MORPHOLOGICAL STUDIES IN THE GRAMINEAE *†

I. Vascular Anatomy of the Spikelet in the Pooideae

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(Communicated by V. Puri, F.N.I.)

(*Received April 24, 1962*)

Abstract

The vascular anatomy of the spikelet has been studied in seven tribes of the subfamily Pooideae, viz. Hordeeae, Eragrosteae, Chlorideae, Stipeae, Phalarideae, Zoiseae and Thysanolaeneae. An important feature of the vascular anatomy of the spikelet in this subfamily is that the palea bundles arise from the vascular tissue destined to supply the floret. In the other subfamily Panicoideae, however, the palea bundles arise conjointly with the laterals of its lemma (author's unpublished work). The structure of the spikelet in the *Chlorideae* suggests that the one-flowered condition of the spikelet in the Pooideae has been derived from the multiflowered condition by suppression of the florets above the lemma 1 and ultimate abortion of the rachilla. *Thysanolaena maxima* (Thysanolaeneae) shows an admixture of both festucoid (pooid) and panicoid characters as regards its spikelet morphology. It has been concluded that in *T. maxima* the reductional tendencies are operative in both the directions, i.e. the existing condition has resulted by both basipetal and acropetal suppression of florets in a multiflowered spikelet.

Introduction

In Gramineae the spikelet and its various constituent parts have been the subject of much discussion in the past (Schuster 1910; Arber 1934; etc.). Very recently Barnard (1957) on the basis of his studies on the floral histogenesis of the various grasses has postulated a hypothesis regarding the morphology of the spikelet and its parts. In the present paper a study has been made of the vascular supply of the spikelet of some seven tribes of the subfamily Pooideae with a view to understanding the morphology of the spikelet and evaluating the various evolutionary trends prevalent in the spikelet of this subfamily. A consideration of the morphological nature of its various constituent parts is, however, postponed for a future communication.

Material and Methods

The following is a tribe-wise list of the species which have been included in this study.

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* Based on part of a thesis accepted for the Ph.D. degree of Agra University.

† Contribution No. 39 from the School of Plant Morphology, Meerut College, Meerut.

1. Tribe Hordeeae

   Triticum aestivum Linn.

2. Tribe Eragrosteae

   Eleusine indica (Linn.) Gaertn.
   Eleusine verticillata Roxb.*
   Eleusine coracana Gaertn.
   Dactyloctenium aegyptium (Desf.) Beauv.
   Eragrostis poaeoides Beauv.
   Eragrostis unioloides (Retz.) Nees ex Steud.
   Eragrostis coarctata Stapf ex Hook. f.

3. Tribe Chlorideae

   Cynodon dactylon (Linn.) Pers.
   Chloris inflata Link.

4. Tribe Stipeae

   Aristida setacea Retz.

5. Tribe Phalarideae

   Phalaris minor Retz.

6. Tribe Zoiseae

   Tragus biflorus (Roxb.) Schult.
   Perotis indica (Linn.) Ktze.

7 Tribe Thysanolaeneae

   Thysanolaena maxima (Roxb.) Ktze.

Most of the grasses were collected locally. Customary methods of dehydration, clearing and embedding were employed; sections were cut 10–12 μ thick and stained with crystalviolet-erythrosin or safranin-fastgreen. The material required three or four days in paraffin bath for perfect penetration. The presence of silica and the chaffy nature of the glumes provided considerable difficulty in sectioning.

Observations

Structure and Vascular Supply of the Spikelet: Tribe Hordeeae.—Only one species *Triticum aestivum* was studied. The inflorescence is a spike bearing a

* Name of this grass has been changed to *Acrachne verticillata* (Roxb.) Chiov. (*see* Raizada 1959).

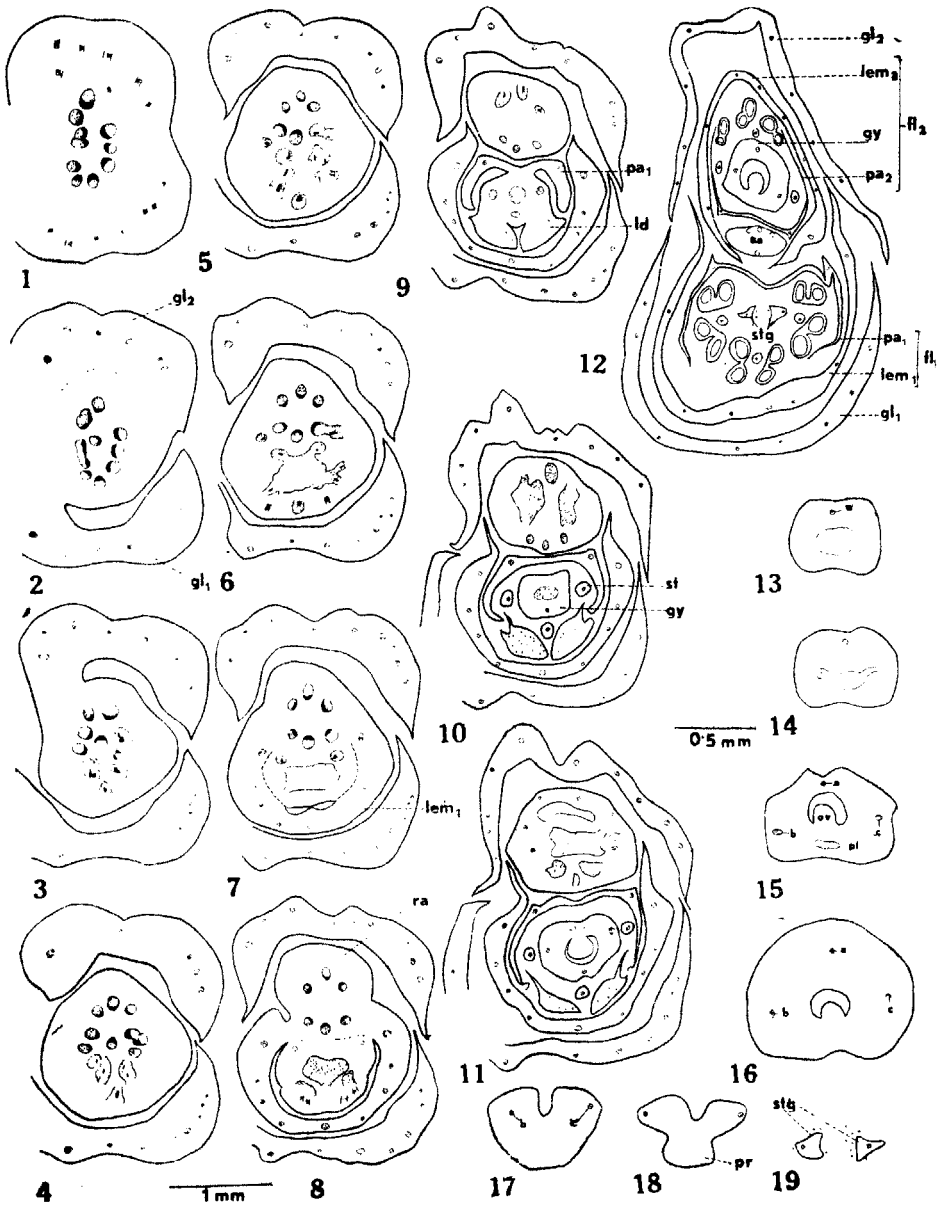
number of awned spikelets. Each spikelet has two outer empty glumes and about 4–6 lemmas, each subtending a flower. The florets at the apex of the spikelet tend to be rudimentary.

At the base of a spikelet in a transverse section there is a flattened ring of about ten vascular bundles and a number of peripheral bundles which are meant for the first and second glumes (Fig. 1). The first and second glumes receive about seven to ten bundles each (Figs. 2 and 3). Some of the bundles occurring opposite the second glume form a plexus of vascular tissue that gives off about nine traces for lemma I (Figs. 3–8). The stelar tissue thus left behind supplies two traces in the postero-lateral direction for the palea (pa_1) and one trace each in the antero-lateral direction for the two lodicules (Figs. 6–9). Each lodicular trace divides into a number of branches that ramify in the lodicule (Figs. 8–10). The remaining mass of vascular tissue gives out one trace each for the three stamens (Fig. 9) and then supplies the gynoecium. It sends off one trace (*a*) in the anterior direction and two traces (*b* and *c*) in the postero-lateral direction (Figs. 13–15). After giving out these three traces to the ovary wall the central bundle (*pl*) supplies the solitary ovule attached on the posterior side of the ovary wall and finishes with it. The anterior bundle in the ovary wall vanishes at the top of the ovary cavity while the two laterals continue into the two plumose stigmas (Figs. 15–19). Another feature of special interest is a short stump-like projection (*pr*) of the ovary wall on the posterior side at the junction of the ovary proper with the stylar branches (Fig. 18). Arber (1934) calls such projections as non-stigmatic processes. Barnard (1957), however, regards it as the reduced fourth posterior carpel.

Meanwhile, on the other side of the first floret, traces diverge out from the rachilla for the second floret (Fig. 9). After supplying the second floret the rachilla has only four bundles, three lying in an arc towards the second floret and one on the opposite side (Fig. 12). Further up this rachilla bears a few other florets.

Tribe Eragrosteae.—The spikelet has a large number of florets arranged on the rachilla in acropetal fashion (Fig. 20). The flowers towards the apex of the spikelet tend to be rudimentary. In a single spikelet all stages from the rudimentary florets at the apex to fully mature flowers at the base or even fruits can be found. The number of florets in a spikelet varies from species to species, e.g. 3–5 in *Dactyloctenium*, 6–12 in *Eleusine*, 10–30 or more in *Eragrostis*. All the species studied are similar in the vascular anatomy of the spikelet and hence the condition in *Eleusine indica* will be described here and attention will be drawn to other species if and when necessary.

At the base of the spikelet there are three vascular bundles in the centre, left after the departure of one median bundle to the first or the outermost empty glume (Fig. 21). Out of the remaining three bundles in the rachilla one occurring opposite the first glume diverges out for the second empty

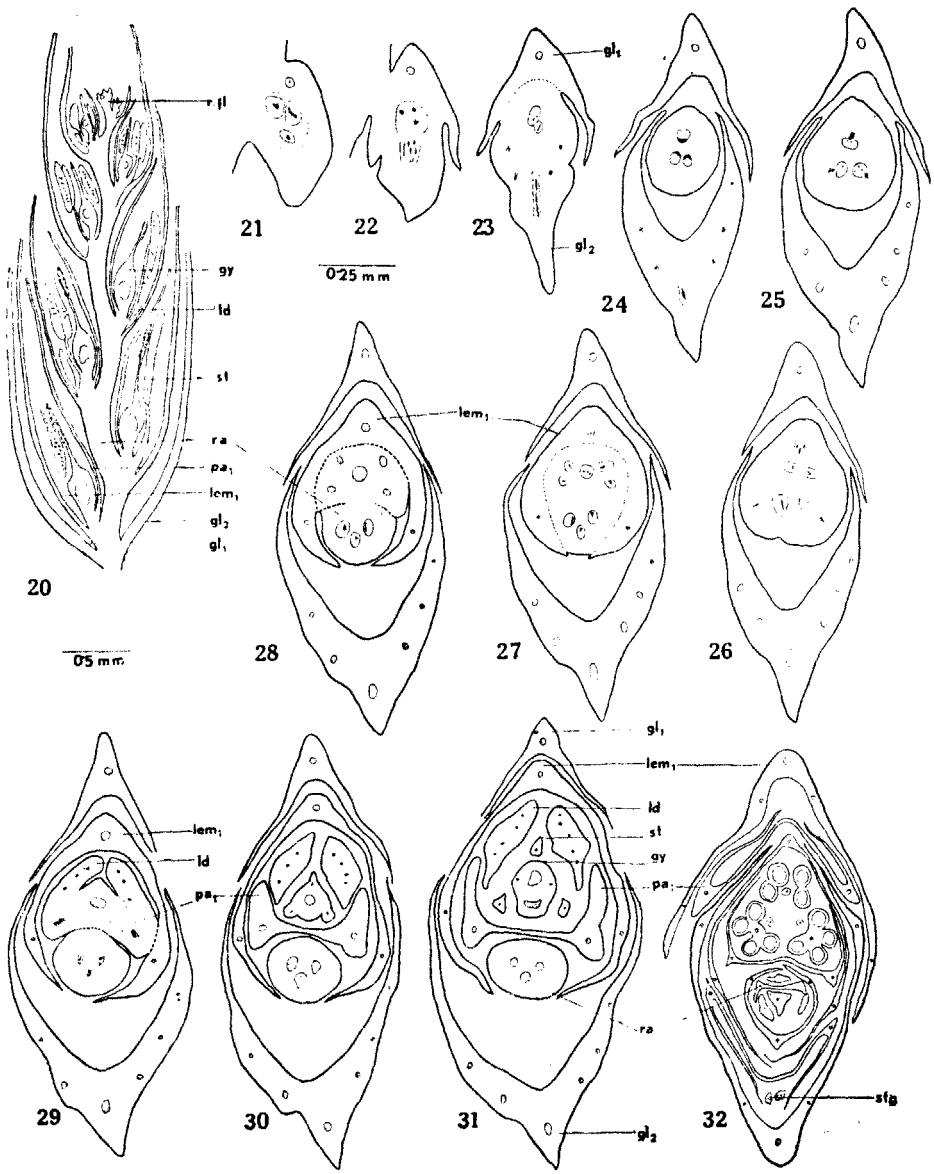


FIGS. 1–19. *Triticum aestivum*. Figs. 1–12. Serial transverse sections of the spikelet from base upwards. Figs. 13–19. Serial transverse sections of a gynoecium from base upwards. Note the anterior bundle '*a*' which vanishes at a higher level in the ovary wall. *a*, anterior bundle; *b* and *c*, lateral bundles; fl_1 and fl_2, flowers I and II; gl_1 and gl_2, glumes I and II; *gy*, gynoecium; *ld*, lodicule; lem_1 and lem_2, lemma I and II; *ov*, ovule; pa_1 and pa_2, palea I and II; *pr*, stump-like process present on the posterior side of the gynoecium at the junction of the ovary with the stylar branches; *ra*, rachilla; *st*, stamen; *stg*, stigma).

glume (Figs. 21–24). This bundle may divide to give rise to 3–5 nerves or the lateral nerves might be derived from one or two very minute bundles that make their way into the base of the spikelet from the rachis itself. In *E. verticillata* and *Dactyloctenium aegyptium*, however, both the outer empty glumes are one-nerved. The two bundles left in the rachilla now unite, but the fusion product soon splits into three bundles (Figs. 22–24). Of these the one present towards the first glume gives out a median trace to the lemma I while the other two bundles provide it with one lateral nerve each (Figs. 25–27). After giving out the median trace to the lemma I this bundle splits up into two vascular masses which again coalesce and then resolve into five components of which the two postero-lateral ones diverge out for the palea and the two antero-laterals for the two lodicules (Figs. 25–29). The palea is strongly bikeeled, specially so in *Eleusine coracana* where the two keels are very prominent and long drawn out. The lodicular bundles divide into three to five or even more minute branches at the base of their respective lodicules (Figs. 29 and 30). After the departure of the lodicular bundles the central mass of vascular tissue gives out three traces, one on the anterior side and two on the postero-lateral sides, for the three stamens (Fig. 30). The remaining vascular tissue supplies the gynoecium. It sends off two traces one on either side to the ovary wall and then continues up as the placental strand getting totally consumed in supplying the solitary ovule borne on the posterior side of the ovary (Figs. 31 and 32). The two lateral bundles traversing the ovary wall continue up into the two plumose stigmas.

Tribe Chlorideae.—In *Cynodon dactylon* the spikelet has only one fertile floret and the rachilla is produced beyond this floret. In *Chloris inflata*, on the other hand, the rachilla bears 3 or 4 barren lemmas above the fertile floret. But the vascular scheme of the spikelet in the two species is almost identical.

In *Cynodon dactylon* at its base the spikelet has a central mass of vascular tissue from which one trace diverges out for the first glume (Fig. 33). Another trace departs from the opposite side for the second glume. After supplying the two outer empty glumes the vascular mass breaks up into two bundles (Fig. 36). The bundle lying towards the first glume sends off a median trace for the lemma while the other bundle sends off two lateral traces—one on either side for the lemma (glume III) which is thus three-nerved (Figs. 36–39). Meanwhile the bundle lying towards the lemma splits into five strands—two postero-laterals for the palea (Fig. 38 ; p_1 and p_2), two antero-laterals (l_1 and l_2) for the two lodicules and one central strand which supplies the stamens and the gynoecium. The other bundle lying towards the second glume passes out into the rachilla (Figs. 41 and 42) that extends beyond the lemma and often bears a vestigial barren lemma. The lodicular traces divide into 3–5 minute branches at the base of their respective lodicules (Figs. 39–41). The central vascular strand now gives off three staminal traces arranged in the usual



FIGS. 20–32. *Eleusine indica*. Fig. 20. Longitudinal section of the spikelet. Figs. 21–32. Serial transverse sections of the spikelet from base upwards. (*r. fl*, rudimentary florets; rest of the abbreviations same as in previous figures).

manner—two postero-lateral and one anterior (Fig. 41). After the departure of staminal traces the central vascular tissue expands a little and gives out two traces one on either side to the ovary wall (Fig. 43). The remaining vascular tissue continues up as the placental bundle and is totally consumed in supplying the solitary ovule. The two lateral bundles traversing the ovary wall continue up into the two plumose stigmas.

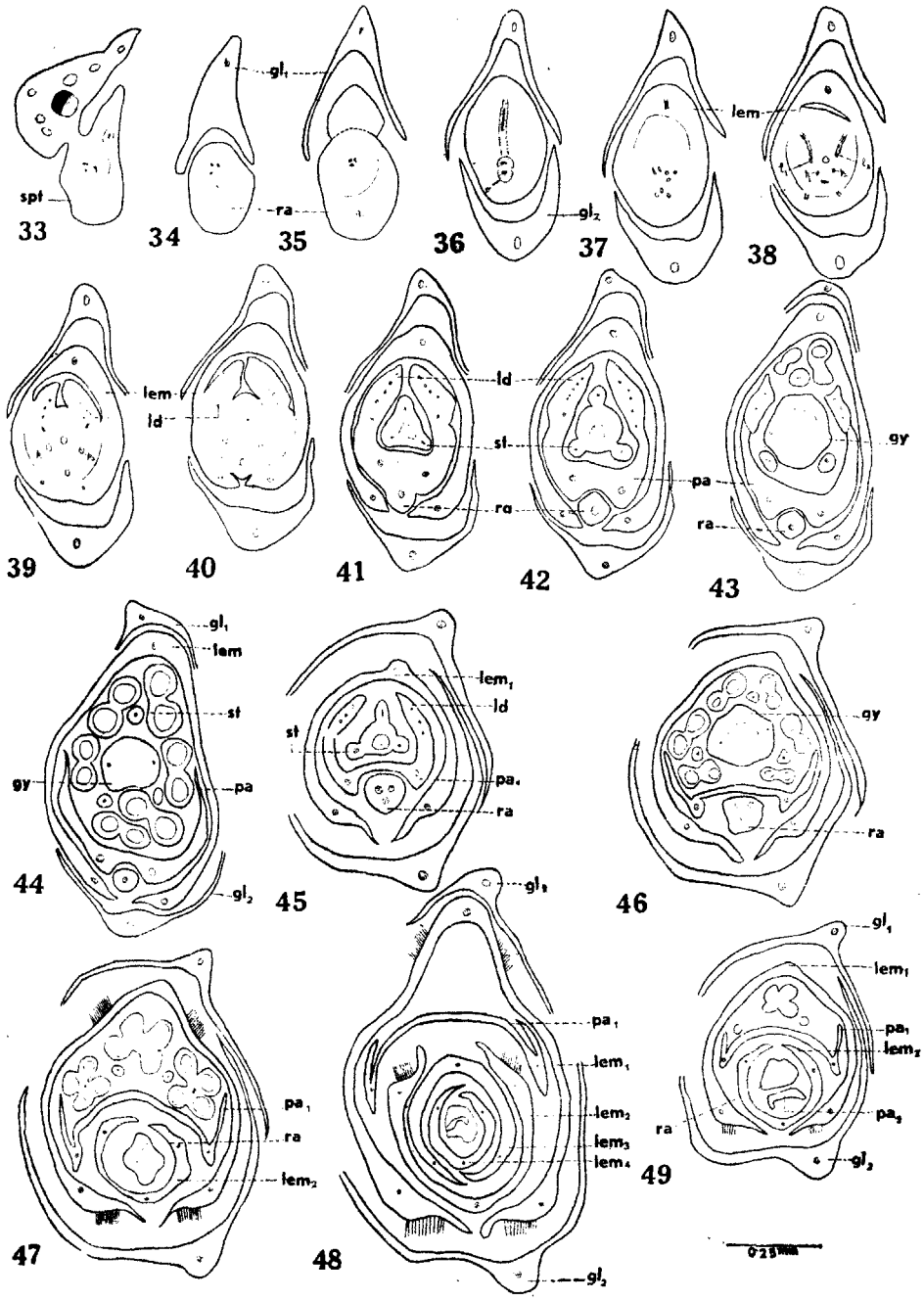
The rachilla, however, has three bundles in *Chloris inflata* and bears a number of barren lemmas beyond the lemma I (Figs. 45–48; lem_{2-4}). In one spikelet the palea of the second lemma was also present (Fig. 49; pa_2).

A noteworthy feature of both these grasses is that the lodicules are fused with the margins of palea at the base (Figs. 42 and 45)—a condition also recorded for some other grasses, e.g. *Oryza sativa* (Arber 1934).

Tribe Stipeae: Aristida setacea.—The inflorescence in this species is a lax panicle with spikelets about 1·5 to 2 cm long, excluding the awn which is tripartite. Each spikelet contains two outer empty glumes and a single floret having one awned lemma, a palea, two lodicules, three stamens and a gynoecium.

In the pedicel of the spikelet there are about seven or eight bundles irregularly distributed as seen in a transverse section (Fig. 50). Out of these, four or five bundles lying towards the periphery go to supply the first or the outer empty glume while the rest fuse and reorganize into four bundles which lie closely appressed to one another (Figs. 51–53). Of these four bundles, one lying opposite the first glume migrates for the second glume (Figs. 54 and 55). The three bundles left in the centre give out some branches towards the centre and themselves migrate for the third glume or the lemma (Figs. 56 and 57). The branches derived from the three outgoing bundles coalesce and form a vascular mass which is destined to supply other organs of the spikelet (Fig. 57). Two traces diverge out from this vascular mass on the postero-lateral side for the palea (Fig. 59; p_1 and p_2). Although the palea is not bikeeled it retains the same number of vascular bundles (two) as is characteristic of this organ. Two traces are now given out for the two lodicules (Fig. 59; l_1, l_2). These traces, however, multiply in number before entering the bases of their respective lodicules (Fig. 60). Each lodicule thus has five or six minute vascular branches. After the separation of lodicules the central vascular tissue gives out three traces for the three stamens (Fig. 61). The remaining vascular tissue supplies the gynoecium and sends off two traces—one on either side to the ovary wall and then continues up to supply the ovule (Fig. 62). The two strands traversing the ovary wall enter the two plumose stigmas (Fig. 63).

A characteristic feature of the spikelet is the continuation of the lemma into a tripartite awn (Figs. 63–65). The three bundles running in the third glume (lemma) continue up into the three branches of the awn. Another



FIGS. 33–49. Figs. 33–44. *Cynodon dactylon*. Serial transverse sections of the spikelet from base upwards. Figs. 45–49. *Chloris inflata*. Serial transverse sections of the spikelet from base upwards. Fig. 49. Transverse section of a spikelet showing a vestigial palea (pa_2) of the second floret. (l_1 and l_2, traces to lodicules 1 and 2 respectively; p_1 and p_2, palea traces).

noteworthy feature of the lemma is that it goes one and a half times round the flower (Fig. 63).

One abnormal spikelet was found to be female and having only vestigial stamens (Fig. 66).

Lodicules are best developed at the time of anthesis and it has been seen that they occupy the entire space between the lemma and the gynoecium (Fig. 67).

Tribe Phalarideae.—The inflorescence in *Phalaris minor* is a terminal spike bearing one-flowered spikelets. Each spikelet has two empty glumes and a lemma bearing a hermaphrodite flower that lacks lodicules.

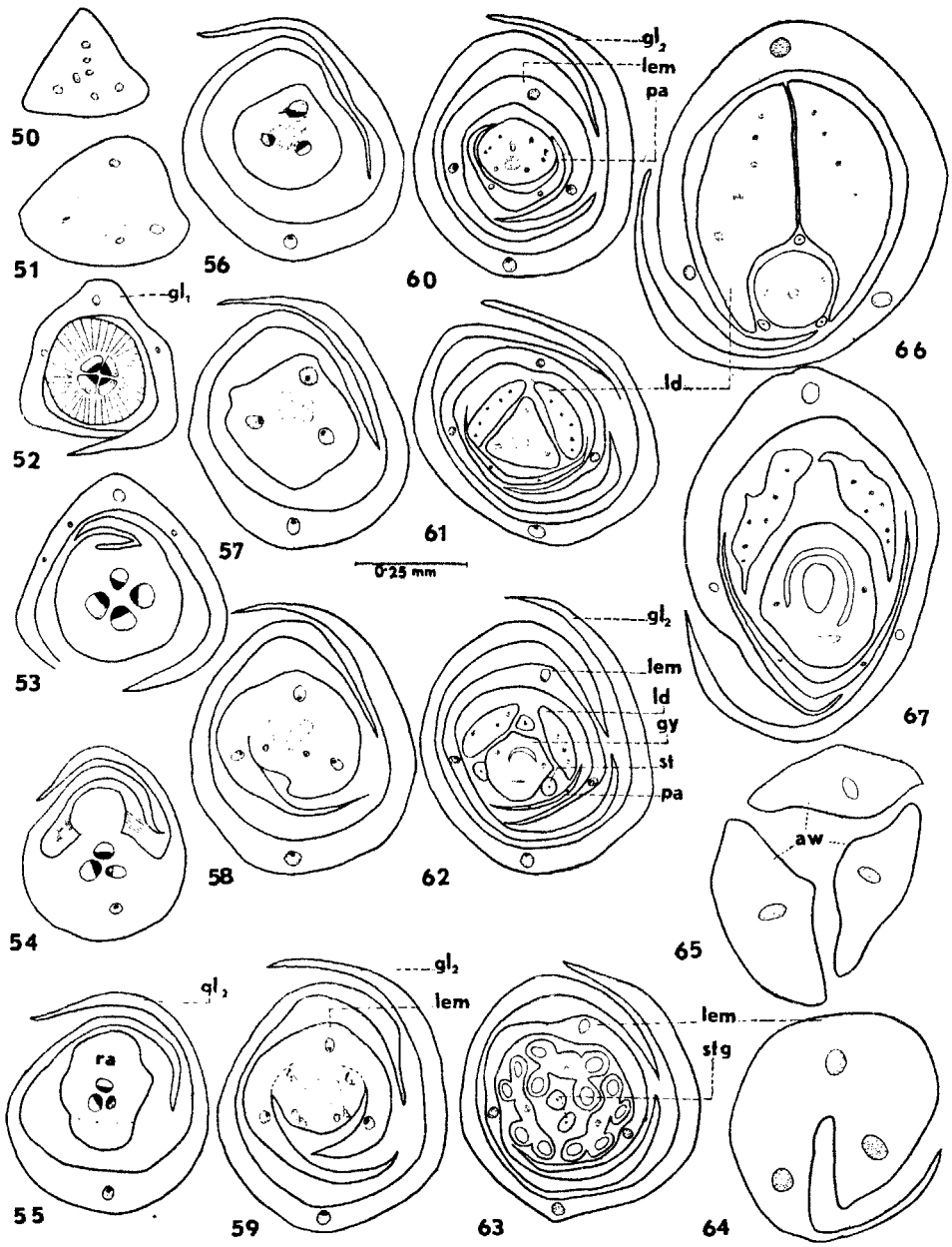
At the base of the spikelet there are six to eight bundles which give out six traces on the peripheral side for the first and second glumes (Figs. 68–71), which are detached as a single unit at the base but higher up they separate off and are three-nerved each (Figs. 71 and 72). Next organ to separate off is a small one-nerved structure (*x*) which is present towards the second glume (Figs. 71 and 72). Five traces now diverge out on the opposite side for the lemma (Figs. 71–73). Palea gets two nerves but is not bikeeled (Fig. 73). Rest of the vascular tissue supplies the stamens and the gynoecium as there are no lodicules. Three traces diverge out in the usual way for the stamens (Fig. 73). One of the lateral stamens is displaced towards the posterior side (Fig. 74). The remaining vascular tissue gives out two traces, one on either side, for the ovary wall and then continues up to supply the single ovule located on the posterior side of the gynoecium (Fig. 74). The two lateral bundles enter the two stigmas (Fig. 75).

From the account detailed above it would seem that the spikelet of *Phalaris minor* presents certain features of interest. Firstly the presence of a one-nerved structure towards the second glume. In *P. tuberosa* this has been regarded as the fourth glume or lemma II (Arber 1934). It seems that in the species under investigation this organ represents the rachilla ending in a barren lemma II and not merely the lemma II as supposed by Arber. The second important feature is the change in the position of one of the lateral stamens which is displaced towards the posterior side of the gynoecium. Arber (1931) ascribes such a condition in *Alopecurus pratensis* to a lateral pressure due to which the spikelet is laterally compressed and the stamen is displaced. Apparently a similar condition prevails in this species.

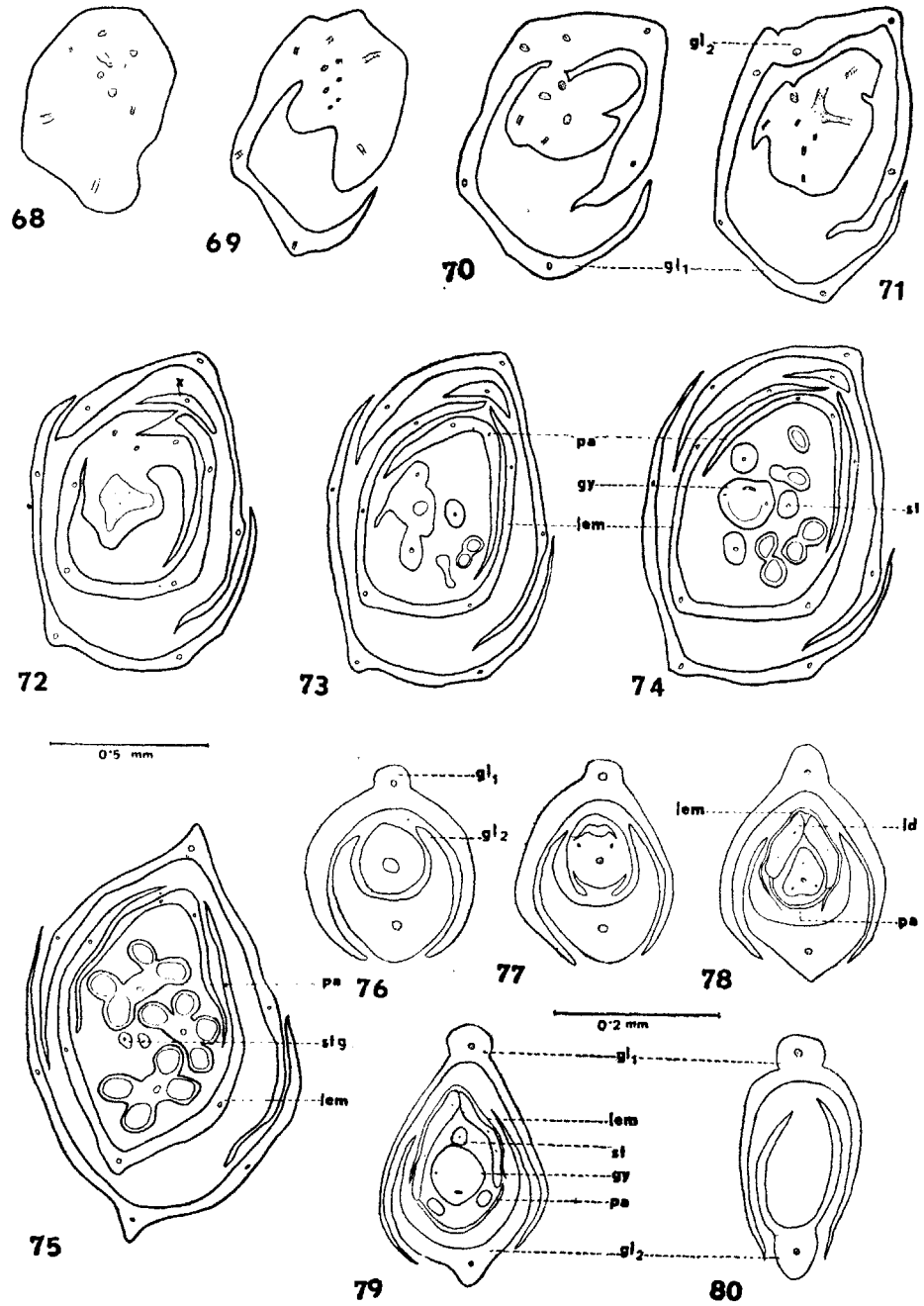
Tribe Zoiseae.—Two species of this tribe, viz. *Perotis indica* and *Tragus biflorus*, have been worked out.

The inflorescence in *Perotis indica* is a spike-like terminal raceme bearing numerous small one-flowered spikelets seated upon very short pedicels.

The spikelet is very simple with two one-nerved empty glumes which continue into long awns. The lemma and palea are non-vascular and hyaline.



FIGS. 50–67. *Aristida setacea*. Figs. 50–63. Serial transverse sections of the spikelet from base upwards. Figs. 64 and 65. Transverse section of the lemma in the *awn* region. Fig. 66. Note the large size of the lodicules. Fig. 67. Note the absence of stamens (*aw*, *awn*).



FIGS. 68–80. Figs. 68–75. *Phalaris minor*. Serial transverse sections of the spikelet from base upwards. Note a one-nerved structure '*x*' present towards the second empty glume in Fig. 72. Figs. 76–80. *Perotis indica*. Serial transverse sections of the spikelet from base upwards.

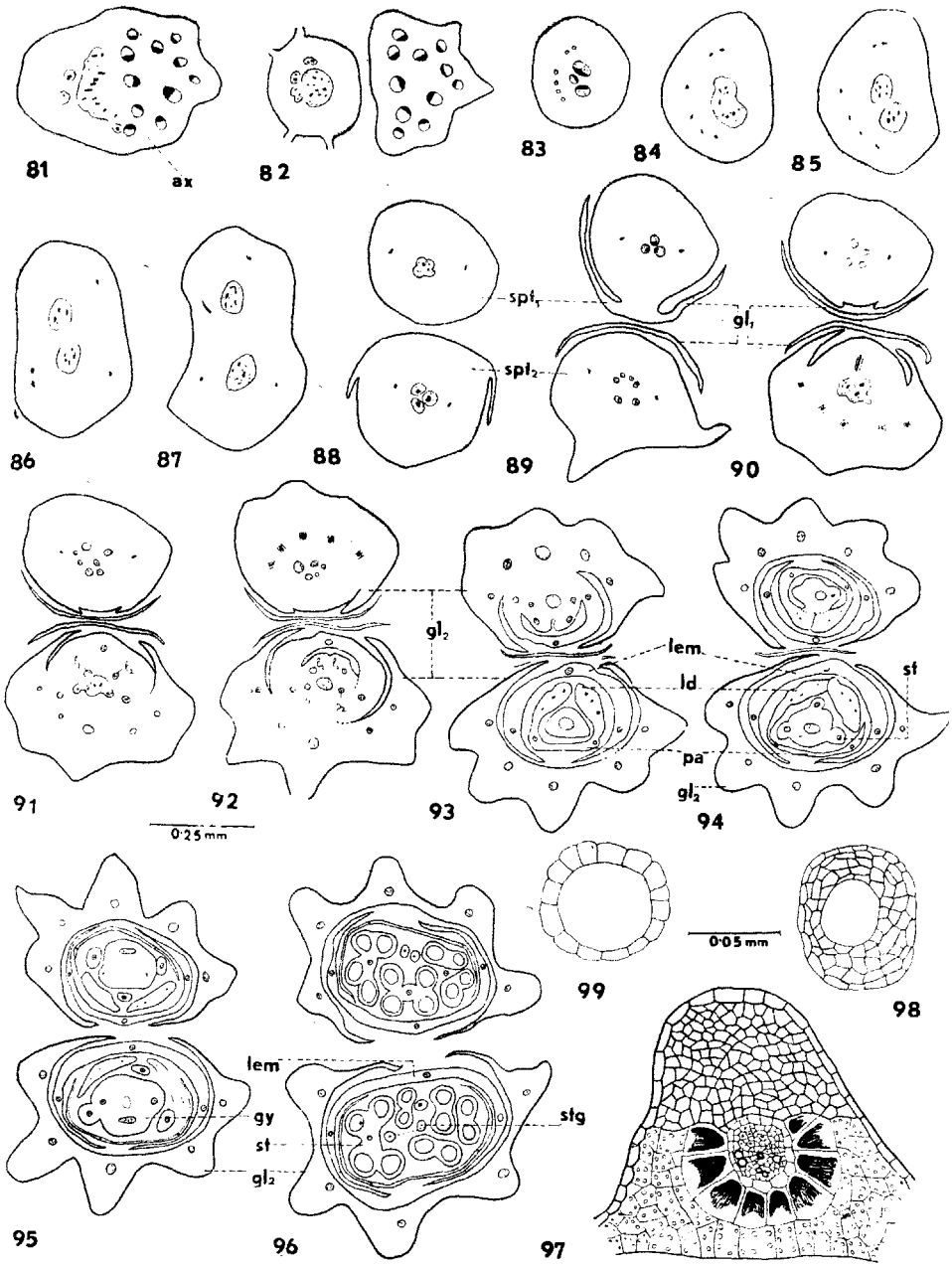
There are two lodicules, three stamens and a gynoecium (Figs. 76–80). In vascular anatomy it resembles other species described before.

In *Tragus biflorus* the inflorescence is a spike-like terminal panicle varying in length from 2–6 cm. The spikelets are arranged in groups of two facing each other and appearing like a single spikelet. Each spikelet has two outer empty glumes—the first glume being minute and hyaline while the second is very thick and is produced into hooks on its outer convex facet. There is one lemma which is paleate and bears a hermaphrodite flower.

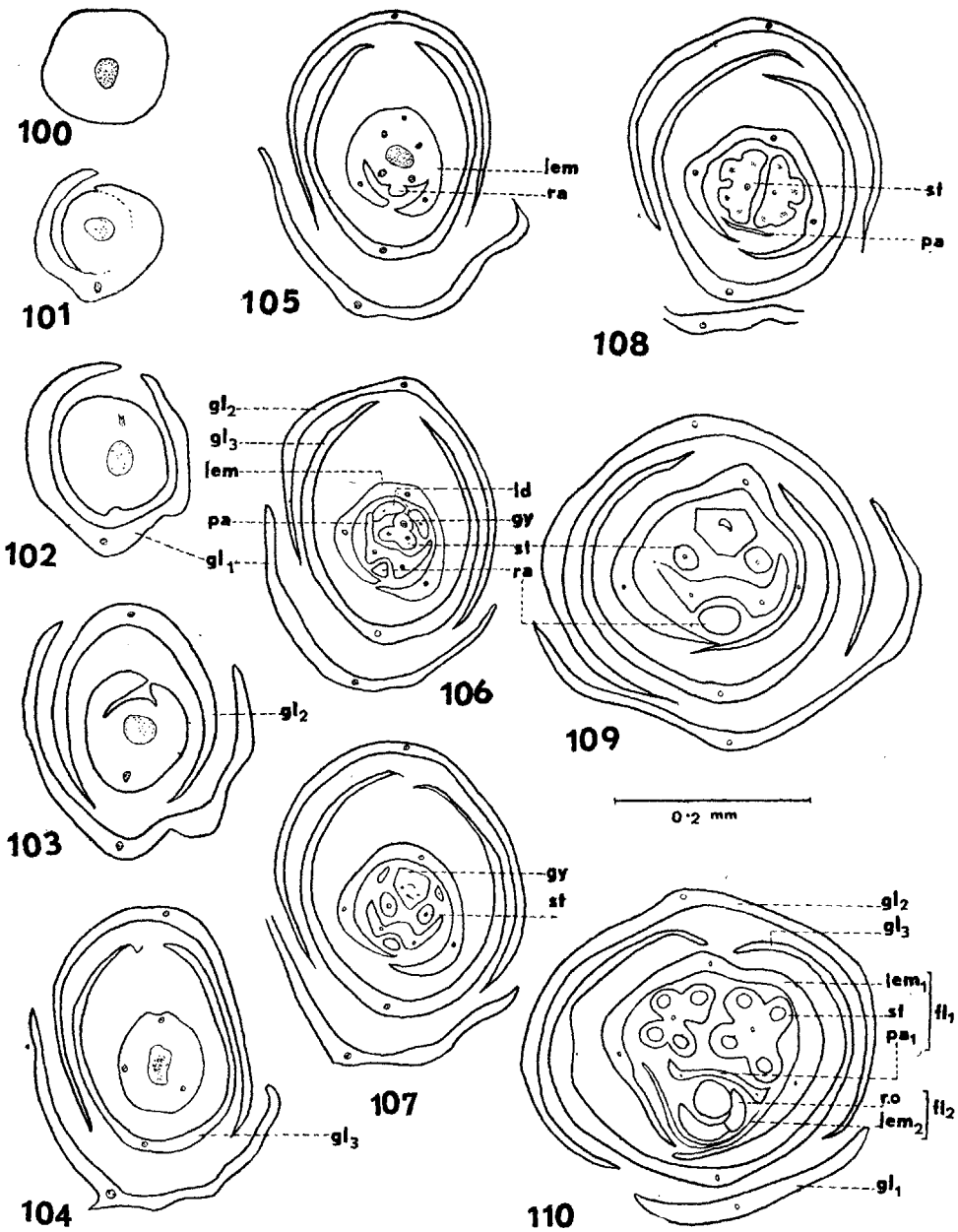
As will be recalled the unit of inflorescence in this species is a pair of spikelets joined below to a common stalk portion.

In a transverse section of the inflorescence axis there are a number of bundles which are distributed irregularly. Some of the bundles multiply and give out traces for the stalk of the paired spikelet unit (Fig. 81). In a transverse section of the stalk of this paired spikelet unit there are a few smaller bundles and three bigger bundles. The three large bundles coalesce to form a single vascular mass (Figs. 83 and 84). Still higher up the central mass of vascular tissue resolves into two—one for each of the two spikelets (Fig. 85). Two or three smaller bundles also go along with each vascular mass destined to supply a single spikelet. In this region the axis of each spikelet separates off from each other (Fig. 88). The first glume is nerveless and hyaline (Fig. 90). Five traces now diverge out for the second glume which includes two or three original smaller bundles (Fig. 90). The central vascular mass gives off three traces, one median and two laterals, on the opposite side for the lemma (Figs. 90–93). The remaining vascular tissue sends off two traces (p_1 and p_2) in the postero-lateral direction for the palea and two traces (l_1 and l_2) in the antero-lateral direction for the two lodicules (Fig. 92). Each lodicular bundle as usual divides into three to five smaller bundles. Now three traces are given out for the three stamens which are arranged in the usual fashion (Fig. 94). The central vascular tissue after supplying the stamens supplies the gynoecium. It sends off one trace on either side to the ovary wall (Fig. 95), and then continues up and vanishes in supplying the solitary ovule. The two lateral bundles traversing the ovary wall finally enter the two plumose stigmas (Fig. 96).

An important feature of the second glume is that it is produced on its outer side, into five longitudinal ridges corresponding to the five vascular bundles (Fig. 96). A transverse section passing through a ridge shows an outer sclerenchymatous region (Fig. 97). Inner to this is a collateral and closed bundle surrounded by two layers of thin-walled cells. Hooks are present on these ridges. A transverse section of a hook shows a central large empty cell and two or three layers of smaller cells surrounding it (Fig. 98). In the apical region of the hook, however, there is a single layer of cells surrounding the central cell (Fig. 99).



FIGS. 81–99. *Tragus biflorus*. Figs. 81 and 82. Transverse sections of the inflorescence axis. Figs. 83–96. Serial transverse sections of the paired-spikelet unit from base upwards. Fig. 97. A portion of the mid-rib region of the second glume in T.S. magnified. Figs. 98 and 99. Transverse sections of a hook from basal and upper regions respectively (*ax*, axis).



FIGS. 100–110. *Thysanolaena maxima*. Figs. 100–108. Serial transverse sections of the spikelet from base upwards. Figs. 109 and 110. Serial transverse sections of another spikelet to show the rachilla bearing a rudimentary second floret (fl_2).

Tribe Thysanolaeneae.—The inflorescence in *Thysanolaena maxima* is a very large soft panicle 30–60 cm long. It is made up of many branches that divide and subdivide into numerous branchlets which bear innumerable minute spikelets. Each spikelet contains three empty glumes, one lemma and its subtended flower. The rachilla is produced beyond the flowering glume or lemma.

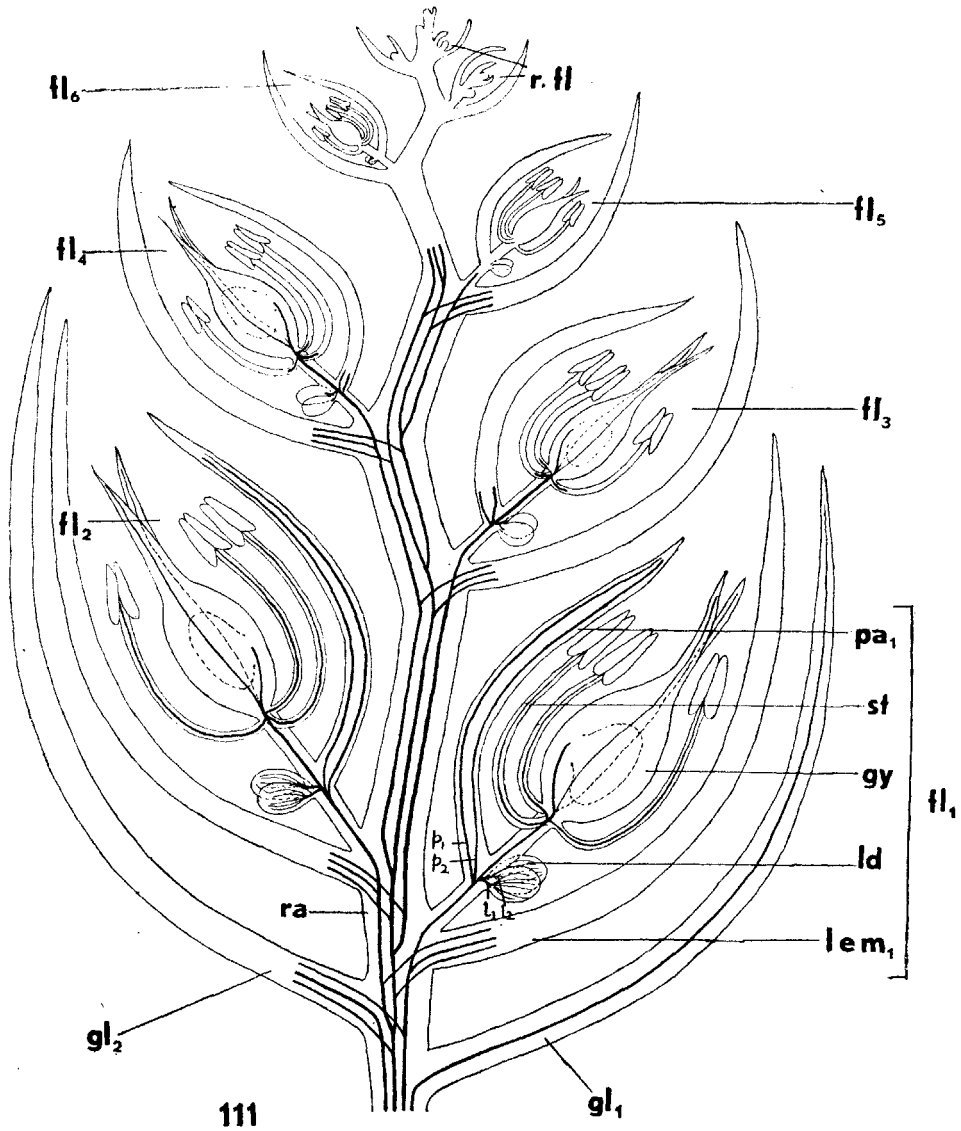


FIG. 111. Diagrammatic representation of a multiflowered spikelet of the Pooideae showing its structure and vascular supply (fl_1–fl_5, florets I to V; *r. fl*, rudimentary florets).

In the pedicel of the spikelet there is a central vascular mass (Fig. 100). This gives off a trace for the first glume and similarly another trace for the second glume on the opposite side (Figs. 101 and 102). As will be recalled, the third glume in this species is barren, i.e. it does not bear any flower. This glume also gets one median nerve (Fig. 104). Three traces are now given out for the flowering glume or lemma which is fertile and paleate and bears a single hermaphrodite flower (Figs. 104–106). Meanwhile the central mass of vascular tissue gives out two traces in the postero-lateral direction for the palea and two traces in the antero-lateral direction for the two lodicules (Figs. 105 and 106). Palea is thus bikeeled and two-nerved. The lodicules are very minute (Fig. 106). The vascular tissue left behind sends off two traces for the two stamens present on the postero-lateral sides and then supplies the gynoecium in the usual manner (Figs. 106 and 107). Although three stamens have also been reported to occur in this species (Bor 1941), in the material studied the anterior stamen is conspicuously missing in all the spikelets.

After the separation of the fertile glume or lemma the rachilla continues up as a non-vascular stump-like projection (Figs. 106 and 107) and has been seen to bear a second rudimentary floret in three or four spikelets (Fig. 110; fl_2).

It seems reasonable to regard the third glume of *T. maxima* as the lemma I of the lower suppressed floret which reminds one of the panicoid grasses. On the other hand the upward continuation of the rachilla which occasionally bears a rudimentary floret is a distinctive festucoid (pooid) character. It follows thus that *T. maxima* exhibits in its spikelet an admixture of both panicoid and festucoid characters.

Discussion

Vascular Anatomy of the Spikelet.—From a perusal of the data detailed above it would seem that the general ground plan of vascular supply of the spikelet in various tribes of the Pooideae follows nearly the same pattern. Figure 111 illustrates the vascular supply of a typical multiflowered spikelet of the Pooideae (Bambuseae, etc., excluded) in which each floret has a lemma, a palea, two lodicules, three stamens and a gynoecium with two stigmas. After supplying traces to the two outer empty glumes the three bundles of the rachilla furnish one trace each to lemma I which thus is three-nerved. One of the bundles of the rachilla which is towards the lemma I, and furnishes its mid-rib bundle, diverges out into the first floret. It gives two postero-lateral traces to the bikeeled palea (p_1 and p_2) and then sends off one trace each for the two lodicules (l_1 and l_2) in antero-lateral direction (Fig. 111). The central bundle now sends off three traces for the three stamens and then supplies the gynoecium. It gives out two lateral traces and then continues up to supply the solitary ovule attached on the posterior side of the ovary wall. The two

lateral bundles traversing the ovary wall ultimately pass out into the two plumose stigmas. Meanwhile one of the two bundles left in the rachilla divides and the resulting three bundles continue up and supply the next floret in a similar manner.

Thus we see that in the Pooideae the palea bundles arise from the vascular tissue destined to supply the floret and the lodicular bundles are inserted on the flower axis at a slightly higher level than the palea bundles. On the other hand in all the members of the Panicoideae investigated here the palea bundles arise conjointly with the laterals of its lemma (author's unpublished work). This may be taken to be an important distinctive feature between the two subfamilies.

In the gynoecium of a majority of species there is one placental strand which supplies the solitary ovule and two lateral bundles, one on either side, which traverse the entire length of the ovary wall and then pass out into the stylar branches. The condition in *Triticum aestivum* is slightly different in as much as there is one additional anterior vascular bundle which vanishes at the top of the ovary cavity. This may be regarded as a transitional stage from that seen in bamboos where the anterior bundle is normally present and supplies the third anterior stylar branch (Arber 1926). Here although the anterior stylar branch is completely suppressed its vascular trace is present.

Trends of Evolution in the Spikelet of Pooideae.—In this subfamily all the grades from a multiflowered spikelet to a single-flowered one are met with. The maximum development of the spikelet is to be found in the tribes Hordeeae, Eragrosteae, etc., where there are a number of acropetally arranged fertile florets in a spikelet. In a spikelet of these grasses we find mature florets below and rudimentary florets at the top. Some members of the tribe Chlorideae show transitional stages in the evolution of the single-flowered condition. Thus we find that in *Chloris inflata* only the lemma I present above the two empty glumes is fertile and bears a perfect flower. Florets above this are reduced to their barren lemmas only. Occasionally, however, there is present a rudimentary palea in the axil of the second lemma, indicating thereby that gradual sterilization has taken place from top to bottom and only the lowermost floret has remained unaffected. In *Cynodon dactylon*, another member of the tribe, there is no trace of these barren lemmas but the one-bundled rachilla extends beyond the fertile floret and sometimes bears a vestigial lemma at the top. In tribes like Zoiseae, Stipeae, etc., further reduction has resulted in complete abortion of the rachilla beyond the first floret which is fertile. Thus we can say that the uniflowered condition of the spikelet in the Pooideae has resulted by the basipetal suppression of the florets and ultimate abortion of the rachilla beyond the first fertile floret.

The spikelets of Phalarideae, Thysanolaeneae, etc., present a somewhat anomalous situation. In *Phalaris minor* which has been studied here there is

present a perfect floret above the empty glumes and the rachilla ends in a barren lemma. An almost similar condition obtains in *P. tuberosa* (Arber 1934). The condition is, however, different in certain other genera of this tribe, e.g. *Hierochloe*, *Anthoxanthum*, etc., where the spikelet has three florets above the two empty glumes, the lower two being either staminate or neuter and reduced to their lemmas while the terminal one is hermaphrodite and perfect (Riecken 1929; Arber 1934). Norstog (1960) has described certain abnormal spikelets in *Hierochloe odorata* wherein there are four florets per spikelet instead of three. Of these the first and the second are staminate while the third and the fourth are hermaphrodite and perfect. According to him the spikelet of *Hierochloe* may be considered as being of an indeterminant number as those of other genera of the Pooideae. He further argues that ' in the Phalarideae the reductional tendencies in the spikelet operate in both the directions to produce sterilization of basal florets and abortion of terminal florets'. This statement of Norstog seems to hold good for the tribe *Thysanolaeneae* also. In this grass the rachilla is produced beyond the fertile perfect floret as a minute, non-vascular outgrowth which occasionally bears a rudimentary floret above. In this case there are present three empty glumes, instead of two, below the perfect floret. The third glume has been regarded as the lemma of the suppressed floret (*see* Tateoka 1956). Thus it can be concluded that in *T. maxima* also the reductional tendencies are operative in both the directions, i.e. the existing condition has resulted by both basipetal and acropetal suppression of florets in a multiflowered spikelet. Such a condition recalls the effect obtained in the Panicoideae where the first floret is often reduced to its lemma.

Acknowledgements

I am extremely grateful to Professor V. Puri, F.N.I., for guidance and encouragement received throughout the course of this study. I am also thankful to Dr. Y. S. Murty for some helpful suggestions, and to the authorities of the C.S.I.R., New Delhi, for financial help.

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