**Carex longicurris** (Pl.3)

*C. longicurris* is a tufted perennial with a short woody rhizome and slender stems measuring 70 - 120 cm in length. It is found commonly growing in wet ground in dense forests at higher altitudes. Leaves are radicle with narrowly linear, stiff blades which are folded at base and flattened above. The stem is trigonous and smooth. Inflorescence is a slender compound panicle, the length of which varies from 25 - 40 cm. Bracts are shorter than the inflorescence and bracteoles are brownish with short bladeless sheaths. Spikes cylindrical, brown, two to five cm long and androgynous. The staminate part subulate five to nine mm long and three-to eight-flowered and the pistillate part loosely three- to twelve-flowered. Each male flower has two stamens. Female glumes lanceolate, hyaline, brown and acuminate. Utricle elliptic, three to four mm long, 0.8 - 1 mm wide, lenticular, hyaline, brown, five - to seven-nerved and two-costate, glabrous, sparsely pilose-setulose on margins, short-stipitate, gradually tapering above to a linear beak with two-toothed orifice. Gynoecium is bicarpellary, syncarpous, with a long style and a bifid stigma. Ovary is unilocular with a single basal ovule. The mature nut is elliptic, two mm long, one mm wide, yellow brown and compressed lenticular.

**Microsporangium, microsporogenesis and development of the male gametophyte** (Fig. 7; Pl.4A-C)

The details of the development of the microsporangium
PLATE 3

Carex longicruris

Photograph of the entire plant.
FIGURE 7

Microsporogenesis and development of male gametophyte in Carex longicruris

A - T.S. anther primoridum showing the formation of primary parietal cells and primary sporogenous cells.

B - T.S. microsporangium showing the formation of tapetum.

C - T.S. microsporangium showing fully differentiated wall layers.

D - T.S. microsporangium showing degeneration of middle layer.

E - T.S. microsporangium showing microspore tetrads and the degeneration of middle layer and tapetum.

F - T.S. microsporangium showing thickenings in the endothecium and two-celled pollen grains.

G - Endothecial cell showing spiral thickenings.

H - Microspore mother cell showing metaphase I.

I - Microspore tetrad showing a functional microspore in division and three nonfunctional microspores.

J - Two-celled pollen grain.

K - Three-celled pollen grain.
and male gametophyte in *Carex longicruris*, are essentially similar to those of *Scleria pergracilis* except that in the former one or two archesporial cells are differentiated (Fig. 7A) in each microsporangium, as seen in transection, in contrast to one-celled archesporium observed in *S. pergracilis*.

**Megasporangium, megasporogenesis and development of female gametophyte** (Figs. 8 and 9; P1. 4D-F)

The structure and development of megasporangium and female gametophyte in *Carex longicruris* resemble in many respects to those of *Scleria pergracilis*. However, there are certain differences which appear to be quite distinctive. In *C. longicruris* the obturator is made up of compactly arranged filaments of cells (Fig. 8A, B), unlike the one seen in *S. pergracilis* where it is made up of only papillar cells. Likewise, the two species differ in respect of the structure and ontogeny of hypostase. In *S. pergracilis*, the hypostase is formed by the differentiation of a plate of six to eight cells at the chalaza but in *C. longicruris*, it arises from a group of five to six cells as seen in longisection (Fig. 8F). In addition, in the mature seed, it is six to eight cells in thickness (Fig. 8I, J) in contrast to that of *S. pergracilis* where it is three or four cells thick. The development of female gametophyte in *C. longicruris* is of the Polygonum type (Maheshwari, 1950) as in *S. pergracilis*. However, the occasional persistence
FIGURE 8
Development of obturator and hypostase in *Carex longicruris*

A - L.S. young seed showing obturator.
B - Micropylar portion of the seed shown in A enlarged.
C, D - Mature seeds to show the hypostase in side and surface views respectively.
E - L.S. young seed.
F - Chalazal portion of the seed shown in E enlarged.
G - L.S. seed showing free nuclear endosperm.
H - Chalazal portion of the seed shown in G enlarged.
I - L.S. mature seed
J - Chalazal portion marked X in I enlarged.
FIGURE 8
FIGURE 9

Megasporogenesis and development of female gametophyte in Carex longicruris

A - L.S. ovular primordium showing archesporial cell.
B - L.S. ovular primordium showing a primary parietal cell and a sporogenous cell.
C - L.S. ovule showing megaspore mother cell.
D - L.S. portion of nucellus showing cells of a dyad in division.
E - L.S. portion of nucellus showing a linear tetrad of megaspores.
F - L.S. portion of nucellus showing dividing functional megaspore and three degenerating megaspores.
G - Two-nucleate embryo sac.
H - Four-nucleate embryo sac.
I - Eight-nucleate organized embryo sac.
J - Mature embryo sac.
PLATE 4

Carex longicurris.

(All photomicrographs)

A - T.S. young anther showing archesporial cells.
B - T.S. anther showing wall layers and sporogenous tissue.
C - T.S. microsporangium showing two-celled pollen grains.
D - L.S. young ovule showing megaspore mother cell.
E - L.S. micropylar part of an ovule showing obturator
F - L.S. chalazal region of a seed showing hypostase.
of megaspores and the formation of twin embryo sacs seen in \textit{S. pergracilis} have not been observed in \textit{C. longicur ris}.

\textbf{Fertilization, endosperm, embryo, seed coat and pericarp}

(Figs. 10-12; P1. 5A-F)

Ontogenetic changes during and after fertilization in \textit{Carex longicur ris} are similar to those of \textit{Scleria pergracilis} in several details. In \textit{C. longicur ris} the entry of pollen tube into the ovule is porogamous and both syngamy and triple fusion are simultaneous. The development of endosperm and embryo are similar to those observed in \textit{S. pergracilis}. However, during further stages of their organization they show certain differences. The development of endosperm in \textit{C. longicur ris} is of the Nuclear type as in \textit{S. pergracilis} but differs from it in lacking endosperm haustoria and in the number of endosperm nuclei during wall formation. Whereas in \textit{S. pergracilis} the wall formation occurs after the formation of about 250 nuclei in the endosperm, in \textit{C. longicur ris}, it sets in after about 500 nuclei are formed. However, in both the species the wall formation is initiated at the micropylar region of the endosperm when the embryo is four-celled. After cellularization, some of the cells at the chalazal region of the endosperm in \textit{C. longicur ris} become larger with two to five nuclei in each having denser cytoplasm than the rest of the endosperm (Fig.10G;P1. 5C). Such multinucleate cells in the endosperm proper have not been observed in \textit{S. pergracilis}. 
The early stages of ontogeny of embryo in *Carex longicruris* resemble that of *Scleria pergracilis*. However, the embryo of *C. longicruris* does not undergo any ontogenic torsion during the course of development and is characterized by basal radicle, lateral epicotyl and terminal cotyledon which conforms to the *Carex* type (Schneider 1932) in contrast to the *Schoenus* type of embryo with sublateral radicle and epicotyl and terminal cotyledon as observed in *S. pergracilis*. The cotyledon of the embryo of *C. longicruris* differs from that of *S. pergracilis* in being smooth surfaced (Fig.11H, P1.5F) without a central conical structure having papillar outgrowths observed in the embryo of *S. pergracilis*. The structure and development of pericarp and seed coat are similar in both the species. However, during the formation of the seed coat in *C. longicruris* the outer layer of the inner integument and inner layer of the outer integument degenerate. The remaining two layers of cells derived from both the integuments form the seed coat at maturity (Fig.12I). This is in contrast to four-layered seed coat of *S. pergracilis* where the outer layer of the inner integument degenerates and all three layers of the outer integument and the remaining inner layer of the inner integument form the seed coat at maturity. Lastly, the pericarp in *C. longicruris* is smooth (Fig.12 H,I) unlike that of *S. pergracilis* where it is tubercled. However, in both the species the pericarp becomes hard and remains free from the seed coat.
FIGURE 10
Development of endosperm in *Carex longicruris*
(All longissections)

A - Portion of nucellus showing fertilized embryo sac.
B - Two-nucleate endosperm.
C - Four-nucleate endosperm.
D - Multinucleate endosperm.
E - Endosperm showing wall formation.
F - Cellular endosperm.
G - Portion marked X in F enlarged.
H - Mature seed.
I - Portion marked X in H enlarged.
FIGURE 11

Development of embryo in *Carex longicruris*

A - Zygote.

B - Two-celled embryo.

C - Proembryonal tetrad.

D - Quadrant embryo.

E - H - Successive stage in the development of embryo.

I - M - T.S. embryos at different stages of development showing epicotylary (hatched) and cotyledonary sectors.
Development of seed coat and pericarp in

*Carex longicruris*

(All longisections)

A - Ovary with ovular primordium showing archesporial cell.

B - Portion marked X in A enlarged.

C - Ovary with ovule showing mature embryo sac.

D - Portion marked X in C enlarged.

E - Young fruit with seed showing globular embryo and cellular endosperm.

F, G - Portions marked x and y respectively in E enlarged.

H - Mature fruit.

I - Portion marked x' in H enlarged.
PLATE 5
Carex longicruris.
(All photomicrographs)

A - Embryo sac showing zygote and primary endosperm nucleus; note the degeneration of one of the synergid.s.

B - L.S. micropylar portion of endosperm at free nuclear stage showing two-celled embryo.

C - L.S. chalazal part of endosperm showing multinucleate cells.

D - L.S. portion of a mature fruit showing thickenings in wall layers, seed coat and endosperm cells filled with reserve food materials.

E - T.S. young embryo

F - L.S. fruit showing mature embryo.
**Carex longipes** (Pl.6)

It is a tufted, perennial with a slender trigonous stem and a short oblique rhizome and grows in forests and grasslands of montane range. The height of the plant varies from 12 - 70 cm. Leaves are clustered at the base, narrowly linear, radicle or subradicle, usually, shorter than to equalling the stem, gradually attenuated to very long acute apex. There are one to seven spikes at each node and all are androgynous. The staminate portion linear-oblong and short and pistillate part, oblong-cylindrical. Male glume is lanceolate, pale ferruginous and faintly nerved and bears three stamens at its axil. Female glume is ovate. Utricle exceeding glume, elliptic, suberect, lenticular, five to seven mm long, 1.5 - 2 mm wide, glabrous, six-to nine-veined, cuneate at apex and abruptly contracted to a compressed bidentate beak. Gynoecium is bicarpellary, syncarpous with a short style ending with a bifid stigma. The ovary is unilocular with a single basal ovule. The mature nut is dark-brown, elliptic, compressed-lenticular, 2.25-3 mm long, 1.5 - 1.8 mm wide and contracted at both the ends.

**Microsporangium, microsporogenesis and development of the male gametophyte** (Fig.13; Pl.7A-C)

The structure and development of microsporangium and male gametophyte in *Carex longipes* are similar to those
PLATE 6

*Carex longipes.*

Photograph of the entire plant.
PLATE 1

Carex longipes o. od.
FIGURE 13
Microsporogenesis and development of male gametophyte in *Carex longipes*

A - T.S. young anther showing archesporial cells and formation of primary parietal cells and primary sporogenous cells.
B - T.S. microsporangium showing secondary parietal layers.
C - T.S. microsporangium showing wall layers and sporogenous tissue.
D - T.S. microsporangium showing microspore tetrads and degeneration of tapetum.
E - T.S. microsporangium showing two-celled pollen grains.
F - Endothecial cell showing spiral thickenings.
G, H - Microspore mother cells showing first and second meiotic divisions.
I - Two-celled pollen grain.
J - Three-celled pollen grain.
of *Scleria pergracilis* in many respects. However, *C. longipes* differs from *S. pergracilis* in showing two or three arche-sporial cells in each microsporangium, as seen in transection (Fig. 13A) in contrast to one- or two-celled archesporium observed in *S. pergracilis* and *C. longicururis* respectively.

Megasporangium, megasporogenesis and development of the female gametophyte (Figs. 14 and 15; Pl. 7D-F and 8A-D)

The structure of ovule and the development of female gametophyte in *Carex longipes* resemble those of *Scleria pergracilis* and *C. longicururis*, however, there are certain differences. In *C. longipes* the obturator is made up of loosely arranged filaments of cells (Fig. 14B; Pl. 7D), unlike in *S. pergracilis* and *C. longicururis* where it is made up of only papillar cells or compactly arranged rows of cells respectively. Likewise, the initiation, development and structure of hypostase in *C. longipes* (Pl. 7E,F) are more closer in details to those of *C. longicururis* than those of *S. pergracilis*. The development of female gametophyte in *C. longipes* is of the *Polygonum* type (Maheshwari 1950) as in *S. pergracilis* and *C. longicururis*. *C. longipes* also resembles *S. pergracilis* with regard to persistence of megaspores (Pl. 8B, C). While in the latter the healthy megaspores are noticeable up to two-to four-nucleate stage of the embryo sac, in *C. longipes* they are seen even up to the mature embryo sac stage. However,
FIGURE 14

Development of obturator and hypostase in *Carex longipes*

A - L.S. ovule showing obturator at the mature embryo sac stage.

B - Micropylar portion of the ovule shown in A enlarged.

C, D - Mature seed showing hypostase in side and surface views respectively.

E - L.S. young seed showing initiation of hypostase.

F - Chalazal portion marked in the seed shown in E enlarged.

G - L.S. seed with free nuclear endosperm and hypostase.

H - Chalazal portion marked in the seed shown in G enlarged.

I - L.S. mature seed.

J - Chalazal Portion marked in the seed shown in I enlarged.

K - Two cells of the hypostase from a mature seed showing diversity in cytoplasmic constituents.
FIGURE 15
Megasporogenesis and development of female gametophyte in Carex longipes

A - L.S. ovular primordium showing archesporial cell.
B - L.S. ovular primordium showing a primary parietal cell and a sporogenous cell.
C - L.S. ovule showing megaspore mother cell and initiation of obturator.
D - L.S. nucellus showing anaphase II in the cells of a dyad.
E - L.S. nucellus showing a linear tetrad of megaspores.
F - Portion of nucellus showing a functional megaspore and three persistent nonfunctional megaspores.
G - Two-nucleate embryo sac and persistent megaspores.
H - Four-nucleate embryo sac.
I - Eight-nucleate organized embryo sac.
J - Mature embryo sac and persistent megaspores.
PLATE 7

Carex longipes.

(All photomicrographs)

A - T.S. anther showing wall layers and sporogenous tissue.

B - T.S. microsporangium showing tanniniferous cells in epidermis, degenerating tapetum and microspore mother cells at anaphase I.

C - T.S. microsporangium showing epidermis with tanniniferous cells, endothecium with thickenings and two-celled pollen grains.

D - L.S. funicular region of ovule showing obturator

F - L.S. chalazal region of a young seed showing just formed hypostase.

F - L.S. chalazal portion of mature fruit showing hypostase.
PLATE 8

Carex longipes.

(All photomicrographs)

A - L.S. ovular primordium showing a primary parietal cell and a sporogenous cell.

B - L.S. portion of an ovule showing a functional megaspore and persistence of nonfunctional megaspores.

C - L.S. portion of an ovule showing two-nucleate embryo sac and persisting nonfunctional megaspores.

D - L.S. portion of an ovule showing two-nucleate embryo sac and degenerating nonfunctional megaspores.
the persistent megaspores do not show any sign of embryo sac organization and remain in situ when normal embryo sac has attained maturity (Fig. 15J).

**Fertilization, endosperm, embryo, seed-coat and pericarp**

(Figs. 16-18; Pl. 9A-F and 10)

The entry of the pollen tube into the ovule is porogamous. Both syngamy and triple fusion take place simultaneously as in *Scleria pergracilis*. The development of endosperm in *Carex longipes* is of the Nuclear type as in *S. pergracilis* but differs from it in lacking endosperm haustoria and in the mode of wall formation. In *C. longipes*, the free nuclear divisions in the endosperm though initially maintain a perfect synchrony, later exhibit a wave of mitotic divisions (Fig. 16E) from the chalazal to the micropylar region. Some of the nuclei situated at the chalazal end are multinucleate and are larger than the rest of endosperm which are pushed to the periphery by a large central vacuole. After the formation of about 400 nuclei, centripetal wall formation takes place all along the periphery (Fig. 16F) at the quadrant or octant stage of the embryo and gradually extends to the entire endosperm which eventually becomes completely cellular (Fig. 16G). The multi-nucleolate chalazal nuclei though escape cellularization for some time later become separated into uninucleate cells (Pl. 9A) as in the remaining part of the endosperm.
FIGURE 16
Development of endosperm in *Carex longipes*
(All longisections)

A - Portion of nucellus showing zygote and primary endosperm nucelus.
B - Two-nucleate endosperm.
C - Four-nucleate endosperm.
D - Eight nucleate endosperm.
E - Multinucleate endosperm showing nuclear divisions.
F - Endosperm showing wall formation.
G - Cellular endosperm.
H - Mature seed.
I - Portion marked x in H enlarged.
FIGURE 17
Development of embryo in *Carex longipes*

A - Zygote.
B - Two-celled embryo.
C - Four-celled embryo.
D - Quadrant embryo.
E - Octant embryo.
F, J - Successive stages in the development of embryo.
K - M - T.S. embryos at different stages of development showing epicotylary (hatched) and cotyledonary sectors.
FIGURE 18
Development of seed coat and pericarp in Carex longipes
(All longissections)

A - Young gynoecium with ovular primordium showing archesporial cell.
B - Portion marked x in A enlarged.
C - Young fruit with a seed showing two-nucleate endosperm.
D - Portion marked x in C enlarged.
E - Young fruit.
F - Portion marked x in E enlarged.
G - Mature fruit.
H - Portion marked x in G enlarged.
PLATE 9

Carex longipes.
(All Photomicrographs)

A - L.S. chalazal part of endosperm showing densely protoplasmic cells formed after delayed cytokinesis.

B - Two-celled embryo.

C - L.S. embryo cut in an anticotyledonary plane showing beginning of notch formation.

D - L.S. embryo showing a deeper notch and initiation of the first leaf.

E - L.S. mature embryo.

F - T.S. embryo at the level of the notch showing coleoptile and epicotylary meristem.
PLATE 10

*Carex longipes.*

Photomicrograph of a portion of longisection of a mature fruit showing thickenings in the cells of the pericarp and darkly stained reserve food materials in the endosperm.
The development of embryo in Carex longipes (Pl.9B-f) resembles that of Scleria pergracilis and C. longicururis. However, the disposition of embryonal regions in the mature embryo conforms to the Carex type as observed in C. longicururis in contrast to the Schoenus type seen in S. pergracilis. The structure and development of pericarp and seed coat are similar to those of C. longicururis. At maturity, the pericarp is six-to eight-layered (P1.lO) and becomes hard due to fibrous nature of its cells and remains free from the seed coat which is two-layered (Fig.18G, H).

Carex baccans (Pl. 11)

This species is an erect glabrous loosely tufted, perennial and grows commonly in wet slopes along roadside and forest margins at high montane zones. Its height varies from 80-125 cm. Stem is erect with its basal region covered by brown fleshy scales. Leaves are caulin and distributed throughout the culms but more denser on the lower portion. Inflorescence is a compound panicle, interrupted below and contiguous above, occupying the upper half to one-third of the stem. Spikes, suberect, cylindrical, two to six cm long and androgynous; pistillate part larger than to shorter than staminate part. Both staminate and pistillate glumes are ovate to elliptic and straw coloured. Each male flower has three stamens. Utricles are ellipsoid to subglobe, very inflated, six- to eight- nerved, dark red at maturity, abruptly contracted at both ends with bidentate hispidulous
PLATE 11

Carex baccans.

Photograph of the entire plant.
beak. Gynoecium is tricarpellary, syncarpous with a short style ending with 3 stigmas. Ovary is unilocular with a single basal ovule. Nut is loosely enveloped, elliptic, acutely 3-angled, dark brown with a short stipe and short-beaked at suddenly contracted apex.

**Microsporangium, microsporogenesis and development of the male gametophyte** (Fig. 19).

*Carex baccans* resembles *Scleria pergracilis* in the structure and development of the microsporangium and male gametophyte. However, it differs in showing two archesporial cells in each microsporangium (Fig. 19A) in contrast to one-celled archesporium observed in *S. pergracilis*.

**Megasporangium, megasporogenesis and development of the female gametophyte** (Figs. 20, 21).

The structure of ovule and the development of female gametophyte in *Carex baccans* resemble those of *Scleria pergracilis*. However, there are certain differences. In *C. baccans* the obturator is made up of loosely arranged filaments of cells (Fig. 20B; Pl. 12A) in contrast to that of *S. pergracilis* where it is made up of only papillar cells. Also, the two species differ in respect of the structure and ontogeny of hypostase. In *S. pergracilis*, the hypostase is formed by the differentiation of a plate of six to eight cells at the chalaza but in *C. baccans* it arises from a group of two or three cells, as seen in longissection. The development of female gametophyte in *C. baccans* is of the *Polygonum*.
FIGURE 19
Microsporogenesis and development
of male gametophyte in Carex baccana

A - T.S. young anther showing archesporial cells.
B - T.S. portion of young anther showing the formation
    of primary parietal cells and primary sporogenous cells.
C - T.S. microsporangium showing sporogenous tissue and
    periclinal divisions in the inner secondary parietal
    layer.
D - T.S. microsporangium showing wall layers and micro-
    spore mother cells at anaphase II.
E - T.S. microsporangium showing two-celled pollen
    grains.
F - Endothecial cell showing spiral thickenings.
G, H-Microspore mother cells showing meiosis I and II.
I - Microspore tetrad.
L - Three-celled pollen grain.
FIGURE 20

Development of obturator and hypostase in Carex baccans.

A - L.S. ovule showing obturator at the mature embryo sac stage.

B - Micropylar portion of the ovule shown in A enlarged.

C, D - Seeds showing hypostase in side and surface views respectively.

E - L.S. young seed showing initiation of hypostase.

F - Chalazal portion of the seed shown in E enlarged.

G - L.S. mature seed.

H - Portion marked in seed shown in G enlarged.
FIGURE 21
Megasporogenesis and development of female gametophyte in *Carex baccans*

A - L.S. ovular primordium showing archesporial cell.
B - L.S. ovular primordium showing a primary parietal cell and a sporogenous cell.
C - L.S. ovule showing megaspore mother cell and initiation of obturator.
D - L.S. portion of nucellus showing a linear tetrad of megaspores.
E - L.S. portion of nucellus showing a functional megaspore and three degenerating megaspores.
F - Two-nucleate embryo sac.
G - Four-nucleate embryo sac.
H - Eight-nucleate organized embryo sac.
I - Mature embryo sac.
type (Maheshwari 1950) as in S. pergracilis. However, an occasional persistence of megaspores and the formation of twin embryo sacs seen in S. pergracilis have not been observed in C. baccans.

*Fertilization, endosperm, embryo, seed coat and pericarp* (Figs. 22,23,24).

The entry of the pollen tube is porogamous and both syngamy and triple fusion take place simultaneously as in Scleria pergracilis. The development of endosperm is similar to that observed in S. pergracilis but differs from it in lacking endosperm haustoria and in the mode of wall formation. In Carex baccans, the free nuclear divisions in the endosperm though initially maintain perfect synchrony, later exhibit a wave of mitotic divisions from the chalazal to the micropylar region (Fig. 22D). The centripetal wall formation takes place at the octant stage of the embryo after the formation of about 800 to 1000 endosperm nuclei and gradually extends to the entire endosperm which thus becomes completely cellular. On the other hand, in S. pergracilis the wall formation takes place at the four-celled stage of the embryo and cellularization begins from the micropylar region. Some of the cells at the chalazal region of the endosperm in C. baccans are larger with two to five nuclei in each having denser cytoplasm (Pl.12B). Such multinucleate cells in the endosperm proper have not been observed in S. pergracilis.
FIGURE 22

Development of endosperm in Carex baccana

(All longisections)

A - Portion of nucellus showing fertilized embryo sac.
B - Portion of nucellus showing two-nucleate endosperm.
C - Portion of nucellus showing four-nucleate endosperm.
D - Portion of nucellus showing free nuclear endosperm and four-celled embryo; note a wave of mitotic divisions from the chalazal to the micropylar region.
E - Portion of nucellus with endosperm showing wall formation and octant embryo.
F - Cellular endosperm.
G - Mature seed.
H - Portion marked x in G enlarged.
FIGURE 23
Development of embryo in *Carex baccans*

A - Zygote.
B - Two-celled embryo.
C, D - Four-celled embryos.
E - Quadrant embryo.
F - Octant embryo.
G - I-L.S. successive stages in the development of embryo.
J - Sagittal section of a mature embryo.
K - Frontal view of a mature embryo.
L-N - T.S. embryos showing epicotylary (hatched) and cotyledonary sectors.
FIGURE 24

Development of seed coat and pericarp in *Carex baccans*

A - L.S. young ovary with ovular primordium showing primary parietal cell and sporogenous cell.

B - Portion marked x in A enlarged.

C - L.S. ovary with ovule showing mature embryo sac.

D - Portion marked x in C enlarged.

E - L.S. young fruit.

F - Portion marked x in E enlarged.

G - Portion marked y in E enlarged.

H - L.S. mature fruit.

I - Portion marked x in H enlarged.
PLATE 12

*Carex baccans.*

(All photomicrographs)

A - L.S. portion of ovule showing an obturator.

B - L.S. chalazal region of endosperm showing multinucleate cells.

C - L.S. portion of fruit showing a mature embryo.
The development of embryo in *Carex beccans* resembles that of *Scleria pergracilis*. The mature embryo is of the *Carex* type as in *C. longicurris* and *C. longipes* (P1.12C). The structure and development of pericarp and seed coat are similar to those of *C. longicurris* and *C. longipes*. At maturity, the pericarp is four-layered and becomes hard due to fibrous nature of its cells. The seed coat is two-layered and remains free from the pericarp.

*Carex glaucina* (P1.13)

It is an erect perennial of 50 -100 cm in height growing on the road cuttings and other openings in forests particularly in ghat section. Leaves are shorter than the stem. Inflorescence forms a partial panicle with foliaceous bracts which are much larger than the panicles. Spikes linear with the male portion forming about one-fourth of the total length and six to ten female flowers occupying the lower part. Each male flower has 3 stamens. Female glumes are dark brown and aristate. Utricle trigonous, straight or slightly curved with numerous, slender nerves and bifid beak. Gynoecium is tricarpellary with a long style ending with 3 stigmas and is unilocular with a single basal ovule. Nut elliptical, pale-yellow, trigonous and shortly stipitate.

**Microsporangium, microsporogenesis and development of the male gametophyte** (Fig.25; P1.14 A,B).

*Carex glaucina* resembles *Scleria pergracilis* in the structure and development of the microsporangium and
PLATE 13

Carex glaucina.

Photograph of the entire plant.
FIGURE 25
Microsporogenesis and development of male gametophyte in *Carex glaucina*

A - T.S. portion of young anther showing archesporial cells and formation of primary parietal layer and primary sporogenous cells.

B - T.S. microsporangium showing secondary parietal layers and sporogenous cell.

C - T.S. microsporangium showing formation of tapetum and middle layer.

D - T.S. microsporangium showing wall layers and sporogenous tissue.

E - T.S. microsporangium showing microspore tetrads and degeneration of tapetum.

F - T.S. microsporangium showing three-celled pollen grains.

G - Endothecial cell showing spiral thickenings.

H - Microspore mother cell showing meiosis I.

I, J - Two-celled pollen grains.
FIGURE 26

Development of obturator and hypostase in

Carex glaucina

A - L.S. ovule showing obturator and mature embryo sac.
B - Micropylar portion of the ovule shown in A enlarged
C,D - Seeds showing hypostase in side and surface views respectively.
E - Chalazal portion of the ovule shown in A enlarged.
F - L.S. young seed showing free nuclear endosperm.
G - Chalazal portion of the seed shown in F enlarged.
H - L.S. seed showing globular embryo and cellular endosperm.
I - Chalazal portion of the seed shown in H enlarged.
FIGURE 27

Megasporogenesis and development of female gametophyte in *Carex glaucina*

A - L.S. ovular primordium showing archesporial cell.
B - L.S. young ovule showing a primary parietal cell and a sporogenous cell.
C - L.S. ovule showing the megaspore mother cell and initiation of obturator (stippled).
D - L.S. portion of nucellus showing a linear tetrad of megaspores.
E - L.S. portion of nucellus showing a functional megaspore and three degenerating megaspores.
F - Two-nucleate embryo sac.
G - Two-nucleate embryo sac in division.
H - Four-nucleate embryo sac.
I - Eight-nucleate organized embryo sac.
J - Mature embryo sac.
FIGURE 28
Development of endosperm in Carex glaucina
(All longisections)

A - Portion of nucellus showing fertilized embryo sac.
B - Portion of nucellus showing two-nucleate endosperm.
C - Portion of nucellus showing eight-nucleate endosperm.
D - Portion of nucellus showing multinucleate endosperm.
E - Endosperm showing wall formation.
F - Cellular endosperm.
G - Mature seed.
H - Portion marked x in G enlarged.
FIGURE 29
Development of embryo in *Carex glaucina*

A - Zygote.
B - Two-celled embryo.
C - Four-celled embryo.
D - Five-celled embryo.
E - Quadrant embryo.
F - Octant embryo.
G - L.S. globular embryo showing epicotylary (hatched) and cotyledonary sectors.
H - L.S. notched embryo.
I - L.S. notched embryo (diagramatic)
J - Portion stippled in I enlarged.
K - L.S. embryo showing formation of first leaf.
L - L.S. mature embryo.
FIGURE 30
Development of seed coat and pericarp in Carex glaucina

A - L.S. young ovary with ovular primordium showing primary parietal cell and sporogenous cell.
B - Portion marked x in A enlarged.
C - L.S. ovary with ovule showing four-nucleate embryo sac.
D - Portion marked x in C enlarged.
E - L.S. young fruit with seed showing free nuclear endosperm.
F - Portion marked x in E enlarged.
G - L.S. fruit with seed showing globular embryo and cellular endosperm.
H - Portion marked x in G enlarged.
I - L.S. mature seed.
J - Portion marked x in I enlarged.
K - Portion marked y in I enlarged.
PLATE 14

Carex glaucina

(All photomicrographs)

A - T.S. microsporangium showing wall layers and a sporo-
genous tissue.

B - T.S. microsporangium showing epidermis with tannini-
ferrous cells, endothecium with thickenings and
two-celled pollen grains.

C - L.S. funicular region of an ovule showing obturator.

D - L.S. chalazal part of a young seed showing initiation
of hypostase.

E - L.S. chalazal part of a slightly older seed showing
hypostase.

F - L.S. chalazal part of a mature seed showing hypostase.
PLATE 15

Carex glaucina.

(All photomicrographs)

A - L.S. young ovary with an ovular primordium showing archesporial cell.
B - L.S. ovary with an ovule showing megaspore mother cell
C - L.S. nucellus showing linear tetrad of megaspores.
D - L.S. portion of nucellus showing four-nucleate embryo sac in division and remnants of degenerated megaspores.
PLATE 16

Carex glaucina.

(All photomicrographs)

A - L.S. portion of a young fruit with a seed showing free nuclear endosperm.
B - Two-celled embryo.
C - L.S. portion of pericarp of a mature fruit.
as in *Scleria pergracilis*. The development of endosperm in
*Carex glaucina* is of the Nuclear type as in *S. pergracilis*
but differs from it in lacking endosperm haustoria and in
the mode of wall formation. After the formation of about
600 to 800 nuclei centripetal wall formation takes place all
along the periphery at the octant stage of the embryo and
gradually extends towards the center of the endosperm which
eventually becomes completely cellular. All endosperm cells
are uninucleate (Fig.28F).

The development of embryo in *Carex glaucina* resembles
that of *Scleria pergracilis*, *C. longicuris*, *C. longipes*
and *C. baccans*. However, the disposition of embryonal
regions in the mature embryo conforms to the *Carex* type
as observed in *C. longicuris*, *C. longipes* and *C. baccans*
in contrast to the *Schoenus* type seen in *S. pergracilis*.
The structure and development of pericarp and seed coat
are similar to those of *C. longicuris*, *C. longipes* and
*C. baccans*. However, in contrast to the other species
studied, in *C. glaucina*, the outer layer of the outer
integument degenerates whereas the inner layer of the
outer integument together with the inner layer of the inner
integument form a two-layered seed coat (Fig.30K). At
maturity, the pericarp is five- to six-layered and becomes
hard due to fibrous nature of its cells and remains free
from the seed coat.

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