On the Distribution of the Monocotyledonous Orders into Primary Groups, more especially in reference to the Australian Flora, with notes on some points of Terminology. By GEORGE BENTHAM, F.R.S.

[Read Nov. 2, 1876.]

(PLATES VII.–IX.)

THE Monocotyledonous Orders appear to be generally connected with each other by a combination of characters at least as complicated as is usually the case with Dicotyledons; and their distribution into subclasses or alliances distinguished by positive characters has not been very successful—although very different methods have been proposed, according to the paramount importance attached by the authors to one or another character.

Lindley, in his 'Vegetable Kingdom,' proposed the separation as a distinct class, under the name of Dictyogens, of a few genera remarkable for the reticulate venation of their leaves. But this has been generally rejected, as dividing groups otherwise nearly related, besides that the venation has been found to be exceptionally reticulate in a few genera belonging to very various orders in which it is generally parallel; and in a large number of Monocotyledons the primary parallel nerves or veins are really more or less connected by fine, rarely conspicuous transverse veinlets.

Elias Fries, in 1835, relied in the first instance on the perianth as presenting the best primary characters, establishing four primary divisions, partly corresponding to those I should be inclined to adopt, but with some important exceptions, such as placing the Cyperaceæ in the Spadicifloræ and mistaking the glumes of Gramineæ for perianths.

Adolphe Brongniart, in 1843, published a very able attempt at a rearrangement of both Dicotyledons and Monocotyledons with a view to obviate some of the chief objections made to the Candollean series. In this arrangement he adopted as a primary character, in Monocotyledons as in perigynous Dicotyledons, the nature of the albumen, whether farinaceous, non-farinaceous, or deficient. Important as these distinctions are, they cannot be taken as absolute; for several genera of Aroideæ, for instance, have the exalbuminous embryo of Naiadeæ; Hemodoraceæ and

Velloziæ become very unnaturally separated from Amaryllideæ and Hypoxideæ, to associate them with Pontederaceæ, &c.

Some other partial rearrangements of Monocotyledons, according to the relative importance attached by different botanists to the several chief characters, have been proposed, but none of them followed out sufficiently to require special mention.

In classing these orders for the 'Flora Australiensis' I have endeavoured, as far as possible, to conciliate practical convenience with supposed natural affinity; and after trying in detail various combinations, the following main groups, corresponding in many respects to those of Fries, have appeared to me the most appropriate—although, in consequence of the necessity of placing them in a lineal series (which is not in nature) some orders become still separated from near connexions, and the characters given can very rarely be regarded as absolute without exception.

Alliance (Cohors) 1. EPIGYNÆ. Ovary inferior. Perianth usually 2-seriate.

* Aquatic plants with regular flowers and exalbuminous seeds: *Hydrocharideæ*.

** Terrestrial plants with irregular flowers and exalbuminous seeds: *Scitamineæ* (including *Musaceæ* and *Canneæ*).

*** Terrestrial plants with irregular or regular flowers and minute exalbuminous seeds, the embryo apparently homogeneous: *Orchideæ* (including *Apostasieæ*) and *Burmanniaceæ*.

**** Terrestrial plants with regular or oblique flowers and albuminous seeds: *Irideæ*, *Amaryllideæ* (including *Hæmodoreæ*, *Velloziæ*, *Hypoxideæ*, &c.), *Taccaceæ*, and *Dioscorideæ*; also the American order *Bromeliaceæ*.

Alliance 2. CORONARIÆ. Ovary superior, usually syncarpous. Perianth usually 2-seriate. Seeds albuminous.

* Perianth of both series petaloid: *Roxburghiaceæ*, *Liliaceæ* (including *Smilaceæ*, *Asparageæ*, *Agaveæ*, *Melanthaceæ*, and several proposed small orders), *Pontederaceæ*.

** Outer perianth calycine or none, inner petaloid: *Philydraceæ*, *Xylideæ*, *Commelynaceæ*.

*** Perianth of both series calycine: *Junceæ* (including *Xerotideæ*), *Palmæ*.

Alliance 3. NUDIFLORÆ. Ovary free, apocarpous monocarpellary or rarely syncarpous. Perianth none, or reduced to a small scale under each anther (except *Alismaceæ*). Seeds with or without albumen.

* Anthers opening outwards or in terminal pores; perianth none, or scale-like: *Pandaneæ, Aroideæ* (including *Orontiaceæ*), *Typhaceæ, Lemnaceæ, Naiadeæ* (including *Zosteraceæ* and most *Juncagineæ*).

** Anthers opening inwards; perianth more or less petaloid: *Alismaceæ* (including *Butomeæ* and *Aponogeton*).

Alliance 4. GLUMALES. Ovary free, 1-ovulate or with 1-ovulate cells. Flowers usually in heads or spikelets within imbricate bracts or glumes. Perianth either none or scarious or glume-like, and usually concealed within the bracts. Seeds albuminous.

* Ovary often with more than one cell; ovule pendulous: *Eriocauleæ, Centrolepideæ, Restiaceæ.*

** Ovary always 1-celled; ovule erect: *Cyperaceæ, Gramineæ.*

There are, besides, a few small American more or less anomalous genera which have been proposed as distinct orders, but which will, I believe, all be referable to some of the above orders of Coronariæ or Nudifloræ.

The first of these alliances, the Epigynæ, has been more or less accepted by the majority of botanists as founded on a principle established by Jussieu and never satisfactorily superseded. It has been objected to by others as separating Hydrocharideæ from Alismaceæ, and Amaryllideæ from Liliaceæ; and the main character is ambiguous or fails entirely in some Bromeliaceæ; yet it is convenient and more definitely marked out in nature than any other that has been hitherto proposed.

The most striking objection to this arrangement is the position of the Hydrocharideæ, so far removed from the Alismaceæ, to which they bear a considerable resemblance in their aquatic habit, their embryo, and, to a certain degree, in the perianth and stamens, and with which they have even been united, as a tribe only, by Ascherson and others. The habit, however, is a resemblance only, which they have in common with genera belonging to widely distant orders, such as Haloragеæ, for instance, among Dicotyledons, and which, being in a great measure adaptive, affords no indication of affinity. The want of albumen is important; but neither here nor any where else can it be taken as an absolute character; and, besides the technical difference in the inferior ovary, the numerous seeds or parietal placentas of several genera of Hydrocha-

rideæ are very different from any thing observed in the essentially apocarpous Alismaceæ and Naiadeæ.

The Scitamineæ (including Musaceæ and Canneæ) are placed next, not with the intention of implying any affinity to Hydrocharideæ, which stand, as it were, alone, but because they could not be conveniently placed between any two of the following orders without breaking through more natural series, which they do not here; for although Hydrocharideæ and Orchideæ are artificially connected by their exalbuminous seeds, there is no natural bond of union beyond the general one common to all Monocotyledons. Scitamineæ are, on the other hand, notwithstanding their very different seeds, in some measure connected with Orchideæ by the peculiar irregularity of their flowers, all but one of the stamens, or at least one out of the six, being suppressed or replaced by petal-like or variously shaped staminodia.

Orchideæ form one of the very few Monocotyledonous orders that are absolutely defined, surrounded on all sides by a gap which is nowhere bridged over. It is here placed as approaching, in some measure, on the one hand the Scitamineæ by the above-mentioned irregularity in their flowers, and on the other the Burmanniaceæ by their minute exalbuminous seeds with an apparently homogeneous embryo.

Burmanniaceæ constitute a small order, also very fairly limited, connected, on the one hand, with Orchideæ through the ovary and seeds, and, on the other, with Irideæ by their centrifugal inflorescence, the equitant leaves of several genera, &c., but without any intermediate genus on either side. Some affinity has also been suggested with Triurideæ, founded, however, merely on adaptive resemblances of some genera of less importance than those which, as above mentioned, seem to connect Hydrocharideæ with Alismaceæ.

With Irideæ we commence a long series of orders extending to the Cyperaceæ inclusive, nowhere separated by definite boundary lines which are not occasionally crossed over from the one side or the other. In the lineal series we are obliged, it is true, sometimes to make sudden breaks; but that is merely owing to the impossibility of representing complicated cross connexions in one continuous line. Having followed out one branch of affinities to its apparent end, we have suddenly to go back to take up another branch which we had been compelled to leave behind.

Irideæ are for the most part distinguished from the other Epigy-

nous albuminous orders by the equitant leaves, regular or oblique triandrous flowers with the anther-cells turned outwards, and frequently by the centrifugal inflorescence. But none of these characters are constant. Equitant leaves occur in various orders, and are not in *Crocus*, for instance. The inflorescence cannot be determined when reduced to a single flower, and in some genera is certainly centripetal. *Diplarrhena* has the irregular suppression or imperfection of one stamen, as in some Scitamineæ. *Campynema*, which, for reasons given in 'Flora Australiensis,' I have transferred from Amaryllideæ to Irideæ, has six stamens; and *Hewardia*, which, from its superior ovary, is placed in Liliaceæ, has the habit and all the other characters of Irideæ.

I have in the 'Flora Australiensis' given my reasons for adopting the wide extent given by some botanists to Amaryllideæ so as to include Hæmodoraceæ, Hypoxideæ, Velloziеæ, and (with somewhat less certainty) Alstrœmerieæ. Their anther-cells turned inwards or lateral, a character apparently more constant here than in the hypogynous or perigynous orders, is perhaps the only certain character to separate this large order from Irideæ; whilst the closely allied Liliaceæ are removed only by the technical character of the superior ovary.

The small order Taccaceæ, closely allied to the Amaryllideæ, is distinguished by the parietal placentation with numerous ovules, and Dioscorideæ by the unisexual flowers and peculiar habit connecting them with some of the climbing genera of Liliaceæ, and especially with Roxburghiaceæ—a specimen of a *Roxburghia* without flowers having even been mistaken by Brown for a *Dioscorea*. Bromeliaceæ, including genera with the ovary partially, and perhaps wholly, superior, connecting the Epigynæ with the Coronariæ, are exclusively American; and I have as yet examined in detail only a few of the genera.

Coronariæ is a name originally given by Linnæus to a small group of Liliaceæ, but is here taken in the extended sense given to it by Endlicher, with the still further addition of that author's *Principes* and of two orders taken from his *Enantioblastæ*. It conveniently expresses one of the chief characters of the alliance, a normally biseriate perianth, of which the inner or both series are spreading or prominent above the subtending bract. This character is, I believe, constant in the alliance, though it is also found in the Alismaceæ classed, for other reasons, with the Nudifloræ and in two small genera of Restiaceæ. The superior ovary

distinguishing the Coronariæ from the Epigynæ is also constant within the alliance, although variable on its borders in the above-mentioned Bromeliaceæ; the ovary is almost, but not quite, constantly syncarpous; and I know of no exception to the albuminous seeds, although that character is so variable in Nudifloræ.

Endlicher's class Enantioblastæ was an artificial and somewhat unnatural union of Commelyneæ and Xylideæ with Restiaceæ and their allies—as previously proposed by Martius, on account of the position of the minute or lenticular embryo at the opposite extremity of the albumen to that of the hilum in a slight cavity rather than deeply immersed in the albumen. In some other instances also it has been endeavoured to distinguish various Liliaceous groups by the position of the embryo with relation to the hilum, but this character proves too variable for practical use. In the great majority of Monocotyledons with solitary or few ovules the embryo or its radicular extremity is basal with respect to the fruit, and is consequently more or less distant from the hilum, according as the ovule had been erect and anatropous, laterally attached and amphitropous, or pendulous and orthotropous. In Commelyneæ, however, it is lateral on the side opposed to the lateral hilum; in *Xanthorhea* it is transverse, whilst the hilum is basal; in several Liliaceæ it is variously oblique, in some Alismaceæ horseshoe-shaped with both ends directed downwards; but in no Monocotyledon, as far as I am aware, is the radicular end or the small embryo superior with relation to the fruit; and it does not, therefore, afford that positive character which we observe in some Dicotyledons.

The characters separating the three subdivisions of Coronariæ founded on the texture of the perianth must be taken as general only, not absolute; for in several of the smaller-flowered genera the petaloid or calycine nature of the perianth is very ambiguous, and the place of such genera has to be determined by general affinity evinced by a combination of other characters.

The very small order Roxburghiaceæ, differing from some Liliaceæ chiefly in their 4-merous, not 6-merous, flowers, and in some measure in the venation of the leaves, is placed first as showing in habit some approach to Dioscorideæ, the last order of Epigynæ.

With regard to Liliaceæ, I have, after much consideration, felt the necessity of adopting the extended view given to that order by J. G. Baker in the series of papers published in our Journal. There are, it is true, a number of characters which

at first sight might appear of sufficient importance to separate ordinally a number of large or small groups, or even single species, such as habit, venation of leaves, inflorescence, anther-cells turned outwards or inwards, styles distinct or united, ovary completely or imperfectly divided into cells, fruit baccate capsular or nucamentaceous, colour and consistency of the seed-testa, albumen hard, fleshy, or more or less farinaceous, distance of the embryo from the hilum, &c. But upon further investigation these characters prove to be either exceptionally isolated, separating groups in other respects evidently nearly related, or if two or more exceptional characters may be observable in one genus or in a group of several genera, they are either so variously combined or so gradually evanescent in intermediate genera as hitherto to render unavailing endeavours to define satisfactorily subordinate groups. I have no distribution into tribes to propose as an improvement upon those adopted by Baker; but at the same time it must be admitted that some of them are purely artificial. Several of the baccate genera are more naturally allied to corresponding capsular ones than to each other; and the baccate character itself is often very uncertain, as, for instance, in *Cordyline*. The outward direction of the anther-cells, so useful in the definition of Irideæ as well as of all the Nudifloræ except Alismaceæ, fails entirely for the separation of Melanthaceæ—the genera usually included in that tribe or suborder showing every degree between the outward, the lateral, and the inward direction.

It is true that, as already remarked, the limitation of the whole order may in the same way be sometimes stigmatized as uncertain or artificial. *Hewardia*, for instance, is in many respects nearer to Irideæ than to Liliaceæ; *Blandfordia* resembles some Amaryllideæ rather than any other Australian Liliaceæ; the main character separating Liliaceæ from Junceæ scarcely holds good, if we compare the small-flowered Asparageæ with the Xerotideæ; but these cases are comparatively few, and wherever the boundary line is drawn, it must be more or less arbitrary or artificial.

Pontederaceæ differ but little from Liliaceæ, chiefly in their aquatic habit and a slight irregularity in the flowers; they are, however, chiefly American, and require further study.

The second subdivision of Coronariæ, those with the inner perianth petal-like as in the first, but the outer one calyx-like or deficient, is a somewhat artificial one, and includes three very

distinct orders, which have been very variously placed by different botanists.

Philydraceæ, limited to four Australian or East-Asiatic species distributed in three genera, cannot nevertheless be brought into, or even very near, any other order. The general structure of the ovary and some other points induced me in the 'Flora Hongkongensis,' to refer them to Xyrideæ; but the anatropous ovules and basal embryo are rather those of Liliaceæ, whilst the peculiar irregularity of the flowers with only one perfect stamen and two staminodia is that of Scitamineæ; and the perianth is quite abnormal, consisting of two rather large petals only; the upper two-nerved one, however, is apparently formed by the combination of two; and the perianth must be probably regarded as limited to the inner series, the outer series being entirely deficient.

Xyrideæ, on account of their glumaceous inflorescence and orthotropous ovules, have been, by Martius and others, associated with Restiaceæ and some others in a separate alliance. *Xyris*, however, differs essentially from the latter order, as well in the great petaloid development of the inner perianth, as in the structure of the ovary. The imbricate glume-like bracts each embracing a single sessile flower occur also in *Johnsonia* and its allies among true Liliaceæ; and the structure of the seed, although usually one of the most important characters, may, like all others, become purely artificial if unaccompanied by other differences.

I would here observe that there is one point in which the homology of the parts of the flower in *Xyris* appears to me to have been in some measure mistaken. The two outer scales (Plate VII. figs. 1–3), usually regarded as two outer perianth-segments, are placed opposite to each other at the very base of the floral axis; they are concave or complicate, and keeled, and persist after the true perianth has fallen away or shrivelled up; they have therefore all the characters of the bracteoles observable in many genera of the epigynous as well as of the coronal orders. The next, or so-called third perianth-segment of the outer series is placed higher up on the floral axis, immediately under the inner series with an annular attachment perfectly closed round the axis when in bud; it is of a very different texture from the bracteoles, completely encloses the inner segments in the young bud, disarticulates at the base, and is cast off as those inner segments grow out. This so-called third segment would therefore appear rather to represent the whole outer series, and to consist of the

union of its three normal segments, as may be seen in some species of *Eriocaulon* and a few other genera.

Commelynaceæ have likewise been associated with Restiaceæ, but with still less reason than Xylideæ, and solely on account of their anatropous ovules and, in some respects, the structure of the seeds. The inflorescence is never glumaceous; and the ovules, even when solitary, are not pendulous. The order, though technically associated with Xylideæ and Philydraceæ, having usually a very delicate petal-like inner perianth or corolla, whilst the outer one is strictly calycine, is a very distinct one, and shows no immediate affinity to any other; nor are there any connecting genera, unless perhaps *Cartonema* may indicate some approach either to Liliaceæ (Chlorophyteæ) or to Junceæ (Xerotideæ).

In a third subdivision of Coronariæ, those with the whole perianth calycine, might be placed two large orders, not usually found in juxtaposition, but which appear to me to be more conveniently associated under Coronariæ than in any other series.

Juncaceæ are, without doubt, so closely connected with Liliaceæ, that some genera have been placed by some botanists in the former, by others in the latter, according to which of the several characters which usually separate them has been taken as absolute. Of these characters, the most constant is the above-mentioned one derived from the nature of the perianth, corolline or petal-like in the Liliaceæ, calycine in the Juncaceæ. In *Xerotes*, however, for instance, the perianth is sometimes very little different from that of some Asparageæ, although in all other respects it is rightly associated with the Juncaceæ rather than with Liliaceæ. The prevalent habit of Juncaceæ, approaching that of the Glumales, is very rare in Liliaceæ; but in *Xerotes* and *Xanthorrhœa* it is often arborescent, as in *Dracæna* and its allies. Again, the black crustaceous testa and fleshy or hard albumen in the seeds of Liliaceæ have been given as absolute characters separating that order from Juncaceæ, where the albumen is usually farinaceous, and the testa membranous or pale-coloured; but in *Blandfordia*, for instance, the testa is pale and soft; in some of the baccate genera of Liliaceæ the hard albumen becomes sometimes almost mealy; and in *Xanthorrhœa*, most unnaturally dissociated from *Kingia* and *Dasypogon*, the testa is black and the albumen hard or fleshy, as in true Liliaceæ. The embryo is in most Juncaceæ (except *Xanthorrhœa*) small and erect from the base of the seed, whilst in Liliaceæ it is very variously placed with

relation to the hilum, rarely absolutely basal. The line separating the two orders may therefore well be the subject of difference of opinion; and a certain number of genera, chiefly Australian, and each one very distinct in itself (*Xerotes*, *Kingia*, *Dasypogon*, and *Calectasia*, with or without *Xanthorrhœa*) have often been grouped together into an intermediate order under the name Xerotideæ, although to me they appear to be much more appropriately regarded as a tribe of Juncaceæ.

The very distinct almost monotypic genus *Flagellaria* has, on account of its farinaceous albumen, been placed by some under Juncaceæ, with which it has little else in common; by others it has still more inaptly been referred to Commelynaceæ because of the embryo almost superficial and remote from the hilum. It would appear, however, that it might well be included in Liliaceæ (Smilaceæ) in the vicinity of *Rhipogonum*.

Palms form a group so natural and so striking that they are universally acknowledged as a substantive order, which some would raise to the rank of an alliance, or even of a separate class; and yet the distinctive character rests chiefly on the organs of vegetation, a woody stem combined with pinnately or palmately divided or lobed leaves, the structure of the flower and fruit in most genera being very nearly that of the Coronariæ, especially of Juncaceæ. The size and hardness of the albumen is exceptional in many, but not in all, the genera. The apocarpous or monocarpellary ovary in few instances has induced an approximation to Pandaneæ, which exhibit a somewhat similar arborescent habit; but that habit occurs also in *Dracœna*, *Xanthorrhœa*, and other Coronariæ, always, however, with undivided leaves.

The spatha enveloping the young inflorescence is usually given as an essentially distinctive character of Palms as well as of Aroideæ, and is really a well-marked and generally prevalent feature, but not quite constant, and in other orders a very uncertain one. The passage from the stem-leaves to the next following bracts is in some Monocotyledons as gradual as in any Dicotyledons; but in the great majority the stem-leaves with their short sheaths and long laminæ, whether radical, or scattered along or terminating the stem or branches, cease abruptly under the peduncle, scape or flowering branch; this bears only bracts or scales, being usually more or less developed sheaths either close or open, but without any or with only very small distinct laminæ. Of these bracts or scales there are sometimes none below the one subtending the inflores-

cence or pedicel; but frequently also there are two or more closely imbricate at the base of the peduncle or scape, or one, two, or more smaller ones scattered along it. These are usually termed sheaths, sheathing scales, or simply scales, according to the degree in which they embrace or envelope the stem. In the inflorescence there is usually, but not always, one subtending each branch or pedicel, and specially termed bract in contradistinction to the scales of the peduncle or scape. In some cases (as in most Aroideæ and Palms) the lowest bract is much larger than the others, enclosing the whole inflorescence when young; and then it receives the special name of spatha. Often, however, it is but little more developed or even smaller than those next above it; and it is then termed a bract or a spatha according to its degree of development in the majority of allied genera. In *Pandanus*, in *Gymnostachys*, in *Typha*, &c., where two or more bracts under some of the upper branches are as much developed as the lowest, they are either all or none, or the lowest only, designated as spathas with almost equal fairness. Where the spatha is well developed, especially in Aroideæ and often in Palms, the enclosed inflorescence is usually termed a spadix; but there is really no more definite distinction between a spadix and a panicle or spike than there is between a spatha and a bract. The spatha, however, enclosing the young spadix is very general in Palms and in Aroideæ; and as, being called upon to exercise a more important function than ordinary bracts, it is also fairly constant in its modifications, it becomes an important though not an absolute character, and there is great convenience in adopting the special terminology in use. But in several other orders, where the passage from the ordinary bract to the specially enlarged one is gradual or uncertain, the vague use of the term spatha in technical characters often tends to mislead rather than to give clearness to a definition.

The Nudifloræ proper include a group of five orders universally acknowledged to be closely allied to each other, although very variable in the structure of their seed. All are without perianth or with only a small scale under each stamen. Bracts are rare except a spatha at the base of the inflorescence, and sometimes under its principal branches. The anthers are usually sessile, or on short thick filaments with the cells opening outwards, or in terminal pores. The ovary is, with few exceptions, apocarpous or monocarpellary. The seeds are albuminous with a small

or axile embryo in two orders (Pandaneæ and Typhaceæ); exalbuminous in one (Naiadeæ); albuminous in some genera, exalbuminous in others in the remaining two (Aroideæ and Lemnaceæ). The distinctive characters of these several orders have been too well marked out in various works to require any comment on the present occasion, except that I cannot agree with Kunth in considering each stamen and each carpel, in *Potomogeton* and its allies, as a separate unisexual flower, and that I would include in Naiadeæ both *Triglochin* and *Scheuchzeria*.

Alismaceæ form a small order very puzzling as to its affinities. The objections to associating it with Hydrocharideæ, as frequently proposed, have been above adverted to. The double perianth of the majority of genera (reduced to two petaloid segments in *Aponogeton*) might refer it to Coronariæ, were it not for the apocarpous ovary and exalbuminous embryo, which bring it so near to Naiadeæ; whilst it differs from the five preceding orders of Nudifloræ, not only in the development of the perianth, but also in the stamens, which, even when definite, are not opposed to the perianth-segments, and in which the filaments are usually slender, and the anther-cells always opening inwards. On the whole it seems best to regard Alismaceæ as an anomalous order, connecting in some measure Naiadeæ with Hydrocharideæ, but more nearly allied to Nudifloræ than to any other series or alliance.

The Glumales are a group of orders established by Lindley and very generally recognized, although within different limits according to the special views entertained by different botanists, and with very different meanings attached to the term glume. Nor, indeed, can any limits or definition be given which shall admit of no exception. Generally speaking, in the five orders to which, after Lindley, I would limit the alliance (Eriocauleæ, Centrolepideæ, Restiaceæ, Cyperaceæ, and Gramineæ) the flowers are sessile or nearly so, and solitary within imbricate dry bracts termed *glumes*, forming heads or spikelets, which may be solitary or variously combined in heads, spikes, racemes, or panicles; the perianth is scarious or glume-like, and concealed under the glumes or entirely deficient; the ovary is free and uniovulate, or divided into uniovulate cells; and the seeds are albuminous. This definition excludes the Xylrideæ and Juncaceæ referred to the group by Steudel; for the former, although, like *Johnsonia* and its allies among Liliaceæ, they may have the imbricate dry bracts of Glumales, have nevertheless a very different ovary as well as the large

petal-like perianths of Coronariæ, and the Juncaceæ never show the spikelets of the Glumales. On the other hand, there are a few species forming exceptions to the general character of the Glumales, although their general affinities require the including them in the alliance. Thus in Centrolepideæ there are often several flowers within each glume, or the glumal arrangement is entirely disturbed; and in a very few Restiaceæ (chiefly *Anarthria* and *Lepyrodia*) the glumes are shorter than the perianths and scarcely or not at all imbricate. These exceptions will be further considered after a few preliminary observations on terminology.

Great confusion has arisen from the varied use made by different botanists of the names given to the organs enclosing the essential parts of the flowers of Glumales. These organs are sometimes perianth-segments, but more frequently bracts or bracteoles, performing the functions of very much reduced or absent perianths. And there would be no absolute error in the uniform employment of the three terms, bracts, bracteoles, and perianth-segments, whenever the distinction between the three is clear, and of the more general terms scales or setæ when it is as yet doubtful to which of the three categories the organ belongs. But in accordance with a very general rule applicable to a variety of organs, as the biological functions of these bracts or bracteoles increase in importance, so also do their characters acquire fixity; and there is therefore great convenience, at least in the three large orders Restiaceæ, Cyperaceæ, and Gramineæ, in the general introduction of the term glume for the primary bracts of the spikelet, and of some special ones, such as perigynium, palea, lodicule, &c., for special modifications of the secondary scales in particular groups. It is, however, very essential for a correct understanding of the floral structure, that, whenever possible, a definite meaning should be given to each term used.

In the three typical glumal orders the term *bract* might be used only for those which subtend the spikelets or the branches of the inflorescence when compound. These bracts are very general, but not universal, in Restiaceæ and Cyperaceæ, very rare but occasionally developed (as, for example, in *Sesleria*) in Gramineæ.

Glumes, in their proper sense, are the imbricate scale-like bracts inserted on the axis of the spikelet; and, following out the views of Mohl and others of the most distinguished among recent organologists, the term should, in these three orders, be applied to *all* the bracts so inserted, irrespectively of any modifications of form or

venation, or of the greater or less development or total absence of the axillary flower, and to no others.

These glumes are universally present in the three orders, and with very few exceptions (as in *Anarthria* and *Lepyrodia*) closely imbricate. Generally speaking, one or two, or sometimes more of the lowest, and occasionally one or more at the end of the spikelet, are empty and usually smaller than the others. Sometimes, however, and especially in some uniflorous spikelets, the uppermost or all of the lower empty glumes is larger or differently-shaped from the others. In androgynous, unisexual, or polygamous spikelets, the glumes frequently differ considerably in form, size, or venation, according as they enclose hermaphrodite male or female flowers or are quite empty; but their alternate imbricate insertion (whether distichous or all round) on the main axis of the spikelet is always constant.

The special terms conveniently applied to the peculiar scales observable in some genera or orders within the glumes on the secondary or floral axis will best be considered under the several orders, on which I shall now offer a few observations. These observations will not be so much directed to the several distinctive characters of the orders, which have been too clearly explained by various botanists to require further comment, as to the various modifications which the spikelets with their glumes and other scale-like organs undergo, and which have given rise to the confused terminology it is my object to expose.

Eriocauleæ have on each scape or peduncle a single terminal spike with closely imbricate bracts, each enclosing a single flower, or the outer ones empty, thus answering to the general character of the spikelet and its glumes; but as the axis of the spike or receptacle is a direct prolongation of the peduncle or scape without any distinctly subtending bract, as the spike itself takes the globular or depressed form usually designated by the term head, very rarely lengthening to a cylinder, and as the imbricate bracts have often a somewhat herbaceous or flaccid consistence not directly associated with the idea of a glume, there appears to be no inconvenience in retaining in this order, as is usually done, the more general terms of flower-head (capitulum) with its imbricate bracts, bearing always in mind their strict homology with the spikelet and its glumes of the larger glumal orders.

The flowers of Eriocauleæ are unisexual, arranged in androgynous or rarely unisexual heads; and although concealed under the

bracts except the anthers and stigmatic tips, they are almost always more or less stipitate, and on their stipes or pedicel, or on the floral axis continuous with this pedicel, are usually 6 or fewer hyaline scales in two series—the upper or inner series close under the stamens in the males, or under the ovary in the females, the outer or lower series often much lower down and sometimes at different heights (see Plate VII.). In many species those of the upper series are, in the male flowers, reduced to small teeth or entirely wanting, and are also occasionally deficient in the females; those of the lower series are sometimes in one or both sexes reduced in number or entirely deficient, or are united in a single spatha-like scale; but their homology is the same in both sexes, and they appear to be quite correctly termed perianth-segments. Yet they are often called by other names, and differently so in the male and female flowers. Thus Lindley and some others have even described those of the outer series as glumes, although they are never glume-like either in consistence or insertion; and most monographers describe the upper portion of the stipes or axis of the male flowers as the solid tube of the inner perianth. Setting aside the contradiction of terms implied in the expression "solid tube," this interval between the outer and inner series of segments is no more a part of the inner one in the males than in the females, where it is never so described, or than in some species of *Campanumæa* and a few other Dicotyledons, where the calyx is attached to the stipes at some distance below the ovary and corolla. It is true that in the female Eriocaulons the two series of segments are sometimes close together, and the interval between the two is generally shorter than in the males; but they are sometimes also as distant as in the males, or both series are at some distance below the ovary. In some species one or both series are deficient. I am not aware of any bracteoles having been observed in Eriocauleæ below the perianth-segments.

The small order Centrolepideæ, which, from the structure of its ovary and seeds and other characters, must be placed in close proximity to Eriocauleæ and Restiaceæ, is nevertheless anomalous as well as much diversified in its floral arrangement. The inflorescence is a small terminal head or spike as in Eriocauleæ, but usually more or less compound, although the bracts or scales are very much reduced in number and often in size. The nearest approach to the normal spikelet is in *Aphelia*, where the bracts are distichously imbricate, the upper ones, or nearly all, enclosing

each a single flower. If, as stated by Hieronymus, in his careful and elaborate monograph of the Order, these flowers were really all constantly solitary and hermaphrodite in *A. cyperoides*, that would be an example of a typical spikelet with distichous glumes; but in the specimens I have examined I have always found two flowers, one or both male only, in the lowest bract, and sometimes also in the second; and in all the other species artificially separated by Hieronymus under the name of *Brizula*, the lowest one or two bracts contain two or more flowers, usually males, and each of the other bracts a single flower only, but a female one. In *Centrolepis* there are usually only two primary bracts; but the flowers are generally two or more together within each, above twenty in *C. Banksii* and *C. exserta*, and so densely crowded on so short an axis that their precise arrangement is not easy to trace. Hieronymus describes this partial group as a centrifugal *cicinnus* (a cyme reduced to a single branch). I have, however, felt convinced, especially after a careful examination of those species where it is most developed, that it is, on the contrary, a centripetal, unilateral, or rather secund spike—that is, that the flowers, though affixed round the short axis, are all turned to one side, the lowest being the first developed. Under each flower, in most of the species, are one, two, or three very thin and slender hyaline scales; as one of these is almost always immediately under a stamen, and the other one or two more lateral, they may possibly represent a reduced perianth, but are perhaps more likely to be bracts and bracteoles. Upon the whole, however, with this uncertainty as to their homology it may be better in Centrolepideæ to make no use of the term glume, but to retain the name of bract for those which are on the primary axis of the inflorescence, and to designate as scales the hyaline ones within the bracts. In the little genus *Trithuria* the minute flowers are numerous in a nearly globular head, as in *Eriocaulon*, but with only a few bracts towards the circumference, the stamens and pistils being densely crowded in the rest of the head without intervening bracts or scales.

In the great majority of Restiaceæ the glumal arrangement is normal, whilst the perianth, although not protruding beyond the glumes, is as regularly developed with its six dry or scale-like segments as in the Junceæ; and yet, by some singular perversion of terms, these perianth-segments are by several botanists described under the name of glumes, which is never applied to their

homologues in Junceæ. In a few genera or species, however, the typical arrangement is apparently at fault. Thus in the two above-mentioned small genera *Anarthria* and *Lepyrodia*, the glumes are small and not closely imbricate, and there are usually two bracteoles under the perianth, bringing these genera nearer to Junceæ, from which, however, they are constantly distinguished by their pendulous orthotropous ovules. In the females of *Leptocarpus Brownii* and a few allied species, the flowers and surrounding scales are so densely crowded in the compact compound inflorescence that it is sometimes very difficult to draw the line between the bracts, glumes, bracteoles, and perianth-segments, whilst in the males of the same species the spikelets are quite normal. In the monotypic genera *Onychosepalum* and *Chætanthus*, the perianths are reduced to small hyaline scales or setæ, and the habit is quite that of some Cyperaceæ; but they have always the leaf-sheaths slit to the base and the pendulous ovules of true Restiaceæ.

In Cyperaceæ the glumal arrangement is usually normal, as in Restiaceæ; but the perianth is, with few not very certain exceptions, either deficient or reduced to small hyaline scales or setæ; and the presence of bracteoles or of a so-called perigynium within the glumes is much more frequent than in Restiaceæ. The term glume, however, is not so generally used by cyperologists as I think it ought to be; several irregularities, which seem scarcely justifiable, have crept into their terminology; and in a very few genera there are real difficulties in describing properly the parts of the spikelet. A few instances may here be given in illustration of these irregularities in diction or in reality.

In *Kyllinga* the spikelet has been described as having usually four scales or glumes, of which two lower ones small and empty, and two larger flowering ones enclosing one flower. Now, as in the general character of the order each flowering scale is said to enclose one or rarely more flowers, it was difficult to conceive how a spikelet with two flowering scales should have but one flower; and on examination the fact proves to be that in most species of *Kyllinga* the spikelet has but three glumes, two empty and one flowering one. What has been termed the lowest small scale is not part of the spikelet at all, but is a bract inserted on the receptacle or main axis of inflorescence, and subtends the spikelet; the next scale, though still small and hyaline, is rather larger or sometimes considerably larger than the bract, and is the lowest

empty glume of the spikelet. The next or upper empty glume or scale, is very different from the lower one, being much larger, broader, of a firmer consistence, and many-nerved; the third, or flowering glume, is so close above it as to appear almost opposite, and is very similar to it, except that it is sometimes larger, sometimes smaller, with one nerve more or less on each side. After flowering, the short floral axis becomes articulate between or below the empty glumes; and the ripe caryopsis, or nut, in falling away, carries with it the closely enveloping upper empty glume as well as the flowering one; and this it is which gave rise to the defective expression "two flowering glumes." In some *Kyllingæ* there may be one or two additional small empty glumes below or above the articulation; and occasionally there is a second flower, that, however, is not placed in the glume which is immediately below the ordinary flowering one, but just above the normal flower, apparently within the flowering glume, but really on a slight prolongation of the axis of the spikelet, in the axis of a small sometimes almost rudimentary glume. The two nuts, like the single one, are enclosed immediately within the normal flowering glume, and outside that, within the upper empty glume; the second flower, when present, is usually male only. This double envelope of the ripe caryopsis does not, to my knowledge, occur in any species of *Cyperus*; and therefore I cannot concur in the union of the two genera as proposed by F. Mueller. At the same time the *Kyllinga macrocephala*, A. Rich., from Abyssinia, and a few other several-flowered species, referred by some authors to *Kyllinga* on account of their habit, may be better considered as true *Cyperi*.

Boeckeler describes as a prominent distinctive character of *Kyllinga* the flower resting on a *disk*. I can find no expansion of the torus or gynophore which could justify the use of that term; nor, indeed, can I realize what he had in view, unless it be the persistent base of the floral axis, for which the word disk would certainly be a misnomer (see Plate VIII. fig. 1)*.

* Herr Otto Boeckeler has, in vols. 35 to 39 of the Linnæa, described in detail the whole of the Cyperaceæ contained in the rich collections of the Royal Herbarium, Berlin. As far as I have followed him, I have found him very accurate; and he has had access to authentic specimens, enabling him to clear up much of the confusion created by Nees and by Steudel. If, therefore, I have been led to make some critical observations on some of the terms he has used, and if I cannot agree with him as to the distinctness of some of the forms he has admitted as species, I am far from wishing to detract from the great value of his work.

The double enclosure of the caryopsis in the flowering glume and upper empty one occurs also in the small or perhaps monotypic allied genera *Courtoisia* and *Remirea*, which, however, are sufficiently distinct from *Kyllinga* in the shape and texture of the glumes as well as in habit and inflorescence.

Within the glumes of some genera of Cyperaceæ, on the secondary or floral axis, and outside or below the stamens or ovary, are certain scales or sometimes setæ, very much diversified in number, shape, and relative position, the terminology of which has been very much confused, and requires settlement according to fixed rules, in so far as their probable homology can be fairly exhibited, and more especially so on the present occasion, with a view to comparison with that of Gramineæ.

In the majority of the species of *Hypolytrum* (Plate VIII. fig. 6) there are at the base of the floral axis two distinct apparently opposite concave or complicate keeled scales, placed laterally with regard to the axis of the spikelet and to the subtending glume, and no others. These, from their position and other characters, may fairly be considered as bracteoles, analogous to those of *Anarthria* and *Lepyrodia* in Restiaceæ, or of *Xyris* and of several genera of Coronariæ. In *Hypolytrum pungens* these two bracteoles are united by their margins next the axis of the spikelet nearly to the apex into a single flat two-keeled scale, open on the anterior face only (next the glume) for the emission of the stamens and pistil. In *Platylepis* (Plate VIII. fig. 7) the union is the same, but more complete at the apex, the whole scale being produced into a short, solid, but flat point. The keels are lateral as in *Hypolytrum*, but broadly winged; and the bracts at their very base are rather obliquely inserted. In *Ascolepis*, a genus closely allied to the *Platylepis capensis*, the scale is more oblique, and consists chiefly of a long solid point, with a short fissure at the base for the stamens and pistil. In *Hemicarpha* the scale is exceedingly reduced; it is flat, or slightly concave, entire, or 2-toothed at the apex, very thin and hyaline, often very difficult to detect, and sometimes disappears altogether. That it is, however, homologous to the scale of *Platylepis*, and not, as suggested by Boeckeler, a staminode, is shown by the frequent bifurcation of its apex; and occasionally (as in a flower examined of *H. occidentalis*, A. Gr.) where there are two stamens the scale is below one of them. Whether this usually rudimentary and

occasionally absent organ is sufficient to remove the two or three species from *Scirpus* is another question*.

In *Lipocarpha* (Plate VIII. fig. 5) there are two scales enclosing the flower, as in *Hypolytrum*; but they are quite flat and placed fore and aft, parallel to the subtending glume, which may leave some doubt as to their homology, whether with the bracteoles of *Hypolytrum*, or with the inner scales of *Mapania* and *Pandanophyllum* to be presently referred to.

In the large cosmopolitan and familiar genus *Carex*, the female flower is well known as enclosed in an organ which, from its shape, has been generally called a utricle, the nature of which has been much discussed, but is now generally admitted to be composed of the union of two scales or bracteoles, as well illustrated by Dr. M'Nab and Mr. Dyer in the 14th vol. of our Journal. Of this explanation there can be no reasonable doubt, though there are still some puzzling characters which slightly invalidate the strict homology of this utricle with the bracteoles of *Hypolytrum*, especially the occasional development of an additional axis of inflorescence within the utricle, and the constant absence of all trace of the utricle in the males, whilst it never fails in the females. However this may be, the organ is so peculiar and so necessarily noticed in every specific description of Cariceæ, that there is great convenience in giving it a special name, for which the term *perigynium* is now generally adopted. Its homology with the above-mentioned scale formed of the united bracteoles in *Platylepis* and *Ascolepis* is so very probable, that there is no objection to giving to that organ also the same name (bracteolæ in perigynium connatæ), and even to the pair of distinct bracteoles of *Hypolytrum*, although here it may be better simply to call them bracteoles. But the giving the same name of perigynium to parts of the flower or fruit which are not even distinct organs, as has been recently done, can only mislead and produce confusion. Thus, in *Ficinia* and the allied genera *Hemichlæna* and *Acrolepis*, Boeckeler uses the term perigynium for what Kunth more correctly calls the disk, a slight expansion at the apex of the gynophore or stipes under the ovary; and the so-called perigynium of *Anoporum* is nothing more than a cellular and rather hard thickening of the pericarp,

* In the 'Flora Honkongensis' I followed the received terminology in describing the flower of *Hypolytrum* as a 1-flowered spikelet; but I had not then had the opportunity of following out the homology through *Platylepis* on the one side and *Mapania* on the other.

below and more or less round the seed-bearing cavity, observable in the ripe caryopsis of several Cyperaceæ belonging to various genera. This genus *Anoporum*, originally founded by Nees on the *Cyperus cephalotes*, has, under Boeckeler's revision, become an unnatural amalgamation of four or five *Cyperi* taken from very distinct sections of the genus, with *Scirpus cubensis*, Kunth, to which has been added as a synonym the *Oxycaryum Schomburgkianum*, Nees, a Guiana plant resembling it in aspect but with differently shaped glumes and without that thickening of the pericarp supposed to be characteristic of *Anoporum*. Grisebach has recently, and perhaps correctly, reduced *Oxycaryum* to a section of *Scirpus*; and the other *Anopora* must be restored to *Cyperus*.

A still less intelligible misnomer appears in the descriptive works of some German and Italian botanists, who give the name of perigonium (usually taken as a synonym of perianth) to the hyaline wings which border the angles of the rhachis in the spikelets of some Cyperi. These wings are decurrent from the margins of the glume next above; and though they sometimes become detached in the shape of small scales, they have no connexion whatever with the flower of which they are represented as the perigonial scales.

In some Cyperaceæ, within the bracteoles or independently of them, and immediately under the stamens or alternating with them, or even apparently almost within them, are six or fewer, rarely more than six, setæ or narrow usually hyaline scales. These are very generally supposed to represent perianth-segments; and there is every reason to believe that that is their real homology. Yet this is scarcely yet absolutely proved, and it may be better to continue to describe them by the general terms of hypogynous setæ or scales, which commit the author to no theory. Amongst the genera which have no bracteoles, it is in *Fuirena* that they come the nearest in appearance to true perianths. They there consist usually of three short, broad, hyaline scales, alternating sometimes with three setæ. In *Scirpus* and several of its immediate allies, they are usually all reduced to setæ, six being apparently still the normal number; but they are often reduced in number or very unequal and irregular, exceedingly deciduous or entirely wanting, and even varying in these respects in the same species, on which account Boeckeler and others have reunited *Isolepis* with *Scirpus*. In a few species of *Scirpus*, *Rhynchospora*, etc. the number is often slightly increased, and in some species of *Erio-*

phorum they are very numerous, and lengthen much after flowering, becoming white and silky, and assuming that appearance which has given to the plants the name of *Cotton-rushes* or *Cotton-grass*. This irregularity in numbers has been one of the chief objections raised to the assimilating these hypogynous setæ to perianth-segments. It must, however, be borne in mind that in Monocotyledons, as well as in Dicotyledons in genera or orders in which a definite number of stamens and perianth-segments is the rule, there are sometimes exceptional species where either the stamens alone or the perianth-segments also are indefinitely multiplied.

Amongst the bracteolate genera of Cyperaceæ, *Mapania*, *Pandanophyllum*, *Diplasia*, *Lepironia*, and perhaps two or three others which I have not had the opportunity of carefully examining, have hypogynous scales usually long linear and narrow though flat, and always within the two bracteoles. These, however, have not been generally recognized as the homologues of the setæ of *Scirpus* and its allies, but the whole flower, with its stamens, scales, and bracteoles, has been described as a secondary androgynous spikelet formed of glumes, monandrous male flowers, and a single terminal female flower, a view in which I am unable to concur on the following grounds:—1. The whole spike supposed to be compound has precisely the structure and aspect of the simple spikelet with its numerous closely imbricate glumes, each completely enclosing what I should consider as a single flower. 2. The scales within each glume are not arranged regularly on the axis (all distichous, or all more or less spiral), as is always the case in normal spikelets, but the two outer ones are nearly opposite like bracteoles, and all the others inserted higher up and as nearly as their mutual pressure will allow in a 1-seriate or 2-seriate whorl, an arrangement never observed in a true spikelet. 3. The stamens are not regularly placed one within every scale, as is the case with the true androgynous spikelet of the Sclerieæ; but scales with and without stamens either alternate with each other or are irregularly mixed in the whorl, or, as is very plain in *Diplasia*, the stamens are in a distinct whorl within the whorl of scales.

On the other hand, the genera *Chrysithrix* and *Chorisandra*, inaptly included by Boeckeler in the Hypolytreæ, have the true androgynous spikelets of the Sclerieæ, and were on that account more correctly placed by Kunth in the latter tribe.

The fine genus *Pandanophyllum*, probably too much subdivided

by Kurz, in the 38th vol. of the Journal of the Society of Bengal, has been, I think, inappropriately united with *Lepironia* by Miquel in his 'Illustrations de la Flore de l'Archipel Indien;' but I do not see how it is to be separated from Aublet's genus *Mapania* (Plate VIII. fig. 8), of which my original *Hypolytrum pycnostachyum*, from Panama, is a second American species (*Mapania pycnostachya*). Both in the New and the Old World, the number of scales within the bracteoles appears to vary from 3 or 4 to 6; and in the flowers I examined I found 2, 3, or 4 stamens, and the habit is very much the same. I thought at first that *Mapania* might be distinguished by the very long leafy development of 1, 2, or all 3 of the involucral bracts and the numerous spikelets in the head, whilst in *Pandanophyllum* the spikelets are often solitary or few, and the involucre does not exceed them; but under this view *Mapania africana*, Boeckel., would be a *Pandanophyllum*, and Miquel's *Lepironia macrocephala* (*Cephaloscirpus*, Kurz), as well as two unpublished African species, would become *Mapaniæ*; and a species from Samoa, and perhaps another from Africa, are in many respects intermediate. We must therefore, I fear, sink *Pandanophyllum* into *Mapania*.

Lepironia, Rich., or *Chondrachaë*, Br., has so very different a habit, that the multiplication of inner scales added to the single lateral spikelet may justify the retaining it as a genus. The Australian plant may be, however, specifically distinct from the original Madagascar species.

Diplasia (Plate VIII. fig. 9) has very nearly the structure of *Mapania*; but the stamens and scales appear to form two distinct whorls, one within the other; and the scales are often, when young, united in a tube, at least at the base, which, together with the peculiar, oblong, flat caryopsis with a thick pericarp and small terminal cavity, characterize it generically. The habit of the typical species is very different, the long narrow spikelets being widely paniculate. But it is only to this genus I can refer Spruce's no. 3833, from North Brazil, with a densely capitate inflorescence, unfortunately distributed under the name of *Hypolytrum pycnostachyum*, Benth., of which it has the habit, but which I have above referred to *Mapania*. Spruce's plant may be characterized as in the subjoined note*.

* Diplasia pycnostachya, sp. n. Folia radicalia 1–3-pedalia, ½–¾ poll. lata, margine scabro-serrulata v. demum vix lævigata, in petiolum basi vaginato-dilatatum longiuscule contracta. Scapus triqueter, scaber, 1–1½-

In the large and familiar order of Gramineæ, the glumal arrangement is again typical; but, owing to some strikingly modified relations in form and size of the upper and lower, or of the flowering and empty glumes observed in a large number of species, the terminology adopted by botanists has been very unsettled, and repeatedly modified, since Linnæus first endeavoured to assimilate the spikelet to a flower with its calyx and corolla. For these terms Jussieu substituted those of glume and calyx; and the latter name appears to be still retained by Baron F. v. Mueller and a few others, notwithstanding that the absence of all homology between the so-called sepals in Grasses and those of perfect flowers has been so repeatedly demonstrated. Other botanists have variously proposed or adopted the terms tegmen, glume, epicenium, peristachyum, tragulum, glumella, palea, lodicule, nectary, etc. for the various scales which enter into the composition of the spikelet, thus giving an appearance of complexity to an arrangement which is really as simple as that of Cyperaceæ, and generally homologous with what may be observed in that order.

When, some five and twenty years since, I began drawing up the generic characters of Grasses for my 'Handbook of the British Flora,' I purposed following the terminology of Kunth, knowing him to be the most accurate as well as the most experienced among the agrostologists of the day; but I was soon brought to a standstill by the anomaly of the spikelet of *Milium* being described as having two flowers and one glume, when I could not expect any of my readers to see more than one flower with three glumes. This induced me to pause till I had carefully examined a great variety of genera, and compared them with the nearest allied Monocotyledonous orders. The result was that it appeared to me that no distinct and universally applicable defi-

pedalis. Involucri bracteæ ad 3, longe foliaceæ, valde inæquales (minor angustissima, 3–4-pollicaris, maxima latior subpedalis). Spiculæ 15–20, ovoideo-globosæ, in capitulum densum sessile confertæ. Glumæ numerosæ, oblongæ, multinerves, 2 lin. v. paullo longiores. Squamellæ hypogynæ, tenuissime hyalinæ, apice sæpius lacero-multifidæ, sub fructu fere evanidæ, 2 exteriores (bracteolæ) complicato-carinatæ, 2–4 interiores basi plus minus in tubum coalitæ. Stamina (3–4 ?) intra squamellas hypogyna. Stylus semi-2-fidus, deciduus. *Caryopsis oblonga, valde compressa, 2 lin. longa*, pericarpio duro crasso albo, parte seminifera prope basin parva nigricante.

Hab. in Brasilia boreali ad cataractam fluvii Taruma prope Barra do Rio Negro, *Spruce*, n. 3833. Specimina omnia, fructu maturo, staminibus stylisque pleramque jam delapsis, staminum numerum non plane ostendunt.

nition of the term glume could be given, unless it were applied, as in Cyperaceæ, to the whole of the primary imbricate scales attached to the main axis of the spikelet, whether enclosing a hermaphrodite unisexual or semi-abortive flower or quite empty—and that other names must be given to the secondary scales inserted within the glume under the flower on the secondary or floral axis. I drew up my generic and specific characters accordingly; and it was only after they were in print that I ascertained that similar views had been independently propounded by Hugo Mohl, Döll and others, in Germany, and more recently by Germain de St. Pierre, in France. The consequent terminology has since been adopted by Dr. Hooker and by Prof. Oliver, but not, I believe, by systematic botanists generally. Those who have long devoted themselves specially to grasses have been so used to consider the flowering glume and its enclosed palea as two paleæ, and the lower empty ones alone as glumes, that they find it inconvenient to adopt a new language, and have adduced arguments in support of their practice, which may appear specious, and may require some further observations in reply; in illustration of which I shall select examples from some of the most familiar genera of Grasses, of which a few diagrams are given in Plate IX.

Whilst insisting on two great laws in terminology—that *homologous and generally similar organs should be designated by the same name*, and that *where the want of homology of two organs has been demonstrated they should be called by different names*, I would nevertheless admit, as an exception to the first rule, that *where in a series of homologous organs a certain number of them are regularly modified in consequence of a difference in the functions they are called upon to perform, it may be convenient to describe them under a different name*. If, therefore, those glumes which in the spikelet of Gramineæ enclose a flower, and are thus called upon partially to replace the perianth, were constantly different from the empty ones, it might have been convenient to give them a distinct name; but it is easy to show that no such difference is at all regular, and that even where the flowering glume is in a slight degree modified the assimilating it to the palea is most inappropriate and misleading.

In several of our large genera of Grasses, the only difference between the one or two outer empty glumes and the flowering ones is that they are rather smaller or rather larger, as is so frequently the case in Cyperaceæ and Restiaceæ, where no difference

in their terminology is admitted; and even in this respect there is often more difference between the first and second empty glume than between the upper empty glume and the first flowering one; and in some cases, as, for instance, in the common Couch-grass (*Agropyron repens*) (Pl. IX. fig. 5), the empty and flowering glumes are precisely similar or very gradually diminish in size from the outer empty to the uppermost flowering ones. A particular empty glume in one spikelet may also correspond to a flowering one in another spikelet of the same plant. Thus in the Rye-Grass (*Lolium perenne*) (Pl. IX. fig. 6), the spikelets are alternately placed in one plane, right and left of the main axis of inflorescence, the single empty glume of each spikelet being the lowest and outer one, and therefore alternately the right-hand and the left-hand one, whilst the second glume, next the axis of inflorescence, is the lowest flowering one. In the uppermost spikelet, however, which, from the non-production of the main axis, is apparently terminal, there are two empty glumes: and this is not owing to the development of an additional outer glume; for the lower of the two empty ones is on the side it ought to be in the regular alternation with the lower spikelets; but the second glume, which in the lower spikelets encloses a flower, is in this subterminal one empty. So in several Paniceæ, the second or third glume, according to the genus or species, has been observed sometimes to enclose a rudimentary, or a male, or even a perfect flower, and at other times to be quite empty without any consequent change in its appearance. It has then been termed either one of the paleæ of the enclosed flower, or, when empty, a *neutral flower*. Now in all other orders, whether Monocotyledonous or Dicotyledonous, a neutral flower signifies one in which the floral axis with the perianth (always regarded as part of the flower) are developed, but the organs of both sexes are either sterile, rudimentary, or deficient; but in these so-called neutral flowers in Gramineæ the whole flower, perianth, bracteoles, axis and all, is deficient, and there remains nothing but the subtending bract, which is in no other case regarded as a part of the flower, still less as a whole flower. Thus in *Panicum* (Pl. IX. fig. 3), according to the Kunthian terminology, the first minute scale is a glume, the second, many times larger, is also a glume, the third, often precisely similar to the second, is not a glume but a flower, and the fourth, whether similar or more or less dissimilar, is a part of a flower. In some Gramineæ there are additional empty glumes, usually small and often different in form, either immediately below the flowering ones, as in *Antho-*

xanthum (Pl. IX. fig. 2) and *Phalaris*, or at the end of the spikelet, as in *Melica*. These have also been often termed neutral flowers, although they have no pretensions to be flowers at all. In some genera, as in *Uniola* (Plate IX. fig. 4), from three to six of the lower glumes are empty, and precisely similar to each other, only differing from the flowering ones by being rather narrower and closer together; and yet we are only allowed to call the two lowest ones glumes, the others are termed flowers. We are not even allowed to define glumes as the two lowest scales of the spikelet; for that of *Leersia* (Pl. IX. fig. 1), which has two glumes, one empty, the other flowering, is described as having no glumes but two flowers. In *Kyllinga* and *Courtoisia*, in Cyperaceæ, where the fruit is similarly enclosed in two glumes, they are correctly described as such, one empty, the other a flowering one.

De Candolle and others have described the small outer glume of *Panicum* as an additional bract; and this may be so far correct, inasmuch as all the glumes are bracts in the most extended sense of the word; but, as above mentioned, it is most convenient in the Glumales to limit the special use of the term bract to those which subtend the whole spikelet or the primary branches of the inflorescence. These, though very general, are not universal in Cyperaceæ, and very rare in Gramineæ. I am not aware of their presence in any British genus except *Sesleria*.

We now come to the contents of the flowering glume, and especially to the palea, commonly called the upper palea, which I need scarcely repeat is neither homologous nor similar to the so-called lower palea, or flowering glume. It is inserted on the axis of the flower, and not on that of the spikelet, as may be readily seen in any of our Grasses, and perhaps most distinctly in the cultivated wheat, where it is perceptibly raised above the base of the axis. It is differently shaped; and having instead of one central rib or keel two prominent nerves, it is generally supposed to be a double organ composed of the union of two scales. That these two scales are the homologues of the two bracteoles of *Hypolytrum* and its allies is very probable; indeed they most closely resemble, in position as in structure, the united bracteoles of *Hypolytrum pungens* and of *Platylepis*. At the same time this homology may not be absolutely proved; and as their presence and general structure is almost as universal as peculiar in Gramineæ, it is convenient to designate them by a special name, for which the generally received term palea is not inappropriate, and commits one to no special theory in regard to it.

One reason given for continuing to designate the flowering glume and palea as two paleæ is that they often spread equally like two parts of a perianth, and that after flowering they often both fall off with the enclosed fruit as if they had been together disarticulated from the axis of the spikelet. But in several species of *Carex*, or of other Cyperaceæ, as well as in some other plants, monocotyledonous or dicotyledonous, the bract is adnate to the pedicel or floral axis, or even to the perianth, and as the fruit ripens is detached with it from the main axis, without ever any such bract being taken as a part of the flower or as a lower bracteole. And as to the convenience of calling both the glume and palea by one name for the purpose of describing them together, that can but very rarely be done on other grounds; the two are almost always so different from each other that they must be separately described; and it appears to me that the accurate designation, flowering glume and palea, is not at all more cumbersome than the deceptive one, lower palea and upper palea.

It is objected also that in uniflorous spikelets the floral axis is in apparent continuation of that of the spikelet, and that it is then hard to ascertain on which axis the upper scale is inserted and thus to distinguish between the glume and the palea; but in the immense majority of genera and species there is no such real difficulty. There is generally an obliquity in the flower, and sometimes, as in *Phleum*, a short continuation of the axis of the spikelet behind the palea, independently of the evidence of the true nature of the upper scale almost universally to be derived from its two nerves without any midrib or keel. The really doubtful cases are exceedingly few, as, for instance, *Leersia* (Pl. IX. fig. 1), where the two scales of the spikelet are similar in form and venation, though the inner one may be rather narrower. The probability is that they are both glumes on the main axis, and that there is no palea, as is evidently the case in *Alopecurus*, where there are three glumes, the two outer empty ones often united, the third a flowering one, and no palea. But granting the exceptional uncertainty in *Leersia*, I would observe that in botanical terminology, as in organography, if we were to allow single exceptions to invalidate rules of otherwise universal application, we should have no general rules left.

The two or, rarely, three small scales above the palea and below or alternating with the stamens in most grasses, have been supposed to represent a reduced perianth; but their homology is not satisfactorily demonstrated, and they have therefore appropriately

received a separate name; that of *lodicules* is the one generally adopted, and does not appear objectionable, although the classical meaning of the word may not be very applicable.

To sum up, therefore,—the spikelets of Gramineæ may be described as composed of a series of alternate glumes, distichously imbricated along the axis, one or two (rarely more) at the base of the spikelets and sometimes a few at the end empty, the others having each a single sessile flower in their axil, the short floral axis bearing a palea, two or rarely three lodicules, and three (rarely two) or six stamens under the terminal ovary.

In conclusion, I have only to add that in making these observations I have had nothing new to bring forward, my only object being to enforce a principle generally admitted, but unfortunately too much neglected by speculative botanists, viz. that to be really useful, descriptions should, in clear and intelligible language, not only enable the reader to identify the plant he has in hand, but call his attention specially to those characters which may indicate its real affinities, the homologies of its parts, and any other relations they may have. But for this purpose it is necessary that the author should distinguish descriptions of plants from theoretical explanations, that he should, in terms the most capable of strict definition, describe only what the observer may actually see, not what it may be theoretically imagined he ought to see, reserving his theories for comments upon what has been actually observed.

P.S. Since writing the above, a further detailed examination of *Lipocarpha* has tended to prove that the two scales within the glume are the homologues of the hypogynous scales of *Fuirena* and of the flat scale-like setæ of *Scirpus littoralis*—these scales being one in *Hemicarpha*, two in *Lipocarpha*, three in *Fuirena*, four in *Scirpus littoralis*, and deficient in *Scirpus* sect. *Isolepis*, genera all very closely allied to each other.—G. B.

DESCRIPTION OF THE PLATES.

PLATE VII.

Diagrammatic Illustrations of the Genus *Xyris*.

Fig. 1. Young bud showing the two bracteoles (*b b*) enclosing the outer perianth (*c*), which then completely envelops the inner perianth, of which the tube has not yet grown out.

Fig. 2. The same further advanced: the inner perianth in lengthening has forced up the outer one, which has left a scar where it had been attached, and is opening on one side to enable it to be cast off.

Fig. 3. The inner perianth expanded, having cast off the outer one.

Fig. 4. The same opened to show the position of the ovary at the base of the tube.

Diagrammatic Illustrations of the Genus *Eriocaulon*.

Fig. 5. *E. septangulare* ♂, showing the three outer perianth-segments much below the three inner small unequal ones, which alternate with the three stamens, with the gland-like rudiment of the ovary in the centre.

Fig. 6. *E. septangulare* ♀, showing the three outer perianth-segments a small distance below the three inner equal, erect, hyaline segments surrounding the ovary.

Fig. 7. *E. rosulatum* ♂, in which the three outer perianth-segments are united into a spatha-like scale; the three inner almost as in *E. septangulare*, but larger, with six stamens.

Fig. 8. *E. rosulatum* ♀, the outer perianth-segments distinct but reduced to two.

Fig. 9. *E. pusillum* ♀, the perianth-segments all linear-subulate, the outer ones at the base, the inner at the apex of the stipes or floral axis.

PLATE VIII.

Diagrams to illustrate the Homology of Parts in the Cyperaceæ.

Fig. 1. *Kyllinga cylindracea*, showing the spikelets disarticulated below the two large upper glumes, the small outer glume remaining on the base of the rhachis or axis of the spikelet, which is persistent and falsely described as a disk, the bract subtending the spikelet also persistent and very small. Both this bract and the small glume remain in some specimens persistent long after the upper part of the spikelet has fallen away; in other specimens they also fall away, leaving the base of the rhachis alone persistent on the general axis of inflorescence. In other species the articulation is at the base of the rhachis, and the small outer glume remains on the spikelet when it falls.

Fig. 2. Spikelet of a *Cyperus*, sect. *Pycreus*, the glumes corresponding to those of Gramineæ (Triticeæ, etc.), the two outer smaller glumes empty and usually persistent after the other flowering ones have fallen off with the enclosed nut.

Fig. 3. *Ficinia*, showing the disk (*d*), falsely described as a perigynium.

Fig. 4. *Cyperus columbetes*, showing the thick white cellular portion of the pericarp (*p*), also falsely described as a perigynium.

Fig. 5. *Lipocarpha*, the glume turned down, showing the two thin scales parallel to the glume, and therefore possibly rather perianths than bracteoles.

Fig. 6. *Hypolytrum*, two navicular bracteoles within the glume.

Fig. 7. *Platycarpha*, the two bracteoles united, and open only in an anterior fissure emitting the flower.

Fig. 8. *Mapania*, two free navicular bracteoles enclosing four (sometimes six) free flat scales, probably perianth-segments corresponding with the setæ of *Scirpus*.

Fig. 9. *Diplasia*, the flat hyaline scales within the bracteoles united in a flat ring round the ovary at the base, divided at first at the top into 4 to 6 lobes, but soon very much torn and jagged.

PLATE IX.

Diagrams illustrating the Homology of Parts in the Gramineæ.

Fig. 1. *Leersia*, two glumes nearly similar, or one larger with more nerves than the other and no palea, the inflorescence very nearly that of *Kyllinga* (compare Plate VIII. fig. 1).

Fig. 2. *Anthoxanthum*, six glumes, all dissimilar, but almost forming three pairs: (1) hyaline with a strong keel, the sides nerveless; (2) twice as large, rather firmer, with a strong keel and a prominent nerve on each side; (3) much smaller, ciliate on the margins with the keel produced into an awn free from above the middle; (4) like no. 3, but rather larger, the awn longer and free from much below the middle of the glume: (5) rather shorter, very broad, hyaline, obtuse, no awn, no cilia, and no keel, but one, sometimes three, very fine nerves; (6) like no. 5, but smaller and narrower with one very fine nerve.

Fig. 3. *Panicum*, four glumes: (1) small, empty, sometimes minute, 1- or 2-nerved; (2) much larger, empty, usually 3- or 5-nerved; (3) sometimes exactly like no. 2, sometimes much larger, empty, or with a palea only, or with a male flower in its axil; of these three, sometimes no. 2, sometimes no. 3 bears a long or short awn; (4) flowering glume, broad, smooth, of a firmer texture, nerveless, or with three fine nerves enclosing the palea and the flower.

Fig. 4. *Uniola*, glumes numerous; nos. 1 to 4, or sometimes 1 to 6 empty, and often but not always smaller; all the others having a palea and flower in their axils.

Fig. 5. *Agropyron*, glumes numerous, all similar, no. 1 and 2 empty, the others having a palea and flower in their axils.

Fig. 6. *Lolium*, spikelets alternating along the rhachis of the spike, each with several glumes, the external glume in each of the lateral spikes empty, the others having a palea and flower in their axils, but in the terminal spikelets no. 1 and no. 2 both empty, no. 1 strictly corresponding in position to the external one in the lower spikelets; but no. 2, which encloses a flower in the lateral spikelets, is empty in the terminal one.

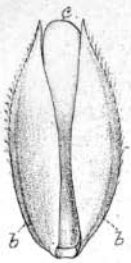


Fig. 1

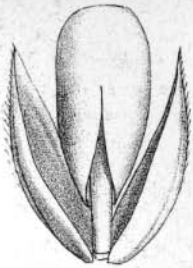


Fig. 2.

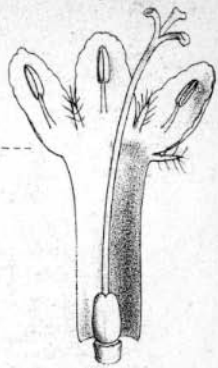
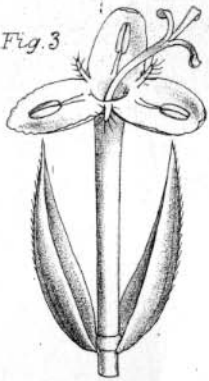


Fig. 4

Fig. 3



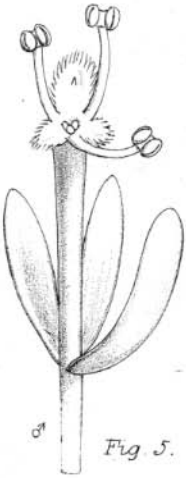


Fig. 5.

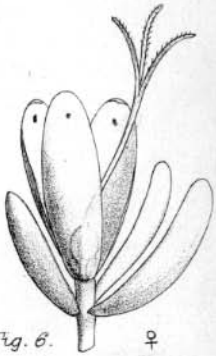


Fig. 6. ♀

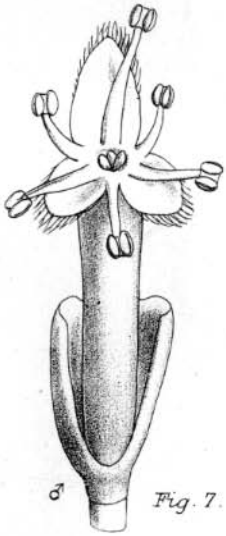


Fig. 7.

Fig. 9.

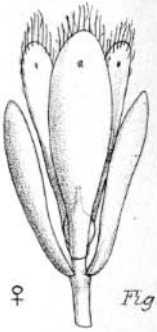


Fig. 8.

J.N. Fitch, lith.

Fitch, imp.

XYRIS & ERIOCAULON

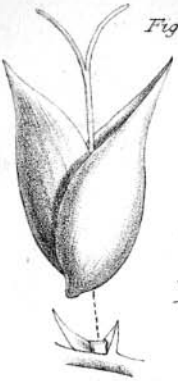


Fig. 1


Fig. 2

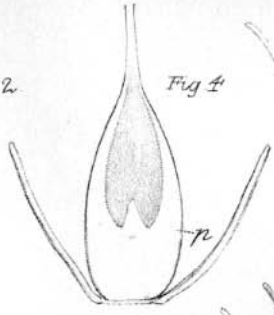


Fig. 4

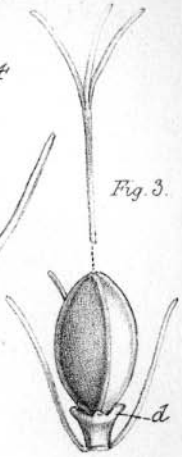


Fig. 3.

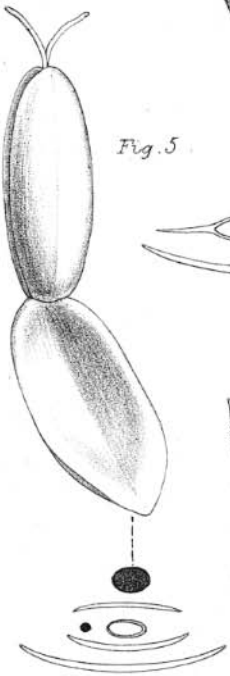


Fig. 5

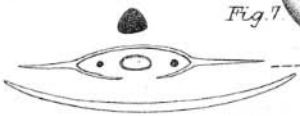
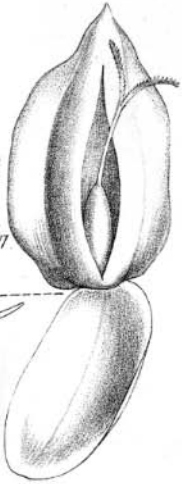


Fig. 7



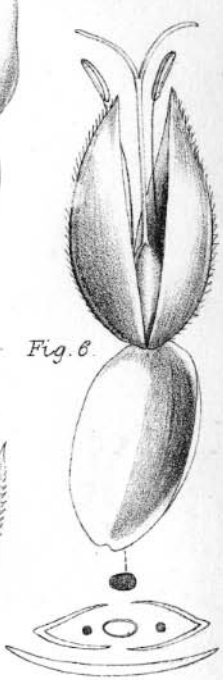


Fig. 6


Fig. 8

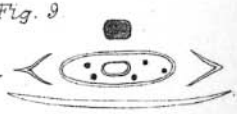


Fig. 9

Fig. 1.

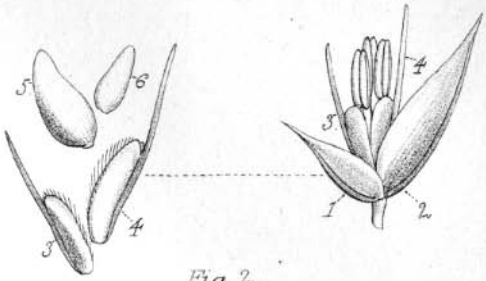


Fig. 2.

Fig. 3.

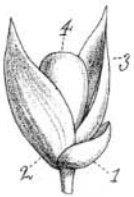


Fig. 4.

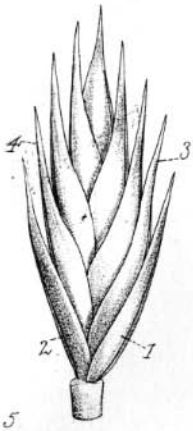


Fig. 5.

Fig. 6.

ERRATUM.

Vol. xv. Botany, p. 491, line 6 from the bottom, for *Agaveæ* read *Aloineæ*.