Glossopterid fructifications from Upper Permian of India : A morphographical correlation

Rajni Tewari

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Scutum-type female Glossopterid fructification is described from the Raniganj Formation (Upper Permian) of Bhatdih and Murulidih collieries of Jharia Coalfield, Bihar, India. Statistical analysis of shape, apex, base and total number of scars on the receptacle show that majority of specimens are lanceolate in shape and have acute apices. The base is stalked with wide marginal border and usually rounded where margins are absent. Total number of scars ranges between 20 and 45. The study shows that a number of multiovulate fructification genera, viz., *Plumsteadia, Hirsutum, Plumsteadiostrobus, Venustostrobus* and *Jambadostrobus*, which have been differentiated on the basis of presence or absence of marginal wings and cuticular features, in all possibilities are related to each other and quite likely represent the developmental or maturation stages of a single type glossopterid fructification.

Key-words—Glossopterid fructification, *Scutum*-type, Raniganj Formation, Upper Permian (India).

Rajni Tewari, Birbal Sahni Institute of Palaeobotany, 53 University Road, Lucknow 226 007, India.

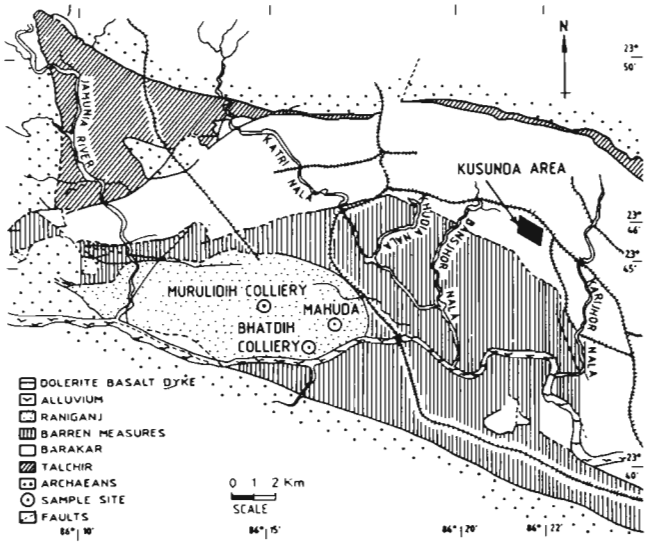
सारांश

भारत के उपरि परमियन से ग्लॉसॉप्टेरिड फलन : आकारिकीय सहसम्बन्धन

रजनी तिवारी

बिहार (भारत) में झरिया कोयला-क्षेत्र की भटडीह एवं मुरलीडीह कोयला खानों के रानीगंज शैल-समूह (उपरि परमियन) से *स्क्यूटम*-सदृश मादा ग्लॉसॉप्टेरिड फलन का वर्णन किया गया है। आकार, शीर्ष, आधार तथा धानी पर कुल विद्यमान स्कारों के साँख्यिकीय विश्लेषण से व्यक्त होता है कि अधिकतर प्रादर्श आकार में भालाकार तथा न्यूनकोणी शीर्ष वाले हैं। पर्णवृन्त युक्त आधार प्रायः चौड़े किनारे से युक्त तथा गोलाकार होने के कारण इनमें किनारा अनुपस्थित है। स्कारों की कुल संख्या 20 से 45 तक है। इस अध्ययन से व्यक्त होता है कि *प्लमस्टीडिआ, हिर्सुटम, प्लमस्टडिओस्ट्रोबस, वेनस्टोस्ट्रोबस* एवं *जम्बादोस्ट्रोबस* नामक फलन प्रजातियाँ जो कि कुछ लक्षणों के आधार पर अलग-अलग बनाई गई हैं, सम्भवतः एक ही ग्लॉसॉप्टेरिडी फलन की विभिन्न विकासीय अथवा परिपक्व अवस्थायें हैं।

SCUTUM was initially described by Plumstead (1952) as a bilaterally symmetrical cupule usually borne on its own short pedicel which arises from the midrib or the top of the petiole of *Glossopteris* leaf (p. 285). Plumstead (1952, 1958) considered *Scutum* to have two halves — the adaxial half or the fertile half had ovule bearing, raised central head and a flat surrounding wing which was fluted, striated and often dentate and the abaxial half or sterile half was protective in nature. Later, in some specimens clusters of pollen grains were found. Plumstead, thus, thought *Scutum* to be bisexual in nature and hence angiospermic. This interpretation was doubted by Surange and Chandra (1975) and Schopf (1976). Surange and Chandra (1975) regarded *Scutum* to be gymnospermous female reproductive organ of *Glossopteris*. They considered the adaxial



Map 1—Showing the locality.

half of the fructification as receptacle which bore ovules and the abaxial half as protective bract.

Later, Surange and Maheshwari (1970) and Surange and Chandra (1974) described *Scutum* species from Kamthi and Raniganj formations (Upper Permian) of Orissa, respectively. Similar fructification was described by Banerji *et al.* (1976) from the Triassic (?) of Nidpur. Of these, only *S. sahnii* (Surange & Chandra, 1974) was found attached to the leaf of *Glossopteris longicaulis*. Rest were all detached specimens.

In the present collection, detached specimens of *Scutum*-type glossopterid fructifications from Bhatdih Colliery are found in close association with the leaves of *Glossopteris formosa*, whereas specimens from Murulidih lack such association. The term *Scutum*-type is being used here because it has been observed that other fructifications, e.g., *Hirsutum* (Plumstead, 1958), *Plumsteadia* (Rigby, 1963 = *Cistella* Plumstead 1958), *Plumsteadiostrobus* (Chandra & Surange, 1977a), *Jambadostrobus* and *Venustostrobus* (Chandra & Surange, 1977b) are related to *Scutum*. A detailed analysis of similarities in these genera is done and their possible correlation is attempted.

All the specimens are devoid of protective bract. None have yielded seeds but bear only impressions of seeds.

MATERIAL AND METHOD

The material for the present study was collected from the Raniganj Formation (Upper Permian) of Bhatdih and Murulidih collieries of Jharia Coalfield, Bihar, India. Bhatdih Colliery lies south-east of Murulidih between 86°16′15″ (East Longitude) and 23°42′55″ (North Latitude). The Murulidih Colliery lies between 86°15′30″: 23° 43′32″ and the seams are seen in east- north east-railway cutting, about a mile west of Mahuda station (Map 1). The fructification specimens were collected from the carbonaceous shale bands in which they are preserved as impressions and compressions. The morphographical features were studied under low power binoculars and cuticular pieces were obtained by Walton's transfer technique. For SEM studies, small pieces of cuticles were coated with gold palladium and viewed with the help of Phillips 505 Scanning Electron Microscope. All the specimens are deposited in the Museum of Birbal Sahni Institute of Palaeobotany, Lucknow.

Genus—*Scutum* Plumstead 1952

Pl. 1, figs 1-12

On the basis of external morphological features, the specimens are divisible into three types : (a) specimens with wide marginal border, (b) specimens with narrow marginal border and, (c) specimens without marginal border. Morphographical features of the three types have been statistically analysed to find out their comparative relationship.

Specimens with wide marginal border—Ten specimens with a flap like marginal border are described. The border is 1.5 (1.3) 3 mm* in width and shows transverse markings at 1.5 to 2.5 mm distance. The specimens measure 1.5 (2.5) 4.1 x 0.8 (1.1) 1.5 cm in size. Of the ten specimens, one is elliptical in shape, three are oval and the rest are lanceolate. Apex is rounded in one, obtuse in three and acute in others. Base is flat in one, rounded in one, apparently wide in one, broken in two and stalked in the rest. Wherever the stalk is present, it is usually striated, about 5 mm long and 2 mm wide. Total number of seed scars on the receptacle ranges from 14 to 49, the average being 33. The scars are circular in shape, 1(1.3) 2 mm in diameter, arranged in horizontal rows,

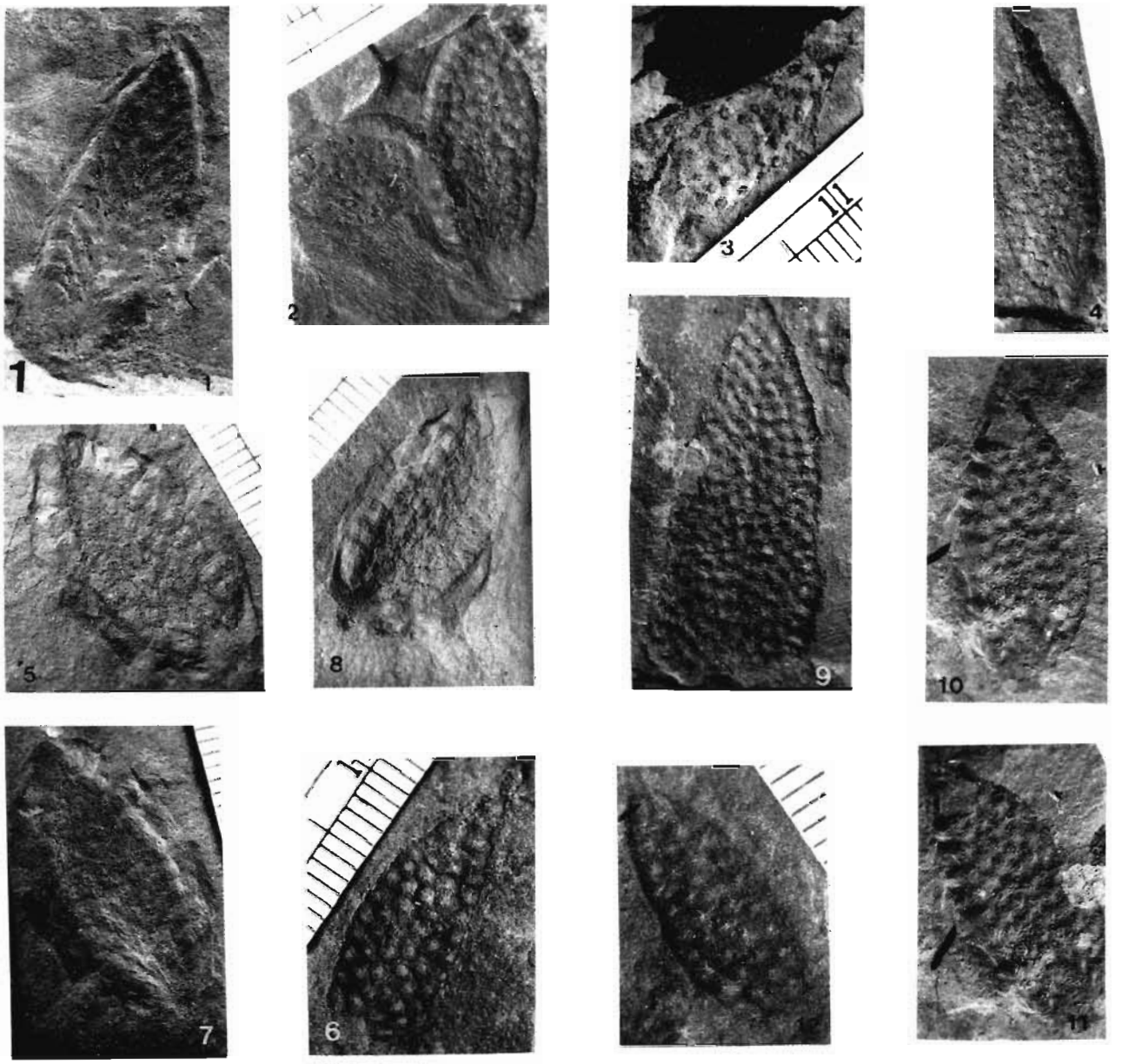


PLATE 1

(All the specimens are from Bhatdih colliery, Jharia Coalfield, Bihar, India).

1. A lanceolate fructification showing narrow marginal border. x 2. Specimen no. BSIP 37058.
2. Another fructification with a narrow marginal border. x 2. Specimen no. BSIP 37403.
3. Specimen showing circular seed scars on the receptacle without a marginal border. x 2. Specimen no. BSIP 36990.
4. Fructification showing an acuminate apex and a stalked base. The receptacle does not possess a marginal border. x1.7. Material utilised for cuticular preparation.
5. An ovate fructification with a broad wing with transverse markings. x 2. Specimen no. BSIP 37057.
6. A lanceolate receptacle without a marginal border showing an acuminate apex, and a rounded base. x 2. Specimen no. BSIP 37404.
7. Another specimen with a broad marginal border. x 2. Specimen no. BSIP 37405.
8. A fructification with a broad marginal border. Material utilised for cuticular preparation. x 2.
9. A lanceolate fructification with a number of seed scars on the receptacle which is without a marginal border. x 2.5. Specimen no. BSIP 37406.
10, 11. Lanceolate fructifications without a marginal border. x 2. Specimen nos. BSIP 37407a, and 37407b.
12. Another fructification without a marginal border. x 3. Specimen no. BSIP 36977.

Table 1—Specimens of *Scutum* with wide marginal border

Specimen no.	Shape	Size (L x W in cm)	Apex	Base	Marginal border (in mm)	Scars towards apex	Scars in centre	Scars towards base	Total no. of scars	Diameter of scars (in mm)
1.	Lanceolate	1.9 x 1.0	Acute	Stalked	2, with transverse markings, 1.5 mm apart	1 - 2	5	4	49	1
2.	Lanceolate	1.5 x 0.9	Not clear	Apparently wide	2	Not clear	5	4	25	1
3.	Lanceolate	1.9 x 0.9	Acute	Broken	2	Not clear	Not clear	Not clear	Not clear	1
4.	Lanceolate	1.9 x 0.8	Acute	Flat	2	1	4	2 - 3	14	1
5.	Lanceolate	2.6 x 1.0	Acute	Stalked, stalk striated	2	1 - 2	4 - 6	4	56	1
6.	Elliptic	2.3 x 1.3	Acute	Stalked	2, flap like with transverse markings 2 mm apart	2 - 3	4 - 6	2 - 3	27	1
7.	Oval	4.0 x 1.5	Obtuse	Attenuate, rounded	1.5, transverse markings not clear	Not clear	4	Not clear	32	1.5
8.	Oval	3.1 x 1.5	Obtuse	Broken	3, transverse markings at distance of 2.5 mm	2	3	Not clear	31	2
9.	Lanceolate	4.1 x 1.2	Rounded	Stalked, stalk striated, 5 mm long, 2 mm wide	2.5, transverse markings at distance of 2.5 mm	1 - 2	3 - 4	1 - 2	34	2
10.	Oval	2.3 x 1.1	Obtuse	Rounded	2	3	5	Not clear	36	1

• Note —Figures within parenthesis denote the average.

scars of one row alternating with those of another row. Maximum number of scars occurs in the centre of the receptacle, viz., 3(5)6, reducing towards apex and the base, i.e., 1(2)3 and 1(3)4, respectively (Table 1).

The statistical analysis of morphographical characters shows that though, majority of fructifications are lanceolate in shape, oval and elliptic fructifications are also common. Likewise, in most of the specimens the apex is acute, though, obtuse apices are also found. The base is usually stalked, sometimes flat and rounded bases are present. Total number of scars on the receptacle in majority of the specimens ranges between 25 and 35. However, they may be up to 55 in number.

Specimens with narrow marginal border—This form is represented by four specimens. The marginal border is narrow, smooth, i.e., without any transverse markings and up to 1 mm wide. Length x width ratio is 1.5 (1.8) 2.0 x 0.6 (0.6) 0.7 cm. All the specimens

Table 2—Specimens of *Scutum* with narrow marginal border

Specimen no.	Shape	Size (L x W in cm)	Apex	Base	Marginal border (in mm)	Scars towards apex	Scars in centre	Scars towards base	Total no. of scars	Diameter of scars (in mm)
1.	Lanceolate	2.0 x 0.6	Acute	Stalked, 1x1 mm	0.5	1	5	4	33	1
2.	Lanceolate	2.0 x 0.6	Acute	Broken slightly, apparently stalked	1, present only in upper half	1	4	2	29	1
3.	Lanceolate	1.6 x 0.7	Acute	Broken	0.5	1	4	Not known	26	0.5 - 1
4.	Lanceolate	1.5 x 0.7	Acute	Rounded	0.5	1	5	Not Clear	23	1

are lanceolate in shape with acute apices. Base is broken in two specimens, rounded in one and stalked in the other. Total number of seed scars ranges from 23 to 33, the average being 28. The scars are circular in shape, 0.5 (1.0) 1.0 mm in diameter. Arrangement is as in the previous type. Scars towards centre are 4 (5) 5, 1 near apex and 2 (3) 4 towards base (Table 2).

Specimens without marginal border—There are 27 specimens without marginal border measuring 1.2(2.0)2.8 cm in length x 0.5(0.5) 1.2 cm in width. Of the 27 specimens, one is oval in shape, two are linear-lanceolate, three specimens are broken (only middle part is preserved) and the rest are lanceolate in shape. Apex is obtuse in one specimen, broken in 3 specimens, acuminate in 8 specimens and acute in 13 specimens. Base is acute in one specimen, attenuate and stalked in two specimens, flat in 3 specimens and rounded in 5 specimens. Total number of seed scars on the receptacle ranges from 13 to 136, the average being 48. The scars are circular in shape, 0.5(0.9) 1 mm in diameter. Arrangement is

Table 3—Specimens of *Scutum* without marginal border

Specimen no.	Shape	Size (L x W in cm)	Apex	Base	Scars towards apex	Scars in centre	Scars towards base	Total no. of scars	Diameter of scars (in mm)
1.	Lanceolate	1.9 x 0.5	Acute	Acute	2	4	2	33	1
2.	Lanceolate	2.3 x 0.8	Acuminate	Stalked, stalk striated	1	4	Not clear	39	1
3.	Lanceolate	2.2 x 0.7	Acute	Broken	1	5	3-4	50	1
4.	Lanceolate	2.8 x 1.0	Acuminate	Flat	1 - 2	7 - 8 (Slightly above base)	4-5	136	0.5
5.	? Lanceolate	2.0 x 0.8	Acuminate	Not Clear	1 - 2	Not clear	Not known	33	1
6.	Lanceolate	1.6 x 0.7	Acute	Broken	1 - 2	5	Not known	50	1
7.	Lanceolate	1.7 x 0.7	Broken	Broken	Not known	5	Not known	25	1
8.	Lanceolate	2.0 x 1.0	Acuminate	Slightly broken, striated	1	3 - 4	Not known	35	1
9.	Lanceolate	2.3 x 0.7	Acute	Stalked, striated 2 x 2 mm	1 - 2	6 - 7	4	69	1
10.	? Lanceolate	2.3 x 0.5	? Acute	Broken	Not known	Not known	4	24	1
11.	? Lanceolate	1.7 x 0.9	Acuminate	Broken	1	4	Not known	33	1
12.	Lanceolate	1.8 x 0.9	Acute	Broken	2 - 3	5	Not known	31	1
13.	Lanceolate	2.0 x 0.7	Apparently acuminate	Apparently flat	Not clear	5	Not clear	33	1
14.	Lanceolate	2.7 x 1.0	Acuminate	Attenuate, slightly broken	1 - 2	5	3	51	1
15.	Not known	1.2 x 0.7	Broken	Flat	Not known	5	3	37	1
16.	Lanceolate	1.9 x 0.7	Broken	Broken	Not clear	Not Clear	Not clear	Not clear	—
17.	Narrow, linear-lanceolate	1.9 x 0.5	Acute	Broken	1	3	Not known	29	1
18.	Lanceolate	1.8 x 0.8	Acuminate	Rounded	1	5	1	61	1
19.	Lanceolate	1.3 x 0.8	Acute	Broken	2	5	Not clear	29	1
20.	Linear-lanceolate	2.4 x 0.6	Acute	Attenuate	1	3 -4	1 - 2	25	1
21.	Oval	1.3 x 0.9	Obtuse	Rounded	2	5	2	28	1
22.	Not known, only middle part preserved	1.8 x 1.2	Not known	Not known	Not known	6	Not known	33	1
23.	Not known, only middle part preserved	1.3 x 0.8	Not known	Not known	Not known	3	Not known	13	1
24.	Lanceolate	2.3 x 0.8	Acute	Broken	1	6	Not known	45	1
25.	Lanceolate	1.4 x 0.7	Acute	Rounded	1	6	4	33	0.5
26.	Lanceolate	2.2 x 1.0	Acute	Rounded	1	10	3	115	0.5
27.	Lanceolate	2.0 x 1.0	Acute	Rounded	Not clear	10	Not clear	105	0.5

same as in the specimens with marginal border. Maximum number of scars occur in the centre of the receptacle, viz., 3(5) 10 reducing towards apex and the base, i.e.,1 (2) 2 and 2 (2) 5, respectively (Table 3). The statistical analysis of morphographical characters shows the dominance of lanceolate shape, acute and accuminate apices and rounded base. Other kinds of bases, viz., flat, acute, attenuate and stalked, however, are also preserved. Total number of scars in majority of specimens ranges between 20 to 45 although in rare cases as many as 136 scars are present.

Thus, basic morphological structure of the fructification consists of a more or less lanceolate receptacle, covered with a number of circular seed scars arranged in horizontal rows and scars of one row alternate with scars of another row. Sometimes, the scars appear to be hexagonal since the corners instead of being round are angular.

Cuticle of receptacle

Cuticle of the receptacle shows highly distorted cells under light microscope. Under Scanning Electron Microscope (SEM) damaged cells are observed. Wherever visible, the cells are polygonal in shape, irregularly distributed and measure 21 to 31x 14 to 27 µm in size. The anticlinal walls of the cells are undulate to sinuous and 1 µm thick. Surface walls are smooth, i.e., non-papillate. Stoma is anomocytic (haplocheilic), 20 µm long and 18 µm wide. Stomatal slit is 9.3 µm long and 1.3 µm wide. Guard cells are 9.3 µm long and 8.4 µm wide. Subsidiary cells are not very clear. A characteristic feature of the cuticle is the presence of circular pores which are distributed in horizontal rows and measure 3 to 3.5 µm in diameter. Exact nature of the pores is not known. Cuticle of one of the specimens shows various seed like structures. One such seed or ovule shows rod-shaped bacteria-like structures which are 6 to 10 µm long and 3 to 3.5 µm wide and also indicates possible bacterial activity. Another structure observed is a globular crystalline mass measuring 8 µm in diameter (Srivastava & Tewari, 1994).

DISCUSSION

Initially, according to the definition given by Plumstead (1952) only those specimens were included under the genus *Scutum* which had a raised central head, bearing oval sacs and a flat surrounding wing which was fluted, striated and quite often dentate. However, uniformity in the morphographical characters like shape, apex, base, arrangement of scars on the receptacle, their diameter and shape in different types of specimens, viz., (a) with wide, flap like marginal border having transverse markings, (b) with narrow marginal border which is smooth, i.e., without transverse markings, and (c) without a marginal border show that all such specimens belong to one basic form (Tables 1-3). The idea gains support from a similar suggestion made by Retallack and Dilcher (1981). The differences, i.e., absence or presence of wing or margin may be due to develop-

Table 4—Morphographical variations in the genus *Scutum* as described by Plumstead (1952, 1958)

S. No.	Name	Shape	Wing	Apex	Base	No. of seed cushions
1.	*S. leslium*	Round, oval, occassionally triangular	Broad, fluted with dentate margin	—	Flat, pedicellate, ribbed	Variable
2.	*S. dutoitides* =*Hirsutum* Plumstead 1958	Oval	Narrow, smooth	Acute	Pedicellate	Variable
3.	*S. stowanum*	Oval	Broad with transverse markings	Acuminate	Flat	Variable
4.	*S. rubidgeum*	Large, ovate	Very wide, fluted, dentate	Round, obtuse	Flat	Variable
5.	*S. draperium*	Large, ovate	Very narrow	Acute	Rounded	Variable
6.	*S. damudica*	Oval	Wide	Broken	Pedicellate	Variable
7.	*S. sewardii*	Oval	Irregularly striated, not fluted	Missing	Pedicellate, pedicel striated	Variable
8.	*S. thomasii*	Oval	Fluted	Rounded, acute	Pedicellate	Variable

mental or maturation stages. Therefore, only on the basis of presence or absence of marginal border, it is not expedient to maintain separate genera.

Plumstead (1952, 1958) described eight species of the genus *Scutum* (Table 4), which showed all possible kinds of variations in morphology and total number of scars on the receptacle.

In 1958, Plumstead described new types of fructifications, e.g., *Hirsutum-type, casket or Cistella* - type, spear or *Lanceolatus* -type and long stalked or *Ottokaria* - type. Of these, the name *Hirsutum* was given to *Scutum dutoitides* kind of fructifications which were discriminated on the basis of narrow wing. However, Mukherjee *et al.* (1966) and Rigby (1971) treated the separation of *Hirsutum* as inappropriate. According to Rigby, separation of the genus *Hirsutum* was based on interpretation and not observations of specimen. The casket or *Cistella*-type (renamed by Rigby in 1969 as *Plumsteadia*) of fructification differs from the *Scutum* and *Hirsutum*-types in being wingless. Other than this difference the three types are similar in all other morphological aspects. Incidentally, *Plumsteadia microsacca* (Rigby, 1963; pl. XI, fig. 3) shows a distinct marginal rim. Maheshwari (1965) too, noted a narrow rim surrounding his specimen of *P. indica*. McLoughlin (1989) described a number of species of *Plumsteadia* from the Late Permian of Australia maintaining that the fructification is commonly winged and reported specimens with up to 4.5 mm wide marginal border. Thus, the fructifications which are strictly categorised as borderless forms, may show a narrow border, making the line of division separating the three genera, thinner.

Chandra and Surange (1977a, 1977b) described three new multiovulate fructifications, namely, *Jambadostrobus, Venustostrobus* and *Plumsteadiostrobus. Jambadostrobus* is a *Hirsutum*-type of fructification from the Jambad colliery of Raniganj Coalfield classified on the basis of different shape and cuticular characters. The shape of *Jambadostrobus* is elliptical or lenticular with the apex drawn out like a beak (acuminate). However, as mentioned earlier, Plumstead (1952) described *Scutum* as round, oval, lanceolate or ovate according to specific variation (p. 285). Moreover, cuticle of receptacle of *Jambadostrobus* is similar to cuticle of specimens which are without border (Srivastava & Tewari, 1994). Hence, similarity in cuticular features also favours their closeness to each other.

Venustostrobus is circular to orbicular in shape, with broad marginal border, divided by transverse marks and a veined, protective bract (1977b, pl. 4, figs 21, 22; text-figures 9 A-C, 10 AB). The authors also described the cuticles of receptacle, bract and seeds. This genus resembles in shape *Scutum leslium* Plumstead which is also almost round with a broad wing. The only difference lies in the wing which in latter has dentate margin (Plumstead, 1952, pl. XLIV, figs 1-4; text-fig. 1a, b). *Plumsteadia semnes* (Rigby, 1978, figs 14-16) resembles *Venustostrobus diademus* in shape but lacks the marginal wing and has cordate base. Incidentally, according to Banerjee (1984), "*Jambadostrobus* and *Venustostrobus* described as *Hirsutum*-type and *Scutum* -type respectively by Chandra and Surange (1977b) resemble two different species of the genus *Scutum* with slight differences in the width of marginal flap. Chandra and Surange (1977a) described yet another new multiovulate fructification namely *Plumsteadiostrobus* which is elliptical in shape, seed-bearing, pedicellate, with a protective spathe like bract and without a wing. Cuticle of bract, receptacle and seed (*Pterygospermum)* were also reported. However, doubts have been expressed by Rigby (1978) and McLoughlin (1989) about the validity of the genus. Chandra and Surange formed this genus on the basis of cuticle of receptacle which characteristically shows lens-shaped openings or holes (pl. 4, figs 14, 15) which they considered as the place where ovules were "seated". Incidentally, one more aspect which shows that these genera might belong to one form is the seeds obtained from *Plumsteadiostrobus* (Chandra & Surange, 1977a, pl. 6, fig. 4), *Jambadostrobus* (Chandra & Surange, 1977b, pl. 3, fig. 16) and *Venustostrobus* (Chandra & Surange, 1977b, pl. 5, fig. 26) which, though, assigned to separate genera, viz., *Pterygospermum, Platycardia* and an unnamed seed respectively, appear to be similar in the photographs. Similarly, the leaves found attached to fructifications *Plumsteadiostrobus* (Chandra & Surange, 1977a, pl. 1, figs 1-4; pl. 2, figs 5-6) and *Jambadostrobus* (Chandra & Surange, 1977b, pl.1, figs 3-4; pl. 2, fig. 5) assigned to two different leaves, viz., *Glossopteris taenioides* and *G.*

Table 5—Morphographical characters of multiovulate glossopterid fructifications showing similarity with *Scutum*

No.	Genus	Shape	Wing	Apex	Base	Seed Scars	Remarks
1.	*Hirsutum* (Plumstead 1958)	Oval	Narrow, not deeply fluted, not dentate	Acute	Pedicellate, pedicel longitudinally striated	22 - 90	Based on Presence of narrow border
2.	*Plumsteadia* (Rigby 1969)	Lanceolate, circular in *P. semnes* (Rigby, 1978)	Wingless, marginal rim 0.4 mm wide in *P. microsacca* Rigby 1963	Almost acute	? Rounded, ovate and auricular	Oval	
3.	*Jambadostrobus* Chandra & Surange 1977b	Elliptical or lenticular	Broad, flat with transverse markings	Acute	Rounded	4 - 6 in middle region, 2 - 3 at base and apex, spirally arranged	*Hirsutum* type fructifications, protective bract absent, receptacle cuticle reported, cuticle similar to those specimens that are without border (present collection).
4.	*Plumsteadiostrobus* Chandra & Surange 1977a	Oval, elliptical	Wingless	Acute	Pedicellate	Many, spirally arranged	*Plumsteadia/Cistella* type fructification, with or without spathe-like veined bract, cuticle from bract receptacle and seed reported, receptacle cuticle shows lens-shaped openings, doubts expressed by Rigby (1978) and McLoughlin (1989) about validity of the genus.
5.	*Venustostrobus* Chandra & Surange 1977	Circular to orbicular	Broad with transverse markings	Rounded	Stalked	Spirally arranged	Bract, receptacle and seed cuticle reported

contracta, respectively, are apparently similar, except for the size.

CONCLUSION

The morphographical study of the fructifications from the Upper Permian of Jharia Coalfield, India and views of different authors on various other similar multiovulate genera, viz., *Scutum, Plumsteadia, Hirsutum, Plumsteadiostrobus, Jambadostrobus* and *Venustostrobus* discussed above have led to the conclusion that, though, all these genera show minor morphological variations in their shape, apex, base,. total number of seed scars and their arrangement on the receptacle; their basic structure is same. Hence, they should not be treated as different genera. However, the possibility of specific circumscription cannot be ruled out. This idea gains support from McLoughlin (1989) who is of the view that general differentiation of multiovulate glossopterid fructification is "optimally based on gross shape of the organ". He further emphasizes that though a genus shows a considerable range varying from 25 to 500 in ovule attachment points this does not necessitate subdivision of the genus but can be useful for differentiation at specific level. Species differentiation, according to him, involves differences in wing morphology and structure of attached ovules.

The variation in the size of marginal border or its total absence may be the result of changes in developmental pattern and subsequent preservation at different maturation stages, or due to anomalies in preservation, depending on ecological factors prevailing at that time. According to Lacey *et al.* (1975) and Rigby (1978) the internal tissue of these fructifications was probably fleshy, soft and juicy. Perhaps, this might be the reason for non-preservation of wings in certain specimens like *Plumsteadia* (although McLoughlin (1989) reported wings in this genus), *Plumsteadiostrobus* and borderless forms of present collection.

On the other hand, Surange and Chandra (1975) considered that during fossilisation the ovules in the middle convex region of the receptacle compressed

vertically downwards into round to oval swellings, whereas, the ovules on the margin compressed laterally or lengthwise and appeared as compactly arranged in a row one below the other giving a "wing like" appearance all along the margin. According to them the width of the wing depended upon the size of the seed which was different in different species.

In the view of present study and analysis of supportive data by Lacey *et al.* (1975), Surange and Chandra (1975), Rigby (1978) and McLoughlin (1989), and the possibility of bacterial decay of marginal border in some genera (Srivastava & Tewari, 1994), it is suggested that fructification genera *Scutum, Hirsutum, Plumsteadia, Plumsteadiostrobus, Venustostrobus* and *Jambadostrobus* (Table 5) belong to one form and represent different developmental stages of a single multiovulate fertile structure. Therefore, these genera may be merged with *Scutum* Plumstead on the basis of priority of publication.

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