

# DISCOVERY OF *EURYDESMA* AND *CONULARIA* IN THE EASTERN HIMALAYA AND DESCRIPTION OF ASSOCIATED FAUNAS\*

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**ABSTRACT**—This paper records the discovery of *Eurydesma* beds at Khemgaon Chorten and Wak in Sikkim, Eastern Himalaya, and of a *Conularia*-bearing horizon in the Subansiri Forest Division, North East Frontier Agency. From Sikkim, three new species of *Eurydesma*—*E. subdepressa*, *E. austini* and *E. subtriangularis*—are described, besides the new brachiopod genus *Ambikella* with a dorsal sulcus and a ventral fold, and the spirifers, *S. papillionata* nov. and *S. duttai* nov. The Sikkim fauna also includes *Eurydesma cordatum* Morris var. *mytiloides* Cowper Reed, *Eurydesma* cf. *globosa* Dana and *Protoretzpora* cf. *ampla* Lonsd.; the authors conclude that the fauna represents the Agglomeratic Slate horizon of Kashmir with which the Sikkim beds are also lithologically identical.

The Subansiri fauna includes a new species of *Conularia*, *C. laskeri*, two new varieties of *Chonetes carbonifera* and the new genus *Subansiria*, combining characters of *Syringothyris* and *Pseudosyrinx*. This fauna is of undoubted Anthracolithic age.

## INTRODUCTION

THE present paper records an important palaeontological discovery of recent years in India, namely, the recognition of a profuse fauna composed of several species of *Eurydesma* at Khemgaon Chorten (topo-sheet 87A/8; 27°11' : 88°22'30") and Wak (topo-sheet 78A/8; 27°13' : 88°21') in Sikkim, and of a *Conularia*-bearing horizon in Bighunala, Ranga valley, Subansiri Division of N.E. Frontier Agency. In addition, a rich brachiopod fauna was found in association with *Eurydesma* and is also described here.

The credit for discovering the *Eurydesma* horizon goes to G. N. Dutt, Geological Survey of India, while the genus *Conularia* was found in highly fossiliferous limestone boulders (not *in situ*) collected by B. Laskar of the same Department. The actual recognition of these two genera is, however, due to the present authors to whom the materials were entrusted for detailed examination.

The results recorded here have accrued from an examination of a collection made during the Field Season, 1952–53 and of a second collection by Dutt in 1954, who revisited the area in 1953–54 at the suggestion of the senior author.

## PREVIOUS WORK REVIEWED

While there are several previous references to the geology and fossil occurrences in Sikkim (Wager, 1930; Muir-Wood, 1941 and Ghosh, 1952 and 1953) the first reference to the fossils of the area immediately under review is by Ghosh who records the occurrence of "*Spirifer* and fragments of the Permo-Carboniferous marine brachiopoda and bivalve casts and shells" (1952). Subsequently, Ghosh (1953) referred to the locality north of Namchi (near Khemgaon) whence T. Banerjee collected some fragmentary fossils (not *in situ*) including the internal caste of a *Spirifer*. This occurrence was referred to by Jacob and Banerjee (1954) in a note based on the work of earlier authors. Among the fossils mentioned by them are *Spirifer* (? *Neospirifer*) cf. *moosakhailensis*, *Productus*, *Fenestella* (? *Fenestrellina*) etc. Unfortunately, most of their identifications need revision and, what is more surprising, no specimen of *Productus* has so far been recognised even in the subsequent large collections from Khemgaon. Moreover, these authors completely missed the occurrence of *Eurydesma* which forms the most characteristic element of the fauna.

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The only detailed description of fossils from the Subansiri gorge is by Diener (1905) who assigned an Anthracolithic age to the the boulders collected by J. Malcolm Maclaren at Drepur, near the mouth of the Subansiri gorge, Assam. He recognised two types of fossil-bearing rocks (i) arenaceous and only slightly calcareous, (ii) extremely hard, blue, argillaceous limestone nodules. In the former he recognised *Productus*, *Spirifer* sp. ind., *Spiriferina* sp. ind., *Reticularia* cf. *inaequilateralis* (?) Gemmelaro, *Dielasma* sp. ind., aff. *uralico* Krotow, *Dielasma* sp. ind. ex. aff. *D. bplex* Waagen, and *Dielasma* sp. ind. The limestone nodules (ii) were reported to be rich in casts of *Chonetes* cf. *carbonifera* Keyserling. Besides *Chonetes* the following species were recognised, *Myalina* sp. ind., *Monopteria subansirica* sp. nov., *Loxonema* sp. ind., *Pleurotomaria* sp. ind. aff. *punjabica*, *Bellerophon* sp. ind. and *Fenestella* sp. ind.

While the fossils described here are all from rolled boulders, Laskar states that he has located the source beds about 20 miles south-west of Subansiri (Maclaren's locality) in the Ranga valley basin, only a few hundred feet from the Tertiary belt lying to the south. It is unfortunate that no fossils from rocks *in situ* were collected.

The fossils from the two areas, Sikkim and Subansiri, will be described separately.

#### I. SIKKIM

The Sikkim fossils were collected from two localities by G. N. Dutt, namely, (i) Khemgaon Chorten and (ii) Wak.

The stratigraphic sequence at Khemgaon given below (as determined in the field by Dutt) is similar to that at Wak (see below) except that the Conglomeratic Sandstone at Khemgaon is dark coloured, the enclosed pebbles larger and there is a thin *Fenestella* horizon at the top of this (Conglomeratic sandstone) horizon.

#### SECTION IN STREAM BED, 0.35 MILES SOUTH OF KHEMGAON CHORTEN

5. Sandstones (Gondwana).....	Thickness not known
4. Black slate.....	15 ft.

3. Blue Conglomeratic Sandstone (fossiliferous) upper 6" contain <i>Fenestella</i> in profusion .....	4 ft.
2. Boulder conglomerate.....	20 ft.
1. Pebbly and gritty slate .....	Thickness not known

In the topmost bed of the sequence we have recognised *Glossopteris*, *Vertebraria* as well as Equisetaceous stems, the ensemble indicating the Lower Gondwanas.

Below these occur Black slates which are not fossiliferous.

The top six inch thickness of the Conglomeratic Sandstone in the Khemgaon section contains *Fenestella* in profusion and weathers into a light yellow, spongy rock. In addition, stray crinoidal plates and, what appear to be portions of *Protoretetpora* (?) *ampla* have also been noticed. The rock specimens at our disposal do not contain any other recognisable fossils, nor is it intended to imply that this represents the *Fenestella* horizon of Kashmir in the stratigraphic sense (see below). In the dark, calcareous Conglomeratic Sandstone, are distributed pebbles and boulders of varying size. This constitutes the main fossiliferous horizon of the sequence, and has also yielded *Protoretetpora* cf. *ampla*, besides *Eurydesma* and other organic remains. The fossils occur here mainly in the form of casts and it was only with great difficulty that specimens with the shell preserved were obtained by the process of heating and sudden cooling or by careful chiselling away the harder parts of the embedding matrix.

Lithologically, this bed bears a remarkable similarity with certain horizons of the Agglomeratic slates of Kashmir. Indeed, the composition of its fauna leaves little doubt that the Sikkim horizon is the exact stratigraphic equivalent of the Agglomeratic slates of Kashmir usually referred to the Upper Carboniferous but maybe in part L. Permian. Both contain, in addition, pebbles, mainly of quartzite, of varying size while the mode of weathering yielding various shades of grey and brown, is also remarkably similar in both cases. It may however, be emphasised that the *Fenestella* shales (M. Carboniferous) horizon of Kashmir occurs *below* the Agglomeratic slates, not *above* as in Sikkim,

According to Dutt, no fossils have so far been reported from the Boulder Conglomerate, or the Pebbly Slates, the lowermost bed of the sequence. However, as far as we are aware, no thorough search has been made nor have we so far examined any rock specimens belonging to this horizon, but by analogy with other occurrences, e.g., the Umaria and Manendargarh faunas, there seems no reason why organic remains should not occur.

The other fossil occurrence lies about one mile north-east of the dispensary at Wak on the foot-track to Padambli ( $27^{\circ}14' : 88^{\circ}22'$ ) at an altitude of about 4,600 ft. The fossils are here found in the Conglomeratic Sandstone weathering to a light brown, *vide* section given below :—

#### SECTION I MILE N. E. OF WAK

5. Daling slates and phyllites.  
—Overfolded or Thrust contact—
4. Grey, fine-grained sandstones and shales, often carbonaceous.
3. Conglomeratic Sandstone of light colour (fossiliferous).
2. Gritty and pebbly grey slates.
1. Blue and grey limestones interbedded with the basal part of bed 2.

According to Dutt, the sequence at Wak is similar to that at Khemgaon (see above) except that the Daling slates and phyllites are missing at the latter locality, nor have the associated grey limestones (which form an horizon distinct from the Gritty grey slates proper) been recorded at Wak. However, we feel that definite comparisons cannot be made at this stage since the main fossil-bearing horizon at Wak is lithologically different. It is a lighter coloured conglomeratic rock and is the principal *Eurydesma* horizon containing species of the genus to the near exclusion (as far as we can judge from the material available) of brachiopods and other fossils. At Khemgaon the position is reversed (judging again from material at our disposal) for the fauna there contains mainly brachiopods and only one or two species of *Eurydesma*, though specimens occur in fair profusion. Nevertheless, the difference in the compo-

sition of the fauna may reflect merely a difference of facies.

It has not so far been possible to define precisely the junction between the Daling slates and the underlying grey sandstones and shales. It will be noted also that the limestones forming the basal part of the Wak section are not exposed at Khemgaon Chertén. The lowest beds of the above sequence are unfossiliferous.

#### SYSTEMATIC POSITION OF THE INDIAN AND AUSTRALIAN EURYDESMIDS

The genus *Eurydesma* is abundantly represented in our collection from Wak whence four species have been recorded. On the other hand, only one species not represented at Wak is recorded from Khemgaon, but the former occurs profusely.

Many of the available specimens show the cardinal fold and small tubercles formed by infilling of the retractor muscle pits, characteristic of *Eurydesma*. These pits (*P*) are also seen in the shell where the apical region is intact (Pl. 35, fig. 4). While the species recognised seem to be comparable with Dana's Australian forms or with certain Indian species from the Salt Range and Kashmir, the nomenclature of the Indian *Eurydesmidae* is still, in our opinion, confused. This is due partly to the fact that nearly all the Kashmir and Salt Range (like the Sikkim) examples are in the form of casts upon the basis of which several species were proposed by Cowper Reed (1936). According to Etheridge (1910, p. 47), none of the Indian species (described upto the time of publication of Waagen's paper) are identical with the Australian forms (with which we are inclined to concur) and he even doubts whether they belong to the genus *Eurydesma* at all. A study of the Sikkim material convinces the authors of the need for detailed comparison of Indian species with actual Australian specimens which unfortunately we do not possess. This we hope to undertake in due course. Meanwhile the identity of Indian with Australian species must be regarded as tentative.

## SYSTEMATIC DESCRIPTION

Family EURYDESMIDAE Cowper Reed

Genus EURYDESMA, Morris

EURYDESMA CORDATUM MORRIS VAR.

MYTILOIDES Cowper Reed

Pl. 34, figs. 1-3

This variety described by Cowper Reed (1932, p. 50) from Kashmir is represented in our collection by several individuals. It exhibits the characteristic vertically sub-oval mytiliform shape with sharply pointed sub-central umbones, deep lunule and post umbonal thickening of the shell.

The shell is partly preserved in one or two examples and is smooth, so far as it can be seen. A well defined cardinal fold (*C*) is seen in at least one example (Pl. 34, fig. 2). Although the identity of this form with Cowper Reed's variety *mytiloides* is well established, we are still uncertain whether the Indian forms should be referred to *E. cordatum* Morris, in view particularly of the fact that the shell is not completely preserved in any example from Kashmir or Sikkim, which makes comparisons difficult.

*Figured specimens.*—G.S.I. Type Nos. 17,641 and 17,642.

*Locality.*—All specimens from one mile north-east of Wak dispensary, on the foot-path to Padamblu.

EURYDESMA CF. GLOBOSA Dana

Pl. 34, figs. 4 and 5

Two perfectly preserved casts, a right and a left valve, appear to be almost identical in shape with the Salt Range specimen, compared with Dana's *E. globosa* by Waagen (1891). Although we have not been able to examine any of Dana's original illustrations of this species, his description (1847, p. 158) agrees well with that of our specimens. The fossil from Wak is distinctly inflated and possesses the oblique, transversely vertical shape characteristic of the species. It is more produced anteriorly than on the posterior side and possesses acute, well curved umbones which overhang a deeply excavate lunule.

The Sikkim examples approach Dana's species much closer in size than Waagen's from the Salt Range which are larger than the Australian fossil.

*Figured specimens.*—G.S.I. Type Nos. 17,43 and 17,644.

*Locality.*—One mile north-east of the dispensary at Wak, on the foot-path to Padamblu.

EURYDESMA SUBDEPRESSA sp. nov.

Pl. 34, figs. 6-7

So far as one can judge from the material available, this is the most common species of *Eurydesma* met with at Wak, being represented by several well preserved casts.

The shell is moderately convex, very slightly oblique and subcircular in outline, except near the anterior part of the hinge where it straightens out; it flattens appreciably on the sides but postero-ventrally the margin is sharply deflected; umbones acutely pointed, prosogyrous, situated medianly, slightly elongated; lunule wide but not deeply excavate; adductor scars and cardinal fold not seen; three or four tubercles marking the position of retractor pits are seen near the apex. Ornamentation feeble, concentric.

*Remarks.*—The characteristic shape, acutely pointed, medianly situated umbones and the deflected postero-ventral margin easily distinguish this species from the Salt Range and Kashmir forms. There is some resemblance with *E. hobertense* Johnston, two varieties of which have been described by Cowper Reed (1936) from the Salt Range, but the species from Sikkim is considerably flatter and the orientation of the retractor muscle scars is different. Apart from differences in relative convexity, the Salt Range varieties *bigener* and *rotundata* possess more obtuse umbones.

*Holotype.*—G.S.I. Type No. 17,645.

*Paratype.*—G.S.I. Type No. 17,646.

*Locality.*—All specimens from one mile north-east of Wak dispensary, on the foot-path to Padamblu.

## EURYDESMA AUSTINI sp. nov.

Pl. 35, fig. 1

In the collection from Khemgaon there is a rather striking form which stands well differentiated from the known species of *Eurydesma*. It is apparently not a very common form and is represented by only two specimens, a right and a left valve, one of which is figured here.

Shell long, transversely oval in shape, strongly inflated, with posterior margin distinctly flattened, forming a very characteristic protruding subtriangular zone on the cast, presumably indicating considerable internal shallowing of the valve posteriorly. The umbones are situated posteriorly and are not prominent. The horizontally projected cardinal fold is seen in one of the specimens while in both our examples the row of small tubercles marking the position of the retractor muscle pits is well preserved.

The shell which is partly preserved in the holotype, is fairly thick and apparently possesses well defined concentric growth lines.

*Remarks.*—In its transversely oval shape, the species recalls *E. ellipticum* Dana, also recorded by Waagen from the Salt Range. However, our species is well differentiated from Dana's in being a distinctly more transverse shell. Moreover, the characteristic posterior angular prolongation as seen in the cast (Pl. 35, fig. 1) is absent in Dana's species. This is continued as a narrow zone in the ventro-posterior region which

is also comparatively more straight than in *E. ellipticum*. Another point of distinction is the more sub-central position of the umbones in our species.

The only other species which possesses a transversely elliptical shape is *E. perversum* Reed, from the Salt Range, but except for the outline there is nothing in common between the two. *E. perversum* is a much more inflated species, lacking the characteristic prolongation and posterior flattening referred to above, while the umbones are also situated much more posteriorly.

*Holotype.*—G.S.I. Type No. 17,647.

*Locality.*—From 0.35 miles, south of Khemgaon Chorten.

## EURYDESMA SUBTRIANGULARIS sp. nov.

Pl. 35, figs. 2-5

This is the only other species of *Eurydesma* found at Khemgaon and is represented by a number of individuals, in some of which the shell is partly preserved.

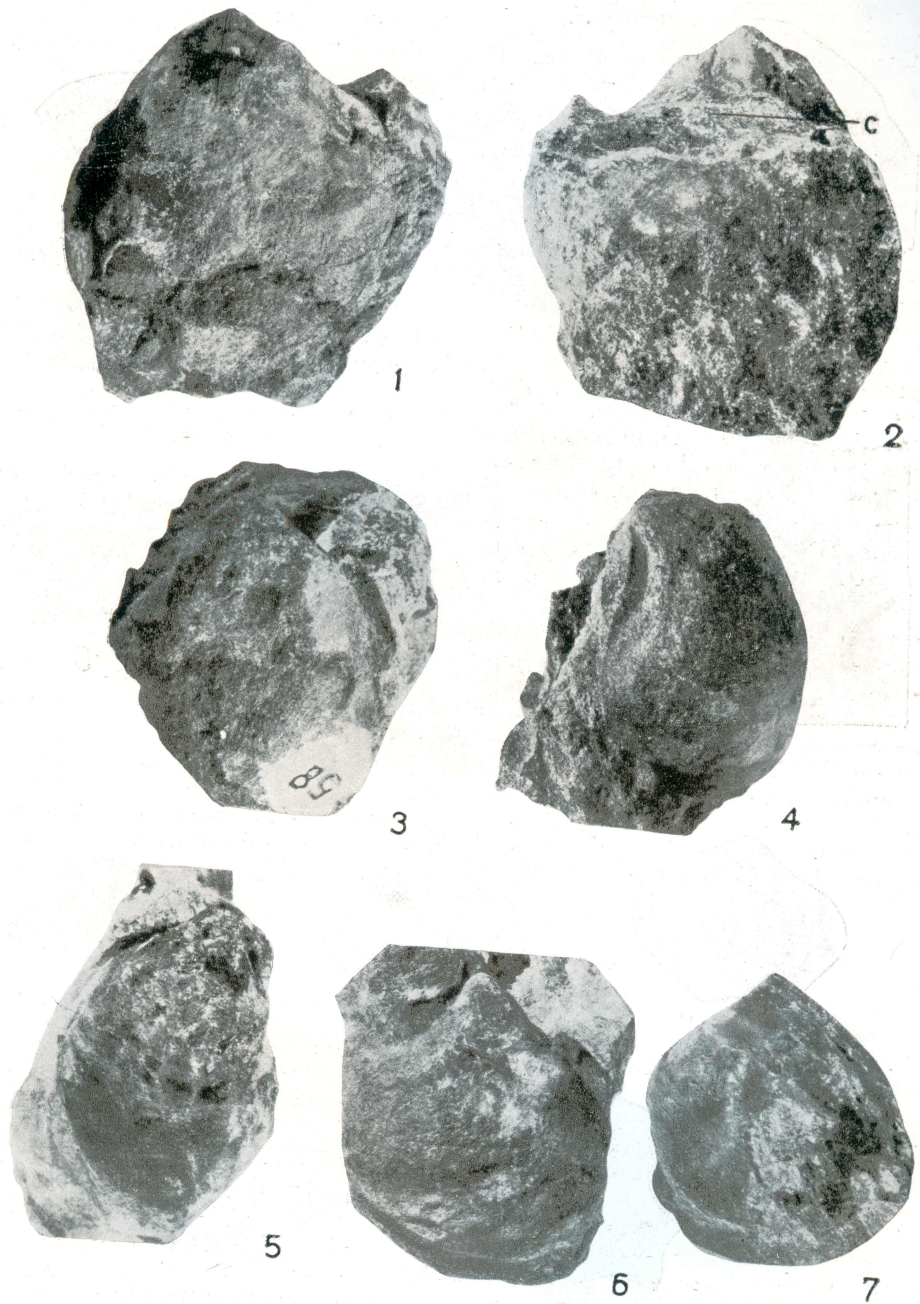
The shell is obliquely triangular in outline, moderately convex, flattening out along the margins. The apical region of the left valve is preserved; the shell here is fairly thick, smooth and possesses faint concentric growth lines.

The umbones as seen in the cast, are acute, and situated posteriorly, with tubercles corresponding to retractor muscle pits showing on the apical region. The points of attachment of the retractor muscles are

## EXPLANATION OF PLATE 34

All figures are of natural size, except where otherwise indicated.

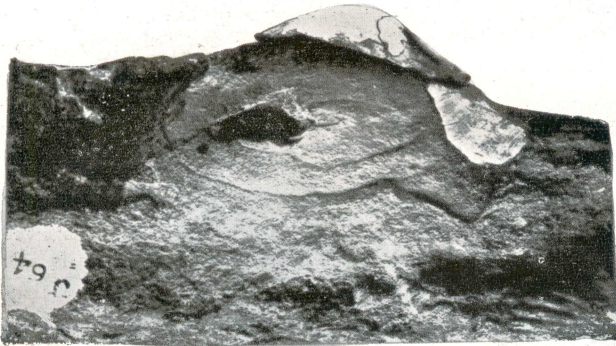
- FIG. 1—*Eurydesma cordatum* Morris var. *mytiloides*, Cowper Reed. Internal cast of right valve showing slightly sub-central, acute umbones and mytiliform shape. G.S.I. Type No. 17,641.  
 2—*Eurydesma cordatum* Morris var. *mytiloides*, Cowper Reed. Internal cast of right valve. Cardinal view showing cardinal fold, *c*, and tubercles marking position of retractor pits.  
 3—*Eurydesma cordatum* Morris var. *mytiloides*, Cowper Reed. Internal cast of specimen showing posterior flattening. G.S.I. Type No. 17,642.  
 4—*Eurydesma* cf. *globosa* Dana. Internal cast of left valve showing well defined, deep lunule, highly inflated shell and sharply curved umbones. G.S.I. Type No. 17,643.  
 5—*Eurydesma* cf. *globosa* Dana. Internal cast of right valve. G.S.I. Type No. 17,644.  
 6—*Eurydesma subdepressa* sp. nov. Internal cast of sub-circular left valve showing nearly central straight umbo, wide but shallow lunule, posterior flattening and ventral deflection. Holotype, G.S.I. Type No. 17,645.  
 7—*Eurydesma subdepressa* sp. nov. Internal cast; lunular portion missing. Paratype, G.S.I. Type No. 17,646.



SAHNI AND SRIVASTAVA : FOSSILS FROM THE EURYDESMA BEDS OF SIKKIM, EASTERN HIMALAYA.



1



2



3



4



5



6



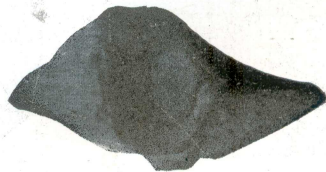
7



8



9



10

indicated by a row of pits (Pl. 35, fig. 4) in the preserved apical region of the shell. The lunule is deep, fairly elongated, and the cardinal fold (*C*) is very well defined (Pl. 35, fig. 5).

*Remarks.*—The only species which resembles *E. subtriangularis* in outline is *E. aequale* Cowper Reed, but the similarity is superficial as our species is more definitely triangular, less globose and has a much narrower hinge region, which probably indicates that the umbones were close to each other. Its shape and other characters separate it from *E. cordatum* and *E. hobartense*.

*Holotype.*—G.S.I. Type No. 17,648.

*Paratype.*—G.S.I. Type No. 17,649.

*Locality.*—All specimens from 0.35 miles south of Khemgaon Chorten.

Superfamily SPIRIFERACEA Waagen

Genus AMBIKELLA\* NOV.

Genotype AMBIKELLA FRUCTIFORMIS sp. nov.

Pl. 35, figs. 6-10

Though the present genus is based upon a single specimen—an internal cast—it is so well preserved that most of its characters can be accurately determined and leave no

doubt that it is well differentiated from known forms. The most characteristic feature of the genus is the presence of a sulcus on the brachial valve (Pl. 35, fig. 6) and a sharp fold on the pedicle valve (Pl. 35, fig. 7), the reverse position to that found in all spirifers, except *Metaplasia*, which is a Devonian form. The apical view of the shell, strongly recalls a fructification, whence the specific designation.

The following description of the genotype encompass the generic diagnosis:—

Form sub-circular, hinge-line short, less than the greatest width of the shell. A portion of the dorsal valve shows prominent concentric lamellae which probably also characterise the pedicle valve, though the cast in its present state is nearly smooth.

*Brachial valve*: characterised by a well-marked sulcus which broadens towards the anterior margin and is produced like a tongue ventrally (Pl. 35, fig. 10). The sulcus is differentiated by ridges on both sides. The surface is marked by fine concentric lamellae reminiscent of *Reticularia*. A narrow median septum extends for almost the entire length of the shell, dividing the sulcus into two halves, terminating at the point where the sulcus descends ventrally. Two longitudinal impressions, presumably

#### EXPLANATION OF PLATE 35

All figures are of natural size, except where otherwise indicated.

- FIG. 1—*Eurydesma austini*, sp. nov. Internal cast of transversely elliptical left valve with shell partly preserved; note the characteristic posterior sub-angular flattening, nearly straight ventral margin and posteriorly situated umbones. G.S.I. Type No. 17,647.
- 2—*Eurydesma subtriangularis* sp. nov. Cast of left valve with umbonal part of the shell attached; holotype G.S.I. Type No. 17,648.
- 3—*Eurydesma subtriangularis* sp. nov. Beak of holotype.
- 4—*Eurydesma subtriangularis* sp. nov. Internal view of same, showing retractor muscle pits, *P*.
- 5—*Eurydesma subtriangularis* sp. nov. Hinge region of another specimen showing well defined cardinal fold, *c*; Paratype G.S.I. Type No. 17,649.
- 6—*Ambikella fructiformis* gen. et. sp. nov. Dorsal view showing sulcus bounded by ridges; note exceptionally long lamellae and median septum. Genoholotype. G.S.I. Type No. 17,650.
- 7—*Ambikella fructiformis* gen. et. sp. nov. Ventral view of above showing abruptly rising fold, long dental lamellae and median septum.
- 8—*Ambikella fructiformis* gen. et. sp. nov. Internal cast of Genoholotype. Cardinal view illustrating short hinge, dental lamellae and dorsal and ventral median septa.
- 9—*Ambikella fructiformis* gen. et. sp. nov. Cardinal view of above. (slightly enlarged).
- 10—*Ambikella fructiformis* gen. et. sp. nov. View of internal cast of holotype. Anterior view of genoholotype showing protrusion of dorsal sulcus (slightly enlarged).

\* For comparisons with *Notothyris*, Harrington (1955) see postscript.



of muscle marks, occupy nearly two-thirds of the posterior portion and are bounded by long thin, lamellae which extend well over half the length of the shell.

#### Dimensions

Length	22.6 mm.
Breadth	30.5 mm.
Thickness	16.0 mm.
Length of dorsal median septum	18.0 mm.
Length of ventral median septum	9.0 mm.

*Pedicle valve*: characterised by a well defined fold extending throughout the length of the shell, but not produced in front. In the posterior region there are two thin, short, dental lamellae (Pl. 35, fig. 8) enclosing narrow, longitudinal muscle marks divided by a median septum, which is more prominent in the posterior region. The fold rises abruptly and is very sharply demarcated from the rest of the shell; beak of medium size, curved over the hinge line.

*Remarks*.—As already stated, the only genus which possesses a dorsal sulcus and ventral fold is *Metaplasia* Hall and Clark (1894, p. 5). But *Metaplasia* possesses, in addition, lateral plicae and has no dental lamellae. Moreover, the genus is confined to the Devonian of America though the point is of no intrinsic importance in so far as the systematic position of *Ambikella* is concerned.

As in the case of *Metaplasia*, we have no evidence whether the genus is spiriferous. This will have to await discovery of more material.

*Holotype*.—G.S.I. Type No. 17,650.

*Locality*.—From 0.35 miles south of Khemgaon Chorten.

#### GROUP OF SPIRIFER TRIGONALIS

##### SPIRIFER PAPILLONATA sp. nov.

Pl. 36, figs. 1-4

The shell is papillionate in shape and about as wide as long; the outline takes an inward sweep some distance below the sub-angular cardinal angle which gives the shell its distinctive outline.

*Brachial valve*.—In most of our specimens this valve is well preserved; it is characterised by a sharp fold, almost in the form of a keel, which is slightly produced anteriorly and accentuates the papillionate aspect of the shell. There is faint evidence, particularly in the holotype, of the dorsal fold bearing subsidiary ridges. There are about 6-8 costae on either side of the fold showing evidence of occasional bifurcation. Short, thick dental lamellae are present.

*Pedicle valve*.—Rather flattened, with a shallow median sinus, on either side of which there are about 8 costae, not sufficiently well preserved to indicate whether they are simple or subdivided.

#### DIMENSIONS

Length.	Breadth.	Remarks.
32 mm.	35 mm.	Brachial valve.
21 mm.	24 mm.	Brachial valve.
33 mm.	28 mm.	Pedicle valve.
(incomplete)		

*Remarks*.—The sharp keel-like dorsal fold is remarkably similar to that found in such species as *S. triangularis*, Martin, *S. trigonalis* Martin and *Spirifer keilhavii* von. Buch, and there is little doubt that *S. papillionata* must be placed in the general group of *Spirifer trigonalis*. However, our species has a distinctly papillionate (rather than triangular) outline, its length is almost equal to its width and there is a tendency towards anterior bifurcation of the costae. These characters separate it from *S. triangularis* which is nearly twice as broad as long. It appears to be related to *S. trigonalis* which bears four distinct subsidiary costae on its dorsal fold.

*Holotype*.—G.S.I. Type No. 17,651.

*Paratypes*.—G.S.I. Type Nos. 17752-54.

*Locality*.—All specimens from 0.35 miles south of Khemgaon Chorten.

##### SPIRIFER DUTTAI sp. nov.

Pl. 36, figs. 5-6

This species is represented by two well preserved shells and a number of casts.

Shell sub-circular in outline, nearly as wide as long; hinge-line slightly less than its greatest width; cardinal margins rounded.

*Brachial valve*.—Convex, characterised by a well defined sharp fold, almost in the form of a keel. It is not produced anteriorly as in *Spirifer papillionata*, but flattens out very slightly. On both sides of the fold there are about 6 broad costae; each of these starts as a simple rib which first bifurcates at a distance of about one-third from the posterior end, becoming wider, while near the anterior margin the rib away from the fold bifurcates again. No concentric lamellae or growth lines are observed.

*Pedicle valve*.—Although no complete individual has been found, one or two isolated pedicle valves possess characteristic trifurcated ribs recalling those of the brachial valve of the present species. There is a sulcus corresponding to the fold on the brachial valve which is devoid of subsidiary ribs; a deep medium septum is present in the posterior region only.

DIMENSIONS		
Length.	Breadth.	Remarks.
32 mm.	32.5 mm.	Brachial valve.
36 mm.	?	Brachial valve. (incomplete)

*Remarks*.—The present species though very similar to *S. papillionata* can be easily distinguished from it by its subcircular outline and particularly by the trifurcation of its lateral costae. Its shape also distinguishes it from *Spirifer trigonalis* and *S. triangularis* though the sharp angulation of the dorsal median fold suggests relationship with them. The species recalls *S. ovalis*, Phillips but the costae are totally different in the two, being simple in the European species.

*Holotype*.—G.S.I. Type No. 17,655.

*Paratype*.—G.S.I. Type No. 17,656.

*Locality*.—All specimens from 0.35 miles south of Khemgaon Chorten.

SYRINGOTHYRIS ? sp. indet.

Pl. 36, fig. 7

An internal cast of the apical region of a ventral valve strikingly recalls that of *Syringothyris*. Besides the divergent dental lamellae, a cavity in the apical region of the cast is also suggestive of a syrinx.

However, the material is insufficient to unequivocally affirm its identification with *Syringothyris*. Therefore the presence of this important genus in Sikkim must for the present be considered provisional.

*Figured specimen*.—G.S.I. Type No. 17,657.

*Locality*.—From 0.35 miles south of Khemgaon Chorten.

#### BRYOZOA

Genus PROTORETEPORA de Koninck

PROTORETEPORA CF. AMPLA Lonsd.

Pl. 36, fig. 8

In certain weathered boulders, presumably derived from the top six inch thickness of the Conglomeratic Sandstone, are scattered numerous portions of bryozoa, including *Fenestella* and *Protoretepora* which (particularly the former) are not sufficiently well preserved for description. However, reference may be made here to the specimen of *Protoretepora* from the main part of the Conglomeratic Sandstone. The specimen has its basal portion which would have been attached to the substratum, remarkably well preserved. The impression of the poriferous face of the colony (Pl. 36, fig. 8) compares well with that of *P. ampla* described by Diener from Kashmir. This forms another link with Kashmir on the one hand and Australia on the other.

*Figured specimen*.—G.S.I. Type No. 17,658.

*Locality*.—All specimens from 0.35 miles south of Khemgaon.

#### II. SUBANSIRI AREA

The fossils obtained from this area were derived entirely from stray boulders collected from the bed of Bighu nala, Ranga

valley, Subansiri Forest Division of N.E. Frontier Agency.

Nearly all the boulders examined by us appear to be waterworn. However, Laskar affirms having discovered the source bed though no *in situ* material seems to have been collected so far. The boulders are of dark-coloured, almost black argillaceous limestone, and apparently belong to category (ii) of Diener. Besides these, a few specimens of a compact black shale were also examined; but except for a large ostracod, they have not so far yielded well-defined organic remains.

The Anthracolithic age of certain boulders from this area was determined by Diener (1905) and was confirmed by the presence of *Productus* and other species. A reference to Diener (1905) leaves little doubt that the fossils described below are from a horizon identical to that from which he described his Subansiri fauna, and that both are Anthracolithic, even though only one species is common. This may, however, be due to the very limited number of species described by Diener and the present authors. According

to Diener (1905, p. 198) it was difficult to assert with confidence whether his Subansiri fauna was Carboniferous or Permian in view of the small number of determinable species. The position remains much the same to-day though further collections should enable one to assign a more precise stratigraphic horizon to this fauna, for there is little doubt that well-preserved fossils can be obtained if sufficient pains are taken.

#### SYSTEMATIC DESCRIPTIONS

Family CONULARIIDAE Walcott

Genus CONULARIA Sow.

CONULARIA LASKERI sp. nov.

Pl. 36, figs. 9-11

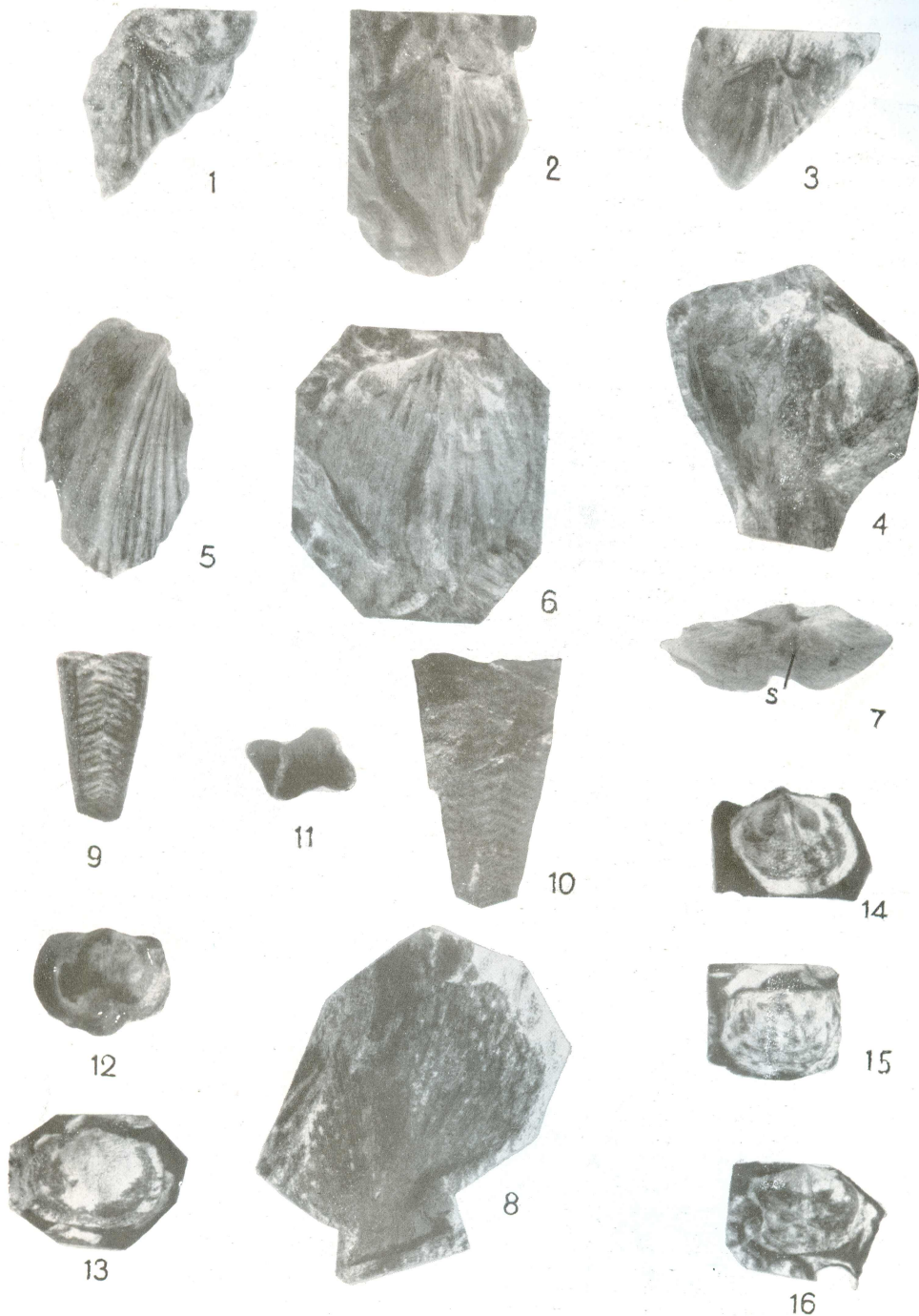
A single specimen of this genus was obtained from a rolled boulder which also contained various crinoid stems and corals too fragmentary for identification.

The *Conularia* specimen examined has a length of 12 mm. but both its apical and distal ends are broken. The impression preserved on the matrix is about 14 mm.,

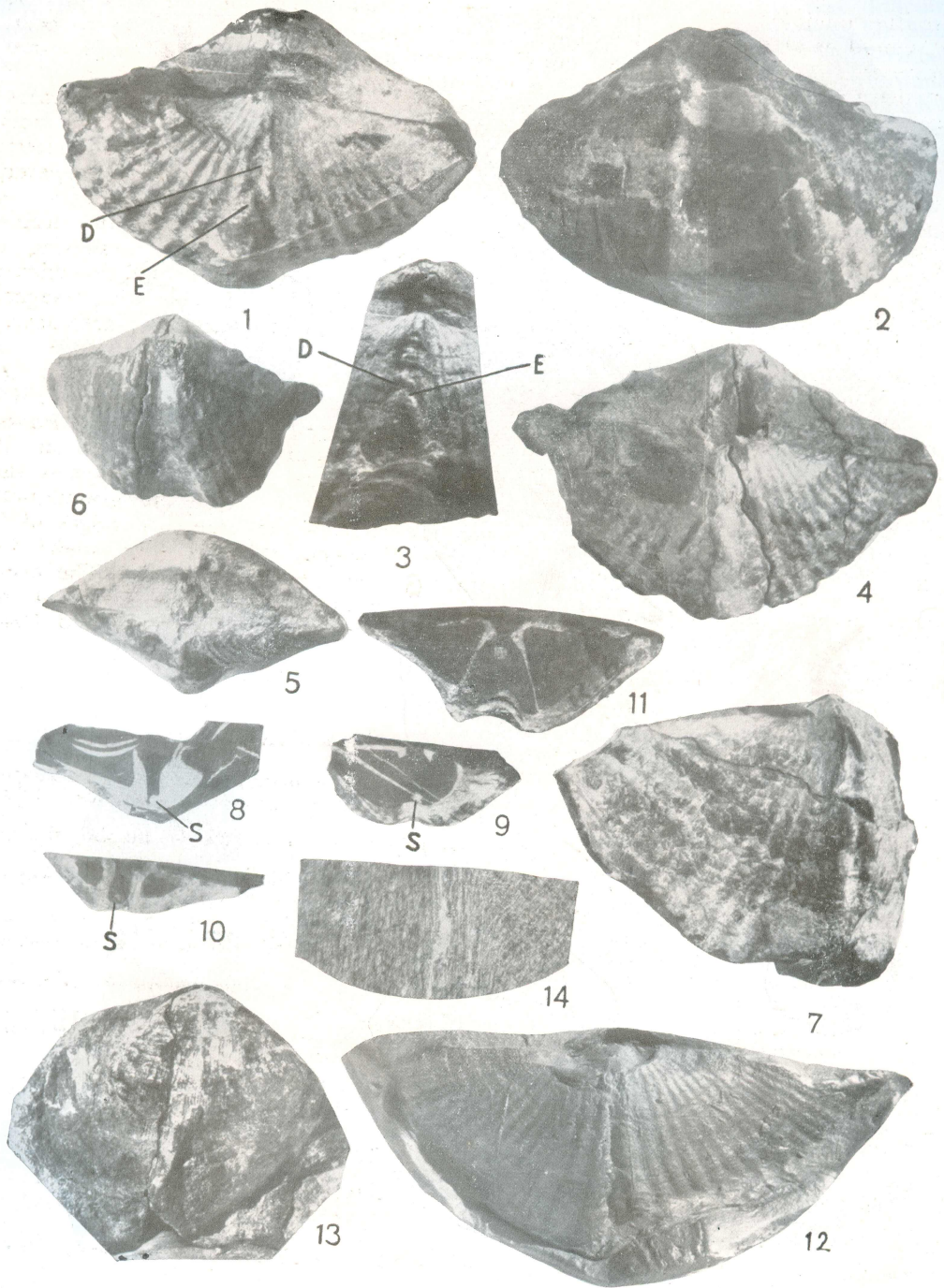
#### EXPLANATION OF PLATE 36

All figures are of natural size, except where otherwise indicated.

- FIG. 1—*Spirifer papillionata* sp. nov. Dorsal view of holotype showing papillionate outline of shell and sharply upraised dorsal fold. G.S.I. Type No. 17,651.  
 2—*Spirifer papillionata* sp. nov. Dorsal view of paratype; G.S.I. Type No. 17,652.  
 3—*Spirifer papillionata* sp. nov. Dorsal view of paratype; G.S.I. Type No. 17,653.  
 4—*Spirifer papillionata* sp. nov. Showing the characteristic form and produced dorsal fold; ornamentation not clearly preserved. G.S.I. Type No. 17,654.  
 5—*Spirifer duttai* sp. nov. Somewhat laterally compressed dorsal valve showing prominent fold and characteristic trifurcate ribs. Holotype, G.S.I. Type No. 17,655.  
 6—*Spirifer duttai* sp. nov. Dorsal view of a more complete, oval specimen with ribs less well preserved but showing trifurcation anteriorly. Paratype. G.S.I. Type No. 17,656.  
 7—? *Syringothyris* sp. Internal cast of pedicle valve showing dental lamellæ and ? syrnix, s. G.S.I. Type No. 17,657.  
 8—*Protorettepora* cf. *ampla*. Basal portion of zoarium. G.S.I. Type No. 17,658.  
 9—*Conularia laskeri* sp. nov. View of broad face of holotype showing impressed groove and alternating ribs. G.S.I. Type No. 17,659.  
 10—*Conularia laskeri* sp. nov. Diagonal view of above (slightly enlarged) showing broad face and feebly grooved narrow face.  
 11—*Conularia laskeri* sp. nov. Cross section of distal end showing the characteristic corner furrows.  
 12—*Chonetes carbonifera* Keysl. var. *lata* nov. Ventral valves showing hinge shorter than maximum width. G.S.I. Type No. 17,660.  
 13—*Chonetes carbonifera* Keysl. var. *lata* nov. Another ventral valve. G.S.I. Type No. 17,661.  
 14—*Chonetes carbonifera* Keysl. var. *lata* nov. Ventral valve, showing septum and conical divergent muscle scars. G.S.I. Type No. 17,662.  
 15—*Chonetes carbonifera* Keysl. var. *lata* nov. Ventral valves showing hinge shorter than maximum width. Internal impression of brachial valve showing prominent growth lines. G.S.I. Type No. 17,663.  
 16—*Chonetes carbonifera* var. *sulcata* nov. Pedicle valve with well-defined triangular sulcus. G.S.I. Type No. 17,664.



SAHNI AND SRIVASTAVA : FOSSILS FROM THE EURYDESMA BEDS, SIKKIM, AND CONULARIA BEDS, SUBANSIRI, EASTERN HIMALAYA.



SAHNI AND SRIVASTAVA : FOSSILS FROM THE CONULARIA BEDS OF SUBANSIRI, EASTERN HIMALAYA.

therefore the minimum length of this individual should be about 24 mm. Its distal end measures 4.1 mm.  $\times$  6 mm. in cross section; the apical angle is about  $16^\circ$ ; the outline of the cross section is in the form of a parallelogram. The narrower side is nearly  $\frac{2}{3}$  of the broader. Both the broader and narrower faces are impressed medianly, the broader being much more deeply grooved. The four corners of the pyramid are marked by narrow but well defined furrows, in which the slightly bent ribs alternate with each other. The transverse ribs on the sides meet in the middle forming an obtuse angle where, with but few exceptions, they alternate on the broader faces, being opposite on the other two faces. The ribs are thin, slightly flattened on the top, smooth and regularly distributed. There are 17 ribs in a length of 10 mm.

No ornamentation or striation is seen on the ribs.

*Remarks.*—A great many species of *Conularia* have been described including several

from the Salt Range and the Kashmir and Spiti Himalaya. While our form bears resemblance in certain characters to some of these, it is well separated from all of them. It resembles most *C. tenuistriata* described by Diener (1908, p. 18) from Kashmir and earlier by Waagen (1891, p. 125) from the Salt Range. However, *C. laskeri* differs from *C. tenuistriata* in cross section, in its much more deeply impressed broader faces, in possessing a higher apical angle and slightly thicker transverse ridges. In *C. laevigata* (Waagen, 1891, p. 123) all the four faces are nearly flat at the corresponding stage of development to that of *C. laskeri*. It differs from *C. haydeni* (Diener, 1915, p. 116) in possessing fewer transverse ridges, there being approximately 23 ribs in 10 mm. The apical angle in *C. haydeni* is also slightly larger ( $20^\circ$ ). The fine granulations on the crest of the transverse ridges of *C. warthi* (Waagen, 1887, p. 126) make distinction from this species easy. The ornamentation on the transverse ridges of the species found in the *Eurydesma* and *Conu-*

## EXPLANATION OF PLATE 37

All figures are of natural size, except where otherwise indicated.

- FIG. 1—*Subansiria ranganensis* gen. et. sp. nov. Dorsal view of genoholotype showing the simple ribs and low median fold with broad depression separated by transverse elevations. G.S.I. Type No. 17,665.
- 2—*Subansiria ranganensis* gen. et. sp. nov. Ventral view of holotype showing the wide smooth sulcus broadening anteriorly.
- 3—*Subansiria ranganensis* gen. et. sp. nov. A portion of the dorsal fold of the genoholotype enlarged to show the depression *D* and transverse elevation *E*.
- 4—*Subansiria ranganensis* gen. et. sp. nov. Dorsal view of paratype. G.S.I. Type No. 17,666.
- 5—*Subansiria ranganensis* gen. et. sp. nov. Posterior view of the same to show the concave area and incurved ventral umbo. (slightly reduced).
- 6—*Subansiria ranganensis* gen. et. sp. nov. Ventral view of the same showing smooth sulcus.
- 7—*Subansiria ranganensis* gen. et. sp. nov. Brachial valve of a very large specimen (incomplete) showing the characteristic fold with depressions and transverse elevations. G.S.I. Type No. 17,667.
- 8–10—*Subansiria ranganensis* gen. et. sp. nov. Sections across the ventral umbo showing a syrinx-like structure, *s* placed near the sulcus, not as in *Syringothyris*. S.G.I. Type Nos. 17,668, 17,669 and 17,670.
- 11—*Syringothyris cuspidata*, thin section showing position of syrinx, for comparison with above. Specimen figured by Diener, from Spiti. G.S.I. Type No. 11,211.
- 12—(?) *Syringothyris* cf. *nagmargensis* (Bion). Brachial view of the internal mould of a specimen showing a deep sulcus in the fold, characteristic of this species. G.S.I. Type No. 17,671.
- 13—*Productus* (? *Linoproductus*) sp. indet. Ventral valve embedded in the matrix. G.S.I. Type No. 17,672.
- 14—*Subansiria ranganensis* gen. et. sp. nov. Photomicrograph of the transverse section of the shell to show the fibrous nature of the test. G.S.I. Type No. 17,673.

*laria* beds of Salt Range shows clearly that these are unrelated with the species from Subansiri.

Lastly it may be emphasised that species from the Western Himalayas lack the deep groove on their broader faces at the corresponding phase of development of *C. laskeri*.

*Holotype*.—G.S.I. Type No. 17,659.

*Locality*.—All specimens from Bighu nala, not *in situ*.

Family CHONETIDAE Hall and Clark

Genus CHONETES Fischer

CHONETES CARBONIFERA Keyserl. var. LATA nov.

Pl. 36, figs. 12-15

The identification of this species has been a matter of some difficulty, the principal reasons being the comparatively wide range of variation shown by the Carboniferous species of *Chonetes*, sensu lato. Taking all factors into consideration we have assigned the Subansiri form to *C. carbonifera*.

However, all our specimens without exception are characterised by a hinge-line shorter than the maximum width, the sides of the shell curving rapidly and evenly inwards towards the cardinal extremities. This gives the shell a characteristic shape, slightly exceeding a semi-circle. On this account we have distinguished the form under review as a distinct variety, *lata*. It may be mentioned here that Diener (1905) describes his specimens as possessing a rectangular outline, which appears to be due to incomplete preservation of the specimens figured by him.

*Figured specimens*.—Nos. 17,660-63.

*Locality*.—All specimens from Bighu nala, not *in situ*.

CHONETES CARBONIFERA Keyserl. var. SULCATA nov.

Pl. 36, fig. 16

It is unnecessary to give a detailed description of the present variety which is identical with the var. *lata* in all respects except that it possesses a shallow but well demarcated median sinus on the pedicle valve extend-

ing from the apical region to the anterior margin. This strongly recalls the example figured by Sokolsky, (1950, text-fig. 19a, p. 55), from the Upper Carboniferous of Russia.

*Figured specimen*.—G.S.I. Type No. 17,664.

*Locality*.—Bighu nala, not *in situ*.

Superfamily SPIRIFERACEA Waagen

Genus SUBANSIRIA nov.

Genotype SUBANSIRIA RANGANENSIS sp. nov.

Pl. 37, figs. 1-10 and 14

Shell large spiriferoid, one and a half times wider than long, the hinge-line forming its greatest width.

*Brachial valve*.—possesses a well defined low fold which broadens anteriorly and is marked by two or three shallow depressions separated by transverse elevations. This characteristic feature is present in all specimens examined, and, so far as we are aware, it has not been observed in any other spiriferid.

*Pedicle valve*.—marked by a deep sulcus which gradually broadens and is produced anteriorly to meet the fold of the dorsal valve. Both the fold and sulcus are without ornamentation. There are ten to twelve thick, convex costae on either side of the smooth fold. The simple costae originate near the umbo and broaden appreciably anteriorly. The surface is also marked by faint, widely spaced, concentric, growth lines.

The hinge-line is straight; the brachial valve is devoid of an area but that of the pedicle valve is fairly well developed and concave. It is divided into a median and two lateral portions none of which possess any distinctive ornamentation.

The measurements of two complete specimens are given below :

Length.	Breadth.	Thickness.
42.4 mm.	62.4 mm.	29.9 mm.
41.0 mm.	61.4 mm.	24.2 mm.

Three or four transverse sections of the apical region of the pedicle valve show a structure similar in outline to the syrinx

but situated close to the ventral sinus. The origin of this structure is rather obscure and the determination of its exact nature must be deferred to a time when more material is available for internal examination. The apical region is characterised by considerable development of callosity.

*Remarks.*—The principal characters of the genus are a smooth fold and sulcus. The only Carboniferous forms with these characters are *Syringothyris* (North, 1920) and *Pseudosyrinx* (Weller, 1914), our species resembling *Syringothyris nagmargensis* (Bion), figured by Cowper Reed, 1932, but *Subansiria ranganensis* lacks the characteristic syrinx of *Syringothyris*, the syrinx-like structure being situated differently in the Sikkim form (compare *Syringothyris*, Pl. 36, fig. 11 with *Subansiria*, Pl. 37, figs. 8–10). From *Pseudosyrinx* which was created for the accommodation of forms with a punctate shell, our forms differs in being fibrous (Pl. 37, fig. 14).

The series of depressions alternating with elevations in the brachial fold are also noteworthy.

A species which is externally rather similar to the genotype is *Pseudosyrinx kolymanensis* (Tolmatschow), figured by Licharew (Pl. II, 1934) from the Permian of Kolyma-Gebietes, Russia. However, the larger specimens (Licharew, 1934, Pl. III, fig. 1) as figured by that author possess a very high ventral area which is not so well developed in our genus.

*Holotype.*—G.S.I. Type No. 17,665.

*Paratypes.*—G.S.I. Type Nos. 17,666–17,670.

*Locality.*—All specimens from Bighu nala, not *in situ*.

SYRINGOTHYRIS CF. NAGMARGENSIS (Bion)

Pl. 37, fig. 12

A well preserved brachial valve (internal mould) in our collection bears striking resemblance with the species originally described as *Spirifer nagmargensis* by Bion and subsequently assigned by Cowper Reed (1932) to *Syringothyris*. A cast of this was prepared (Pl. 37, fig. 12) and shows the characteristic sulcus in the fold of the bra-

chial valve, but the fold is less prominent than in the Kashmir specimen. The lateral ribs are simple, broad and decrease in size towards the cardinal extremities. Their number and size agree well with that of *Spirifer nagmargensis* Bion. If this identification were confirmed, it would establish the presence of *Syringothyris* in the Subansiri area.

*Figured specimen.*—G.S.I. Type No. 17,671.

*Locality.*—Bighu nala, not *in situ*.

PRODUCTUS (? LINOPRODUCTUS) sp. indet.

Pl. 37, fig. 13

There is a single specimen of a *Productus* probably referable to *Linoproductus* (Chao, 1927, p. 128). It is so deeply embedded in hard limestone that it has not been possible to isolate it from the matrix for exact determination, which must await the find of additional material. The chief importance of this specimen is that it supports the Anthracolithic age of the fauna.

*Figured specimen.*—G.S.I. Type No. 17,672.

*Locality.*—All specimens from Bighu nala, not *in situ*.

#### POSTSCRIPT

Since this paper went to the press our attention has been drawn to an important and interesting Permian *Eurydesma* fauna described by Harrington (January, 1955) from Argentina, the first record of its kind from this region. It may be noted that the Argentine species of *Eurydesma* appear to be related to the Sikkim forms, more so than to the Salt Range ones. The composition of the fauna as a whole which includes brachiopods, beside bivalves, is also similar in both cases, some of the Sikkim bivalves being still undescribed.

The difficulty of identifying species of *Eurydesma* Morris has been rightly stressed by Harrington; also the need for clearing up confusion in nomenclature brought about by the analytical (as opposed to synthetic) approach of certain authors.



AMBIKELLA FRUCTIFORMIS, gen. et. sp. nov.

The genus *Ambikella* shows many points of resemblance with *Notospirifer* Harrington, (1955) particularly in regard to dental lamellae, long dorsal septum, concentric lamellae etc., but our genus possesses a dorsal sulcus and a sharp ventral fold; moreover it entirely lacks the plications characteristic of *Notospirifer*.

The specimen (natural cast) figured here is very similar to *Notospirifer darwini* (Morris) described under *Martiniopsis darwini* by Waagen (1891, p. 131) and *Spirifer (Brachythyris) darwini* from India by Reed (1932, p. 27), more recently figured by Harrington (1955) from Argentina, but the resemblance is purely superficial for the folds are entirely different.

#### REFERENCES

- BION, H. S., 1928, The fauna of the Agglomerate slate series of Kashmir; *Pal. Ind.* N.S., Vol. 12.
- CHAO, Y. T., 1927, Productidae of China, Pt. I, *Pal. Sinica* Ser. B, Vol. 5, Fasc. II.
- , 1929, Carboniferous and Permian Spiriferids of China, *Pal. Sinica*, Ser. B, Vol. II, fasc. 1.
- DANA, J. D., 1847, Description of Fossil shells of the collections of Exploring Expedition under command of Charles Wilkes, U.S.N., obtained in Australia, *Amer. Journ. Science and Arts*, Second series, Vol. 4.
- DAVIDSON, T., 1858-63, British Fossil Brachiopods, Vol. 2, pt. 5, Carboniferous species.
- DIENER, C., 1905, Notes on the Anthracolithic fauna from the mouth of Subansiri Gorge, *Rec. Geol. Surv. Ind.*, Vol. 33, pt. 2.
- , 1908, Anthracolithic fauna of Kashmir and Spiti; *Pal Ind.* Series 15, Vol. 1, pt. 2.
- , 1915, Anthracolithic fauna of Kashmir Kanaur and Spiti—*Pal. Ind.*, N.S., Vol. 5, Mem. No. 2.
- DE KONINCK, L. G., 1898, Descriptions of the Palaeozoic fossils of New South Wales, *Mem. Geol. Surv. New South Wales Pal.*, No. 6.
- ETHERIDGE, J. P., 1910, A monograph of the Carboniferous and Permo-Carboniferous invertebrata of New South Wales, Vol. 2, pt. 2, Palaeontology No. 5, Memoir of the Geology of New South Wales.
- GHOSH, A. M. N., 1952, A new coalfield in Sikkim Himalaya, *Current Science*, Vol. 21, no. 7.
- , 1953, Preliminary note on the Ranjit Valley coalfield, Western Sikkim, *Ind. Min.*, Vol. 6, No. 6.
- HALL, J., and CLARK, J. M., 1894, An Introduction to the study of the genera of Palaeozoic Brachiopoda, pt. II, *Geol. Surv. New York*, Palaeontology, Vol. 8.
- HARRINGTON, H. J., 1955, The Permian *Eurydesma* fauna of eastern Argentina. *American Journal of Palaeontology*, Vol. 29, no. 1, pp. 112-128, Pls. 23-26.
- JACOB, K., and BANERJEE, T., 1954, The occurrence of *Glossopteris* found in the N.-E. Frontier Tracts, *Proc. Nat. Inst. Sc. India*, Vol. 20, no. 1.
- JOHNSTON, R. M., 1882, Systematic Account of the Geology of Tasmania.
- LICHAREW, R. K., 1929-30, Geologische Expedition Ins Kolyma-Gebiet, *Acad. der Wissenschaften der U.S.S.R.*, Bd. 1, 2 Teil.
- MORRIS, J., 1845, In P. E. de Strzelecki's Physical description of New South Wales and Van Diemen's Land, 1845, p. 274.
- MUIR-WOOD, H. M., 1941, Upper Palaeozoic Fauna of North Sikkim, *Pal Ind.*, N.S. Vol. 31, Mem. No. 1.
- NORTH, F. J., 1920, On *Syringothyris*, Winche and certain Carboniferous Brachiopoda referred to *Spiriferina*, *Quart. Journ. Geol. Soc. London*, Vol. 76.
- REED, COWPER, F. R. C., 1932, New fossils from the Agglomerate slate of Kashmir; *Pal. Ind.* N.S. No. 20, Mem No. 1.
- , 1936, Some fossils from the *Eurydesma* and *Conularia* beds (Punjabian) of Salt Range, *Pal. Ind.*, N.S. Vol. 23, Mem No. 1.
- SOKOLESKY, A. N., 1950, Chonetidae *Trans. Pal. Inst. Acad. Sciences*, U.S.S.R., Tom. 27.
- WAGER, L. R., 1939, The Lachi Series of North Sikkim and the age of the rocks forming Mount Everest, *Rec. Geol. Surv. Ind.*, Vol. 74, pp. 177-188.
- WAAGEN, W., 1891, Salt Range Fossils, *Pal. Ind.* Series 13, Vol. 4, pts. 1-2.
- WELLER, St., 1914, The Mississippian Brachiopoda of the Mississippi Valley Basin, *Monogr. State Geol. Surv., Illinois*, No. 1.