OBSERVATIONS ON BLYSMUS AND BLYSMOPSIS

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ABSTRACT. A comparative account of the anatomical features of the genera *Blysmus* and *Blysmopsis* (Cyperaceae) is given in order to substantiate the segregation of the two taxa which had previously been included in the genus *Blysmus* s.l. The global distribution of the taxa are also provided.

INTRODUCTION

In North temperate Floras, *Blysmus* s.l. has generally been considered as a natural unit, consisting of two species, viz. *B. compressus* (L.) Panz. and *B. rufus* (Hudson) Link. Although the diagnoses and descriptions of the two species reveal clear distinctions between them, they have persistently been treated as belonging to the same genus (Hegi 1908; Gleason 1952; Clapham, Tutin & Warburg 1962; Roschevitz 1964). An even wider view was taken by Schultze-Motel (1966) who inlcuded both species in *Scirpus* L.

Marek (1958), working on the fruit anatomy of some species of European genera in Cyperaceae, suggested the generic separation of *Blysmus rufus* from *Blysmus* s.s. This suggestion came from the observation that the induration leading to the pericarp formation in *B. rufus* takes place in the inner epidermis (endocarpic layer) and part of the mesocarpic layer, and from inside outwards; while in *B. compressus*, the process takes place in the whole ovary with the exception of the outer epidermis (exocarpic layer) and proceeds from outside inwards. These two processes, according to Marek, occur independently in different groups of Cyperaceae. Subsequently he referred to the fruits that result from the pericarp formation by the two processes as 'pseudostone' (or 'stone' after Artyushenko & Korovalov 1951) and 'nut', respectively. The former of the two processes had earlier been observed in *Cladium* (Wilczek 1892).

The haploid chromosome numbers, as reported by Clapman et al., *l.c.*, and Fedorov (1969), show that *Blysmus rufus* has a constant number of 20, while *B. compressus* has been recorded as having numbers of 22, 39 and 40.

In an earlier paper by the present author (1974), *B. rufus* was recognised as a taxon distinct from *Blysmus* s.l. and published as a new genus, *Blysmopsis*. The present paper is a report of the detailed observations that have been made in the two taxa, substantiating their separation.

MATERIALS AND METHODS

The collections of *Blysmus* s.l. housed in the following herbaria were examined for morphological features: BM, E and K. Voucher specimens for the anatomical investigations for *Blysmopsis* included *G. Pahusch* (E) from Russia, *Valentin Norlind* (E) from Sweden, *C. A. & Una F. Weatherly* 1327 (E) from Canada; and for *Blysmus* included *Davis & Hedge, D.* 32529 (E), *Davis* 13059 (E), *Davis* 13966 (E), all from Turkey, and a number of collections made by the author at Aberlady (Scotland) in 1970.

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Spikelets from herbarium specimens were boiled in a crucible filled with water with a few drops of "Teepol" for about 10 minutes. Using a binocular dissecting microscope, the spikelets were carefully dissected from below upwards. Parts of the spikelets, especially glumes and flowers, were mounted in 10% glycerine on a slide.

For anatomical preparations of vegetative parts, the methods described by Metcalfe (1971) were followed. The procedure for the preparations of the fruit was suggested by F. Richardson (pers. comm.). The fruits were kept in formalin acetic acid alcohol (F.A.A.) or 70% alcohol for a minimum period of 16–24 hours, then transferred into water for another 24 hours. From the water, the fruits were placed in polythene tubes filled with 4% hydrofluoric acid and left for 24 hours. The hydrofluoric acid was carefully decanted, and the fruits were rinsed in several changes of hot water or boiled gently for a few minutes to remove any traces of acid from the tissues. Sledge microtome sections were made. The sections were cut at 15*µm*. Hot water was used to irrigate the knife and the material during the section cutting. The sections were mounted straight in gum chloral, without staining.

VEGETATIVE AND FLORAL MORPHOLOGY

SIMILARITIES. Both species are perennial, with creeping rhizomes covered with brown scales. The shoots are solitary or tufted, ± nodeless above, the internodes sometimes concealed in the leaf sheath; very often the non-leafy part is longer than the leafy part, slender to ± robust, up to ± 2 mm in diameter.

The leaves are basal or sub-basal, sheaths open or closed, with variously shaped ligules (from obtuse, rounded through retuse to truncate). In T.S., the leaf epidermis consists of uniformly sized cells becoming smaller and shorter over the hypodermal sclerenchyma. The chlorenchyma is not radiate, consisting of rounded to polygonal cells, sometimes palisade-like, especially near the vascular bundles. The bundle sheath of the vascular bundles is 2-layered, with the outer sheath parenchymatous, the inner fibrous. The inner sheath being uniformly thick-walled and/or partially U-shaped at the phloem poles.

The stomata are paracytic and are often arranged in many irregular files between the costal cells.

Both genera have a peculiar terminal inflorescence form in which the spikelets are distichously arranged on the main inflorescence axis; the arrangement being compact and/or distant. The involucral bracts appear glume-like, the lowermost with a long barbed/prickly awn progressively reduced in size on the upper ones.

The spikelets are sessile, subterete and many-flowered. The glumes are spirally arranged, fertile except the lower one or two, scarious, with obtuse or acute apex and ovate to lanceolate outline. They are caducous, the mid-nerve reaching the very apex of the glume but without awns. The flowers are bi-sexual, consisting of 3–6 hypogynous perianth segments, 3 stamens and a pistil. The stigma is 2-fid, often strap-like and minutely papillose. The styles have slender bases which are confluent with the apex of the ovary, and are deciduous falling off as the ovary matures and leaving behind their bases which appear as long beaks.

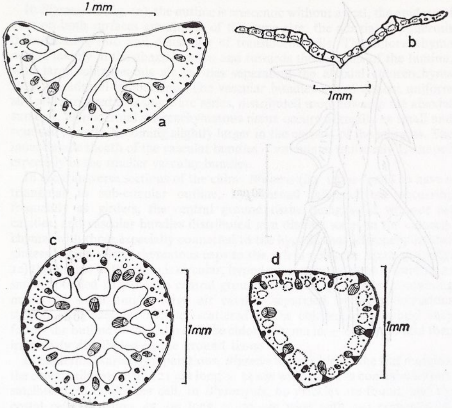

FIG. 1. T.S. of leaf and culm: a, T.S. leaf of *Blysmopsis*; b, T.S. leaf of *Blysmus*; c, T.S. culm of *Blysmopsis*; d, T.S. culm of *Blysmus* (× 50).

The fruits are ovoid to elliptic, long-apiculate, smooth and shiny, with relatively long attenuate bases. In transverse sections of the fruit, both genera show two areas of nervation or vasculation (corresponding to two carpels) in the pericarp; and they occur laterally. The exocarp and endocarp layers are each one-layered. The exocarpic cells are isodiametrical, with thick anticlinal and thin outer tangential (periclinal) walls. The inner tangential walls are thin and do not bear silica bodies.

The shape of the embryo conforms to the '*Carex*' type in having a general form which is centrifugal or turbinate with a lateral coleoptile and a basal root cap (Van der Veken, 1965).

DIFFERENCES. The leaf blades in *Blysmus* are well-developed, grass-like, showing a distinct midrib region with a well expanded lamina. In *Blysmopsis*, they are channelled or canaliculate, having no distinct midrib, the abaxial surface rounded off, the adaxial surface widely concave and the lamina not well-expanded.

Transverse sections of the leaves show *Blysmus* (fig. 1b) as having a flanged V-shaped or inversely W-shaped outline with a prominent keel; epidermal cells in the abaxial and adaxial surfaces not being uniform, with the adaxial surface cells inflated and differentiating into bulliform cells.

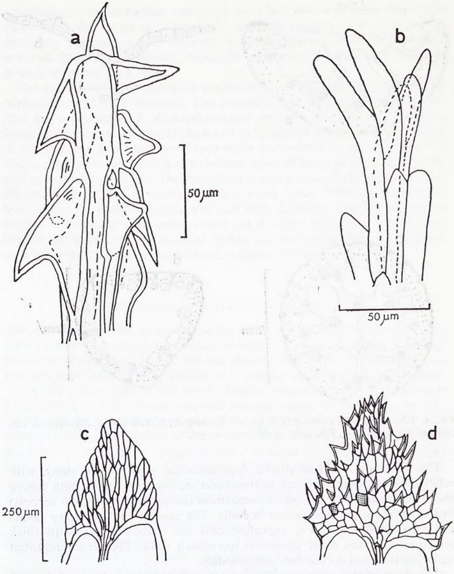

FIG. 2. Hypogynous perianth bristle and staminal crests: a, retrorsely barbed bristle in *Blysmus*; b, antrorsely barbed bristle in *Blysmopsis*; c, smooth, obtuse, staminal crest in *Blysmopsis*; d, prickly, obtuse, staminal crest in *Blysmus*.

Chlorenchyma occurs at both abaxial and adaxial regions, separated by lysigenous air cavities, especially towards the middle of the lamina. The vascular bundles are arranged in single V- or W-shaped series, according to the leaf outline, equidistant from the adaxial and abaxial surfaces, not uniform, with 3–6 bundles being larger. Tall abaxial and/or adaxial hypodermal sclerenchymatous girders connect most of the larger vascular bundles.

In the prominent keel region, one median vascular bundle is found. The inner sheath of the bundle sheath is either uniformly thick-walled or partially U-shaped at the phloem poles.

In *Blysmopsis* (fig. 1a), the outline is crescentic without a keel, the epidermal cells on both surfaces are almost of the same size, the adaxial hypodermis differentiating into and consisting of translucent cells. The chlorenchyma occurs mainly in the abaxial region and towards the margins of the lamina, with large schizogenous air cavities separating the abaxial chlorenchyma from the adaxial hypodermis. The vascular bundles are of almost uniform size and arranged in a single arc series, distributed more towards the abaxial surfaces. Hypodermal sclerenchymatous tissue occurs normally as small and rounded strands, becoming slightly larger in the corners of the margins. The inner bundle sheath of the vascular bundles is sometimes uniformly U-shaped especially in the smaller vascular bundles.

In the transverse sections of the culms *Blysmus* (fig. 1d) is found to have a triangular to sub-circular outline, hypodermal sclerenchyma occurring frequently as girders, the central ground tissue being solid without air cavities, and vascular bundles distributed in a distinct series in the chlorenchyma, with those especially connected to the hypodermal sclerenchymatous girders having sclerenchymatous caps to the xylem poles. In *Blysmopsis* (fig. 1c) the outline of the culm is circular, hypodermal sclerenchyma occurring as small, rounded strands, the central ground tissue being net-like, containing numerous small and/or large air cavities separated by parenchymatous strands, and vascular bundles scattered in the chlorenchyma where they follow the outline of the culm and the chlorenchyma in ± one series and then irregularly distributed in the ground tissue.

In epidermal surface preparations, *Blysmus* has prickles at the leaf margins, the costal cells measuring 21 μm long × 24 μm wide with 1–2 conical-without-satellite silica bodies per cell. In *Blysmopsis*, no prickles are found, and the costal cells measures 45 μm long × 30 μm wide with 2–4 conical-with-satellite (but tending to be nodular) silica bodies per cell.

Hypogynous perianth segments in *Blysmus* are persistently yellowish-brown with retrorse scabridity, the barbs being one-celled, thick-walled with acute tips (fig. 2a). Those in *Blysmopsis* are caducous, whitish with antrorse scabridity, the barbs being one-celled, thin-walled with rounded to obtuse tips (fig. 2b).

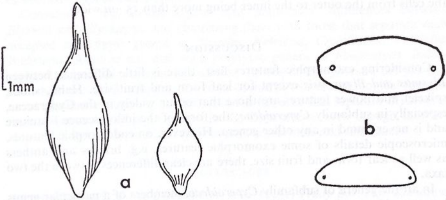

FIG. 3. Fruit outlines of *Blysmopsis* and *Blysmus*: a^1, *Blysmopsis* and a^2, *Blysmus* in side view; b^1, *Blysmopsis* and b^2 *Blysmus* in diagrammatic T.S.

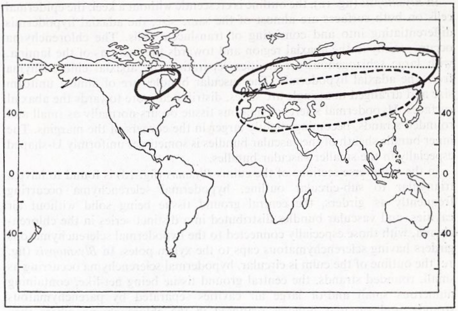

FIG. 4. Distribution of ——— *Blysmopsis* and – – – – – – *Blysmus*.

The profile of the crest of the anthers in *Blysmus* is prickly (fig. 2d) whereas in *Blysmopsis* (fig. 2c) it is ± smooth to papillose.

The fruits in *Blysmus* are blackish and up to 2 mm long, while those in *Blysmopsis* are light brown and more than 2 mm wide and up to 4 mm long (fig. 3).

Transverse and longitudinal sections of fruits show that *Blysmus* has a mesocarp layer which is uniformly thickened, 36–45 μm high and made up of 2–3 cell layers, the lumen of the cells being 3–8 μm wide. *Blysmopsis* has a mesocarp layer which is irregularly thickened and spongy, 105–120 μm high, and made up of ± 10 cell layers, the innermost cells (i.e. towards the endocarp) thick-walled, the outermost (i.e. below the exocarp) thin-walled; the cells distributed between the two are slightly thickened to thin, the lumen of the cells from the outer to the inner being more than 15 μm wide.

DISCUSSION

Considering exomorphic features first, there is little difference between *Blysmus and Blysmopsis* except for leaf form and fruit size. Habit, shoot, spikelet and flower features are those that occur widely in the Cyperaceae, especially in subfamily *Cyperoideae*; the form of the inflorescence is unique and is never found in any other genera. However, on endomorphic features, microscopic details of some exomorphic features, e.g. bristles and anthers as well as leaf form and fruit size, there are clear differences between the two taxa.

In all the genera of subfamily *Cyperoideae*, members of a particular genus have a uniform type of leaf: either ± crescentic or ± V-shaped; these are correlated with such features as presence or absence of bulliform cells, hypodermis, prominent keel, nature of air cavities, arrangement of vascular bundles, etc.

Blysmus has a flanged V-shaped or W-shaped leaf, just as in *Scirpus* s.s. or *Bolboschoenus*: and *Blysmopsis* has a crescentic leaf as in *Schoenoplectus*.

In the transverse section of culms, the nature of the ground tissue is characteristic in a number of genera. The type that is referred to as net-type, and occurs in *Blysmopsis*, is predominant in *Schoenoplectus*, *Hymenochaeta* and *Pseudoschoenus*.

The types of silica bodies in the costal cells of the epidermal surfaces are also restricted to particular genera. Conical-without-satellite forms observed in *Blysmus* are also found in such genera as *Nemum*, *Trichophorum*, *Eleogiton* etc.; while the conical-with-satellite forms which tend to be nodular and occur in *Blysmopsis* are also found in *Bolboschoenus*, *Oxycaryum*, *Remirea* etc.

Of the four forms of needle-like bristles observed in subfamily *Cyperoideae* (Oteng-Yeboah 1972), two forms, retrorsely or antrorsely scabrous, are observed widely; but their distributions are restricted to certain genera, e.g. *Fuirena* and *Bolboschoenus* having the same form as in *Blysmus*; and *Trichophorum* and *Erioscirpus* having the same form as in *Blysmopsis*. The shapes of profile of the crest of the anthers from the adaxial surface is also constant in all the genera of the *Cyperoideae*. The prickly profile in which prickles are distributed on the sterile apical part of the connective, and observed in *Blysmus*, is found in all species of *Bolboschoenus*. The smooth profile which tends to have papillae are found also in *Websteria*.

In the mesocarp layer of the fruit, the two processes leading to the formation of this layer in the Cyperaceae (Marek, 1958) may be observed in the two taxa. In *Blysmopsis* the mesocarp layer resembles that of *Cladium* and the related genera in tribe *Rhynchosporeae* (*Rhynchosporoideae*) whereas *Blysmus* has the mesocarp layer found in other members of the *Cyperoideae*, e.g. *Cyperus*, *Bolboschoenus*, *Schoenoplectus* etc.

The distributions of the two taxa are shown in fig. 4. *Blysmus* is widely distributed in the northern Hemisphere of the world, its southernmost limit lying in Morocco and Algeria; it is found mostly in wet marshy places in open communities. *Blysmopsis* is distributed in the northern Hemisphere of both Old and New Worlds occurring north of 53° and found mostly in salt or brackish shores and marshes.

Considering the morphological and anatomical differences between *Blysmus* and *Blysmopsis* and comparing them with those that separate such accepted monotypic genera as *Nemum*, *Nelmesia*, *Crosslandia*, *Volkiella*, *Websteria*, *Remirea* etc. and such polytypic genera as *Fimbristylis*, *Bulbostylis*, *Abildgaardia*, *Fuirena*, *Lipocarpha*, *Ascolepis*, *Eriophorum*, *Scirpus* s.s., etc. which are all identified on the basis of one or two morphological features or on correlated features, one sees that the features that separate *Blysmopsis* from *Blysmus* are of generic level in the Cyperaceae, even though they are closely related on the basis of their overall similarities and differences.

REFERENCES

ARTYUSHENKO, Z. T., & KOROVALOV, I. N. (1951) *Trudy Bot. Inst. Komarova Akad. Nauk SSSR ser.* 7, *Morfol. Anat. Rast.* 2:170–191.

CLAPHAM, A. R., TUTIN, T. G., & WARBURG, E. F. (1962). *Flora of the British Isles. Ed. 2.*

FEDOROV, A., ed. (1969). *Chromosome numbers of flowering plants.* Leningrad.

GLEASON, H. A. (1952). *The new Britton and Brown Illustrated Flora of the North-Eastern United States and adjacent Canada I.* New York.

HEGI, G. (1908). *Illustrierte Flora von Mittell-Europa* 2:5–49.

MAREK, S. (1958). A study on the anatomy of fruits of European genera in the subfamilies Scirpoideae Pax, Rhynchosporoideae Aschers. & Graebn. and some genera of Caricoideae Pax. *Monogr. Botan.* 6:151–177.

METCALFE, C. R. (1971). *Anatomy of the Monocotyledons* V. *Cyperaceae* 597 pp.

OTENG-YEBOAH, A. A. (1972). *Taxonomic studies in Cyperaceae-Cyperoideae.* Ph.D. Thesis. University of Edinburgh.

——(1974). Four new genera in the Cyperaceae-Cyperoideae. *Notes R.B.G. Edinb.* 33:307–310.

PALLA, E. (1889). Zur Kenntnis der Gattung Scirpus. *Bot. Jahrb.* 10:293–301.

ROSCHEVITZ, R. (1964). In Komarov, *Fl. URSS* 3:45–46 (English translation). Jerusalem.

SCHULTZE-MOTEL, W. (1966). Scirpus in Hegi, *Illustrierte Flora von Mittel-Europa* ed. 2, 2:10–42.

VAN DER VEKEN, P. (1965). Contribution a l'embryographie systématique des Cyperaceae-Cyperoideae. *Bull. Jard. Bot. Bruxelles* 35:285–354.

WILCZEK, E. (1892). Beiträge zur Kenntnis des Baues der Frucht und des Samens der Cyperaceen. *Bot. Centralblatt* 51:129–138.