30, 1904	11:00 A.M.	Closed....	16°	83%	Closed....	43°	Dry
Mar. 30, 1904	11:30 A.M.	Closed....	16°	83%	Open.....	43°	Dry
Mar. 30, 1904	12:00 M.	Closed....	16°	83%	Open.....	43°	.....
April 7, 1904	8:00 A.M.	Closed....	13°	81%	Closed....	29°	Dry
April 7, 1904	8:15 A.M.	Closed....	.....	.....	1/4 Open....	29°	Dry
April 7, 1904	8:40 A.M.	Closed....	.....	.....	Open.....	29°	Dry
April 7, 1904	11:00 A.M.	Opening..	14.8°	26.5%	.....	.....	.....
April 15, 1904	10:00 A.M.	Closed....	17°	51%	Closed....	20°	39%
April 5, 1904	10:20 A.M.	Closed....	.....	.....	Open.....	22 1/2°	34%
April 15, 1904	11:00 A.M.	Open.....	17°	36%	.....	.....	.....

Date	Hour	SOUTH HOUSE			WARM CHAMBER		
		Condition	Temp.	Rel. Hum.	Condition	Temp.	Rel. Hum.
Jan. 30, 1905.	10:30 A.M.	Bud 1/2 open	19.8°	63%	Bud 1/2 open	23°	Moist
Jan. 30, 1905.	10:55 A.M.	Bud 1/2 open	19.8°	62%	1/2 + open..	25.9°	Moist
Jan. 30, 1905.	11:12 A.M.	Bud 1/2 open	20°	60%	Open.....	28°	Moist

Open dandelions when put into the cold chamber do not ordinarily close at night in the manner of those under normal conditions. They look perfectly natural and do not wither on removal, but seem to be in a rigid condition. The change from normal temperature to that of the cold chamber (19° or 21° to 2° or 5° C.) is probably so extreme that the flower is unable to react to the stimulus of the variation in temperature, for, when a plant with open flowers is put out of doors or in another room where the temperature difference is not so great, closing occurs very readily at any time of day. When the temperature in the cold chamber was not too low, closing occurred in certain instances at about the normal time.

Following are two instances of this sort with figures showing normal closing:

Date	Hour	SOUTH HOUSE			COLD CHAMBER		
		Condition	Temp.	Rel. Hum.	Condition	Temp.	Rel. Hum.
Feb. 22, 1905	9:00 A.M.	Open.....	19.4°	57.5%	Open.....	.....	.....
Feb. 22, 1905	10:30 A.M.	Open.....	25.6°	56%	Open.....	10°	.....
Feb. 22, 1905	11:30 A.M.	Open.....	27.3°	51%	Open.....	10°	.....
Feb. 22, 1905	2:30 P.M.	Open.....	31.7°	44.5%	3/4 closed..	10°	.....
Feb. 22, 1905	5:00 P.M.	1/2 closed..	23°	57%	1/4 + closed	17°	.....

Date	Hour	SOUTH HOUSE			COLD CHAMBER		
		Condition	Temp.	Rel. Hum.	Condition	Temp.	Rel. Hum.
Feb. 27, 1905	10:00 A.M.	Open	24.8°	45%	.....	.....	.....
Feb. 27, 1905	10:45 A.M.	Open .....	.....	.....	Open .....	.....	.....
Feb. 27, 1905	12:00 M.	Open	25°	41%	Open	12.5°	.....
Feb. 27, 1905	1:25 P.M.	Open	26°	38.5%	Open	12.5°	.....
Feb. 27, 1905	3:00 P.M.	Open	23°	35%	Open	12.4°	.....
Feb. 27, 1905	5:00 P.M.	½ closed..	19°	43%	½ closed..	14.4°	.....

The following data show the effect of a lowering of temperature such that closing occurs from 2 to 6 hours earlier than normal. In certain cases the lower temperature of a different part of the greenhouse was made use of, in others, the open:

Date	Hour	SOUTH HOUSE			EAST HOUSE		
		Condition	Temp.	Rel. Hum.	Condition	Temp.	Rel. Hum.
Jan. 21, 1905	10:00 A.M.	Open	18.6°	52%	Open	12°	.....
Jan. 21, 1905	11:00 A.M.	.....	.....	.....	¼ closed..	14°	.....
Jan. 21, 1905	11:45 A.M.	.....	.....	.....	½ closed..	17°	.....
Jan. 24, 1905	10:30 A.M.	¼ open...	13°	43%	¼ open...	7.8°	.....
Jan. 24, 1905	12:00 M.	.....	.....	.....	¼ open...	5°	93.7%
Jan. 24, 1905	1:30 P.M.	.....	.....	.....	Closed...	6.5°	88.4%
Jan. 24, 1905	5:00 P.M.	.....	.....	.....	Closed...	1.4°	.....
Feb. 2, 1905	10:30 A.M.	¼ open...	18°	55%	¼ open...	8°	.....
Feb. 2, 1905	12:00 M.	.....	.....	.....	¼ open...	16°	.....
Feb. 2, 1905	3:00 P.M.	.....	.....	.....	Closed...	8.6°	.....
Feb. 2, 1905	5:30 P.M.	.....	.....	.....	Closed...	7.5°	.....
Feb. 4, 1905	10:00 A.M.	Open	16.8°	58%	Not open.	13.5°	.....
Feb. 4, 1905	5:00 P.M.	Open	18.6°	63%	Closed...	16.2°	.....
Feb. 9, 1905	9:30 A.M.	Open	12.8°	58%	Open	10.5°	.....
Feb. 9, 1905	11:00 A.M.	Open	20.5°	20%	Closing...	13°	.....
Feb. 9, 1905	2:40 P.M.	Open	20°	41%	Closed...	14.8°	.....
Feb. 9, 1905	5:00 P.M.	¼ closed.	18.2°	63.5%	Closed...	9°	.....

Date	Hour	SOUTH HOUSE			NORTH HOUSE		
		Condition	Temp.	Rel. Hum.	Condition	Temp.	Rel. Hum.
Feb. 25, 1905.	9:50 A.M.	Open	23.4°	51%	.....	.....	.....
Feb. 25, 1905.	10:30 A.M.	Open	16.4°	49%	Open	19.4°	82.6%
Feb. 25, 1905.	1:10 P.M.	Open	29.9°	52.5%	Open	16.8°	73.4%
Feb. 25, 1905.	5:00 P.M.	Open	16.4°	54%	¾ closed..	23°	68.5%

Date	Hour	SOUTH HOUSE			OPEN		
		Condition	Temp.	Rel. Hum.	Condition	Temp.	Rel. Hum.
Feb. 25, 1903	9:30 A.M.	½ open...	19°	.....	Closed....	3.5°	.....
Feb. 25, 1903	10:30 A.M.	Open	19°	.....	Closed....	.....	.....
Feb. 25, 1903	11:30 A.M.	Open	20°	.....	Closed....	.....	.....
Feb. 25, 1903	1:15 P.M.	Open	19°	.....	Closed....	(Taken into green-	.....
Feb. 25, 1903	1:45 P.M.	Open	19°	.....	¼ open....	19°	[house]
Feb. 25, 1903	2:00 P.M.	Open	19°	.....	¾ open....	19°	.....
Feb. 25, 1903	2:15 P.M.	Open	18°	.....	Open	18°	.....
Feb. 25, 1903	4:00 P.M.	Open	18°	.....	Open	18°	.....
Feb. 25, 1903	5:00 P.M.	Open	17°	.....	¾ closed..	17°	.....
Feb. 25, 1903	6:00 P.M.	¾ closed..	15°	.....	¾ closed..	15°	.....
Feb. 25, 1903	7:30 P.M.	Closed....	14°	.....	¾ + closed	14°	.....
Feb. 21, 1905	10:00 A.M.	Open	25°	50%	Open .....	.....	.....
Feb. 21, 1905	11:10 A.M.	Open .....	.....	.....	Open	13°	.....
Feb. 21, 1905	12:00 M.	Open .....	.....	.....	Open	14°	.....
Feb. 21, 1905	3:0 P.M.	Open	26°	53%	¾ closed..	7.5°	.....
Feb. 21, 1905	5:00 P.M.	½ closed..	20.8°	60%	¾ closed..	6°	.....

Date	Hour	SOUTH HOUSE			OPEN			NORTH HOUSE		
		Cond.	Temp.	Rel. Hum.	Cond.	Temp.	Rel. Hum.	Cond.	Temp.	Rel. Hum.
Feb. 27, 1905	10:00 A.M.	Open ..	24.8°	45%	.....	.....	.....	.....	.....	.....
Feb. 27, 1905	10:30 A.M.	Open ..	.....	.....	Open ..	11°	82%	.....	.....	.....
Feb. 27, 1905	10:45 A.M.	Open ..	.....	.....	Open ..	.....	.....	Open ..	.....	.....
Feb. 27, 1905	12:00 M.	Open ..	25°	41%	Open ..	13°	74%	Open ..	21.8°	56.2%
Feb. 27, 1905	1:25 P.M.	Open ..	26°	38.5%	Open ..	12.5°	58.4%	Open ..	21.2°	71.8%
Feb. 27, 1905	3:00 P.M.	Open ..	23°	35%	¾ clo'd	13.5°	68.4%	Open ..	20.8°	64.6%
Feb. 27, 1905	5:00 P.M.	½ clo'd	19.4°	4%	Closed..	13.5°	53.8%	¾ clo'd	17.4°	68.9%

Date	Hour	SOUTH HOUSE			OPEN		
		Condition	Temp.	Rel. Hum.	Condition	Temp.	Rel. Hum.
March 1, 1905	8:30 A.M.	Open	25°	61%	.....	.....	.....
March 1, 1905	9:30 A.M.	Open .....	.....	.....	Open	5°	78.4%
March 1, 1905	10:30 A.M.	Open .....	.....	.....	¾ closed..	12°	68.4%
March 1, 1905	11:30 A.M.	Open	27.8°	54.5%	½ + closed	14°	73.3%
March 1, 1905	2:30 P.M.	Open	27°	47.5%	¾ closed..	16°	52%
March 1, 1905	4:35 P.M.	Open	21.6°	54.5%	Closed....	15.5°	.....
March 2, 1905	8:35 A.M.	Open	17.2°	60%	Open	11°	.....
March 2, 1905	9:45 A.M.	Open	23.4°	61%	Open	15°	.....
March 2, 1905	5:00 P.M.	Open	24°	40%	¾ closed..	20°	.....
March 6, 1905	9:00 A.M.	Open	21.2°	65.5%	Open	1.8°	92.2%
March 6, 1905	11:00 A.M.	Open	24.5°	66%	Open	3°	77.5%
March 6, 1905	1:30 P.M.	Open	27.4°	64%	¾ + closed	5.4°	79.7%
March 6, 1905	3:45 P.M.	Open	20°	62%	¾ + closed	6°	81.2%
March 6, 1905	5:00 P.M.	Closing...	22°	65.5%	¾ + closed	6.8°	74.4%

Date	Hour	SOUTH HOUSE			OPEN			NORTH HOUSE		
		Cond.	Temp.	Rel. Hum.	Cond.	Temp.	Rel. Hum.	Cond.	Temp.	Rel. Hum.
March 9, 1905	8:45 A.M.	Open ..	19.2°	59%	Closed.	7°	.....	$\frac{1}{3}$ open	18.4°	.....
March 9, 1905	11:00 A.M.	Open ..	23.6°	53%	Open ..	14°	.....	$\frac{1}{3}$ open	19.4°	.....
March 9, 1905	1:30 P.M.	Open ..	24°	33 $\frac{1}{2}$ %	Open ..	13°	.....	$\frac{1}{3}$ open	21.6°	.....
March 9, 1905	2:30 P.M.	Open ..	22.8°	41%	Open ..	10°	.....	Open ..	18.9°	.....
March 9, 1905	5:00 P.M.	$\frac{3}{4}$ closed	16°	47 $\frac{1}{2}$ %	Open ..	7°	.....	Open ..	17.2°	.....

Light readings also were taken by exposing solio paper to the light to show that the intensity did not influence opening or closing. Following are some data regarding the amount of light present at the times of opening and closing. If we take the tables just preceding, giving temperature and humidity values, and observe the time at which closing occurs in the different situations, and note at the same time the relative light values, light can be seen at once to be of no value in effecting closing, since it is strongest where flowers close earliest. The relative values are obtained by comparing the exposures on solio paper in a photometer, for the different situations, with a sun standard taken at noon on a certain clear day, e. g., March 21, 1905.

On February 27, 1905, dandelions were not closed in the greenhouse at 3:00 P.M. when the relative light value was .05, while out of doors they were two-thirds closed and the light value was .1. At 5:00 P.M., dandelions in the greenhouse were one-third closed with a light value of .02, while out of doors they were entirely closed, and the light was .05. In the stronger light they closed earlier.

On March 1, 1905, open dandelions put out of doors at 9:30 A.M. were one-third closed at 10:30 A.M. with a light value of .5, while indoors they were open, and the light was .1. At 4:35 P.M., those in the greenhouse were still open, with light at .03, while out of doors they were closed with light at .06.

On March 6, 1905, at 1:30 P.M., the open dandelions put out of doors at 9:00 A.M. were two-thirds or more closed, the light being .15, while indoors at the same time, where the light was .03, they were open as usual.

OTHER HEMERANTHOUS TYPES

The flowers of *Gentiana parryi*, the large blue gentian, open for two or more days only during the day from 8:00 to 10:00 A.M. and close from 5:00 to 6:00 P.M. It is very noticeable that they do not open on cloudy, cold, or rainy days and that they close on the approach of rain. Detached flowers will stay open in the house at night but will close out of doors; if brought indoors they will open in the dark. *Gentiana acuta* behaves in much the same way, and opens at about the same time. It also stays open for almost the same number of days, possibly a little longer.

I carried on a few experiments with tulip flowers, but was unable to do much with them as they did not seem to close at night. They were forced bulbs potted for me by a local greenhouse. I did succeed in opening a few with increased temperature but not with $\frac{1}{2}^{\circ}$ C. difference, such as Pfeffer says is possible; nor was it possible to close the flowers with either a moderate or extreme degree of cold.

NYCTANTHOUS TYPES

Experiments with Mentzelia nuda. The flowers of this plant open from 3:00 to 5:00 P.M. and are closed again the following morning between 5:00 and 6:00 A.M. This is repeated for 3 to 5 days. The sepals do not close around the corolla after once opening, but stay reflexed. When first opened, the flower emits a fragrance which is lacking after a few hours, a fact probably in some way connected with pollination. On rainy days, when it is cool and cloudy, the opening is two hours or more earlier than on bright sunshiny days. The experiments which I was able to carry on were all performed in the fields, in the mountains at Halfway, Colorado. The gravel slides on which *Mentzelia* grows experience very great extremes of temperature on their surface: during a single day, from 10° C. between 6:00 and 7:00 A.M. to as high as 46° C. at 11:00 A.M. or 25° to 35° C. between 2:00 and 3:00 P.M. On account of this fact, I took soil samples of the gravel at the time the flowers opened or a little

before, and also a little before their closing, in order to determine whether the water-content of the soil had anything to do with the phenomenon. No differences in per cents were obtained that could be construed as influencing movement by increasing the turgescence of the cells. The per cents varied very little, from 4-5 per cent being the normal in July and August for root depth.

Rather crude experiments were also carried on to measure the amount of transpiration in shoots bearing flowers about to open, and also those about to close. Vigorous blooming shoots were cut off and placed in large test tubes well stoppered, the shoot fitting into the stopper through a split in the latter, the end resting for an inch or more in the water. The amount of water transpired was practically the same during the day and night, showing that turgescence is not the efficient stimulus.

I also tried shading the plants continuously to induce an earlier opening, but it was not possible to get a sufficient change in temperature by this means.

Relative humidities taken just at the top of the plant at the time of opening vary extremely, as also those taken at the time of closing. When the flowers were opening, relative humidity values from 17.1 per cent to 95.6 per cent were obtained between 2:45 and 6:45 P.M.; when the flowers were closing in the morning, between 6:00 and 7:00 A.M., values from 54.2 per cent to 63.8 per cent were obtained. It is evident, then, that the water-content of the air does not influence opening, as neither do water-content of the soil nor light. That temperature is the controlling factor can only be deduced from temperature readings taken at the times of opening and closing, for, as mentioned earlier in the paper, it was impossible to grow *Mentzelia* in the greenhouse, and in the field conditions were extremely hard to control. As to figures showing temperatures at which the flowers open in the afternoon from 2:45 to 7:45 P.M., the range is from $14\frac{1}{4}^{\circ}$ to 23° C., while the corresponding range of temperatures when they close in the morning is from 8° to 16.8° C.

EPHEMERAL TYPES

Only three ephemeral, day blooming flowers were experimented with: the morning glory (*Ipomoea purpurea*), the common flax (*Linum usitatissimum*), and the yellow wood sorrel (*Oxalis stricta*); the other two were night bloomers, the evening primrose (*Pachylophus caespitosus*) and the four o'clock (*Mirabilis jalapa*).

Experiments with Ipomoea purpurea. Ipomoea opens from 5:00 to 6:00 A.M. and closes as early as 10:00 or 11:00 A.M. when it is quite warm. (All experiments were performed in the greenhouse.) Generally, however, closing occurs between 1:00 and 3:00 P.M. Contrary to the results with the dandelion, it was always possible to keep the flowers open for a considerable time (24 hours at least) beyond the normal, by placing the plant in a temperature as low as 3 to 4° C.; also to close the flowers earlier than their time by increased temperature (28 to 32° C.) with dry air or with water vapor introduced. On the other hand, heat does not work here as a direct stimulus, but rather only to hasten the growth processes. The following tables show how closing is hindered in temperatures lower than the normal:

Date	Hour	SOUTH HOUSE			EAST HOUSE			NORTH HOUSE		
		Cond.	Temp.	Rel. Hum.	Cond.	Temp.	Rel. Hum.	Cond.	Temp.	Rel. Hum.
Dec. 16, 1904	10:30 A.M.	Open ..	23°	54.5%	Open ..	.....	.....	Open ..	.....	.....
Dec. 16, 1904	11:00 A.M.	Open ..	20.7°	53%	Open ..	17.2°	.....	Open ..	17.7°	.....
Dec. 16, 1904	12:00 M.	Open ..	23.2°	50.5%	Closing	17.2°	.....	Open ..	17°	.....
Dec. 16, 1904	1:30 P.M.	Open ..	20°	49.5%	Closing	17.2°	.....	Open ..	19°	.....
Dec. 16, 1904	3:00 P.M.	Open ..	17.4°	49.5%	Closing	16.2°	.....	Open ..	18.9°	.....
Dec. 16, 1904	5:00 P.M.	½ clo'd	15.4°	50.5%	Closing	13.8°	.....	Open ..	17.8°	.....
Dec. 16, 1904	6:00 P.M.	¾ clo'd	16.2°	51.5%	Closing	13.8°	.....	Open ..	17.4°	.....
Dec. 16, 1904	9:00 P.M.	closed.	15°	41%	Closed.	13.8°	.....	Closed.	16.2°	.....

Date	Hour	SOUTH HOUSE			EAST HOUSE		
		Condition	Temp.	Rel. Hum.	Condition	Temp.	Rel. Hum.
Dec. 19, 1904	10:30 A.M.	Open	22°	50%	Open	15°	55.5%
Dec. 19, 1904	12:00 M.	Open	16°	55%	Open	10 4°	82.8%
Dec. 19, 1904	2:30 P.M.	Open	20°	63%	Open	11.2°	68.5%
Dec. 19, 1904	4:00 P.M.	Open	21°	59%	Open	11.6°	73%
Dec. 19, 1904	6:00 P.M.	$\frac{1}{2}$ of fls. cl.	22.6°	37%	Open	16.4°	43%
Dec. 19, 1904	7:00 P.M.	$\frac{3}{4}$ of fls. cl.	23°	56.5%	Open	16.4°	63.2%
Dec. 19, 1904	9:00 P.M.	All closed.	24 7°	51.5%	Open	17.5°	60.8%
Dec. 20, 1904	3:30 P.M.	Bud op'ng	13°	58%	Bud op'ng	10.6°	85.2%
Dec. 20, 1904	8:00 P.M.	.....	.....	.....	Open	16.5°	81.1%
Dec. 21, 1904	10:00 A.M.	.....	.....	.....	Beg to cl.	12.2°	88.2%
Dec. 21, 1904	12:10 M.	.....	.....	.....	$\frac{1}{4}$ closed..	13.4°	83.8%
Dec. 21, 1904	2:45 P.M.	.....	.....	.....	$\frac{3}{4}$ + closed	15.4°	85.1%

Date	Hour	SOUTH HOUSE			NORTH HOUSE			COLD CHAMBER		
		Cond.	Temp.	Rel. Hum.	Cond.	Temp.	Rel. Hum.	Cond.	Temp.	Rel. Hum.
Feb. 25, 1905	9:30 A.M.	Open ..	22.8°	51%	.....	.....	.....	.....	.....	.....
Feb. 25, 1905	10:30 A.M.	$\frac{1}{4}$ clo'd	26.4°	49%	.....	.....	.....	.....	.....	.....
Feb. 25, 1905	10:35 A.M.	$\frac{1}{4}$ clo'd	27°	50%	Open ..	.....	.....	Open ..	9°	Moist
Feb. 25, 1905	1:10 P.M.	$\frac{3}{4}$ + cl'd	29.9°	52.5%	$\frac{1}{4}$ clo'd	16.8°	73.4%	Open ..	7°	Moist
Feb. 25, 1905	5:00 P.M.	Closed.	26.4°	54%	$\frac{3}{4}$ + cl	23°	68.5%	Open ..	11°	Moist

Date	Hour	SOUTH HOUSE			NORTH HOUSE			OPEN		
		Cond.	Temp.	Rel. Hum.	Cond.	Temp.	Rel. Hum.	Cond.	Temp.	Rel. Hum.
March 6, 1905	9:00 A.M.	Open ..	21.2°	65.5%	Open ..	19.4°	40.1%	Open ..	1.8°	92.2%
March 6, 1905	11:00 A.M.	Open ..	21.5°	66%	Open ..	19.6°	73.5%	Open ..	3°	77.5%
March 6, 1905	1:30 P.M.	$\frac{1}{4}$ clo'd	27.4°	64%	$\frac{1}{4}$ clo'd	20.8°	82.4%	Open ..	5 4°	79.7%
March 6, 1905	3:45 P.M.	Closed	20°	62%	$\frac{3}{4}$ clo'd	17.4°	81%	*Chil'd	6°	87.2%
March 6, 1905	5:00 P.M.	Closed.	22°	68.5%	Closed.	17.6°	68%	.....	.....	.....

* Taken into the south house, where it opened in perfect condition at a temperature of 22° and a relative humidity of 68.5%.

Date	Hour	SOUTH HOUSE			NORTH HOUSE			SHADE TENT		
		Cond.	Temp.	Rel. Hum.	Cond.	Temp.	Rel. Hum.	Cond.	Temp.	Rel. Hum.
March 8, 1905	8:30 A.M.	Open ..	18.6°	57%	Open ..	19°	.....	.....	.....	.....
March 8, 1905	10:00 A.M.	Open ..	19 5°	56%	Open ..	19°	.....	Open ..	23°	.....
March 8, 1905	10:30 A.M.	Open ..	22°	54%	Open ..	19°	.....	Open ..	27°	.....
March 8, 1905	11:45 A.M.	Open ..	27.2°	45%	Open ..	19°	.....	Open ..	32 4°	.....
March 8, 1905	1:45 P.M.	Nearly all cl'd	26.8°	50%	.....	.....	.....	.....	.....	.....
March 8, 1905	2:45 P.M.	Closed.	25.8°	46%	Closing	20.4°	63.2%	Closing	31.8°	.....
March 8, 1905	4:45 P.M.	Closed.	19.1°	43%	Closing	20.8°	69.3%	Closing	31.2°	57.9%
March 8, 1905		Closed.			Closed.	18.5°		Closed.	23°	.....

The third column of the last series, March 8, 1905, shows very well the negative effect of light. The tent was made of black cambric, which produced so diffuse a light that an exposure of solio paper for five minutes at 3:00 P.M. on a bright day, December 1, 1904, resulted in no coloration whatever of the sensitive paper. Here, the flowers close as early as those situated where the light is more intense.

Following are three instances out of a dozen or more showing the effect of increased temperature:

Date	Hour	SOUTH HOUSE			WARM CHAMBER		
		Condition	Temp.	Rel. Hum.	Condition.	Temp	Rel. Hum.
Dec. 31, 1904	9:45 A.M.	Open	18°	57%	.....	.....	.....
Dec. 31, 1904	10:00 A.M.	Open	19°	56%	Open	30°	Moist
Dec. 31, 1904	12:15 P.M.	Open	21°	51.5%	¼ closed..	37.2°	Moist
Dec. 31, 1904	2:00 P.M.	Open	23°	45.5%	Closed....	37.2°	Moist
Jan. 11, 1905	9:00 A.M.	Open	22°	60.5%	.....	.....	.....
Jan. 11, 1905	10:45 A.M.	Open .....	.....	.....	Open .....	.....	.....
Jan. 11, 1905	11:00 A.M.	Open .....	.....	.....	Open .....	.....	.....
Jan. 11, 1905	12:00 M.	Open	22.4°	61.5%	¼ closed..	31°	Moist
Jan. 11, 1905	1:45 P.M.	Open	22°	59%	Closed....	31°	Moist
Jan. 11, 1905	4:30 P.M.	Closing...	20.8°	57.5%	.....	.....	.....
March 6, 1905	9:00 A.M.	Open	21.2°	65.5%	.....	.....	.....
March 6, 1905	9:30 A.M.	Open .....	.....	.....	Open .....	.....	.....
March 6, 1905	9:45 A.M.	Open .....	.....	.....	Open	23°	Moist
March 6, 1905	10:00 A.M.	Open .....	.....	.....	Open	28°	Moist
March 6, 1905	11:00 A.M.	Open	24.5°	66%	¼ closed..	30°	Moist
March 6, 1905	1:30 P.M.	¼ closed..	27.4°	64%	Closed....	32°	Moist
March 6, 1905	3:45 P.M.	Closed....	20°	62%	.....	.....	.....
March 6, 1905	5:00 P.M.	Closed....	17°	68%	.....	.....	.....

The relative light values may be considered here also. On February 25, 1905, at 10:30 A.M., light was 0 in the north house, and .33 in the south house; in the former the flowers were still open, while in the latter they were beginning to wither. At 1:10 P.M. in the north house, the flowers were beginning to close in darkness (0), while in the south house they were nearly closed in a light value of .33. At 5:00 P.M. in the north house, with light 0, flowers were nearly closed, while in the south house, light .01, they were entirely closed.

On March 6, 1905, at 9:00 A.M., morning glories were open in the north house with light 0, in the south house with light .012, and in the open with light .06. At 1:30 P.M., they were

beginning to close in the north house with light .003, and in the south house with light .04, while in the open, with light .15 they were still open.

These figures all go to show that light is not effective in opening and closing flowers, for closing takes place latest in nearly every instance where there is the most light, this being where it is also coldest. The experiment of March 8, 1905, in the shade tent, given on page 27, shows that closing occurs as soon in the darkness as in the light. Morning glories, ready to open, when put in a dark tent at night and kept there all of the following day, behave exactly in opening and closing as they do in normal light with the same temperature.

It was quite noticeable that when buds ready to open were put in too low a temperature (13° or less) they did not open at all but assumed the closed position as normally after opening; the temperature was too low for the ordinary processes of life to be carried on.

Experiments to show that humidity of the air is not the cause of opening and closing. On November 10, 1904, at 5:00 P.M., three plants, each with buds almost open, were put into different bell jars with light and heat practically the same in all three cases. One was a moist bell jar and one a dry bell jar, with the pot wrapped in a rubber cloth, etc. Still others were left out from under the bell jars. At 8:00 A.M. on November 11, 1904, all the buds were open with a temperature of 21° C. On November 14, 1904, at 5:00 P.M., a similar experiment was performed with the same results.

*Experiments with *Linum usitatissimum*.* The flowers of this plant open from 5:00 to 8:00 A.M. and close from 10:00 A.M. to 2:00 P.M., or, rather, they drop their petals at that time if there is sufficient movement of the air to bring about the process. Otherwise, the petals wither and dry in place. Flax flowers can be caused to drop their petals sooner than normal by increasing the temperature. Following are tables showing the results of such experiments:

Date	Hour	SOUTH HOUSE			WARM CHAMBER		
		Condition	Temp	Rel. Hum.	Condition	Temp.	Rel. Hum.
April 6, 1905	9:45 A.M.	Open	26°	38%	.....	.....	.....
April 6, 1905	9:50 A.M.	Open .....	.....	.....	Open	30°	Moist
April 6, 1905	10:15 A.M.	Open .....	.....	.....	Open	33°	Moist
April 6, 1905	10:45 A.M.	Open	28°	36%	Open	34.5°	Moist
April 6, 1905	11:25 A.M.	Open	28.5°	33%	Pet. fal'ng	35°	Moist
April 6, 1905	2:30 P.M.	Pet. fal'ng	28°	38%	.....	.....	.....
April 29, 1905	8:35 A.M.	Open	21.2°	36%	.....	.....	.....
April 29, 1905	9:00 A.M.	Open	21.2°	36%	Open	20°	Moist
April 29, 1905	9:25 A.M.	Open	21.5°	35.5%	Pet. fal'ng	24.5°	Moist
April 29, 1905	11:00 A.M.	Open	22°	35%	.....	.....	.....
April 29, 1905	12:00 M.	Pet. fal'ng	23.5°	32.5%	.....	.....	.....

Temperature, when lower than the normal, prolongs the existence of the flower, as is readily seen on mornings when it is cooler than usual because of cloudiness, etc. In this event, the flower lives on into the afternoon.

Date	Hour	SOUTH HOUSE		
		Condition	Temp.	Rel Hum.
Feb. 1, 1905	8:40 A.M.	½ open...	10°	62.5%
Feb. 1, 1905	12:00 M.	¾ open...	19°	51%
Feb. 1, 1905	3:00 P.M.	¾ + open.	16.4°	4%
Feb. 1, 1905	5:00 P.M.	Closing...	13°	53%
Mar 28, 1905	8:30 A.M.	Open	17.5°	71%
Mar. 28, 1905	9:30 A.M.	Open	19.1°	79%
Mar. 28, 1905	10:20 A.M.	Open	17.4°	61%

Date	Hour	SOUTH HOUSE			OPEN		
		Condition	Temp.	Rel. Hum.	Condition	Temp.	Rel. Hum.
Mar. 28, 1905	11:20 A.M.	Open	18.4°	60%	.....	.....	.....
Mar. 28, 1905	1:45 P.M.	Open	18°	61%	.....	.....	.....
Mar. 28, 1905	5:00 P.M.	Pet. fal'ng	15.6°	62.5%	.....	.....	.....
Mar. 24, 1905	10:00 A.M.	Open	27.8°	53%	Open	22°	.....
Mar. 24, 1905	12:00 M.	Pet. fal'ng	26°	51%	Open	22°	.....
Mar. 24, 1905	2:30 P.M.	Pet. fal'ng	26.8°	41%	Closed....	22°	.....
May 4, 1905	9:55 A.M.	Open	24.5°	32%	.....	.....	.....
May 4, 1905	10:00 A.M.	Open .....	.....	.....	Open	12.5°	.....
May 4, 1905	11:00 A.M.	Open	25°	35%	Open	12.5°	.....
May 4, 1905	12:00 M.	1 flr. with fall'g pets.	24.5°	36%	Open	14.5°	.....
May 4, 1905	1:30 P.M.	All petals falling...	.....	.....	Open	16°	.....
May 4, 1905	2:00 P.M.	All petals falling...	23.4°	31.5%	Closing...	17°	.....

In the following instance opening was not complete at any time during the day:

Date	Hour	SOUTH HOUSE		
		Condition	Temp	Rel. Hum.
April 10, 1905	10:00 A.M.	Opening a trifle	12.6°	60%
April 10, 1905	1:30 P.M.	Opening a trifle	12.8°	68%
April 10, 1905	4:30 P.M.	Opening a trifle	20.5°	70%

This late closing is always associated with a late opening in the morning accompanied by a low temperature.

Experiments with Oxalis stricta. The flowers of *Oxalis stricta* open from 9:30 A.M. to 11:00 A.M., and close for the first and only time between 1:30 and 3:00 P.M. The same phenomena are to be observed as in the other ephemeral day blooming species studied, i. e., a low temperature hinders opening and also prolongs it when there has been a temperature high enough to induce opening. Opening can be made to occur earlier than normal also, as in the case of the other flowers studied, by increasing the amount of heat to a few degrees above the normal. As evidences of the effect of low temperatures on the time of opening, the following figures are conclusive. Table I shows the normal condition of the flowers under normal temperatures; table II, the effect of a lower temperature continuing more or less throughout the day:

I.

Date	Hour	Condition	Temp.	Rel. Hum.
March 21, 1905.....	8:30 A.M.	Not open.....	22.4°	56%
March 21, 1905.....	9:30 A.M.	½ open.....	24.6°	54%
March 21, 1905.....	11:30 A.M.	Open.....	27.2°	54%
March 21, 1905.....	1:30 P.M.	Only 2 flowers still open.	28.4°	50%

II.

Date	Hour	Condition	Temp.	Rel. Hum.
March 28, 1905	8:30 A.M.	Not open	17.5°	71%
March 28, 1905	9:30 A.M.	½ to wide open	19.1°	59%
March 28, 1905	10:20 A.M.	½ open	17.4°	61%
March 28, 1905	11:20 A.M.	½ open	18.4°	60%
March 28, 1905	1:45 P.M.	Open	18°	61%
March 28, 1905	5:00 P.M.	Closed	15.6°	62.5%

The effect of a temperature slightly higher than normal in inducing a more rapid opening is shown by the following table:

Date	Hour	SOUTH HOUSE			WARM CHAMBER		
		Condition	Temp.	Rel. Hum.	Condition	Temp.	Rel. Hum.
April 26, 1905	9:30 A.M.	Not open.	25.3°	57.5%			
April 26, 1905	10:15 A.M.	Not open.	23°	60%	Not open.	22°	Moist
April 26, 1905	10:40 A.M.	½ open.	16.2°	63%	¾ open.	22°	Moist
April 26, 1905	10:45 A.M.	¾ + open.	14.5°	74%	1 flr. wide open.	27.5°	Moist
April 26, 1905	11:00 A.M.	¾ + open.	14.8°	63%	All flow'rs wide open.	27.5°	Moist
April 26, 1905	11:15 A.M.	Open	14.5°	64%			
April 29, 1905	8:35 A.M.	Not open.	21.2°	36%			
April 29, 1905	9:00 A.M.	Not open.	22°	34%	Not open.	21°	Moist
April 29, 1905	9:25 A.M.	1 flower ¾ open.	23.5°	31%	All open.	24.5°	Moist
May 3, 1905	8:40 A.M.	Not open	22°	82%	Not open.	22°	Moist
May 3, 1905	9:20 A.M.	¾ open	22.6°	78%	Wide open	26.8°	Moist
May 3, 1905	9:40 A.M.	¾ open	23.2°	77%	Wide open	26.8°	Moist

That *Oxalis* flowers should not yet be open at 8:35 A.M., April 29, 1905, and at 8:40 A.M., May 3, with the same temperature or practically so, 21.2° and 22°, and the light practically the same, shows that the widely different relative humidities do not count for much, 36 per cent in the first instance, and 82 per cent in the other. Opening occurs at practically the same time, 9:30 A.M., with temperature and light the same, but the relative humidities still widely different, 31 per cent and 78 per cent.

Several experiments, a half dozen at least, relative to the effect of light in opening flowers, show, as for the other flowers experimented upon, that opening occurs as well when plants were put into the shade tent as when in the open with full light.

EPHEMERAL TYPES

Night bloomers

Experiments with Pachylophus caespitosus. Field conditions, rather than controlled experiments, were made use of here to obtain information as to sleep movements, since it was impossible to grow the plants in the greenhouse. The plant as observed grew on the gravel slides of the mountains around Halfway, Colorado. Its delicate fragrant white flowers open from 4:50 P.M. to 8:00 P.M., and close from 10:00 to 11:00 the next morning, when they become a dull pink color. It often happens that the flower stays open the entire day when it is cool and cloudy, and, rarely, on to the next day. The early or late opening in the evening is not due so much to the immediate temperatures as to those that have prevailed during the day, thus enabling growth to go on faster and opening to occur sooner. This is shown by the varied temperatures at which opening and closing occur. On certain days, the flowers are still open in the morning when the temperature rises as high as 31° , while in other cases they are closed when the temperature is as low as 13.5° C. or as high as 23.5° C. Opening in the evening occurs when the temperature is as high as 19.5° C. while, when it remains as low as 16.5° C., they may still remain unopened.

Plants copiously watered showed no earlier opening than those normally treated.

Experiments with Mirabilis jalapa. In the greenhouse, in March and April, these flowers stay open until noon or after, sometimes 2:00 or 3:00 o'clock, but occasionally are closed or almost closed by 10:30 A.M. when the day has been warm and bright. The opening almost never occurs at 4:00 o'clock, as tradition goes, but at 6:00 or 9:00 o'clock or later. It is possible to prolong the period of opening by lowering the temperature below the normal. This is illustrated by the following tables:

Date	Hour	SOUTH HOUSE			NORTH HOUSE		
		Condition	Temp.	Rel. Hum.	Condition	Temp.	Rel. Hum.
April 15, 1903	10:00 A.M.	Open	12.8°	55%	.....	.....	.....
April 15, 1903	10:15 A.M.	Open	13°	50%	Open	12.5°	51%
April 15, 1903	10:30 A.M.	Open	17.4°	41.5%	Open	12.5°	61%
April 15, 1903	11:05 A.M.	Open	17°	16%	Open	13°	33%
April 15, 1903	12:00 M.	½ closed..	21°	28%	Open	14.5°	49%
April 15, 1903	2:30 P.M.	Closed	25°	26%	¼ closed..	13°	35%
April 15, 1903	3:00 P.M.	Closed	26°	26%	½ closed..	13°	62%

Date	Hour	SOUTH HOUSE			EAST HOUSE		
		Condition	Temp.	Rel. Hum.	Condition	Temp.	Rel. Hum.
Jan. 24, 1905	10:30 A.M.	Open	13°	43.5%	Open	7.8°	.....
Jan. 24, 1905	12:00 M.	.....	.....	.....	Open	5°	93.3%
Jan. 24, 1905	1:30 P.M.	.....	.....	.....	Open	6.5°	88.4%
Jan. 24, 1905	3:15 P.M.	.....	.....	.....	Open	1.6°	.....
Jan. 24, 1905	5:00 P.M.	.....	.....	.....	Open	1.4°	.....
Jan. 25, 1905	11:30 A.M.	Open	21.4°	42%	.....	.....	.....
*Jan. 25, 1905	2:20 P.M.	Closed	25.8°	30%	.....	.....	.....
Feb. 2, 1905	10:30 A.M.	Open	18°	55%	Open	8°	.....
Feb. 2, 1905	12:00 M.	.....	.....	.....	Open	10°	.....
Feb. 2, 1905	3:00 P.M.	.....	.....	.....	Open	8.6°	.....
Feb. 2, 1905	5:30 P.M.	.....	.....	.....	¼ closed..	7.5°	.....

*The flower which was open on the morning of January 24, 1905, was still open the next morning at 11:30 A.M., but closed at 2:20 P.M.

When the temperature is raised above the normal, closing can be brought about earlier than usual, a fact shown by the following table:

Date	Hour	SOUTH HOUSE			WARM CHAMBER		
		Condition	Temp.	Rel. Hum.	Condition	Temp.	Rel. Hum.
April 15, 1904	10:00 A.M.	Open	12.8°	55%	Open	17°	51%
April 15, 1904	10:20 A.M.	Open	16°	51%	¾ closed..	22.5°	34%
April 15, 1904	10:30 A.M.	Open	17.4°	41.5%	.....	.....	.....
April 15, 1904	11:05 A.M.	Open	17.6°	16%	.....	.....	.....
April 15, 1904	12:00 M.	½ closed..	21.4°	28%	.....	.....	.....
April 15, 1904	2:30 P.M.	Closed	25°	27%	.....	.....	.....
April 29, 1905	8:35 A.M.	Open	21.2°	36%	Open	20°	Moist
April 29, 1905	9:00 A.M.	Open	22°	35%	Closing...	24.5°	Moist
April 29, 1905	9:25 A.M.	Open	23.5°	34%	Closed....	24.5°	Moist
April 29, 1905	10:30 A.M.	Open	24.2°	34%	.....	.....	.....
April 29, 1905	12:00 M.	Closing...	25°	32%	.....	.....	.....

Humidity in no way influences closing as evidenced by the following:

Date	Hour	MIDDLE HOUSE			MOIST CHAMBER			DRY CHAMBER		
		Cond.	Temp.	Rel. Hum.	Cond.	Temp.	Rel. Hum.	Cond.	Temp.	Rel. Hum.
April 15, 1904	10:00 A.M.	Open ..	12.8°	55%	Open ..	16.8°	66%	.....	.....	.....
April 15, 1904	10:30 A.M.	Open ..	17.4°	41.5%	Open ..	.....	.....	.....	.....	.....
April 15, 1904	11:05 A.M.	Open ..	17°	16%	Open ..	.....	.....	.....	.....	.....
April 15, 1904	12:00 M.	$\frac{1}{2}$ clo'd	21.4°	28%	$\frac{1}{2}$ clo'd	.....	.....	.....	.....	.....
April 15, 1904	2:30 P.M.	Closed.	.....	.....	Closed.	.....	.....	.....	.....	.....
April 20, 1905	10:00 A.M.	Open ..	15.4°	57.5%	Open ..	14.5°	.....	Open ..	14.5°	.....
April 20, 1905	11:30 A.M.	Open ..	16.8°	55.8%	Open ..	15°	.....	Open ..	14.5°	.....
April 20, 1905	3:00 P.M.	Open ..	16.2°	51%	Open ..	16.8°	.....	Open ..	15.4°	.....

Variations in the amount of light present do not seem to affect closing, for, when a plant with open flowers is put into the tin box with increased temperature, and practically no light, except the small amount from the non-luminous alcohol flame, closing occurs as readily as in the open, if not more so. Opening and closing also occur as in the open when the plants are put in the black shade tents. Closing may take place at as low a degree of temperature as 7.5° C., when the flower has been kept open beyond its usual time by several hours, as in the case cited on page 34, for February 2, 1905. This is to be explained on the basis that, since the flower's existence is normally only one day or a part of it, the flower has remained open its usual time according to its hereditary habits, its activities were completed, and hence closing occurred. Whenever closing occurs in the morning between 11:00 and 12:00, the temperature is nearly always 19° to 26° C., while, when it is delayed until 2:00 to 4:00 P.M., it is as low as 13° or 17° C. with high humidities, showing that it is not the extremely low temperature, but the constantly low temperature, continued for a considerable time, which is the cause of the late opening.

SUMMARY

I have been able to control the opening and closing of dandelion flowers in so far that I can close them permanently with lower temperature than normal, and open them when temperature has continued too low, by the application of either dry or moist heat. It is also possible to close any ephemeral flower be-

fore its time by an extra amount of heat, with either dry or moist air. It is impossible, however, to open an ephemeral flower by placing the plant in a lower temperature, since this checks growth, and opening is here rather a growth movement than a stimulatory one as in the other types.

In the careful study by experiment of *Taraxacum taraxacum*, *Mentzelia nuda*, *Ipomoea purpurea*, *Linum usitatissimum*, *Oxalis stricta*, *Mirabilis jalapa*, and *Pachylophus caespitosus*, light, humidity of the air, and water-content of the soil have been successfully eliminated as possible physical factors likely to cause the opening and closing of flowers by the movement of the petals (or florets). Heat, on the other hand, by its variations during twenty-four hours, is the direct cause of movement in hemeranthous and nyctanthous types that bloom for more than one day. In the case of those ephemeral flowers which open very early in the morning before the temperature has risen to any extent, as the morning glory, in contrast to those like purslane which open as the temperature rises, or those like the evening primrose which open a short time after the higher temperatures of the day have given place to the lower ones of night, the phenomenon is not to be explained so easily; it is possible that they react to a smaller variation in temperature than do the others mentioned.

The closing of ephemeral flowers is, however, a different process from that of periodic flowers, since it signifies the end of the existence of the flower. This closing, as has been shown, can be delayed for several hours by a temperature constantly lower than normal, showing that the two are closely connected. It would seem to be a tenable theory that ephemeral types of flowers have arisen by an extra need for protection of the flower against excessive heat and evaporation, e. g., in a dry or warm climate, for it is true in nearly every instance that the ephemeral type of flower either blooms at night or for only a few hours during the day. The differentiation into these types in the past generations must have come about in some such way, and they have persisted because of this favorable adaptation.

The cause of the periodic movements of hemeranthous and nyctanthous types is, however, explainable through the influence

of variations in temperature, acting, not through turgescence, but by stimulation of the protoplasm.

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II.—On the Conflict of Parties in the Jacobin Club (November, 1789–July 17, 1791)

BY CHARLES KUHLMANN

The Breton Club having ceased its activity after the discussion of the veto in August, 1789, the popular party in the assembly found itself without a rallying point. Although differences of opinion had shattered the loosely organized club at Versailles, the memory of its usefulness soon induced the same members to attempt the formation of a new and more regularly organized association in the capital.¹ The exact date of the formation of the Jacobin Club it is impossible to determine from the evidence so far discovered, but everything points to the close of November or the first days of December, 1789, as the period during which the first meetings were held. From a letter of Boullé, deputy of Pontivy, dated December 18,² we learn that the society had recently been formed but had existed long enough to have received numerous requests for correspondence from provincial societies.³

¹ For the fate of the Breton Club, see my article in the *University Studies* for October, 1902, pp. 77–87. For the condition of the popular party at the time when the Jacobin Club was formed, see the letter of Boullé cited below. This letter also practically disposes of the controversy as to the origin of the new club. Some of the members later denied that the Breton deputies were the founders, and while Boullé's letter does not prove that his colleagues from Bretagne were alone concerned, it shows that the Jacobin Club was looked upon at the time of its formation as a continuation of the Breton Club. For the controversy see Aulard, *La société des Jacobins*, I, xvii–xxi, cited as "Aulard" in the following pages.

² Kerviler, *Recherches et notices*, art. Boullé. The letters of Boullé are now in the archives of Morbihan.

³ That the club had not yet been formed on November 18, we may conclude as practically certain, for in the *Observateur* of that date a certain Imbert, who had been asked by the editor, Feydel, to urge the formation of a *Society of the Revolution*, expresses surprise that no one had as yet thought of such a thing. Imbert sent three louis to Desenne as a subscription for the formation of such a society and invited others to do the same. As Imbert seemed well informed and as Desenne's was a place where the

This new organization adopted the name of "Society of the Revolution" which it soon changed to "The Society of the Friends of the Constitution."¹ The name "Jacobin" was unofficial before September 21, 1792, and was given it by the public who knew it as the society which met in the Jacobin convent.² A formal constitution or *réglement* was voted on February 8, 1790, entrance cards and initiation fees required, and persons not members of the National Assembly freely admitted.³ Preparation for the debates in the National Assembly, which had been practically the sole object of the Breton Club, was only one of the objects of the new society. Its aim was nothing less than the conversion of the whole of France to the support of the revolution. It was the center of an enormous propaganda, with secondary centers in all the principal cities of the kingdom, and soon spreading into the villages and even the country districts.⁴ Three large standing committees were appointed, meeting on fixed dates as deliberating bodies. These were the committees on membership, correspondence, and administration.⁵

The Jacobin Club is not to be regarded as a party in the usual sense of the term, for it was not composed of men holding the same views upon the questions of the hour. Its members were not required to subscribe to any specific political faith. They promised merely to uphold the revolution as it had been or was

deputies frequently gathered for consultation, it is not likely that this movement would have been undertaken had the *Society of the Revolution* already existed. On the other hand, for the Jacobin Club to have become known in the provinces and have received requests for correspondence from there by the 18th of December argues that it had already existed for several weeks. Barnave, author of the Jacobin constitution, in a letter of June 25, 1790, gives the close of November as the time when the society was founded.

¹ This name is given in the constitution of February 8, 1790, Aulard, I, xxviii-xxxiii.

² Aulard, I, xxii.

³ See constitution of the club, and Aulard, I, note 1, p. xxx.

⁴ See preamble to the constitution and Aulard, I, lxxxii-lxxxix, where a list of the affiliated societies down to June 19, 1791, is given, a list which is probably very incomplete.

⁵ For the membership of these committees on May 1, 1791, see Aulard, I, lxxvii-lxxix. How extensive the work of administration became in 1791, and the formal manner in which these committees proceeded may be learned from the *Procès-verbaux des séances du comité d'administration de la société des amis de la constitution*, etc., *Archives Nationales*, F.⁷,⁴⁴³⁰ M.SS.

still to be expressed in the work of the National Assembly.¹ This by no means implied that all its members were necessarily satisfied with the solution of every question so far treated by the assembly, but that as a matter of policy they acquiesced. Difference of opinion was often as violently expressed in the club as in the assembly. It is equally misleading to use the terms "Jacobin" and "revolutionary" as synonymous, as Ferrières so frequently does,² for the society never contained all the deputies in sympathy with the revolution and it certainly was not responsible for the whole revolution. It was by such loose terminology that the enemies of the club attempted to render it responsible for every radical measure or popular disturbance.³

At the close of November, 1789, when the society was organized, the grouping into parties in the assembly had hardly passed beyond a loose division into left and right. As the work proceeded, the men of various temperaments were attracted about their respective centers of affinity, a process which very soon made itself apparent among the Jacobins. That discontent existed in the right wing of the club as early as January, 1790, is to be inferred from the negotiations of Malouet with Liancourt-Laroche, Lafayette, and others for the formation of a more moderate society, the "Impartials."⁴ Malouet did not succeed, but some of the men he sought to detach from the Jacobins soon discovered their tendency in entering the "Club of '89." Throughout the whole duration of the assembly there was a constant loss of members from the right of the club and a corresponding gain on the left, a tendency which largely explains its passage from a moderate to a radical organization.

This process was, from its positive side, largely the result of necessity. Calumniated by its enemies, the society was forced to take the public to some extent into its confidence. As it was the

¹ See the constitution of the club, Aulard, I, xxviii-xxxiii.

² *Mémoires*, *passim*.

³ This was the usual practice of the pamphleteers. See pamphlets published by Aulard in volumes one and two.

⁴ For these negotiations see *Révolutions de France et de Brabant*, No. 8, 1790, *Journal des impartiaux*, No. 1, and *Mémoires* of Malouet, I, 374-81.

intention of the deputies to prepare themselves for the discussions in the National Assembly they could not well admit friends and enemies alike, even as mere spectators. So, to allay the suspicions of the people of Paris, they received into membership an ever-increasing number of citizens who by their character and reputation would discredit all evil reports.¹ But this policy, very fatal to the society in the end, contributed in March, 1790, to bring about the revolt of some one hundred and twenty deputies who were offended at the influence non-deputies were thus enabled to exercise upon the decisions of the National Assembly. These secessionists established themselves in a rival club at the house of the Comte de Crillon, holding its meetings upon the same days and hours as those of the Jacobins, and admitting all members of the latter society who were at the same time deputies to the National Assembly. This greatly alarmed the Jacobins, who began at once to make overtures of peace. On March 15, 1790, Charles Lameth, then president of the society, followed by a large number of members, appeared at the Crillon assembly and besought its members earnestly to return in the interest of unity among the patriots. They promised that thereafter two or three sessions a week should be held from which non-deputies would be excluded. What agreement was finally reached—certainly not the one here proposed—we do not know, but the efforts of the Jacobins were successful in bringing the schism to an end.²

But the presence of non-deputies was not the only cause that had driven some of the members of the National Assembly from the society. The Lameths and their friends had already begun to exercise more influence than some were able to endure. So severe was the personal strife, that Charles Lameth declared the Comte de Crillon and Larochefoucauld to be "vile courtisans."³ It was supposed, too, by some that the society was directed by a secret committee composed of Barnave, the Lameths, D'Aiguillon, Duport, Labord, and Baron Menou, who assembled at a place in the Rue Saint-Nicaise or Basse-du-Rempart. This con-

¹ Dubois-Crancé, *Analyse de la révolution française*, p. 51, cited by Aulard, I, xix.

² Duquesnoy, *Journal*, I, bulletin of March 16, 1790.

³ *Ibid.*

jecture, entered by Duquesnoy under date of March 16, 1790, is frequently repeated by the enemies of the Jacobins as a fact, but our trustworthy sources give no evidence of the existence of a formally organized committee of this nature.¹

Hardly had the Crillon difficulty been disposed of before the long debate in the National Assembly upon the judicial system began, creating a new division in the popular party. Adrien Duport, rejecting the report of the committee on the constitution, toward the close of March, read a plan of his own which the society officially approved by printing it. On March 30, it was attacked in the society itself, after Loyseau had on the 24th read a long and favorable commentary on it.² The point of greatest difficulty was whether or not juries should be introduced in civil cases as Duport had proposed. Barnave, the Lameths, and Robespierre warmly seconded Duport against the advocates and procurers who almost to a unit opposed it. In spite of the violence of Charles Lameth, who declared that he would oppose the aristocracy of the advocates as he had opposed the other aristocrats, and the talk of despotism and counter-revolution, the party of Duport was defeated.³ But the debate had beyond question driven a number of deputies from the club.

It was at this time that the "Triumvirate," composed of Barnave, Alexander Lameth, and Adrien Duport, established their supremacy in the society. The formation of the "Club of '89" about this time contributed to this result by removing a large number of deputies who would have opposed them had they remained. Their power in the club and in the assembly was attested by the fury with which their enemies attacked them. From May or June, 1790, to March, 1791, innumerable pamphlets and articles in the newspapers were directed against them

¹ Duquesnoy, *Journal*, I, bulletin for March 16, 1790.

² Aulard, I, 42-58, speech of Loyseau.

³ The discussion on the jury system is somewhat fully reported in the *Correspondance de MM. les députés des communes de la province d'Anjou*, IV, Nos. 22 and 23. Ferrières says that the *avocats* were a disturbing element among the "revolutionists" at this time. Robespierre claims that the *avocats* acted as a unit against the jury in criminal cases. *Mémoires authentiques de M. de Robespierre*, Paris, 1830, II, 66. See also *Chronique de Paris*, No. 98, 1790.

with no apparent effect other than to increase their popularity.¹ Duport, former member of the *Chambre des Enquêtes* of the Parliament of Paris, came to the National Assembly with his reputation as an opponent of the government already made.² Possessed of considerable organizing talent, he supplemented the work of the intriguer Lameth and the oratorical powers of the proud but incisive advocate of Grenoble, Barnave, who, although very soon remarked, made his reputation upon the committee on colonies and in his famous debate with Mirabeau.

As another group in the society, the friends of the Duc d'Orleans are sometimes cited. Not infrequently the enemies of the club charged it with being in the pay of this notorious character or with working in his interests.³ As the duke was a popular character, it is certain that many members of the club were favorably disposed toward him, but nothing worthy the name of evidence has been found showing that the club, during this early period of its existence, ever contemplated putting him forward as against the ruling branch of the family. His son was a popular member of the society,⁴ and Desmoulins early in 1790, speaking of the imminent return of the Duc d'Orleans from England, addressed him in one of the numbers of his "Révolutions de France et de Brabant," in his half-bantering tone, urging him to go to the Jacobins where he would be gladly received.⁵ Laclos, the editor of the Jacobin journal of correspondence, was held to be an agent of the duke secretly working for his interests at the

¹*Chronique de Paris*, No. 174. Pamphlets published by Aulard, in volumes one and two.

²He was one of the principal opponents of the government during the parliamentary revolution of 1787-1789, and gave his name to a revolutionary club of this period, the *Comité Duport*.

³Pamphlet, *Le carnaval Jacobite*, Aulard, II, 154-65; *Les chefs des Jacobites*, I, 1-9.

⁴Aulard, I, 325.

⁵No. 8. "Dans un moment où Malouet et les ministres veulent mener le roi aux Augustins, c'est pour nous une affaire capitale d'entraîner son frère aux Jacobins. En conséquence, le procureur général de la lanterne ne se souvient plus que de ces paroles du prophète: *Quand vous seriez rouge comme l'écarlate, tous vos péchés seront lavés, et vous serez blanc comme neige si vous venez aux Jacobins.* Mais il faut renvoyer madame Balbi d'où elle est venue. Alors *noster eris*, et nous vous ferons président des Jacobins honneur qui vaut bien celui d'être frère du roi."

club.¹ On the other hand, Mirabeau, who was probably in position to know, declared in his seventh note to the king that the Duc d'Orleans had never been anything to the Jacobins.²

Although the society was, almost from the moment of its birth, accused of violence and agitation for selfish motives,³ it was not until November, 1790, that such charges could be made with entire justice. Until that time the reports of the meetings of the society indicate that the discussions were orderly in outward form and sane in content. Formal papers, dissertations by scholars or educated men, predominated during the first period of its existence. Questions confronting the National Assembly were discussed in an exhaustive way, by considering them in their fundamental elements. This mode of debate, which, it must be understood, was never the exclusive practice, gave place gradually to more impromptu efforts by less intelligent disputants.⁴ The society naturally became more irresponsible as the more moderate deputies and scholars withdrew, a process which has been described above.

Alexander Lameth, no doubt with a desire of shielding himself and his friends, ascribes the violence of the Jacobins to the policy of "pessimism" adopted by the court in filling the society with hotheads for the purpose of discrediting it.⁵ How much truth there is in this, it is difficult to determine, but it seems that the plan was at least seriously considered. It is only a part of Mirabeau's greater scheme for destroying the National Assembly by driving it to extremes.⁶ It is certain that the Jacobins at the beginning of 1791 believed that traitors had been introduced among them so that for a long time they considered the advisa-

¹ Michelet claims that Laclos as editor of the *Journal des amis de la constitution* used this newspaper in the interest of the duke. I confess I can not see the slightest evidence of this, especially since Laclos did little beyond publishing extracts from the correspondence of the affiliated societies.

² Bacourt, *Correspondance entre le Comte de Mirabeau et le Comte de la Marck*, II, 70. Cited in the following pages as "Bacourt."

³ Aulard, I, 1-9.

⁴ This tendency is very noticeable in the sources published by Aulard, volumes one and two.

⁵ *Histoire de l'assemblée constituante*, I, 424-25.

⁶ Bacourt, II, note 43.

bility of taking a vote of purification (*scrutin épuratoire*)¹ and that Desmoulins defended the moderation of Barnave in the address he had drawn up for the affiliated societies in March, 1791, on the grounds that its enemies were trying to destroy the society by means of its own excesses.²

But aside from these causes at work in destroying the moderation of the Jacobins, there were others more positive in their character and better established by evidence than is the assertion of Lameth. In the first place, toward the close of 1790 the atmosphere became overcharged with rumors of counter revolution which poured into the club from the affiliated societies and were spread in endless profusion by the papers of Desmoulins, Fréron, Carra, Prud'homme, and others. What more natural than that the Jacobins also should take fire? In the second place, Barnave has made an extremely important and instructive confession, one fatal to Lameth's statement, so far as its defensive character is concerned. He and his friends having for some time been occupied with committee work, Barnave found, upon his return to the general discussions, that the confidence the National Assembly had had in him and his popularity at large had been greatly weakened. To regain his lost ground he began his career of denunciation, so evident in December, 1790, and January, 1791, and which drew upon him and his friends the most venomous attacks of the pamphleteers and the opposing press.³

Until about April, 1791, Barnave and his friends succeeded in maintaining their ascendancy over the Jacobins, carrying the mass of the members with them in their fury of denunciation. Whether any members actually abandoned the society because of these excesses, as was claimed at the time, is difficult to determine, but it can not be doubted that many of its friends were disappointed and that it was ultimately injurious to the reputation of the society. Before the leaders became convinced of the pernicious influence they exercised, their enemies fell upon them with a fury even greater than their own. While some attacked

¹*Journal des amis de la constitution*, III, No. 35, note p. 330.

²*Révolutions de France et de Brabant*, VI, No. 68, 166.

³See pamphlets published by Aulard in volume two.

the society as a whole, others absolved the majority of its members, while fixing the blame upon the "Triumvirate."¹ These latter, like Mirabeau and Montmorin, set themselves the task of destroying the power of the leaders in the club, after which the other members might perhaps be directed to better objects.² As long as this attempt was evident as the work of the reactionary party, it could not fail to have an effect exactly the contrary to the one intended, for to be the object of attack from this quarter was to be designated as a good patriot. Much more dangerous were the maneuvers led by Mirabeau, aided by Montmorin and La Marck. Duport and Alexander Lameth, in their violent attack upon Mirabeau on February 28, 1791, had intended to drive him from the club, but failed completely. A burst of applause greeted Mirabeau's reply to his opponents, and his correspondence shows that he did not consider himself defeated.³ He knew that the position of the Lameths and their friends was not at all secure and that their very violence evidenced their embarrassment.⁴ But on March 2, an extremely clumsy act of Duquesnoy spoiled everything. Like Mirabeau and many others, Duquesnoy had been denounced by Lameth on the 28th of February and now had the evil inspiration of replying in a letter to the Jacobins, which seemed to them to divulge the plan they had so long suspected, namely, that an attempt was being made to divide the society. Duquesnoy openly praised the majority of the members but severely took to task the Lameths and their friends. "I will tell you, then," he wrote, "with the frankness appropriate for all, that the most dangerous enemies of liberty are those who, like M. Lameth, concealing a profound ambition under the mask of patriotism, regard the people only as a ladder upon which to mount to power. . . . The insupportable despotism of the MM. Lameths and of several of their friends has driven from

¹ See pamphlets published by Aulard in volume two.

² Bacourt, II, 384, note 45, December 4, 1790, and III, Mirabeau to La Marck, March 4, 1791, 78.

³ See the debate on the 28th of February, 1791, in Aulard, II, 95-113.

⁴ Bacourt, III, note 49, January 17, 1791. La Marck thought the Jacobin leaders on the verge of overthrow even in December, 1790. Letter to Mercy-Argenteau, December 30, 1790, Bacourt, II, 530.

your society some very ardent friends of liberty; the more one loves it [liberty], gentlemen, the more one hates every kind of domination; I call your own proud souls to witness. . . . Public opinion seems to-day to judge the men of whom I speak; when it shall be more strongly expressed, when those who dishonor your society shall be more universally judged, you will see all the friends of liberty reunite themselves to you, and the party spirit which now divides us and causes the misfortune of France will cede to the irresistible force of public spirit. . . . I have not in my whole life advanced a single principle, a single fact, which I ought to disavow. I place before you the most formal defiance for M. Lameth to cite a single one. I shall reply categorically to each one of them. I know my crime towards him: I have disdained to incline my head before his pride; I have loved for itself a revolution which gives me my rights and my happiness; I have refused to believe that it was the work of M. Lameth, and I have dared to say so. I know at what price I might have pleased him: I might have consented that the general system of liberty should receive a few exceptions in his favor.”¹

When Mirabeau learned of this he was in despair. “What I foresaw,” he wrote to La Marck, “has happened; the letter of Duquesnoy received at the Jacobins, I absent, raised them to the diapason of fury, and furnished M. Barnave the occasion for making a long enumeration of the services the MM. Lameth have rendered to the revolution, and to declare that they will perish together. Hence an ecstatic choir of applause, hence an insolent reply, hence especially the detestable consequence of uniting the Jacobins to their leaders instead of separating the leaders from the Jacobins as my measures were doing. I am indeed very discouraged, very embarrassed, very disappointed to have put myself forward so entirely alone.”²

The reply of the Jacobins to the letter of Duquesnoy, to which Mirabeau referred, was a resolution of confidence in the Lameths and their friends in which they showed at the same time that they were aware of the attempts made to disunite them. “The

¹ Aulard, II, 152-54.

² Bacourt, III, letter of March 4.

Society of the Friends of the Constitution," they declared, "knows all the measures which are being employed to mislead public opinion and divide good citizens. It knows the libels with which the capital and the departments are inundated, and it was not surprised to rediscover the language of them in the letter signed 'Duquesnoy.' As the only answer it declares that the declamations of the intriguers are in its eyes honorable titles for the friends of liberty; that the letter it has just heard read adds to its esteem and attachment for M. Alexander Lameth and for those who, like him, have begun the revolution and have sustained it without vacillating. It declares that all attacks upon individuals will serve only to bind closer the ties by which they are united in all parts of the kingdom."¹

This was the last triumph of the "Triumvirate."

It seems that Mirabeau and Montmorin intended to ask deputies of the center, such as D'André and Beaumetz, to return to the Jacobins, presumably to aid in overturning the leaders, but the Duquesnoy incident caused them to abandon this design.² Yet neither La Marck nor Montmorin shared Mirabeau's extreme discouragement, being convinced that the rule of the Jacobin leaders was near its end.³ "Moreover," wrote La Marck, "these [the Jacobin leaders] no longer sustain themselves except by the use of cordials, and such remedies have never cured those in their death agonies."⁴

Events soon justified this belief. Barnave and the Lameths with their friends had begun to fear the results of their own excesses and the "cordials" they had used were to prove a factor in their undoing, for the suspicions and passions they had helped to arouse overpowered them when they wished to allay them. Below them a group of radicals had formed in the society, ready to attack them at the first sign of weakness or the first opportunity that offered success. The character of the men in the society in the spring of 1791 was not that of the spring of 1790.

¹Aulard, II, 153-54.

²Bacourt, III, Montmorin to Mirabeau, March 3, 1791.

³*Ibid.*

⁴Bacourt, III 79, La Marck to Mirabeau.

The deputies were now greatly in the minority and ignorance had taken the place of enlightenment. The group of men who were to attack and displace the Jacobin leaders was largely composed of republicans, Brissot, Pétion, Robespierre, Robert, and a number of others who adhered to them. Camille Desmoulins, who was a special friend of Robespierre, belonged to the same group, but for a long time defended the Lameths because of their services to the revolution.¹ Of these, Brissot was the most dangerous opponent. He was the founder of the *Société des amis des noirs*,² and as editor of the *Patriote française* represented it in the press. To this society belonged such men as Mirabeau, Pétion, Condorcet, Sieyès, Lafayette, Abbé Grégoire, and Larochefoucauld. It was a combination of the *Amis des noirs* with the radicals and the right of the assembly which struck the decisive blow against the Jacobin leaders, enabled to do so through the long campaign of enlightenment waged by Brissot and the *Amis des noirs*. Brissot, whose enmity dated from the decree of March 8, 1790, relative to the colonies, allowed no opportunity of annoying them to pass.³

Through the agitation of the abolitionists and the principles announced in the declaration of the rights of man, grave troubles had arisen in the colonies between the planters, their slaves, and the free mulattos not possessed of political rights. It was a subject which called for delicate treatment by the National Assembly and which furnished its enemies a good occasion for embarrassing it. A great deal of hidden maneuvering seems to have been indulged in by both parties, the *Amis des noirs* and their supporters and the colonial deputies, the deputies of commerce, aided by a strong group in the Jacobin Club.⁴ Mosneron de l'Aunay read a paper at the society on February 26, 1790, in which he strove to answer the *Amis des noirs* upon the question of the abolition of the slave trade by admitting that it was wrong

¹ *Patriote française*, No. 656, May 26, 1791.

² Founded in 1787, a kind of French abolition society.

³ *Patriote française*, Nos. 515, 543, 545, 546, 553, 566, 582, 598, 609, and many others in 1790 and 1791. All those cited are in the first three months of 1791.

⁴ The leaders of the Jacobins, especially Barnave and the Lameths.

from the standpoint of principle, but argued that expediency was the guide for statesmen, and that expediency in this instance called loudly for a continuation of the trade; for, were it to be abolished, France, through the intrigues of England, favored by the resulting disorders, would lose her colonies. He therefore asked the society to declare, among other things, that it did not intend to extend its decrees to the colonies, in order to reassure the colonists by allowing them the initiative in legislation.¹ Mirabeau answered De l'Aunay the same evening, opposing the slave trade, but with what success is not known, nor do we know what action, if any, was taken by the society.²

That slavery and the slave trade were inconsistent with the principles of the National Assembly announced in the declaration of the rights of man was immediately apparent to everyone, and was freely admitted by De l'Aunay, and it was the constant fear of the colonists and of those in France directly interested in the colonies that the assembly would prove consistent. But many deputies preferred being inconsistent to being the cause of immediate disaster to France. Tallyrand, as president of the assembly, replied to a deputation which had asked for a continuation of the slave trade, slavery, and the prohibitive régime in force with regard to the colonies, that the assembly would know how to "conciliate the rules of prudence and justice with the principles of liberty."³ The subject came up in the assembly on March 2 when Grégoire, one of the most ardent *Amis des noirs*, read some papers from Martinique in his capacity as member of the com-

¹ Aulard, I, 9-17.

² This subject had long been agitated in the press, and many pamphlets and letters had been published upon it. De l'Aunay was a "député extraordinaire du commerce de Nantes," to the National Assembly, and he and his five colleagues applied to Le Roulx, deputy of Lorient, to present them to the Jacobins in order to read their address. Lorient being greatly interested commercially, Le Roulx readily gave his aid. This attempt was made toward the close of January, but for some unexplained reason, the reading of the address was postponed after permission had been received from the club. Even here "philanthropic ideas" were advanced against the granting of permission to read the address. Letter of Le Roulx January 23, 1790. MS. *Archives de Lorient*.

³ *Correspondance de Bretagne* (of the deputies of Rennes), No. 1, February 25, 1790.

mittee on reports.¹ It was imperative for the opponents of the *Amis des noirs* that the subject of slavery and the slave trade should never be discussed in the assembly as an independent question, for in that case there could be but one issue, the *Amis des noirs* would have had the best of the argument, and all France would soon have learned that the assembly had either sacrificed the colonies and many home interests connected with them or that it had formally contradicted one of its own most fundamental principles. The right foresaw this dilemma and was eager to drive the assembly upon one or the other of its horns. Maury said triumphantly, "I shall force you to decree the freedom of the negroes; it is a necessary consequence of your principles. Commerce will be ruined, bankruptcy will follow, and you will all be lost."² The right of the assembly and the *Amis des noirs* thus found themselves fighting for the same object, namely, to bring about a thorough discussion of these questions. But they were in the minority and outmaneuvered at the same time. Alexander Lameth interrupted Grégoire in his reading and moved that the matter be referred to a special committee on colonies. In the debate which followed upon this motion his party was victorious. Lameth, Barnave, and a number of the colonial deputies, who of course favored the plan, were appointed on the committee.³ On March 8, Barnave, as chairman of the committee, reported a plan which left the colonies under the existing régime until they themselves should undertake to change it, thus adopting the essential point in the proposition De l'Aunay had made at the Jacobins.⁴ No sooner had he concluded than came reiterated calls of "question! question!" Mirabeau, Pétion, Grégoire, who rushed to the tribune, failed to obtain the floor; the discussion was "closed" before it had been opened, and Barnave's decree passed.⁵ It was a typical Jacobin maneuver, later

¹ *Correspondance des députés du département d'Angers*, IV, 225-28, also *Correspondance de Bretagne*, supplement to no. III, 1790.

² Duquesnoy, *Journal*, II, bulletin of March 8, 1790.

³ See *Correspondance des députés du département d'Angers*, IV, 225-28. Also *Correspondance de Bretagne*, supplement to no. III, 1790.

⁴ Barnave's report with his introductory speech is given in the *Correspondance des députés . . . d'Anjou*, IV, 263-64.

⁵ *Bulletin de Brest*, volume for 1790, no. 29.

credited to Barnave alone, and one which his enemies never pardoned.

Barnave says in his *Mémoires* that his decrees upon the colonies gave him his popularity as well as robbed him of it.¹ With the more sane men, still dominant in the Jacobin Club, and at large his practical measures may well have won him support. Certain it is that he and the Lameths from this time on gained greatly in popularity and prominence and became the recognized leaders of the Jacobins from whom the formerly influential members were beginning to withdraw. A fresh discussion of the colonial difficulties found the Jacobin "Triumvirate" approaching the crisis of their career. If at the close of 1790 they had found it necessary to inaugurate a campaign of denunciation in order to sustain themselves, how much more was this necessary now when all appeals to moderation and prudence were regarded as evidence of perfidy or reaction. It was therefore extremely unfortunate for them that, at the very moment when they were attempting to retrace their steps, they should have been confronted with the necessity of defending a colonial policy which had now become unpopular. Thanks to Brissot, to Mirabeau, to the *Amis des noirs*, the affiliated societies and France generally had been enlightened upon the maneuvers that had resulted in the decree of March 8, and upon the inconsistencies of which the assembly had been guilty in passing it.² Some of the affiliated societies protested in addresses which Brissot printed with the intention of destroying his enemies.³ Then the society on March 11 adopted an address to the affiliated societies urging moderation, Brissot attacked Barnave, who had drawn up the address, ridiculing his language and condemning the advice it

¹ *Oeuvres de Barnave, mises en ordre et précédées d'une notice historique sur Barnave par M. Berenger de la Drome* (Paris, 1843), II, 366.

² After the decree of March 8, a part of no. CCXLVII of the *Courrier de Provence* was devoted to enlightening its readers upon this subject and the manner in which it had been disposed of. The *Amis des noirs* even addressed some of their literature to the societies affiliated to the Jacobins (*Patriote française*, nos. 607, 617).

³ See *Patriote française*, nos. 598, 602, 604.

contained as dangerous to the revolution.¹ Gorsas seconded Brissot and asked, "When will M. Barnave have done with these attempts to carry measures by storm?" referring to the manner in which the address was carried in the society and the decree of March 8 in the assembly.²

Despite the reassuring character of the decrees of the assembly the colonists had remained discontented, and Barnave and his supporters now urged that the declaration of non-interference be incorporated in the constitution in order that the status of the individual, the all-important question, might no longer be subject to regulation by mere legislative decree.³ The debate, extremely violent, was carried on simultaneously in the National Assembly and the Jacobin Club. Brissot, aided by Pétion, on May 11 found the courage to attack Barnave in the club but sustained a defeat.⁴ Two days later Robespierre and a certain mulatto continued the attack, this time with success.⁵ Charles Lameth, who tried to defend his party, was driven from the tribune with shouts of hostility.⁶ The next day they were defeated in the National Assembly also.⁷ On May 29, the conservative committee on correspondence, of which Barnave and the two Lameths were the most prominent members, was changed.⁸

With the fall of the "Triumvirate," the Jacobin Club lost the only element which could still have directed it along moderate lines and preserved it from the excesses which were later to give

¹ Aulard, II, 189-92. Address given on pp. 185-89. Aulard does not assign any definite date to the address, but the *Feuille du jour*, no. 76, states that it was adopted on March 11.

² *Courrier de Paris*, XXII, no. 13.

³ *Moniteur*, VII, no. 128.

⁴ This fact is given in the *Lendemain*, May 13, 1791, and *Feuille du jour*, May 14, 1791, both opposition papers, but there seems no good reason for rejecting the evidence in this case, especially since both journals seem never to have invented the bare facts although they frequently distorted them. It should be added that from the similarity of their accounts it is clear that these two journals used a common source in nearly everything they published relative to the Jacobin meetings.

⁵ Aulard, II, 412-15. Accounts taken from *Journal de la révolution*, May 15, 1791, and *Le Lendemain* of the same date.

⁶ *Le Lendemain*, May 15, 1791.

⁷ *Point du jour*, XXII, no. 673.

⁸ *Courrier de Paris*, by Gorsas, XXIV, no. 31.

it such an odious reputation. Although no deputies at this time formally severed their connection with the society, few continued to attend its meetings. This was the moment of the real secession of the deputies, although the formal declaration of separation was not made until the 17th of July following.¹ There was no change of constitution, but the society from now on no longer remained true to its original aims, namely, to sustain and popularize the work of the National Assembly.

Of the character of the debates and the composition of the society about this time several witnesses have left us contemporary or almost contemporary accounts. The deputies of Maine et Loire, writing to the Friends of the Constitution of Angers, July 20, 1791, give such a vivid picture of conditions in the society that I quote them at length. "The undersigned, deputies of Maine et Loire," they wrote, "all founders or members of the Club of the Friends of the Constitution at the Jacobins of Paris, believed that it was their duty to separate themselves from it last Saturday with almost all their colleagues; [of the National Assembly] only four or five remained. They thought that it was no longer appropriate for them to remain in an association of which they were believed to have the direction and the majority, when that same association, formerly so useful for the destruction of tyranny and the reedification of a regular government based upon reason, has come to be guided by a crowd of foreigners who have obtained admittance, who have nothing to lose, and of whom the major portion is paid by these same foreigners who desire absolutely to cause our revolution to fail like that of Brabant. From that time, this assembly presented only the image of an assembly of furies who believed they could be useful to the country only in preaching disorder and anarchy and in degrading all authority by causing the people to destroy them and who not only for six weeks or two months suffered the expression of but one opinion, reasonable or not unless it were incendiary, but even drove out with violence members who expressed an opinion contrary to the one our most cruel enemies could most desire because it evidently led us to civil war. Never-

¹Aulard, III, 30.

theless, we do not pretend that the club is composed entirely of men such as we have described; indeed, a very large portion of the members not deputies to the National Assembly have withdrawn from the club, and among those who show themselves the most fanatic there are unquestionably many honest and estimable citizens who, not having studied mankind sufficiently and estimated the elements which ought to compose a government, although these elements are everywhere the same, because reason is indivisible, ought nevertheless to be differently combined according to the country, the population, the customs, language, civilization, wealth, commerce, etc., and, allowing themselves to be drawn on by a just indignation, think only of a vengeance which is without doubt very legitimate, but not thinking that long years of frightful misfortunes and the loss of liberty will be the necessary consequences of their action. These persons, misled by detestable men who profit by the inconsiderate ardor of noble and generous souls, make of them the instruments of their ambitious projects and seek by their aid to open the door to the most unbridled factions."¹

One might suspect from the tone of this letter that the writers exaggerated the faults of the society in order to better justify their own action in withdrawing from it, but, unfortunately, their testimony is only too well borne out by that of the intelligent Prussian, Conrad Oelsner, who was a member of the club and reasonably free from partisanship.² Most convincing, however, is the official record of the club itself giving the outline of the debates beginning with June 1, 1791.³ In reading this, one is tempted to believe the accounts of their meetings given in the

¹*Journal du département de Maine et Loire*, published by the *Amis de la constitution* of Angers. Bib. Nat. Lc. ⁰/229.

²Luzifer oder Gereinigte Beiträge zur Geschichte der französischen Revolution. Erster Theil (1797), 160. Among other things he wrote in the spring of 1791: Es hat sich eine Menge rollelustiger Glücksritter und Ehrgeiziger angedrängt, die, um zu Kredit zu gelangen, einen schreienden Patriotismus affichirt und zu jedem ausschweifenden Projekte die Hand bietet. Tumult und Bitterkeiten ersticken die Stimme der aufgeklärten Mässigung, und haben viele scharfsehende, aber furchtsame oder zu un-rechten Zeit empfindliche Leute verscheucht, etc.

³*Journal des débats de la société des amis de la constitution, séant aux Jacobins, à Paris*. Republished by Aulard, II.

hostile journals, *Le Lendemain* and *Le Feuille du jour*, often the only record we possess before the official journal just mentioned was published.

The Jacobin leaders were driven from the club because they were no longer in sympathy with it. They had been true, in outward form at least, to the published principles of the society; whereas the radicals who had succeeded them in the favor of its members had come to regard the assembly as reactionary and not to be trusted. But it was not until the flight of the king that the society assumed an attitude that forced the deputies to withdraw from it in order not to appear in a false light. The constitution was monarchical and almost all the deputies were monarchists. The Jacobins also were avowed monarchists, although they had long ceased to show monarchical sentiments in their discussions. Many had expressed their bitterness against the ministers and all the other servants of the king, but either through policy or an irrational sentiment excused the king himself. The king was eternally the dupe of his counsellors. The flight of the king to Varennes was more, however, than most of the Jacobins were able to excuse upon this theory, and the question as to what should be done with the king was openly brought to discussion.

But the deputies who had informally withdrawn made one more effort to regain control of the society, making the flight of the king the occasion for the attempt. This attempt was foreseen by the man, perhaps, most interested, Robespierre, who successfully defeated it. The Jacobins had met at noon on the 21st of June, 1791, in extraordinary session, with all excitement studiously suppressed, as it was in the whole of Paris. For once the agitators now in possession intended to aid in preventing disturbances, and sent out some of its members to preach peace and calm in the public places.¹ The entrance of Robespierre, fresh from the National Assembly, changed the entire tone of the meeting, which now became intensely dramatic. Robespierre represented France as in the greatest danger, not because the king had fled to return at the head of a foreign army, but be-

¹ Aulard, II, 532.

cause of the friends he had left behind, many of whom it was impossible to distinguish from the patriots. "What frightens me most," he exclaimed, "is that which seems to reassure everyone else. . . . It is that this morning all our enemies speak the same language as ourselves. All are reunited, all wear the same countenance." The minority long since and the entire National Assembly with its committees had shown by its action that morning that it was in the plot with the king for the destruction of liberty. "And as if this coalition were not enough, I know that presently it will be proposed that you unite with all your most notorious enemies; in a moment, all of '89, the mayor, the general, the ministers, it is said, will arrive! How can we escape?" He concluded by saying that he knew that in the denunciations he had just made he had drawn a thousand assassins upon himself, but he would receive death almost as a blessing because it would spare him the sight of the evils he saw were inevitable. Upon this, the eight hundred or more members present arose and swore that they would sacrifice their lives in protecting him.¹

As Robespierre concluded, the arrival of the deputies was announced, whereupon Danton sprang to his feet and exclaimed: "Gentlemen, if the traitors present themselves here I take the formal engagement with you to leave my head upon the scaffold or prove that theirs ought to fall at the feet of the nation they have betrayed." Seeing Lafayette among those who had entered, he violently apostrophised him, going over the entire list of grievances the radical members of the club had long held against him. "And you, M. Lafayette, who only recently responded for the person of the king with your head, do you pay your debt in appearing in this assembly? You have sworn that the king would not depart. Either you have betrayed your country or you are stupid in having answered for a person for whom you could not answer. In the more favorable case, you are declared incapable of commanding us. . . . France can be free without you. Your power weighs upon the eighty-four departments. Your reputation has passed from pole to pole. Do

¹ *Révolutions de France et de Brabant*, no. 82. Aulard, II, 553.

you wish to be really great? Become a simple citizen again, and no longer nourish the just distrust of a large portion of the people."¹

A strange spectacle followed this attack of Danton. Alexander Lameth, whose thundering anathema had on the 28th of February preceding fallen on Mirabeau and Lafayette alike, now stepped forward in the latter's defense. "I have always regarded M. Lafayette as one of the firmest supports of the constitution," he said, "and although I have often blamed his conduct and under some circumstances spoken of him perhaps with bitterness, I have told M. Danton himself that if the constitution were in danger Lafayette would die for it sword in hand. . . . It is necessary to abjure all hate, cause every division to cease, in order to disconcert all the maneuvers of the enemies of liberty and march with a sure and firm step to the completion of the constitution."²

After Lameth, the proud Lafayette, whom neither prayers nor denunciations had moved to return to the Jacobins, humiliated himself in attempting a defense before those whom he despised. He spoke but a few very unsatisfactory words. Sieyès was more successful in explaining away a certain address of his, very obnoxious to the Jacobins, and Barnave succeeded in another "Triomphe d'assaut" in causing an address to the affiliated societies, drawn up by himself, to be adopted, in which it was said that "All divisions are forgotten, all patriots are reunited. The National Assembly is our guide, the constitution our rallying cry."³

This address, the official attitude of the club only in form, must not be allowed to mislead us. The debates in the club show us that this attempted reunion was a complete failure. The deputies, if they ever returned in any considerable number, remained silent and without influence.⁴ Lafayette, whose answer

¹ *Révolutions de France et de Brabant*, no. 82. Aulard, II, 553.

² *Ibid.*, II, 536.

³ Aulard, II, 538.

⁴ See the debates during the latter part of June and the beginning of July as given in the official journal republished by Aulard, II. A few of the

to Danton was considered very unsatisfactory, refused the invitation to come to the club and make another.¹ The society continued its tumultuous sessions as before, inclining more and more to the view that the king had forfeited his right to the throne—that is, taking a position more and more in opposition to the National Assembly—until, on the 17th of July, 1791, the deputies who were still nominally members of it formally withdrew and formed the new society of the Feuillants.

more radical deputies had always remained with the club, and on June 29 Charles Lameth is mentioned in the debates as objecting to some remarks of Anthoine against certain persons whom he did not name, but received little applause and a great many "*murmures*" ("*murmures excessifs*").

¹ Aulard, II, 547.

III.—On the Substantivation of Adjectives in Chaucer

BY ARTHUR GARFIELD KENNEDY

INTRODUCTION

The substantivation of adjectives in English has, like most other processes of our language, been so gradual that it is difficult to fix the beginning of it in the case of any particular word or group of words, or at any one time to measure accurately its progress. Perhaps the most satisfactory results are obtained by comparing the data made up from the writings of authors of different periods. This investigation is offered as a study of the process of substantivation of adjectives in the fourteenth century, as shown in the writings of Chaucer.

Kellner¹ names three ways in which adjectives become substantivized: first, the quality of a thing is so striking that the name of the adjective is adopted for the substantive itself. So *gold* was originally 'the yellow metal,' *wheat*, the 'white grain,' etc. Secondly, ellipsis may bring about this process of substantivation. Since the adjective conveys the idea of the noun to which it is attached, the noun is dropped. So we have *the Almighty*, *a saint*, *a sage*, *the good*, etc. Finally, adjectives are used as substantives when they denote abstract ideas, as *good*, *evil*, *ill*, etc.

Adjectives may be used in different degrees of substantivation. One usage which was quite common a few centuries ago was that in which the adjective modifies a preceding noun. When Chaucer says, "A true swynk and a good was he," we feel that *good* is, at least partially, a substantive. Again, the use of the

¹ *Outlines of English Syntax*, pp. 144-50.

adjective with *one* has gradually become more common. To say "the bravest one I ever knew" is quite in keeping with modern usage. The most complete substantivation, however, requires no other word for the adjective to lean upon. Thus we say, the *good*, the *true*, the *beautiful*, the unknown *dead*, for 'goodness,' 'truth,' 'principle of beauty,' etc.

It is not the purpose of this paper to enter into a discussion of the causes and beginnings of this process of substantivation. The most probable cause seems to be that of the force which Professor Paul¹ calls "economy of expression." It would seem the most natural thing to abbreviate *the noble people* to *the noble*, or the Old English *se betsta guma* to *se betsta*, especially if the expression is so common that no one would misunderstand it. This seems especially probable when we note that most of the substantivized adjectives in the *Beowulf* and the earlier English literature are personal substantives.

SUBSTANTIVATION OF ADJECTIVES IN OLD ENGLISH

Many words which are nouns, pure and simple, in Chaucer's day, have been developed from earlier adjectives or participles. As examples we have *strete*, from Latin *strata via*; *mile*, from Latin *milia passuum*; *friend*, for Gothic *frijonds*; *side*, for Old English *sīd*; *wheat* and *gold* have been mentioned; and many others might be cited.

In the *Beowulf* we find the prevailing usage,—the adjective for the person described:

Hāfde se *goda* cempan gecorone, l. 205. Cf. also 355, 676, 1191, etc.—Gewat him þa se *hearda*, l. 1964. *hares* hyrste Higelace bār, l. 2988.—on þām se *rica* bād, l. 310.—Nāfre ic *maran* geseah eorla ofer eorðan, ll. 247–48.—cwæð þāt se *almightiga* eorðan worhte, l. 92.—þāt he on eorða geseah þone *leafestan* lifes āt ende, l. 2834.

Gradually, after the Anglo-Saxon period, we find a broadening in the use of substantivized adjectives. Many examples ap-

¹*Principien der Sprachgeschichte*, p. 263.

pear in Chaucer of words of French origin which seem to have been used substantively for a long time. As examples Einkenel¹ gives the following:

laxatyf, equinoxial, digestives, necessities, mocubles, contraries, the suffrant, his pacient, this innocent, pen-etentys, nobles, etc.

II. SUBSTANTIVATION OF ADJECTIVES IN CHAUCER

For a proper appreciation of the substantivation of adjectives in Chaucer we must consider examples of all three usages, namely, qualifying a preceding noun, with *one*, and without *one*, as a pure substantive. Then a comparison can be made with reference to the relative importance of the three in Chaucer's time. Also it might be of interest and profitable to compare the use of positives, comparatives, and superlatives in this respect. The syntactical relations of substantivized adjectives seem to demand consideration. In what constructions do we find them prevailing? Do they appear in any special constructions in Chaucer? Finally, and of some importance it seems to me, are the questions and theories relating to the beginnings of this process of substantivation. Is it a native tendency or does it come into the language through some foreign influence? Are the adjectives so substantivized largely native words or foreign? Perhaps a careful comparison of the two elements will throw a little light on the subject of the origin of adjective substantivation.

Einkenel makes a distinction, which might well be kept in mind all through the consideration of this subject, between adjectives previously, and hence thoroughly, substantivized, and those which are substantivized merely for the occasion. For instance, we think of *nobles* as a pure noun but the *wise* as a temporary substantive only. This distinction will be touched upon again, however.

¹*Streifzüge durch die Mittelenglische Syntax.*

A. Semi-substantivized adjectives referring to preceding nouns.

This use of the adjective is quite common in Chaucer. No attempt will be made to cover the field entirely, but simply to give illustrations which seem most characteristic.

A thief he was, forsoth, of corn and mele, And that a *sleigh*. Reeves Tale, 20.—A true swynk and a *good* was he. Cant. Tales: Prologue, 531.—of Gamelyn the *bolde*. Tale of Gamelyn, 290.—of Gamelyn the *yonge*. *ibid.*, 342.—At the root of Vesulus the *colde*. Clerkes Tale, 2.—this January the *olde*. Marchaundes Tale, 798.—For sche was on the *fairest* under sonne. Frankelynes Tale, 6.—Ther was a monk, a fair man and a *bold*. Schipmannes Tale, 25.—but a governour, a *wily* and a *wyse*. Prologue of Monkes Tale, 52.—this Seneca the *wyse*. Monkes Tale, 525.—To Cupido the *recheles*. Hous of Fame, Bk. II. 160.—Gaweyn the *worthy*. Romaunt of the Rose, 2209.

B. Substantivized adjectives used with *one*.

This use of the adjective is very limited in Chaucer. And not only are there few examples of it, but there is not much variety in the adjectives so used. Varying forms of our modern *such* appear most common.

That han *swich oon* icaught withouten net. Troylus and Cryseyde, Bk. II. 583.—To slane *swice oon*. *ibid.* Bk. II. 265.—I am *oon* the *fayreste*. *ibid.* Bk. II. 746.—with *swich oon* as he is. *ibid.* Bk. V, 740.—For I have falsed *oon* the *gentileste* and *oon* the *worthyeste*. *ibid.* Bk. V. 1050.—that betrisshed *many oon*. Romaunt of the Rose, 1648.—Thou herdest never *sich oon*, I trow. *ibid.* 5409.—Ymaginyng that travaille nor game Ne myghte for so *goodely one* be lorne. Troylus and Cryseyde, Bk. I. 372.—As help me God I was a *lusty one*. Prologue of Wyf of Bathe, 605.

Einenkel¹ gives the last two examples and adds, "Dies sind die beiden einzigen Fälle wo ich das Zahlwort beim positiven Adjectiv entdecken konnte. Sein eigentlicher Platz ist beim Superlativ." Illustrative of the latter statement he gives the following:

¹ *Streifzüge durch die Mittlenglische Syntax*, p. 27.

A maide *oon* of this worlde the *best* *preysed*. Troylus and Cryseyde, Bk. V. 1474.—Of hire delite or joies *oon* the *leste*. *ibid.* Bk. III. 1261.—For sche was *on* the *fairest* under sonne. Frankleynes Tale, 6.

Examples might also be given of the use of adjectives with other weakened substantives such as *man*, *woman*, *thing*, etc. Often with these words, just as with *one*, the adjective becomes slightly substantivized. In the case of most of these, however, the substantivization is not far enough advanced to make them worthy of special comment.

C. Substantivized adjectives used without *one*.

Adjectives substantivized without the aid of *one* are very common in Chaucer. Of course there are varying degrees of substantivization. Sometimes we feel that the adjective force of the word has largely been lost sight of, as in *nobles*, *gentils*, or *goode* (meaning property), *at last* (used adverbially), *elders*, etc. At other times the word is little more than an adjective, even though it stands in the place of a noun.

1. As personal substantives in singular and plural (without *-s*). This use of the adjective is very common. In a comparatively thorough examination of Chaucer I have noted 137 examples, including 66 different forms.

Of the plural personal substantives the following are good examples:

to visit the *ferrest* in his parrische. Cant. Tales Prologue, 493.—We will slee the *gultyf*. Cokes Tale of Gamelyn, 822.—Herkneth what is the sentens of the *wyse*. Man of Lawes Tale, 15.—Faire they were welcomed, bothe *leste* and *meste*. Cokes Tale of Gamelyn, 460.—That at the fest leet slee bothe *more* and *lesse*. Man of Lawes Tale, 861.—And further goeth all the contre bothe *moste* and *leste*. Court of Love, 1431.—Sche was not with the *leste* of hire stature. Troylus and Cryseyde, Bk. I. 281.—he commendeth with the *beste*. Man of Lawes Tale, 76.—and bothe of *yonge* and *olde* Ful wel beloved. Troylus and Cryseyde, Bk. I. 129.—“Trentals” sayd he, “delyvereth from penance Her frendes soules as *wel eld* as *yonge*.” Sompnoures Tale, 16.—Therefore

she stood in love and grace Of *riche* and *poore* in every place. Romaunt of the Rose, 1169-70.—Born of the *gentilest* and the *heighest* of this land. Clerkes Tale, 75.—he wil not visite the *sike*. Persones Tale.—And ponysche . . . the false *untrew* Court of Love, 582.—she pleyeth with *fre* and *bonde*. Troylus and Cryseyde, Bk. I. 840.—*Lered* or *lewde* lord or lady. Romaunt of the Rose, 6620.—Whereso thou comest, amonges *heih* or *lowe*. Maunciples Tale, 257.—alle the *grettest* that were of that land. Tale of the Pardoner, 145.—Men seyn the *suffrant* overcomth, *parde*. Troylus and Cryseyde, Bk. IV. 1556.—For he nought helpeth the *needful* in his need. Man of Lawes Tale, 14.

So also we find *gulteles*, *all wofulle*, *the meekest*, *the unworthieste*, etc.

Of the use of the adjective as a singular personal substantive we find many examples.

I not which was the *fairer* of hem two. Cant. Tales: Prologue, 190.—*Feirest* of alle that ever were or be! Court of Love, 631.—*Best* unto *best*. *ibid.* 594.—So stant this *innocent* before the king. Man of Lawes Tale, 520.—I have a wyf, the *worste* that may be. Prologe of Marchaundes Tale, 6.—The foul royal above yow in degree The *wyse* and *worthy*. . . . Assembly of Foules, 395.—This *yongest* which that went to the toun. Tale of the Pardoner, 375.— . . . the *Romayn*, Galien Ne dorste never been so corageous, Ne noon *Ermyn*, ne noon *Arabien*, Ne *Surrien*, ne noon *Egipcien*. Monkes Tale, 348.—But if for love of som *Troyan* it were. Troylus and Cryseyde, Bk. V. 877.—though that be true, my *dere*. Court of Love, 173.—That every yere wolde have a *newe*. Hous of Fame, 302.—and she was holden there A *seint*. Legende of Lucrecie, 192.—the *worthieste* of knyghthode . . . of blode the *gentyleste*. Assembly of Foules, 548.—ye lovers, for the *konnyngeste* of yow. . . . Troylus and Cryseyde, Bk. V. 331.—a *coveytous* and a *wriche*. *ibid.* Bk. II. 1324.—Tellynge his tale alway, this olde *greye*. *ibid.* Bk. IV. 99.—Now writeth, *swete*. *ibid.* Bk. V. 1399.—The *formest* was alway behynde. Boke of the Duchesse, 889.—*Humblest* of herte, *higheste* of reverence. Complaynte Unto Pite, 57.—Now faire *blisfulle*, O Cipris. Troylus and Cryseyde. Bk. II. 10.—But nothing thinketh the *fals* as doth the *trew*. Anelyda and Arcite, 168.—In love a *fals*er herde I never none. Legende of Phillis, 5.—The *stronge* the *feble* overgoth. Romaunt of the Rose, 6823.—He kepte his *pacient* wondrously wel. Cant.

Tales: Prologue, 415.—The neye *slye* maketh the ferre *leef* to be loth. Milleres Tale, 206.—Ne never saugh I a *more bounteous* . . . ne a *more graciously*. Troylus and Cryseyde, Bk. I. 883.—And therto I saugh never a *less Harmful* than she was in doinge. Boke of the Duchesse, 993.—Emelye, the *rewfullest* of al the companye. Knyghtes Tale, 2028.

2. As personal substantives in plural (with -s). As we would naturally expect, the use of adjectives in this way is very much limited. For an adjective must be pretty thoroughly substantivized before we can feel free to decline it in the plural, as we do other nouns. The best examples, and in fact almost the only ones, are the following:

As custom is unto these *nobles* alle. Marchaundes Tale, 645.—And he forth the *seyntes* ladde. Secounde Nonnes Tale, 369.—There *saintes* have here comyng. Court of Love, 120.—right anoon the *gentils* gan to crie. Prologue of the Pardoner, 37.—Of honoures thatoure *eldres* with us lefte. Monkes Tale, 208.—By God and by his *halwes* twelve. Boke of the Duchesse, 830.—To *innocents* doth such grevance. Romaunt of the Rose, 4273.—And the *seculars* comprehende. *ibid.*, 7175.—Brynge us to that paleyce that ys bilte To *penytentys*. Chauceres ABC:Z.—And after hem of *comunys* after here degre. Knyghtes Tale, 1715.

3. As abstract nouns in singular. The class of adjectives used by Chaucer as abstract nouns is by far the largest of all. While it is, perhaps, hardly necessary to give examples of all, out of the sixty different adjectives which I have noted under this head, we may consider a few of the most typical. One very important division of this class is made up of color adjectives. Of these *green* is used most frequently.

And Emelye, clothed al in *grene*. Knightes Tale, 827.—Twenty bokes clad in *blak* and *reed*. Cant. Tales: Prologue, 294.—of fyn scarlett *reed*. *ibid.* 457.—A long surcote of *blue*. *ibid.* 611.—A marchant was ther . . . in *motteleye*. *ibid.* 271.—They gloweden betwixe *yolw* and *reed*. *ibid.* 1274.—With face deed, betwyxe *pale* and *grene*. Anelyda and Arcite, 356.

Of all the abstract adjective substantives *good* is used most commonly:

and doon us som *good*. Cokes Tale of Gamelyn, 664.—And ches the *best* and lef the *worst* for me. Knyghtes Tale, 756.—And bad him doon his *best*. Cokes Tale of Gamelyn, 238.—That yeveth hem ful ofte in many a gyse Wel *better than* they can hemself devyse. Knyghtes Tale, 1253.—I recche naught what *wrong* that thou me profre. Secounde Nonnes Tale, 489.—He thar nat weene that *evyl* doth. Reeves Tale, 400.—Who hath the *worse* . . . ? Cant. Tales: Prologue, 490.—By alle *right* it may do me no shame! Troylus and Cryseyde. Bk. II. 763.—And al his *erdest* turneth to a jape. Milleres Tale, 204.

This last is one of Chaucer's favorite expressions. The combinations, *erdest* and *jape*, or *erdest* and *game* occur very often.

Nature, the vyker of thalmyghty Lorde, That *hoot, colde, hevvy, lyght, moist* and *drye* Hath knyght. Assembly of Foules, 397.—but of myn oughne *sore* . . . I telle may no more. Prologue of Marchaundes Tale, 31.—for *foule ne faire*. Man of Lawes Tale, 426.—Leving the *streight*, holding the *large*.—Other combinations are *good* or *ille*; *softe ne sore*; *schort* and *plain*; *heigh* or *lowe*; *colde* or *hote*.

He had a jape of malice in the *derk*. Cokes Prologue, 14.—For unto him it is a bitter *swete*. Prologue of the Chanonnes Yeman, 325.—Your *bittier* tornen into swettenesse. Troylus and Cryseyde Bk. III. 130.—Or Cecile is to saye, the waye of *blynde*. Secounde Nonnes Tale, 92.—As shulde a maister of *dyvyn*e. Romaunt of the Rose, 6490.—Her heed for *hore* was whyte as floure. *ibid.* 356.

Other examples of this usage are: the *contrary*, a *litel*, *grete* (for greatness), *mene*, *newe*, the *revers*, *faire*, *untrewe*, *quiete*, *veyne*, *unright*, *remenaunt*, *wery* (for weariness); *large*, *harde* (for hardship).

We find quite frequently the proper adjective used as the name of a language.

Naught wist he what his *Latyn* was to saye, Prioresses Tale, 71.—And for ther is so grete *dyversite* In *Englissche*, and in *wrytynge* of our tonge. Troylus and Cryseyde. Bk. V. 1807.

A large number of adjectives are found as objects of prepositional phrases and are so plainly adverbial as to require special treatment. No doubt they were at first abstract nouns, but the adjective force seems very largely to have disappeared even in Chaucer's time. For examples of such usage see II. E. 5.

4. As abstract nouns, in plural (with -s). As in the case of personal substantives with -s, we find that examples are not so common. Only a limited number of abstract adjective substantives seem to have arrived at that stage where they could be pluralized as nouns.

By certeyn *means*. Man of Lawes Tale, 382.—or ye have your *rightes*. Marchaundes Tale, 418.—But thilke *wronges* may I not endure. Secounde Nonnes Tale, 491.—schewynge me the perils and the *evils*. Tale of Melibeus.—the grete *goodes* that comen of pees. *ibid*.

5. As neuter concrete nouns. Adjective substantives used as neuter concrete nouns are found very frequently in Chaucer. Of these only ten, however, are used in the plural.

Whanne wille and *goodes* ben in comune. Romaunt of the Rose, 5209.—And *deyntes* mo than I can of devyse. Man of Lawes Tale, 321.—The somme of fourty pound anoon of *nobles fette*. Chanounnes Yemannes Tale, 353.—Sith thus of two *contraries* is a lore. Troylus and Cryseyde. Bk. I. 645.—the rentes and *rightes*. Persones Tale.—feldes and *playnes*. Hous of Fame, 389.—Such maner *necessaries* as ben plesynges. Man of Lawes Tale, 613.—A day or tue ye schul have *digestives* Of wormes, er ye take your *laxatives*. Nonne Prestes Tale, 141.—And him she yaf her *moeubles* and her thing. Tale of Melibeus.

Of examples in the singular we may easily make two classes, namely, those which are so thoroughly substantivized as to have a nominal function without the context, and those which depend upon the context for their substantive value. It is, of course, only from nouns of the former class that plurals are made. Most common of this class is the word *good* (meaning 'property').

to yive a penny of hir *good*. Freres Tale, 277.—Than in the Tour the *noble* iforged newe. Milleres Tale, 10.—That day that I shall drenchen in the *deepe*. Man of Lawes Tale, 357.—Thay doon a grete *contrarie*. Romaunt of the Rose, 4478.—Thou darst nat standen by thy wyves *right*! Monkes Prologue, 24.—the dyche over the *pleyne*. Romaunt of the Rose, 4202.—And woneden so neigh upon a *grene*. Legende of Thisbe, 7.—For Goddes sake as take som *laxatuf*. Nonne Prestes Tale, 123.—By nature knew he each ascensioun of *equinoxial*. in thilke toun. *ibid*. 35.

Of the following the substantivation depends upon the context:

Which that hath the *schortest* schal begynne. Cant. Tales: Prologue, 836.—And cowde a *certeyn* of conclusiouns. Milleres Tale, 7.—of stedes in my stalle Go chese thee the *best*. Cokes Tale of Gamelyn, 180.—For trusteth wel it is an *impossible* That any clerk schal speke. Prologue of the Wyf of Bathe, 688.—al the *revers* seyn of his sentence. Nonne Prestes Tale, 157.—Of alle happes the *alderbest*, The *gladdest* and the moste at reste. Boke of the Duchesse, 1278.—And if the *next* thou wolt forsake. Romaunt of the Rose, 2822.—Peyne the not eche *crooked* to redresse. Good Counseil of Chaucer, 8.

In addition to the above examples, the following also occur: *worst*, *lesse*, many *smale* maketh a *gret*, with the *first* and with the *best*, the *remenant*.

6. Numeral adjectives as substantives. The use of the numeral as a substantive is very common in Chaucer.

(a) Numerals used as personal substantives.

to that *on* as well as to that *other*. Cokes Tale of Gamelyn, 39.—(Chaucer's use of these two words would indicate that even in the XIV century very little of their numerical value remained.) Adam felde *tweyne* and Gamelyn felde *thre*. *ibid.* 593.—a *thousand million* rejoising love. Court of Love, 589.—*on* of the *tweye*. Troylus and Cryseyde. Bk. I. 493.

(b) Numerals used adverbially.

they dalten it in *two*. Cokes Tale of Gamelyn, 45.—and then at *erste*. Troylus and Cryseyde. Bk. IV. 1293.—and parted hem in *four*e anoon. Romaunt of the Rose, 7749.—As though your herte anoon in *two* wolde breste. Praise of Women, 58.

(c) Numerals referring to time.

Er it be fully *prime* of day. Tale of Sir Thopas, 114.

7. Pronominal adjectives as substantives.

Mystruste *alle* or elles *alle* leve. Troylus and Cryseyde. Bk. III. 688.—And he that mover is of *alle*. Hous of Fame. Bk. I. 81.—*Fewe* was ther that night that slept. Swich an *other* for to make. Hous of Fame. Bk. III. 81.

Many illustrations of the use of *oon* and *other* as pronouns can be found.

D. Substantivation of superlatives and comparatives.

In addition to the use of adjectives in the positive degree many comparatives and superlatives are found to be substantivized by Chaucer.

1. Comparatives.

Ne never saugh I a *more bountevous* Of hyre estate ne *gladder* nor of speche A *frendlyer*. Troylus and Cryseyde. Bk. I. 883.—Of harmes the *lesse* is for to chese. *ibid.* Bk. II. 470.—In love a *false* herde I never none. Phillis, 5.—Of honours that oure *eldres* with us lefte. Monkes Tale, 208.—That at the fest leet slee both *more* and *lesse*. Man of Lawes Tale, 861.

2. Superlatives.

to the *lest* and to the *meste*. Squyeres Tale, 292.—*best* unto *best*. Court of Love, 594.—Emelye, the *rewfullest* of alle the companye. Knyghtes Tale, 2026.—He that semeth the *wisest*, by Jesus, Is most fool. Born of the *gentilest* and the *heighest* Of al this land. Clerkes Tale, 75.—I am oon the *faireste*. Troylus and Cryseyde. Bk. II. 746.

It is to be noted that the use of comparatives and superlatives with *one*, a very common usage in modern English, is seldom seen in Chaucer. Probably not more than a half dozen examples are to be found. Of special interest in this connection is the following statement by Dr. Louise Pound,¹ "Examples of the substantivation of comparatives and superlatives as personal substantives through *one* are not frequent even in the last half of the sixteenth century, when it was very common with the positive. Dr. Gerber, investigating fifteenth and sixteenth century English, finds but one example."

¹*Comparison of Adjectives in English in the XV. and the XVI. Century*, p. 64.

E. The Syntax of substantivized adjectives.

Chaucer uses his adjective substantives, as a general rule, just about as he uses other nouns. Certain peculiarities of usage we may note specially.

1. General uses:

(a) As subject of a verb.

Now *foule* falle hire for thi wo and care. Troylus and Cryseyde. Bk. IV. 434.—*good* and wikkednesse ben two contraries. Tale of Melibeus.—The *stronge* the feble overgoth. Romaunt of the Rose, 6823.

Adjectives thus substantivized are used very often in apposition to the subject.

Faire they were welcomed, bothe *leste* and *meste*. Cokes Tale of Gamelyn, 460.—Ful besily they wayten, *yonge* and *olde*. Squyeres Tale, 80.

(b) As the object of a verb.

A! wolde ye nowe repent and love some *newe*? Court of Love, 462.—and sauf your feithful *trewe*. *ibid.* 993.—That any clerk schal speke *good* of wyves. Prologue of Wyf of Bathe, 689.—So that ye offren *nobles* or starlings. Prologue of Pardoner, 445.

(c) As the predicate noun.

he is the *worthyeste*. Troylus and Cryseyde. Bk. II. 739.—For trusteth wel, it is an *impossible*. Prologue of Wyf of Bathe, 688.

(d) Traces of the old partitive genitive are shown still in a few expressions:

I am a sede foule, oon the *unworthieste*. Assembly of Foules, 512.—And yet was he, wher-so men went or riden Found oon the *fairest* under sonne. Troylus and Cryseyde. Bk. I. 493.—For sche was oon the *fairest* under sonne. Frankeleynes Tale, 6.—I have the most stedefast wyf And eek the *meekest* oon that bereth lyf. Marchaundes Tale, 307.—I am oon the *faireste* out of drede. Troylus and Cryseyde. Bk. II. 746.

(e) As the object of a preposition:

To make him lyve by his propre *good*. Cant. Tales: Prologue, 581.—As custom is unto these *nobles* alle. Marchaundes Tale, 645.—Uproos the oon of these olde *wise*. Tale of Melibeus. Born of the *gentilest* and the *heighest* of this land. Clerkes Tale, 75.—By certeyn *menes*. Man of Lawes Tale, 382.—That day that I shall drenchen in the *deepe*. Prologue of Wyf of Bath, 314.

2. Use in the vocative and in exclamations.

Have mercy on me, *swete*, or ye wolen do me deye. Frankelynes Tale, 250.—Com doun my *leef*, and if I have myssayde. Marchandes Tale, 1145.—Farwel, my *swete*! farwel my Emelye. Knyghtes Tale, 1922.—Now faire *blisfulle*, O Cipris. Hous of Fame. Bk. II. 10.—myn owne *deere*. Romaunt of the Rose, 4377.—*Humblest* of herte, *higheste* of reverence. Complaynte of Dethe of Pite, 57.—O seely prest O sely *innocent*. Court of Love, 631.—*Feirest* of alle that ever were or do! Court of Love, 631.

3. Use with adjective and adverb modifiers. The general statement made at the beginning of this discussion of syntax applies here. Adjectives substantivized may be modified by other adjectives just as nouns are. So we find in Chaucer:

the neye *slye* Maketh the ferre *leef* to be loth. Milleres Tale, 206.—That goode *leef* my wyf. Prologue of Monkes Tale, 6.—And I to ben youre veray humble *trew*e. Troylus and Cryseyde. Bk. III. 92.—the proverbe saith that many *smale* maketh a *grete*. Persones Tale.—And chyde her the holy *innocent* your wyfe. Sompnoures Tale, 275.—And to the doctrine of these olde *wyse*. Prologue of Legende of Goode Women, 19.—For unto hem it is a bitter *swete*. Prologue of Chanounnes Yeman, 325.—And saugh the soruful *erdest* of the knyght. Troylus and Cryseyde Bk. II. 453.

4. Those adjectives which are not so completely substantivized as to have lost altogether their adjective nature may be modified by adverbs:

(a) In the positive degree:

The sonne saugh nevere yet . . . so inly *faire*, so *goodly* as is she. Troylus and Cryseyde. Bk. III. 1555.—That yeveth him ful ofte wel *better* than thei can hemself devyse. Knyghtes Tale, 395.—And seyst thou hast to *litel* and he hath al. Man of Lawes Tale, II.

In the case of *verray right* (Romaunt of the Rose, 1627) *verray* seems to be in that transitional state where it is either adjective or adverb.

(b) In the comparative degree:

Ne never saugh I a more *bountevous* ne a more *graciously*. Troylus and Cryseyde. Bk. I. 883.—And therto I saugh never yet a less *Harmful* than she was in doynge. Boke of the Duchesse, 993.

5. Use with the article.

(a) The indefinite article.

Of the use of the indefinite article with substantivized adjectives, Maetzner¹ says: "The transmutation of an adjective into an uninflective substantive, as a name of a person, is not favored in Modern English, in connection with the indefinite articles. Adjectives and participles, otherwise capable of being used substantively with the definite article, support themselves when referred to an indeterminate individual by the pronominal *one*, which is to be regarded as the substantive bearer of the adjective. 'There cometh one mightier than I after me' (Mark I, 7)." This shows us modern conditions as Maetzner found them and also gives us his opinion concerning the degree of substantivation of adjectives when so used with *one*.

In Chaucer we find, however, a slight variation from present usage in this respect. For examples we have:

a true swynk and a *good* was he. Cant. Tales: Prologue, 531.—
A theef he was, forsooth, of corn and mele And that a *sleigh*.
Reeves Tale, 20.

¹ *Englische Grammatik*, vol. III, p. 182.

It is to be noted that whereas we now use the expression, *such a one*, Chaucer omits the article, thus:

With *swich oon* as he is. Troylus and Cryseyde. Bk. V. 740.—To have a *newe*. Anelyda and Arcite, 277.—In love a *false* herde I never none. Phillis, 5.—And cowde a *certeyn* of conclusiouns. Milleres Tale, 7.—For trusteth wel, it is an *impossible*. Prologue of Wyf of Bath, 688.—The proverbe saith that many smale maketh a *gret*. Persones Tale.—To lene a man a *noble* or two or thre. Chanounnes Yemannes Tale, 26.

The use of *a* in the last example is somewhat different, however, because *noble* is so thoroughly substantivized. So also with an *evyle*, a *grene*, etc.

(b) The definite article. By Chaucer the definite article is often omitted where in modern usage it seems necessary. With plural personal substantives (without -s) we do not omit except in such couplets as *good* and *bad*, *old* and *young*, *wise* and *foolish*, etc. But Chaucer is much more free to omit the article.

O trouble wit, O ire recheles That unavised smytest *gulteles*. Maunciples Tale, 175.—The way of *blynde*. Secounde Nonnes Tale, 92.—Victorious tre, proteccioun of *trew*. Man of Lawes Tale, 358.—Now, lady bright, to whom alle *wofulle* cryen. *ibid.* 752.

Of course the personal substantives (with -s) are so far substantivized that the article may be used or omitted, just as with any other noun. This is true also of the plural abstracts.

With the singular abstract substantives the article may be used or omitted. With substantivized adjectives of color it is generally omitted as in Modern English. "a lady thus al in *blak*." Knyghtes Tale, 600. Likewise with proper adjectives it is generally omitted. "Who couthe ryme in *Englissh* properly." Knyghtes Tale, 600.

Neuter concrete nouns, made from adjectives, are used with *the* or without. "the *goodes* of nature." Persones Tale.—"For lak of *goode*." Court of Love, 1142.

6. Use as adverbial substantives. Many adjectives substantives, which were undoubtedly abstract nouns at first, seem

gradually to have assumed the function of adverbs when used with prepositions. Of course it is difficult to draw any line between those which are still abstract nouns and those that are adverbial, but a number have been listed here quite confidently because they seem so very plainly adverbial.

The expression *atte last* or *at the laste* seems to mean little more than our adverb *finally*.

And *atte last* this hende Nicholas Gan for to syke. Milleres Tale, 301.—Tho was I war, lo! *at the laste*. Hous of Fame. Bk. I. 495.—The expression *atte lest* or *at the leste* is also very common. Two days, *atte lest*, or thre. Romaunt of the Rose, 1684.—Loke *at the leest* thou have a pair. *ibid.* 2265.—To helpe delen his londes and dresen hem *to rightes*. Cokes Tale of Gamelyn, 18.—Amonges alle these othere *in generale*; And forthy see that thou, *in speciale*. Troylus and Cryseyde. Bk. I. 901.—God saith thou schalt not take the name of thy Lord God *in vayne* or *in ydil*. Persones Tale.—governeth alle *in comune*. Nonne Prestes Tale, 180.—sith this thing *of newe* is yeve me. Court of Love, 643.—To telle *in shorte*, withoute wordes mo. Troylus and Cryseyde. Bk. III. 185. So also the expressions, *for the beste*, *atte full*, *by right* (rightfully), *in ydel* (idly), *with wrong* (wrongfully), *in earnest*, *at large*, *atte meste*, *for fynal* (finally), *in certeyn*, *in hye* (on high), *for as much* (inasmuch), *from eterne* (eternally), *for soth*, *of old*.

F. Relative substantivation of native and Romance words.

With the question of the beginning of this process of substantivation, comes the suggestion that the French were responsible for it. It is not the purpose of this investigation to discuss that question, but at the same time a thorough study of the process in Chaucer requires at least a comparison of the words as we find them.

1. Of the personal substantives (without *-s*), the sources are as follows:

(a) Old English words. *lesse*, *leste*, *more*, *meste*, *goode*, *beste*, *yonge*, *yongest*, *heigh*, *heighest*, *olde*, *fairer*, *feirer*, *worthy*, *worthieste*, *trew*, *untrew*, *ferrest*, *gultyf*,

gultles, wyse, wisest, riche, sike, fre, bonde, grettest, lowe, worst, dere, ncwe, konnyngeste, greye, swete, formest, blisfulle, stronge, wofulle, needful, harmful, rewfullest, leef, slye.

(b) French words. *poore, gentlest, feble, humblest, innocent, coveytous, seint, suffrant, pacient, graciouse, bountevous.*

2. Personal substantives (with -s).

(a) Old English words. *eldres, halwes.*

(b) French words. *nobles, scyntes, gentils, innocents, penytentys, communes.*

It is to be noted that in the case of these words which have been substantivized thoroughly enough to take on inflectional forms, the majority are of French origin. This might argue that the process of substantivation started with the French.

The figures for the different classes are as follows:

1. Personal (without -s)....	Old English—	33	Romance—	11
2. Personal (with -s).....	" "	2	" "	6
3. Abstract (without -s)....	" "	31	" "	11
4. Abstract (with -s).....	" "	5	" "	1
5. Neuters	" "	14	" "	10
Totals	Old English	85	Romance	39

This summary does not include the few Latin words which appear for Chaucer. While these lists do not pretend to record every example of the substantivation of adjectives in Chaucer, yet they are so nearly complete as to give a fair presentation of conditions.

III. GENERAL CONCLUSIONS

For the most part, in Old English, the adjective was used only as a personal substantive. This substantivation, moreover, seems to have been due almost altogether to the second cause given by Kellner, namely, the dropping of an unnecessary noun. This is

done very frequently even in the *Beowulf*. On the contrary very few examples are found of the other uses of adjective substantives, so common in later English.

Judging from conditions as we find them in Chaucer, we can not say that the *process* of substantivation in the fourteenth century was much different from that of the twentieth century. A large per cent of the examples which have been given can be paralleled in modern English. We substantivize as many of our adjectives as Chaucer did. In fact almost every adjective can be so used.

The narrowing in is in the *manner* of substantivation. We can not substantivize in as many ways as did earlier speakers of English. This is doubtless what Franz means when he says,¹ "Die Grenze, innerhalb deren die Substantivierung des Adjektivs möglich ist, sind in Shakespeare's Zeit noch wesentlich weitere als in der modernen Sprache." This is true especially with regard to the definite article. As a general rule we never think of omitting the article when we make personal substantives of adjectives. Where Chaucer said, "The way of blynde" we must write, "The way of *the* blind."

One exception to this rule is found in such couplets as *young* and *old*, *good* and *bad*, *wise* and *foolish*, *living* and *dead*. This is apparently an isolated survival of a use common in the time of Chaucer.

We find the personal adjective substantives in the plural, (with *-s*), at about the same stage of substantivation in Chaucer as in modern English. This seems also true of the adverbial expressions. *At last* appears, with Chaucer, to mean *finally*, just as it does to-day.

In the case of partially substantivized adjectives we find a complete change since the fourteenth century. Chaucer used the adjective with *one* very seldom; to-day it is our most common method of substantivizing. On the other hand, the adjective referring to a preceding noun as a good man and a *true*, was quite common in Chaucer's day and became even more so in Shakespeare's time; to-day we find few instances of such usage.

¹Shakespeare Grammatik, p. 60.

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