ORTHOGENETIC SERIES RESULTING FROM A SIMPLE PROGRESSIVE MOVEMENT*.

Studies in Determinate Evolution III.

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The five cases of orthogenetic series presented below will illustrate the general principle evident in endless numbers of characters from one end of the plant kingdom to the other. The progression in perfection of the main characteristic of each series apparently depends on the progressive evolution of a single mutative property, except in the last example given, which appears to involve several additional harmonious movements before the extreme is reached. As intimated in a previous paper, although the series in each case probably represents some of the actual evolutionary steps which the highest members took in attaining to their advanced condition of perfection, we are at present not so much concerned with the details of the actual movement as we are in presenting the phenomena of the series for consideration. For it is self-evident that no theories of heredity and no theories of evolution are worthy of serious consideration by the scientist, who is attempting to fathom some of the mysteries of nature, unless they take these things into account. At present, almost any presentation, even though based on the most profoundly irrational philosophy and taking no account of the volume of biological knowledge so far amassed and tested as to its reality, when masquerading under the name of science and assumed authority, is able to take possession of the very citadel of scientific education. The plant taxonomies, for example, which are persistently perpetuated offer a most profound contradiction to any rational theory of evolution. Yet it is practically impossible to get a manual of plants which shows any influence whatever of the modern phylogenetic studies. To continue to use a system of taxonomy which makes evolution untenable and at the same time teach the subject as a scientific

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dogma is like persisting in the belief that the world is the flat fixed center of the universe and at the same time teaching the unfortunate student that the earth revolves around the sun. A correct taxonomy is the first requirement of a correct understanding of evolution just as much as a correct evolutionary viewpoint is a necessary basis for a correct taxonomy. The two are interdependent. The same may be said in relation to evolution and genetics. A genetics which does not go parallel with phylogenetic taxonomy is no genetics at all.

1. A PROGRESSIVE SERIES IN THE REDUCTION OF THE CARPELLATE BRACT OF ABIES.

(See Figure 1).

The reduction of the leaf blade of the sporophyll is evident in many independent groups of vascular plants, and not only is this reduction manifest in the individual series but there is a consistent progression in the reduction in the entire series of vascular plants from the lowest ferns to the highest composites. The example given shows this progression in the fir. The same characteristic progression can be traced in other groups of conifers having ovuliferous scales. In Abies the movement is very prominent.

In the bristle-cone fir (*Abies venusta* (Dougl.) Koch. (Fig. 1-a) the carpellate bract is about three times as long as the ovuliferous scale and is still very leaf-like in texture. *Abies nobilis* Lindl. (Fig. 1-b) shows a considerable change, the carpellate bract being less than twice as long as the ovuliferous scale, and in *Abies fraseri* (Pursh) Poir. (Fig. 1-c) the reduction is still greater. In *Abies cephalonica* (Endl.) Loud. (Fig. 1-d) the carpellate bract is shorter than the ovuliferous scale and decidely membranous. The final steps, represented by *Abies grandis* Lindl. (Fig. 1-e), and *A, lasiocarpa* (Hook.) Nutt. (Fig. 1-f), bring the carpellate bract down to a mere vestigial appendage at the base of the ovuliferous scale. All the species of fir will come into this series in this respect, ranging from the bristle-cone fir to the alpine fir. In the firs the prominent ovuliferous scale remains fairly uniform, but the reduction of the carpellate bract has no relation to the uniformity of the ovuliferous scale. The carpellate blade or bract shows an orthogenetic reduction also in groups in which the ovuliferous scale is evolving to a great size as well as in groups in which no ovuliferous scale whatever is developed.

The progressive reduction of the carpellate bract might be considered morphologically as an evolution backward or as a loss of something that was formerly possessed, but this would be an entirely superficial and erroneous point of view. The evolution is through the acquirement of a progressive potentiality of the protoplast. The carpellate bract is a leaf. In the lowest vascular plants with a simple hereditary system, the homologous lateral appendages, differentiated as foliage leaves and sporangium-bearing leaves, are essentially alike. The

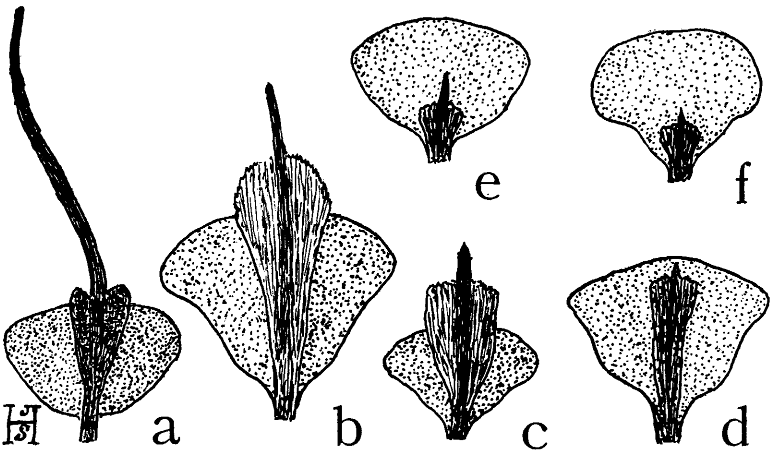


FIG. 1. Carpels of species of fir showing reduction in the size of the carpellate bract. a, *Abies venusta* (Dougl.) Koch., Bristlecone Fir. b, *A. nobilis* Lindl., Noble Fir. c, *A. fraseri* (Pursh) Poir., Fraser Fir. d, *A. cephalonica* (Endl.) Loud., Cephalonian Fir. e, *A. grandis* Lindl., Grand Fir. f, *A. lasiocarpa* (Hook.) Nutt., Alpine Fir. All Figures natural size.

evolution progresses step by step in producing a more complex reaction system until the degree of difference is very great, as in the alpine fir. The difference is not due to a loss of anything but to the evolution of a more complex reaction system which can, from homologous leaf incepts, bring out not only an ordinary foliage leaf but also a highly specialized woody-membranous bract. In the lower firs the resemblance to a leaf is still considerable, in the more advanced species the resemblance is slight, while in very highly evolved plants the resemblance becomes unrecognizable.

Now this loss of leaf character of the megasporophyll is of no advantage or disadvantage to the plant, neither is there any advantage or disadvantage in the different lengths of this vestigial organ to the different species of Abies. If the plant had few leaves the early loss of chlorophyll in any part might be a disadvantage but firs have an abundance of leaves so the extra food is not needed. Any utilitarian or selective explanation offered as a causative agent to account for this orthogenetic series would have to be dismissed as the childish guess of credulity.

2. THE PROGRESSIVE ENLARGEMENT AND PERFECTION OF THE AWN AND SPIKELET OF STIPA.

(See Plate I).

Just as the preceding case was a progression in the reduction of the sporophyll, so the present series represents an increase in the development of the lemma or outer flowering glume. Stipa is a highly evolved genus of grasses and we are, therefore, prepared for the development of a highly bizarre type of fruit, not because this type of fruit with its indurated flowering glumes, its sharp-pointed callus, and its remarkable awn, twisted and plumed, are peculiar to this group, they are evolved in many independent lines, but because when the protoplast becomes full of certain highly evolved potentialities the progression very commonly ends in very remarkable forms, which from one point of view may be regarded as abnormalities or freaks. Many of the remarkable characteristics of man himself belong to this category. Of course, this language is not to be interpreted as meaning that these forms have not come through the orderly progression of evolution but only that in them a large number of orthogenetic movements have culminated. Apparently the protoplast with a complex hereditary potentiality is more subject to large and extreme mutations than the protoplast which is comparatively unevolved and thus has comparatively few hereditary potentialities or complexities.

The fruits illustrated represent the entire mature spikelet as it falls out of the empty glumes. Figure 1 represents the fruit of *Stipa macounii* Scribn. This is a rather small structure whose parts could be duplicated in many other groups of grasses. It has only a short awn and the lower awl-point is not conspicuous. Nevertheless it has nearly all of the characteristics of the highly evolved species except the plumose hairs on the awn. *Stipa scribneri* Vas. (Fig. 2) and *Stipa viridula* Trin. (Fig. 3.) show considerable improvement in the structure and this improvement is carried forward consistently through *S. robusta* (Vas.) Scribn. (Fig. 4), *S. occidentalis* Thurb. (Fig. 5), *S. avenacea* L. (Fig. 6), and *S. tweedyi* Scribn. (Fig. 7). In *Stipa comata* T. & R. (Fig. 9) we note a decided increase in size together with a certain degree of flexuousness which is such a prominent characteristic of the last two members of the series. Figure 9 is the fruit of the well-known porcupine-grass, *Stipa spartea* Trin. Every detail of the various parts has been perfected until one has a fruit which can literally bore its way into the sand as well as into the wool and skin of some unfortunate sheep. The neck of the awn is prominently twisted and very hygroscopic, the point is very sharp, and the hairs on the body of the fruit act retrorsely in their resistance to a backward action when the point is once started into the ground. The tail of the awn stands out at right angles to the arm and both wind and moisture cause a twisting motion. I have seen such fruits penetrating 2 or 3 inches into the sand and the awn circumscribing a perfect circle around the center. Commonly such an action does not take place since there is an abscission between the awn and the body of the lemma so that the awn is readily detached. It is also self-evident that in the same plot of prairie with the porcupine-grass other grasses succeed in being planted just as frequently, if not more so, even if they have no such wonderful equipment, in fact have no "special adaptation" whatever. *Stipa neomexicana* (Thurb.) Scribn. (Fig. 10) has added two interesting characteristics, namely flexuousness of the awn and hairs, and these characters as well as all the rest come to full fruition in the last species given, *Stipa pennata* L. (Fig. 11). This is truly a vegetable feather and can be used with as much effect as the highly prized aegret. The length of the awn is truly remarkable, often measuring over a foot. The structure is most beautiful and delicate. The other structures of the fruit are much like in the porcupine-grass. Now compare Fig. 1 with Fig. 11 and we see a most remarkable orthogenetic movement which has resulted in a structure which can certainly be of no use to the plant unless we follow the faith of the credulous selectionist and say that this remarkable device was especially evolved or created to attract monkeys and men by tempting them to use the fruits as ornaments and thus insuring distribution. But humor aside, the orthogenetic movement must have about expended itself. It does not seem possible to carry the progression much farther.

3. ORTHOGENETIC SERIES IN THE DEVELOPMENT OF THE HORN IN THE CORONA-HOODS OF MILKWEEDS.

(See Plate II).

The andrecium of the Asclepidaceæ is provided with a peculiar 5-lobed crown or corona. The corona-hoods are perfectly plain on the inner side, in the lower genera, like Acerates. Two species are represented in the drawings. Figure 1 represents the corona-hood of *Acerates viridiflora* (Raf.) Eat. It has two minute auricles at the sides near the base, thus really making the hood three-lobed. Figure 2 is the hood of *Acerates angustifolia* (Nutt.) Dec. The hood is three-toothed at the end, the acute middle tooth being merely a projection of the thickened midvein. In figure 3, which represents a corona-hood of *Asclepiadora viridis* (Walt.) Gr., a new structure is in evidence. The front side of the hood is cut off in order to expose the little crest or horn, since it does not project beyond the edges of the walls of the hood. This is a structure which has no antecedent. It is a new mutation and certainly has no utility to the apparatus in which it occurs. But a new process has been initiated in the system which may now progress until it evolves to a very prominent structural part of the milkweed flower. In the pleurisy-root, *Asclepias tuberosa* L. (Fig. 4), the horn has elongated greatly but is still nearly straight, while in *Asclepias sullivantii* Engelm. (Fig. 5) the horn is greatly enlarged and decidedly curved, the point projecting over the top of the stigma. A very extreme condition is attained in the horn of the hood of *Asclepias verticillata* L. (Fig. 6). The horn is about twice as long as the corona-hood and curves inward over the top of the stigma. Thus we see that in such a minute and useless structure as this little horn, the principle of progressive advancement and perfection is just as much in evidence as when the evolutionary change involves some important organ of the plant. All the milkweeds can be arranged in reference to the degree of evolution of this little corona horn. The whole series represents a succession of greater attainments until the limit is reached in the extreme species where the flower is decked out with this perfected device which has been supposed to aid in pollination but which plainly can have no such utility since Asclepiodora is really more successfully pollinated than the higher species of Asclepias. The whole series has survived and is successful today; so it would be ridiculous to asumes an eliminative utilitarian cause to account for its origin and progression toward perfection.

4. A SIMPLE ORTHOGENETIC SERIES LEADING TO OVER-ADAPTATION.

(See Plate III).

We have all heard of how the giraffe got his long neck. The present series deals with the evolution of a "neck" at the upper end of an achene. There are a number of quite similar, independent evolutionary series in the Chicory family. The higher Compositales have very commonly developed a capillary pappus which takes the place of the vanished calyx. This pappus is, of course, epigynous in the composites while quite similar although hypogynous, capillary pappuses are developed in some of the Cyperaceæ. The ovulary of the composites is devoloped from the cortical layer of the flower bud and is not the ovulary of the carpels. The carpels are extremely vestigial and give rise only to the stigmas, style, and top of the ovulary. The neck at the top of the developing ovulary is thus a modified, cauline, cortical structure.

In *Sonchus oleraceus* L. (Fig. 1) the achene is normal, no lengthening factor being in evidence at the top. The pappus spreads out around the upper end and makes a very effective device for wind distribution. Our common species of sow-thistle are very successful weeds. When we take one step over to the genus Lactuca or lettuce a disturbance becomes evident as is shown in *Lactuca villosa* Jacq. (Fig. 2). A distinct elongation is present just below the pappus. Now this neck does not give the achene any special carrying advantages when compared with the Sonchus fruit because the neck is still too short and insignificant. Yet a mutative potentiality is indicated which, as the sequel will show, ends in a truly marvelous development. *Lactuca sagittifolia* Ell. (Fig. 3) has evolved a neck several times as long and is thus in the first stages of the production of an effective parachute. The neck is still considerably shorter than the body of the achene. In *Lactuca hirsuta* Muhl. (Fig. 4) the neck is about as long as the body of the achene, while in the highly evolved prickly lettuce, *Lactuca virosa* L. (Fig. 5) it is about twice as long. All the species of Lactuca arrange themselves in a close, orthogenetic series in respect to the neck character. The prickly lettuce fruit is an ideal parachute and the seed is carried on downy wings of ease in the most exquisite fashion. But these plants have by no means reached the limit of progressive evolution either in respect to the structure under consideration or in various other important potentialities. Going a little father up the scale we meet a near relative of the lettuce, our common dandelion, *Leontodon taraxacum* L. (Fig. 6). Comparing the fruit of the dandelion with that of the prickly lettuce, we see that the latter is only a crude amateur in the production of an ideal parachute. The neck is now three to four times as long as the body of the achene which is ornamented by projecting prongs in a very pleasing manner. This ornamentation is already slightly in evidence in the achenes of Sonchus and Lactuca, for they are also comparatively highly evolved organisms and ornamentation is characteristic of high or extreme developments in very many lines of plants as well as animals.

We have all played at blowing the dandelion fruits from their disk and watched the parachutes sail away like a man gliding from a balloon in a man-made parachute. Now this perfected device is of no use to the dandelion. I am convinced that if it were no better than the one possessed by the sow-thistle my front lawn would still be well seeded from my next-door neighbor's crop or from the abundant dandelion community in a pasture several miles away to windward. In my back yard I have sow-thistles without the long neck on the achene and it keeps me busy at attempted eradication, just as the dandelion does in the front yard, and 20 years of effort have not succeeded in making my garden a desert in respect to Sonchus. In the dandelion we have a plain case of over-adaptation. The seed-carrying device is enormously more perfect than required for the safety and survival of the race. The dandelion has this structure not because it is of any life and death advantage to the individual but because it is one of the progressive stages in the orthogenetic development. Now one would think that nothing further would evolve. But evolution is commonly perfective in its main lines and when we study the dandelion fruit we see that a few perfective processes have not yet made their appearance. Following out another phylogenetic line of the Cichoriaceæ, which in itself would show the same interesting orthogenetic movement as the Lactuca series, we come to the last step which will be considered. In *Tragopogon porrifolius* L. (Fig. 7), the salsify of the garden, the neck is about as long as in the dandelion, being two to three times as long as the body of the achene. These long necks of the dandelion and salisfy apparently have about reached the limit. The rays of the parachute radiate out stiffly and from their sides long webby-plumose branches extend, interlocking with those from the next ray and thus weaving an ideal filmy canvass for the plane of the parachute. After the seed has been transported, the rays of the parachute are detached from the top of the neck by means of an abscission layer so the achene is not hindered in its descent into the earth. What more would you want? We have here the ideal of perfection. Now run through the series from Sonchus to Tragopogon and we see an orthogenetic evolutionary series moving persistently toward the extreme. And the entire evolutionary sequence was of no importance to the individual in its struggle against the adversities of its environment. Every one of the series would have been completely successful in its distributional and migratory requirements if the achene had never evolved a neck at all but had remained in the more simple state represented by Sonchus. Even a pappus would not be necessary. *Chrysanthemum leucanthemum* L. has no pappus whatever and no one would have the audacity to say that the oxeye daisy has any trouble in getting about in the world. You might just as well argue about the advantage or disadvantage of the green color to a green crystal, or about the advantage that a crystal may have in being 14-sided instead of 6-sided.

5. AN ORTHOGENETIC SERIES RESULTING IN A DECIDED FLATTENING OF THE VEGETATIVE SYSTEM.

(See Plate IV).

In Plate IV is given a series of diagrams to show the evolutionary progression from a radially three spiral system to a flat bilateral system. The lower Liliales, like other lower Monocotylæ, are plants with a three-spiral, radial symmetry and this condition is carried through to the lower, epigynous Iridales. Figure 1 represents a diagramatic transverse section of the stem and leaves of *Manfreda virginica* (L.) Salisb. belonging to the Amaryllidaceæ. The stem is cylindrical and the leaves are placed in the normal, radial positions. The reaction system developing the centers of activity for the production of lateral organs dances a three-step. In other words, the property of correlation of dependent interaction extends but a third of the way around the stem bud. This as stated is the universal, primitive, monocotyl condition. In *Hymenocallis occidentalis* (Le C.) Kunth (Fig. 2) the reaction system is changed to a two-step, giving rise to a stem with two-ranked leaves. The centers of activity, developing the lateral appendages, are now 180° apart which shows that the correlation influence of the system has advanced considerably over the previous condition, so that the unitary reaction of the cells takes in a greater area or mass of cells than in the lower three-spiral system. This condition has evolved independently any number of times in the monocotyl series. It even appears occasionally as a temporary condition of bud-sporting, only to disappear again, as in the case of a Screw-palm (Pandanus) which suddenly changed from the normal three-spiral to a perfect two-ranked form and grew that way for five years when it again passed back suddenly to the three-spiral condition.

Figure 3 represents a projection of the stem and leaves of *Nemastylis acuta* (Bart.) Herb. of the Iridaceæ. Here we see the beginning of the flattening process. The stem is still cylindrical but the leaf blades show a peculiar vertical folding. *Iris germanica* L. (Fig. 4), the common iris or fleur-de-lis, shows a decided evolutionary progress in the flattening potentiality. The stem is considerably flattened; the leaf sheaths are keeled or equitant, and the leaf blades are completely flattened vertically. Figure 5 represents the condition developed in *Olsynium douglasii* (Dietr.) Bickn., a close relative of Sisyrinchium. The stem is much more flattened than in Iris. In *Sisyrinchium hastile* Bicken. (Fig. 6) the stem is flattened and has two prominent ridges on the two edges. The leaf sheaths and blades are becoming very narrow and thin. In *Sisyrinchium campestre* Bickn. (Fig. 7) the two ridges have expanded into two broad wings and in *Sisyrinchium graminoides* Bickn. (Fig. 8) the wing development has proceeded to the extreme extent. Thus the evolutionary movement has brought out a flat plant. The advance shows a movement step by step to the ultimate limit and has finally produced a plant that is ideal for the botanist to put into his plant press, when he is intent on preparing specimens for his *hortus siccus;* for which plants reduced to practically two dimensions are very appropriate. What more could you ask? The vegetative part of the plant is as flat as a pancake. Something has evolved in the plants that tends to throw the entire system to extreme flatness. Of what use is this to the plant? Why it is of no use. The plants which never passed one step from the primitive radial symmetry grow side by side with the blue eyed grass just as abundantly or even more so. If you must have a self-evident immediate use for this remarkable development, you will find it, as intimated above, by putting a specimen of this kind in your plant press. Your troubles in trying to reduce contrary plants to two dimensions will largely have vanished.

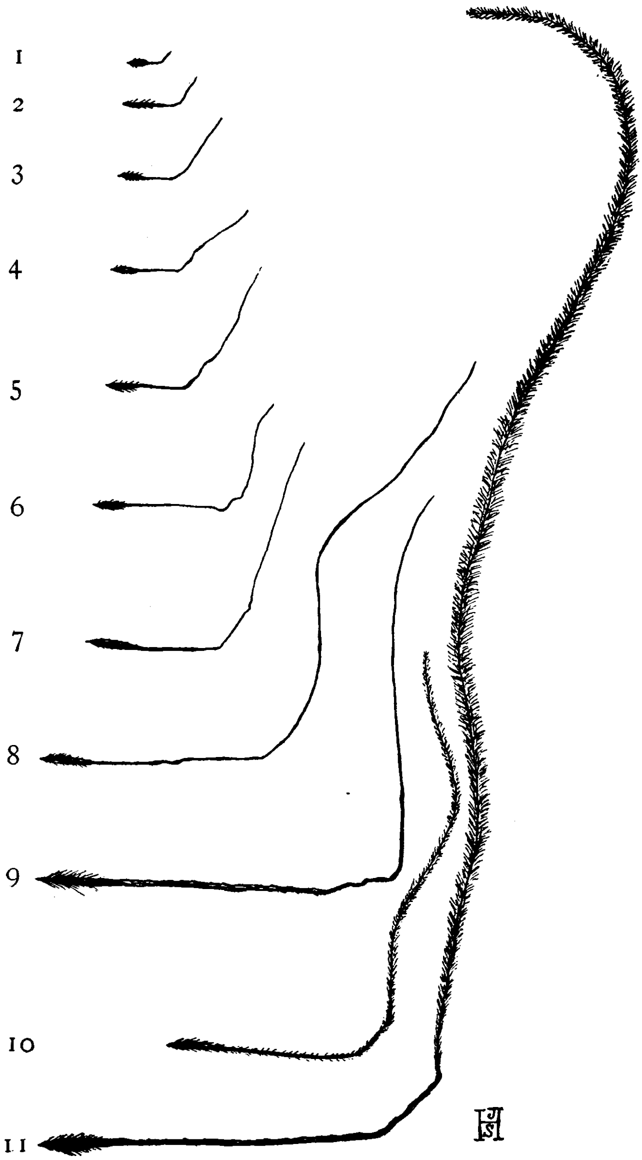
All of these studies again show that evolution does not proceed along utilitarian lines but that it is an intrinsic, kinetic process which is progressive, orthogenetic, and perfective in its results, the end product of the series often being a decided detriment to the convenience of the individual or, on the other hand, often a decided utility, developed enormously beyond the most extreme demands necessary for the successful perpetuation of the race. If we ask the question as to whether the plants which have taken the first steps in the progressive series will ever take any more and finally evolve to the ultimate possibility of the orthogenetic series, we have no evidence for an answer outside of the fragmentary answer of paleontology. In paleontology the evidence points mainly to the conclusion that there will be *no further change in the species as a whole* but it is possible that any individual in any of the species may take further steps in advance until the determinate limit of the series is attained. But such individuals are the first of new species and the old species continues to reproduce itself unchanged according to its hereditary constitution until it is eliminated through adverse conditions.

EXPLANATION OF PLATE I.

Progressive series in the evolution of the awn in Stipa.

Fig. 1. *Stipa macounii* Scribn.
Fig. 2. *S. scribneri* Vas.
Fig. 3. *S. viridula* Trin.
Fig. 4. *S. robusta* (Vas.) Scribn.
Fig. 5. *S. occidentalis* Thurb.
Fig. 6. *S. avenacea* L.
Fig. 7. *S. tweedyi* Scribn.
Fig. 8. *S. comata* T. & R.
Fig. 9. *S. spartea* Trin.
Fig. 10. *S. neomexicana* (Thurb.) Scribn.
Fig. 11. *S. pennata* L.

All reduced on the same scale to one-half natural size.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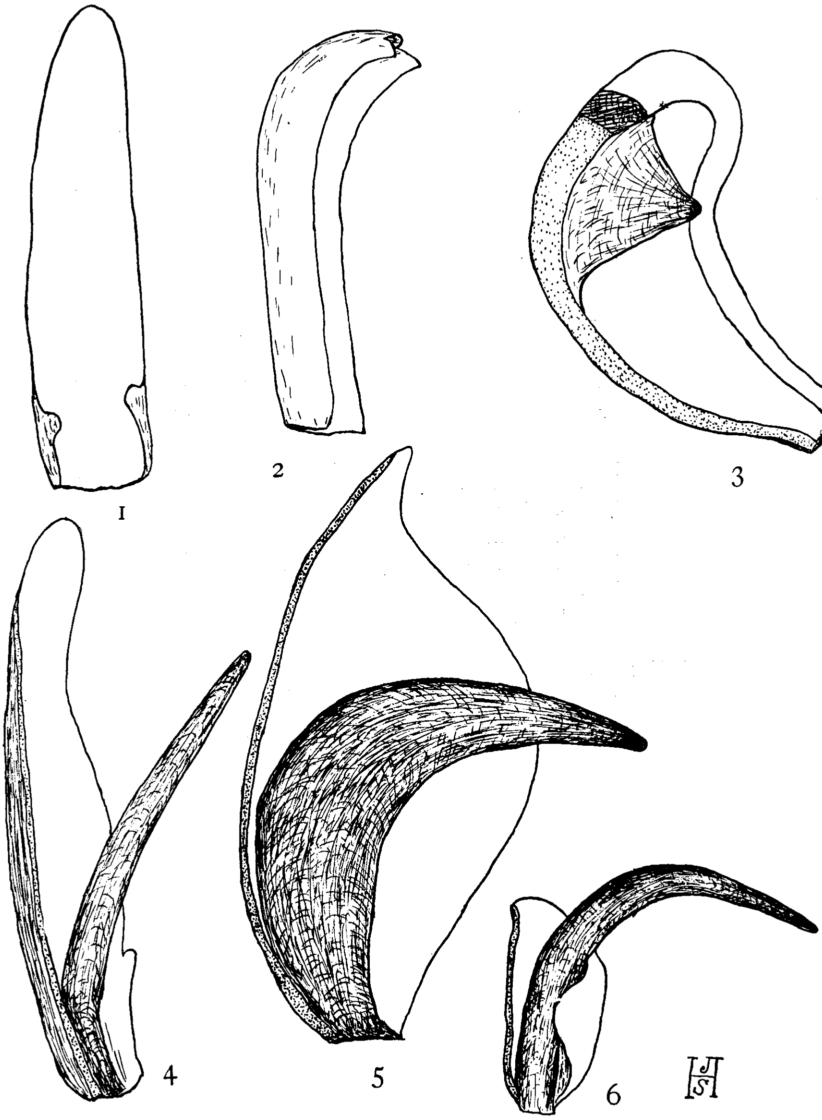
EXPLANATION OF PLATE II.

Evolution of the horn in the stamen appendage of species of milkweed.

Fig. 1. *Acerates viridiflora* (Raf.) Eat.
Fig. 2. *Acerates angustifolia* (Nutt.) Dec.
Fig. 3. *Asclepiadora viridis* (Walt.) Gr.
Fig. 4. *Asclepias tuberosa* L.
Fig. 5. *Asclepias sullivantii* Engelm.
Fig. 6. *Asclepias verticillata* L.

All magnified on the same scale about 6 diameters.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EXPLANATION OF PLATE III.

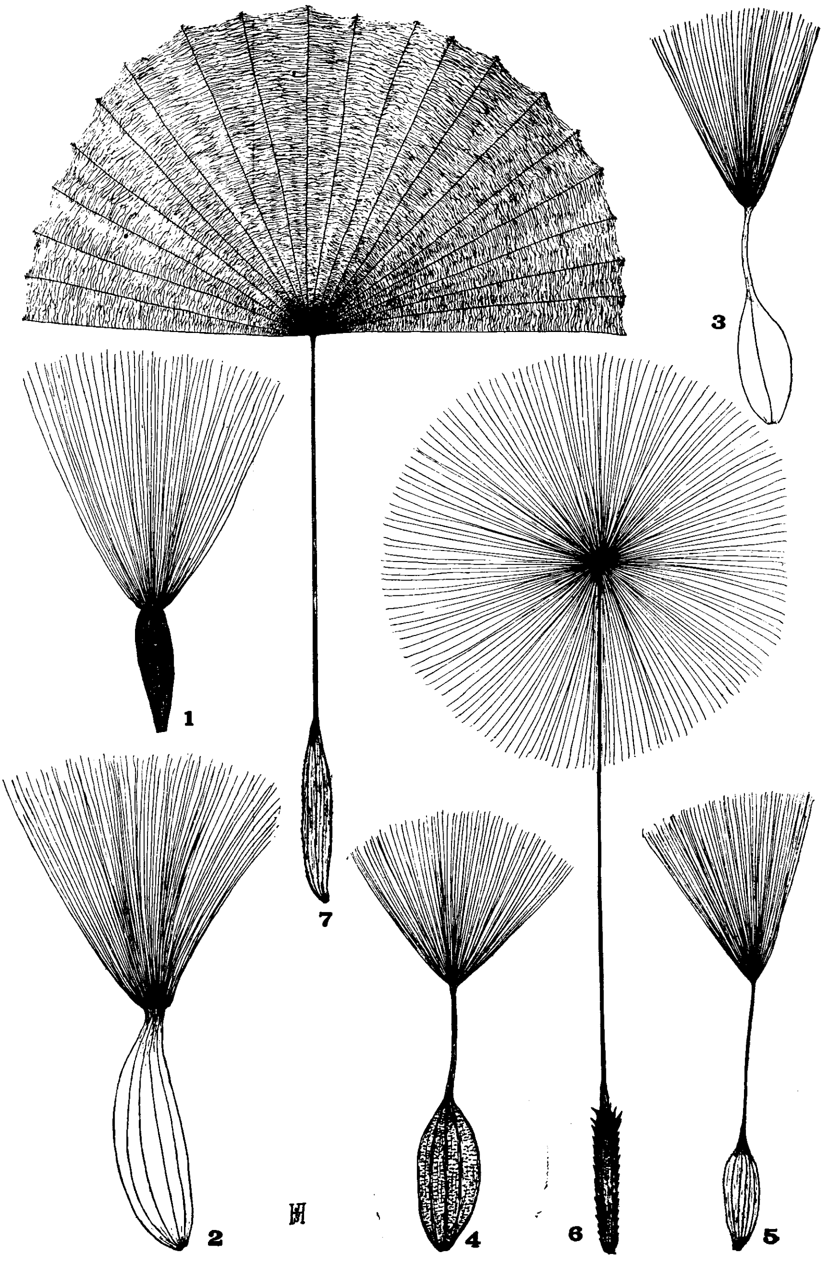
Orthogenetic series in the evolution of an elongated neck between the body of the achene and the pappus in the chicory family.

Fig. 1. *Sonchus oleraceus* L.
Fig. 2. *Lactuca villosa* Jacq.
Fig. 3. *L. sagittifolia* Ell.
Fig. 4. *L. hirsuta* Muhl.
Fig. 5. *L. virosa* L.
Fig. 6. *Leontodon taraxacum* L.
Fig. 7. *Tragopogon porrifolius* L.

All Figures magnified about 4 diameters except Fig. 7, which is magnified about 2 diameters.

Studies in Determinate Evolution. III
John H. Schaffner

PLATE III.

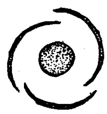


EXPLANATION OF PLATE IV.

An orthogenetic series from the Iridales showing a remarkable change from a radially three-spiral system to a flattened bilateral system. The figures are profile projections or cross-sections of the stem and leaves.

Fig. 1. *Manfreda virginica* (L.) Salisb. × ½.
Fig. 2. *Hymenocallis occidentalis* (Le C.) Kunth. × ½.
Fig. 3. *Nemastylis acuta* (Bart.) Herb. × 2½.
Fig. 4. *Iris germanica* L. × ½.
Fig. 5. *Olsynium douglasii* (Dietr.) Bickn. × 8.
Fig. 6. *Sisyrinchium hastile* Bickn. × 8.
Fig. 7. *S. campestre* Bickn. × 8.
Fig. 8. *S. graminoides* Bickn. × 8.

PLATE IV.



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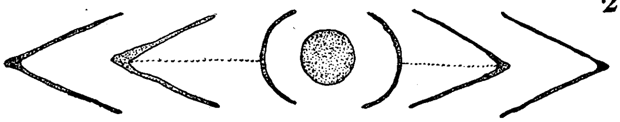

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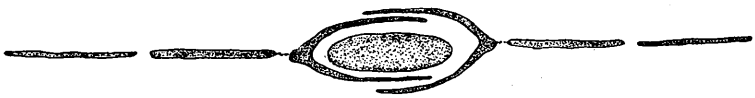

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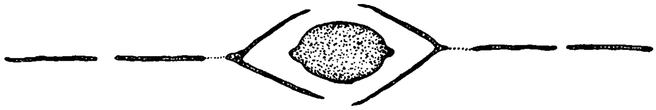

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BOOK NOTICE.

INSECTS, TICKS, MITES AND VENOMOUS ANIMALS OF MEDICAL AND VETERINARY IMPORTANCE. By W. S. PATTON AND ALWEN M. EVANS.

This work of 785 pages and numerous illustrations must be considered a successor to the very comprehensive and valuable *Text Book of Medical Entomology*, by Patton and Cragg, which is now out of print. The new book is adapted especially for class use and consists of exercises for twenty-eight lectures and laboratory periods with elaborate discussion of the material used for demonstration and reference to methods of preparation for the different species. It is especially full in descriptions and is admirably illustrated with figures of the morphological details concerned with the attacks of the species on their hosts and those used in identification. There is also considerable detail concerning life history and habits and some discussion of control measures. Other parts to be devoted to (2) "public health," (3) "tropical hygiene," and (4) "veterinary," are announced as in preparation. For students outside of the School of Tropical Medicine there may be a feeling of disappointment that no bibliographical references are given to works which are mentioned or which must naturally be consulted by a student of medical entomology. Possibly for the isolated student it would have been preferable to give some of this, even at the expense of less detail concerning specimens that are used as demonstrations under the direction of the authors. The book is available directly from the authors and the following announcement from Dr. Patton should be carefully noted:

> "As it is the only practical book on the subject, the writer is strongly of the opinion that its price should be within the reach of all to whom it may be of use. Had it been published in the usual way its price would have been prohibitive to most medical officers and nearly all students of entomology. Under the circumstances it can only be obtained from the Entomological Department, Liverpool School of Tropical Medicine, and would-be purchasers will therefore only waste time by applying to booksellers, who will themselves have to obtain it from the above source. Any number of copies can be sent, and it will be just as easy, if not easier, to obtain it in this way as from a bookseller. The price, 20/–, includes packing and postage to any part of the world. All copies going to the United States will contain an invoice for Customs purposes. The duty will bring the price to about **$5.00.**"

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The book is a fine example of technical work and beautifully printed. It will certainly be warmly welcomed by students of medical entomology.

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