DEPARTMENT OF MINES
SOUTH AUSTRALIA

# GEOLOGICAL RECONNAISSANCE AND STROMATOLITES OF THE NORTHERN FLINDERS AND WILLOURAN RANGES

by

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PALAEONTOLOGY SECTION

CONTENTS | PAGE



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## ABSTRACT

Although a reconnaissance search of the Callanna Beds in two areas revealed no columnar stromatolites, new occurrences were located in younger units. At South Hill, Willouran Ranges, the lower member of the Skillogalee Dolomite contains a new form of *Baicalia*, *B. blastophora*. The Wonoka Formation contains an indeterminate form of *Linella* in the Willouran Ranges and *Tungussia inna* at Bunyeroo Gorge. These finds reinforce earlier biostratigraphic conclusions but do not elucidate the ages of the Lower and Upper Callanna Beds.

New geological information from the Willouran Ranges includes the location of large scale slump structures in three localities, the re-interpretation of beds previously thought to be tillites as slump breccias, and the identification of younger formations west of the Willouran Ranges up to the base of the Pound Quartzite not recognized in previous mapping.


## INTRODUCTION

The first studies of South Australian Precambrian stromatolites (Preiss, 1971, a,b) were concentrated on the abundant stromatolites of the Burra and Umberatana Groups. Data from the lowermost units of the Adelaidean were scarce, and it was hoped to clarify the problem of the age of these beds by further stromatolite collecting. Previously, the following records of pre-Burra Group or probable pre-Burra Group stromatolites were known:

(1) Conophyton garganicum garganicum occurs in a dolomite raft in the Paratoo Diapir. These stromatolites are unique in South Australia, and are possibly derived from equivalents of the Lower Callanna Beds, since the lithology and the stromatolites are different from Burra Group or Upper Callanna Beds known from elsewhere. A younger age limit is provided by the upper Burra Group which the diapir intrudes.

(2) Undulatory and pseudocolumnar silicified stromatolites from near the base of the Callanna Beds near Nilpinna, Peake and Denison Ranges.

(3) Undulatory stromatolites in a yellow weathering dolomite from the Duff Creek Formation, near Nilpinna, Peake and Denison Ranges.

(4) Possible Baicalia burra from possible River Wakefield Group equivalents, near Carrieton. It is likely that these beds are in fact part of the Skillogalee Dolomite (Forbes, 1971, pers. comm.).

## FIELD WORK

A reconnaissance of certain areas of the Flinders and Willouran Ranges was undertaken in conjunction with Mr. R.P. Coats, during the period between February 23 and March 12, 1971. The areas visited are numbered in Fig. 1.

(1) Bunyeroo Gorge (Locality 1). Here the lower member of the Pound Quartzite (Bonney Sandstone, Forbes, 1971) grades down into a sequence of green silty shales with interbedded limestones, provi-

sionally included in the Wonoka Formation, although it contains a prominent fine grained quartzite. Ripple marks in this quartzite have axes trending N 70° E. The limestones are dark grey, partly thinly laminated and partly oolitic, with flat intraclasts concentrated in layers. The laminae in the laminated limestones are frequently either cross-bedded or wavy, but in the latter case, the laminae tend to smooth out irregularities of the substrate rather than to exaggerate them. This is an inconclusive point against them being interpreted as algal laminations; they are more likely to be mechanically deposited. The detailed stratigraphy of this interval is shown in Fig. 2.

One small ovoid stromatolitic bioherm, first located by Forbes (1971), 70 cm wide and 30 cm high occurs within an oolitic limestone band, but the precise nature of its contacts with the surrounding rock is obscured by recrystallization and stylolites. The stromatolites are moderately discrete columns of elliptical or lobate cross-section, arranged in a dendritic fashion, with some markedly divergent branching (Figs. 3 & 4). Specimen WP (22) was collected from the bioherm.

(2) Arkaroola Area. Following an inspection of what is currently interpreted as a glacial pavement at Merinjina Well (Locality 2) (Mirams, 1964), a notice regarding the conservation of the outcrop was erected.

The Wywyana Formation was searched for the possible occurrence of stromatolites in its least metamorphosed outcrop near the Lady Buxton Mine (Locality 3). The chiefly brownish-grey, flat-laminated dolomite is metamorphosed throughout the outcrop; it is a relatively coarse-grained marble, frequently containing talc. Near the southern limit of the outcrop it is also strongly lineated. There appears to be little prospect of finding stromatolites in this area, and even if some were found, it is likely that the metamorphism is too advanced to permit a detailed study.

Following a collection of samples from the Mount Painter Complex by R.P. Coats, the Callanna Beds were examined near Arkaroola Bore (Locality 4). The gradation from the basal Paralana Quartzite into the overlying Wywyana Formation was observed; here the Wywyana Formation consists predominantly of schistose calc-silicates, again with no prospect of finding stromatolites. The overlying Wooltana Volcanics are also more metamorphosed than at Merinjina Well. The unconformity above the Lower Callanna Beds was not seen in outcrop, but volcanic pebbles were found in both the lower part of the Upper Callanna Beds sequence, and in a quartzite previously mapped (Coats et al., 1969, Mount Painter Province Map) as equivalent to the Humanity Seat Formation (immediately and conformably above the volcanics). This quartzite may in fact belong to the Upper Callanna Beds.

(3) Willouran Ranges. A map prepared by R. Ruker and Associates (1966) was found very useful in the reconnaissance search of the Willouran Ranges, but some minor points of disagreement arose. West of Witchelina H.S. the South Hill structure (Locality 5) was examined, and it was confirmed that the facing of the folded Witchelina Quartzite is to the west. Conclusive facings are rare but one example of cross-bedding (Fig. 5) was eventually found. In addition, a pale brown coloured dolomite occurring stratigraphically above the

Witchelina Quartzite was found to contain columnar stromatolites, which supported the interpretation of a westerly facing (Figs. 6,7, 8,9,10). This dolomite, assigned to the lowest part of the lower member of the Skillogalee Dolomite, is interbedded with shales and laminated buff dolomites and occurs in the core of the South Hill structure. Immediately west of the stromatolite locality, the dolomite is in contact with a diapir. The stromatolites (specimens WP(2), WP(3), WP(4)),are described below.

The upper part of the Burra Group was examined immediately to the west of the Norwest Fault, near West Mount Hut (Locality 6). This unit is probably equivalent to the Bungarider Formation (Ruker, 1966) east of the fault, but here it contains much more abundant dolomite. Most of the dolomites are stromatolitic (one specimen, WP(6) was collected) and appear to be identical to the stromatolitic beds of the Skillogalee Dolomite containing Baicalia burra (Preiss, 1972). The base of the Umberatana Group was examined, and the lower part of the glacial sequence, beneath a prominent arkose unit, was found to contain numerous boulders of stromatolitic dolomite, probably derived from the underlying Bungarider Formation. No examples of stromatolites grown in situ in the tillite, as suggested by Mr. B. Murrell (pers. comm.) were found. The Bungarider Formation is presumably equivalent to the Myrtle Springs Formation of the COPLEY area (Coats, et al., 1972).

The section through the Umberatana Group west of West Mount Hut was briefly examined, and several units not previously mapped by Johns et al. (1966) on ANDAMOOKA or by Ruker (1966) were recognized. On the east limb of the anticline west of West Mount

Hut (Locality 7) several bands of Wundowie Limestone were recognized, of which at least one contains small bioherms of Linella munyallina (Figs. 11, 12, 13). Below the Wundowie Limestone, several bands of laminated yellow-brown weathering dolomites are interbedded in the top of the Tapley Hill Formation; they are displaced by several prominent NE - SW trending faults. These dolomite beds may correspond in part to a western extension of the Balcanoona Formation of the Flinders Ranges. When followed along strike, the beds are seen to become discontinuous; in places the underlying siltstones of the Tapley Hill Formation are deeply scoured, and the channels are filled with slump breccias consisting mainly of disrupted blocks of laminated dolomite. The slumps were not located on the western limb of the anticline, but similar structures were seen further east in the Willouran Ranges.

Near the West Mount Copper Mine (Locality 8), a band of sandy and gritty grey limestone similar to much of the Etina Formation of the Central Flinders Ranges, overlies the stromatolitic Wundowie Limestone. This is in turn overlain by green shales of the Enorama Shale, containing a few 5 cm thick interbeds of dolomite and dolomite intraformational breccia. The Elatina Formation is represented by calcareous gritty sandstone, in part with red granules. The Wilpena Group commences with the Nuccaleena Formation, consisting of pink dolomites with interbedded red shales, and passes into greenish and reddish silts, shales and impure sandstones of the Brachina Formation. Pure quartzites, assigned to the ABC Range Quartzite, are thin. The contact with the overlying red shale of the Bunyeroo Formation was distinct, but the latter grades up into flaggy laminated limestones of the Wonoka Formation. Near the top of the Wonoka Formation (Locality 9), a stromatolitic band was found and sampled (specimens WP(6), WP(7), WP(8), WP(9)), but outcrop was inadequate to determine its extent. The stromatolites are irregularly columnar and poorly preserved, the column margins being affected by stylolites, (Figs. 17,18,19). The Wonoka Formation is overlain by a flaggy white quartzite, probably the Pound Quartzite.

Next the country north of Witchelina H.S. was traversed. Immediately north of the homestead (Locality 10), the Upper Callanna Beds outcrop and a prominent dolomite bed was examined at 0.8 km north. A doubtful stromatolite-like structure found in float was resolved on cutting to be a liesegang-ring effect. Other dolomites are commonly laminated, sometimes with an undulatory structure, or intraformational breccias.

The glacial and overlying sequences were examined at Chintapanna Dam (Locality 11). Here the tillite is strongly cleaved, and mainly contains only small pebbles. The overlying Tindelpina Shale is similarly cleaved, and contains numerous thin, finely laminated limestone interbeds. Near the top of the Tapley Hill Formation there are interbeds of slump breccia overlain by gritty limestones, sometimes showing crude graded bedding. Below the slump breccia, disoriented blocks of dolomite occur in the poorly laminated siltstones.

Near Kingston Bore (Locality 12), 3 km NE of Chintapanna Dam, conglomerates and breccias overlie the Myrtle Springs (Bungarider) Formation of the Burra Group. These beds are not tillites; although they contain facetted boulders of quartzites and dolomites derived from the Burra Group, these were probably reworked from glacial sediments. The breccias are not overlain by Tindelpina Shale and are interpreted as another instance of slump breccias within or near the top of the Tapley Hill Formation; this view is supported by the presence in them of pebbles of Tindelpina-type carbonates and of actual tillite. The breccias differ from those of the West Mount area and Chintapanna Dam in lacking clasts of pene-contemporaneous dolomites, and occur at a stratigraphically lower horizon.

A road approximately midway between Kingston Bore and Mt Norwest H.S. gives a useful section of the Upper Callanna Beds. The lowest part of the section of interbedded laminated dolomites and siltstones with rare halite casts, is separated from the upper part of the sequence by a strike fault. The latter sequence passes up into predominantly siltstones and shales. Just below a prominent quartzite band, a dark grey stromatolitic dolomite was sampled (WP(15)). The stromatolites which are poorly visible except on etched slabs, consist of very short, bulbous columns covered by laterally-linked stromatolites. The outcrop and specimen were inadequate to determine whether any true branching is present.

In the northern part of the Willouran Ranges, a section containing quartzites, silststones and laminated dolomites was examined east of Mirra Bore (Locality 13). The stratigraphic position of these units is uncertain; they may belong to the Upper Callana Beds. Other areas visited included a diapir south of Rischbieth Well, containing a large number of dolerite plugs (Locality 14) and the

Callana area. Near Callanna H.S. (Locality 15), there is a sequence of mainly dark grey siltstones and quartzites with moderately frequent halite casts. Interbedded dolomites are yellow-brown weathering and unevenly banded, perhaps by sedimentary folding. No stromatolites were found. Coats (1971, pers. comm.) has suggested that these beds are equivalent to the Duff Creek Formation of the Peake and Denison Ranges.

A further week was spent in the area west of Marree examining isolated outcrops of Burra Group (mainly quartzites, minor siltstones) but work was hampered by heavy rain and flooding. Stromatolites were examined in the Balcanoona Formation north of Leigh Creek (Locality 16), where specimens WP(17), WP(18), were collected, and in the Wundowie Limestone east of Copley (Locality 17, WP(21)).

## DISTRIBUTION OF STROMATOLITES

The new data on the distribution of stromatolites, identified in the laboratory (see descriptions, Appendix I) may be summarized as follows:

(1) *Baicalia burra* Preiss has been found for the first time in the Myrtle Springs (Bungarider) Formation of the western Willouran Ranges, above the Skillogalee Dolomite, to which the form was previously thought to be restricted (stromatolites have not been found elsewhere in the upper part of the Burra Group).

(2) *Baicalia blastophora*, a new form, occurs in one locality in the lower member of the Skillogalee Dolomite, South Hill, Willouran Ranges.

(3) *Linella munyallina* Preiss occurs in the Wundowie Limestone near West Mount Hut. These closely resemble the holotype from the Wundowie Limestone, Myrtle Springs.

(4) *Linella ukka* Krylov, previously known in South Australia only from the Balcanoona Formation, Burr Well, was found in the same formation north of Leigh Creek, but poorly preserved.

(5) An indeterminate form of *Linella* occurs in the Wonoka Formation, on the western margin of the Willouran Ranges.

(6) *Tungussia inna* Walter, previously known only from the Ringwood Member of the Pertatataka Formation, Central Australia, was located in the uppermost beds of the Wonoka Formation, Bunyeroo Gorge.

## BIOSTRATIGRAPHIC CONCLUSIONS

Field investigations have so far failed to locate stratigraphically useful stromatolites in sediments older than the Skillogalee Dolomite. The uncertainty regarding the age of the base of the Adelaidean and the duration of the time-break represented by the unconformity between the Upper and Lower Callanna Beds remains. The new stromatolites first described in this report do not conflict with previous conclusions based on stromatolite biostratigraphy. *Baicalia blastophora*, from the lower member of the Skillogalee Dolomite, differs from previously described forms, but is recognizable as a form of *Baicalia*; it most closely resembles *B. capricornia* from the Bangemall Group of Western Australia. This new find reinforces the view that the Burra Group contains no diagnostic Late Riphean elements, and the correlation of the Skillogalee Dolomite with the youngest Middle Riphean of the USSR is maintained. The age of the

Callanna Beds cannot be determined, but the specimen from the Upper Callanna Beds sequence from the Willouran Ranges bears some resemblance to Baicalia burra.

No new stromatolites were located in the Umberatana Group, but stromatolites from the Wonoka Formation of the Wilpena Group are described for the first time. The Wonoka Formation overlies the younger glacials, whose presumed equivalents in the Kimberley Region are about 660 m.y. old, and underlies the fossiliferous Pound Quartzite, whose Ediacara fauna allows correlation with Vendian deposits elsewhere. It is therefore almost certainly of Vendian age (690 ± 20 m.y. to 570 ± 10 m.y.). The stromatolites from the Willouran Ranges are assigned to Linella f. indet. In the USSR, Linella is reported to be exclusively Vendian, although it first appeared in Australia in the Late Riphean. At Bunyeroo Gorge, the stromatolite found is Tugussia inna, previously described from the Ringwood Member of the Pertatataka Formation, Central Australia (Walter, 1971) which probably correlates with part of the Umberatana Group of South Australia. This find thus extends the time range of T. inna well into the Vendian.

In order to find biostratigraphic evidence for the age of the lowest units of the Adelaidean it will be necessary to search the known outcrops of Duff Creek Formation in the Peake and Denison Ranges, and its probable equivalents near Callanna in detail.

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WVP:FdA
28.10.71

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APPENDIX I

## SYSTEMATIC DESCRIPTIONS

Stromatolite taxa new to South Australia will be described in detail; occurrences of previously described forms will be noted with additional information pertinent to those occurrences, and comparison with type material. The terminology used herein is that outlined in a previous report (Rept. Bk. No. 71/91) and Preiss (1972, in press).

### GROUP BAICALIA Krylov

*Collenia baicalica* Maslov (1937, p.287).

*Baicalia* Krylov (1963, p.64).

*Baicalia* (Semikhatov, 1962, p.198).

*Baicalia* (Komar, 1966, p.82).

*Baicalia* (Krylov, 1967, p.25).

*Baicalia* (Nuzhnov, 1967, p.135).

*Baicalia* (Cloud & Semikhatov, 1969, p.1035).

*Baicalia* (Walter, 1971, in press).

*Baicalia* (Preiss, 1972, in press).

Type form: *Baicalia baicalica* (Maslov) Krylov, from the Uluntuy Suite of the Pribaikalye.

Diagnosis: Tuberous, bumpy, swelling and constricting, parallel to markedly divergent branching columns, generally without wall, with frequent overhanging laminae. Lamination is distinctly banded.

Content: Previously described forms are *B. baicalia* (Maslov) Krylov, *B. kirgisica* Krylov, *B. rara* Semikhatov, *B. unca* Semikhatov, *B. prima* Semikhatov, *B. ampla* Semikhatov, *B. ingilensis* Nuzhnov, *B. aimica* Nuzhnov,

B. *maica* Nuzhnov, B. *minuta* Komar, B. *capricornia* Walter and B. *burra* Preiss.

Age: Middle Riphean to early Late Riphean.

*Baicalia burra* Preiss.

Figs. 20, 21.

*Baicalia burra* Preiss (1972, in press).

Material: One new specimen (WP(16)), Myrtle Springs Formation, 2km north of West Mount Hut.

Description: The specimen was collected from an extensive biostromal dolomite bed, intercalated in green siltstones of the Myrtlė Springs (Bungarider) Formation. Several such biostromes, up to one metre thick were noted. The specimen was inadequate for reconstruction, but most of the typical features of *Baicalia burra* could be identified on weathered surfaces and in thin section (Figs.20,21).

Longitudinal sections of the specimen suggest that the columns are markedly tuberous, with slightly to markedly divergent branching. Many laminae or groups of laminae overhang the column margins, forming peaks and cornices. Laminae are smooth, markedly convex or domed, with frequent discordances due to contemporaneous erosion. The microstructure of this stromatolite closely resembles that of *Baicalia burra* from elsewhere in having distinctly banded lamination. The lamination is very continuous across the width of columns. Relatively darker laminae vary in thickness from 0.1 to 0.8 mm, and consist of brown, xenotopic dolomite of grain size approximately 0.005 mm, with scattered linonite grains 0.001 to 0.004 mm in diameter. Mostly these laminae alternate with paler silty or pelletal laminae; the texture of the latter may be partly a primary detrital texture and partly due to patchy recrystallization to sparry dolomite. In places the dark laminae are almost completely in contact, separated by stylolites or by concentrations of limonite. The paler laminae are up to 2 mm thick, and may contain traces of an internal lamination, the finest laminae being 0.02 to 0.08 mm thick.

Interspaces are filled with intraclast grainstones with numerous secondary solution voids, cutting across both intraclasts and cement. They may be due to Recent weathering. Intraclasts were mainly derived from the breakdown of the dark micritic laminae of the stromatolites; they are ovoid or platy, and range from 0.2 to 5 mm in their maximum dimension. Intraclasts are closely packed, the tabular ones generally being aligned parallel to bedding or slightly imbricated. The nature of the interspace filling is very similar to that of the stromatolites previously described from the Skillogalee Dolomite of the Willouran Ranges, and likewise suggests a high energy environment as compared to other areas, e.g. Burra.

Baicalia blastophora f. nov

Figs. 6,7,8,9,10,22,23,24,25,26

Material: Three specimens (WP(2), WP(3), WP(4)) from one locality.

Holotype: WP(2)

Name: From Greek "blastos" (growth or sprout), referring to the frequent rounded projections on columns.

Diagnosis: Baicalia with erect, sub-parallel, tuberous and constricted columns, rare dichotomous, slightly divergent branching and an unwalled bumpy margin structure. Short lateral outgrowths are common. Laminae are smooth, gently to moderately convex and broadly, indistinctly banded.

Description

Mode of occurrence: The stromatolites occur in an isolated outcrop, forming a bed about 1m thick. This overlies a medium bedded dolomite substrate with large dolomite clasts up to 10 cm long (Fig. 10). The whole bed is affected by dolomitization and structures are very obscure, but partial silicification and coarser grain size make the stromatolite columns weather out in relief. The base of columns was not visible. Columns are mainly sub-parallel to slightly divergent; little variation was observable in the field (Figs. 7,8).

Column Shape and Arrangement: Columns are dominantly erect and sub-parallel to slightly divergent, and vary in shape from sub-cylindrical to tuberous, with frequent expansions and constrictions. In places, large bumps grade into short rounded, projection-like outgrowths, separated from the main column by deep constrictions (Fig.22). In transverse section, columns vary from round to polygonal, or strongly elongated in various directions. Their diameter ranges from 1 to 10 cm, but is most commonly 3 to 6 cm.

Branching: Branching into complete new columns is rare, and where it does occur, it is dichotomous, slightly divergent. More common is the occurrence of short lateral outgrowths from the main vertical column; these diverge from it at up to $40^{\circ}$, and are frequently accompanied by a constriction in the main column. Projections may be very closely spaced on any column.

Margin Structure: Column margins are poorly preserved. Frequently, columns can be distinguished from interspace sediment only by the coarser grain size of dolomite and by their partial silicification. Therefore the details of column margins shown on the reconstructions are approximate. Thin sections show that columns are frequently more recrystallized near their margins, and the lamination is difficult to discern (Fig. 26). Where visible it suggests that laminae approach the margin at a high angle and do not bend down and form a wall, but this may not be true everywhere, since recrystallization has frequently obliterated the margin structure.

Lamina Shape: Laminae are always gently to moderately convex, domed or slightly arched, occasionally doubly-crested (Fig.23). Of 55 laminae measured, 91% have convexities between 0.2 and 0.5, very gently convex laminae being rare, (Fig.24). There are no abrupt changes in lamina shape. The fine scale structure is smooth to very gently wavy, without wrinkles. No micro-unconformities were observed.

Microstructure: The stromatolitic rock is completely dolomitized, obliterating most primary structures. The difference between columns and interspaces is preserved only as a difference of grain size and silicification of the constituent dolomite. The lamination is extremely poorly preserved, but appears originally to have been banded. Relatively darker, homogeneous laminae, varying in thickness from 0.7 to 2.5 mm, persist across the width of a column, thinning only slightly towards the margins. Very rarely, the laminae are lenticular. They are sometimes slightly more strongly pigmented (by ?limonite) at the top, and have relatively sharp upper surfaces (Fig. 26). These laminae consist of hypidiotopic inequigranular dolomite, ranging in grain size from 0.03 to 0.15 mm, with scattered irregular secondary quartz blebs. Though a few show traces of a faint, thinner lamination within them, they show no consistent internal differentiation.

The darker laminae are separated by thinner, more lenticular laminae, up to 0.5 mm thick, composed of less pigmented, partially silicified dolomite. Quartz crystals, often euhedral, ranging in grain size from 0.1 to 0.3 mm, and irregular chert blebs, are arranged in more or less continuous layers, which are frequently the only discernible separation between the homogeneous dark laminae. Dolomite rhombs frequently occur within the silicified layers.

Interspaces: Interspaces between columns are 2 to 10 cm wide, and are filled entirely with unbedded, dolomitized, slightly silicified lime mud (Figs. 25, 26). The dolomite is xenotopic to hypidiotopic, ranging in grain size from 0.02 to 0.05 mm, and contains much interspersed quartz, probably secondary. No ghosts of larger carbonate allochems were observed.

Secondary Alteration: The stromatolitic rock has been extensively altered and is now a buff to pale brown dolomite; much of the detail of primary structures has been obliterated. The following diagnetic events are interpreted.

(1) Dolomitization. This affected the whole sediment, but the carbonate mud of the interspaces remained finer grained than the columns. The grain size increases near the column margins, reaching a maximum of about 0.6 mm.

(2) Silicification. Subhedral quartz crystals and irregular cherty aggregates replace dolomite in the paler laminae and especially near column margins. Frequently quartz is poikiloblastic with carbonate inclusions.

(3) Cross cutting fissure, several millimetres wide, are common in stromatolitic columns. They are filled with dolomite identical to and continuous with that of the interspaces.

(4) Metamorphic. Isolated acicular crystals, probably of tremolite, occur randomly oriented throughout the dolomite, suggesting low grade metamorphism.

Comparisons: The stromatolites are assigned to Baicalia on the basis of their irregularly tuberous, bumpy, unwalled columns, and banded microstructure. They differ from B. burra in having only sub-parallel columns and lateral projections. Sub-parallel column arrangement is also displayed by B. aimica Nuzhnov, B. prima Semikhatov and B. capricornia Walter, but distinguishes these from other forms of the group. B. blastophora is distinguished from all previously described forms, including B. burra, by the rarity of dichotomous branching and the frequency of short rounded outgrowths; similar projections occur rarely in B. capricornia. It also resembles B. capricornia in having rare peaks and cornices and similar column shape. Like B. capricornia, it bears some resemblance to Inzeria in having projections, sometimes in niches, but the tuberous columns, absence of ribs, and the banded microstructure distinguish these. B. capricornia differs from B. blastophora in having more distinct lamination, greater variation in lamina shape, and more frequent true branching. B. blastophora is distinguished from B. prima also by its more even, continuous, less distinct lamination, with broader dark laminae, while B. aimica has greater variation in lamina shape and more frequent coalescing of columns, with a fringed margin structure and more lenticular microstructure.

Distribution: The stratigraphic position is not certain beyond doubt, since the stromatolites were found in only one discontinuous outcrop in a structurally complex area, but the bed probably occurs within the lower member of the Skillogalee Dolomite, on the southern limb of the South Hill structure, on the track 11km west of Witchelina.

Age: Early Adelaidean, correlated with the Middle Riphean of the USSR.

GROUP LINELLA Krylov.

Linella Krylov (1967, p.37).

Type form: Linella ukka Krylov, from the Uk suite of the Southern Urals.

Diagnosis: Bumby, subcylindrical to tuberous columns with parallel to markedly divergent branching and numerous, often pointed projections. Columns usually have walls.

Content: L. ukka Krylov, L. simica Krylov, L. avis Krylov and L. munyallina Preiss.

Age: Apparently only Vendian in the USSR, but in Central Australia, L. avis occurs in a typically Late Riphean assemblage (Walter, 1971). In South Australia, Linella has hitherto been known only from rocks correlated with the youngest Late Riphean (Umberatana Group).

Linella ukka Krylov (1967, p.39)

Figs. 27,28

Material: Two new specimens, WP(17), WP(18) from the Balcanoona Formation in a roadside outcrop, 8 km north of Leigh Creek (locality (16)).

Description: These stromatolites closely resemble Linella ukka previously described from Burr Well (Preiss, 1971a), in column shape, branching and presence of pointed projections, but columns are more closely spaced (Figs. 27, 28). As at Burr Well, columns appear dark grey in outcrop, and are separated by brown to buff interspace sediment. In thin section, the whole rock is seen to be recrystallized, largely obscuring the distinction between columns and interspaces. Slight concentrations of limonite grains indicate the presence of interspace sediment, and also occur in some lenticular laminae. Columns are composed of xenotopic mosaic calcite of grain size 0.01 to 0.02 mm., and contain scattered pitmented areas 0.1 mm in diameter, which give the columns their dark colour. About 5% of angular quartz and minor feldspar silt are included. The columns are almost totally unlaminated (interpreted to be due to recrystallization), except for the lenticular limonite-rich laminae.

Linella f. indet.

Figs. 17,18,19,29,30,31,32.

Material: Three specimens from one locality: WP(7), WP(8), WP(9).

Description:

Mode of occurrence: The stromatolites occur in a poorly exposed outcrop, either as a bioherm or biostrome; thebed is about 50 cm thick, and of unknown extent. Only part of this thickness is made up of columnar stromatolites, apparently arising from an undulatory stromatolite base.

Column shape and arrangement: Columns are predominantly sub-cylindrical, slightly bumpy, sometimes tuberous, of round, oval or irregularly indented transverse section. Columns are mostly sub-parallel and nearly vertical, though the original orientation of some is difficult to determine from the loose blocks found at the ground surface, (Figs. 17,18,19). Some columns are in the form of broad, short, pointed projections (Fig.29).

Branching: Branching is mainly beta- to gamma- parallel to slightly divergent, and is moderately infrequent. Branching more frequently gives rise to pointed projections than to separate columns. Coalescing of adjacent columns is moderately frequent.

Margin structure: Column margins, where preserved are smooth to gently bumpy, with rare overhanging peaks. Much of the column surface is affected by stylolites, but elsewhere a wall is intermittently developed. Where well developed, the wall may involve up to 10 laminae, but elsewhere laminae approach the margin at various angles and terminate.

Lamina shape: Lamina shape is moderately variable, with a range of values of convexity from 0.1 to 0.8. For the 77 laminae measured, the modal interval (31%) is the range 0.4 to 0.5 (Fig. 30) Laminae vary from gently domed to steeply arched, rarely rectangular, and are commonly wavy but not wrinkled. The undulations have a wavelength of 3 to 8mm, and an amplitude of 1 to 4 mm (Fig. 31). At the margins, laminae either bend down to cover previous laminae, in places over an erosional micro-unconformity, or they terminate at a high angle to the margin, sometimes projecting into the interspace.

Microstructure: Microstructure is indistinct, streaky to lenticular. Three lamina types may be discerned: pale, dark and sparry. Pale and dark laminae alternate, and to some extent grade into one another, but the sparry laminae are only sporadically developed. Pale laminae vary in thickness from 0.009 to 0.5 mm, and are moderately continuous across the width of a column, but sometimes grade laterally into dark laminae. They consist of xenotopic dolomite of grain size varying from 0.005 to 0.02 mm, with rectangular concentrations of limonite between grains. The dolomite of the pale laminae tends to form a background against which are set the more distinct, lenticular dark laminae. The latter vary in thickness from 0.08 to 1.4mm; most commonly they are about 0.5 mm thick, but pinch and swell markedly along their length. Their upper and lower boundaries are non-parallel, and generally gradational over a narrow interval, but their upper boundaries are often sharper. Frequently the laminae break up into a series of clots and lenses, with pointed, rounded or irregular lateral terminations. Some of the thicker more continuous, dark laminae have a graded appearance, being more intensely iron-stained at the top. Dark laminae are of similar grain size to pale laminae, but consist of subhedral to euhedral dolomite rhombs with much finely dispersed hematite and/or limonite on grain boundaries and in interstices. Sparry laminae, where developed, are lenticular, up to 0.2mm thick, and concordant with underlying and overlying laminae. They consit of clear, sparry, idiotopic dolomite, of grain size ranging from finer at the margins to coarser in the centre. This suggests that the sparite filled an open cavity, possibly formed by shrinkage of the enclosing laminae.

Interspaces: Columns are moderately closely spaced, the interspaces varying in width from 2mm to 3cm. They are filled predominantly with poorly bedded intraclast and pellet grainstone, packstone and wackestone. In places these lithologies occur as 1 to 2 cm thick bands alternating with micritic layers, ½ to 1 cm thick. Even the micritic layers, composed of relatively pure, hypidiotopic dolomite of grain size ranging from 0.004 to 0.008 mm, contain a few allochems. In places, subangular silt and fine sand-sized quartz occurs in the micritic laminae. Some micritic laminae are thinner, and grade laterally into the dark laminae of stromatolitic columns; they may represent extensions of the algal mat into the interspaces. In other places they abut against pre-existing columns. The granular layers in interspace sediments consist of flat, rounded or irregular micritic intraclasts, 0.4 to 3 mm long, scattered rounded quartz sand grains, superficial ooids and structureless limonite-stained pellets 0.1 to 0.2 mm in diameter. These grains vary in their state of packing, and in the amount of interstitial micrite matrix. The better winnowed grains are cemented by sparry dolomite.

Secondary alteration: The whole rock, including sparry cement, is composed entirely of dolomite, suggesting replacement of original calcium carbonate at an early stage after deposition, perhaps synchronously with cementation. Internal structures are moderately well preserved, despite dolomitization, but it is uncertain how much of the lenticularity of dark laminae is due to secondary processes. The main form of destructive alteration is the formation of stylolites, which have removed large areas of column margins. They are rarely concordant with the layering, and frequently cut obliquely across columns. Fine tensional cracks, predating stylolites, are filled with sparry dolomite. The ubiquitous finely dispersed limonite is probably secondary, and may be related to weathering processes near the present land surface.

Comparisons: The stromatolites are identified as *Linella* Krylov on the basis of their bumpy, subcylindrical, partly walled columns with moderately frequent pointed projections. They are distinguished from *L. avis* Krylov by their patchy wall, generally less steeply convex laminae and less gnarled columns. *L.*

munyallina Preiss has similar column shape, but branches more frequently and has smoother, less lenticular and less wavy laminae. The lamination is better preserved than in South Australian specimens of L. ukka Krylov, but the margin structure is obliterated by stylolites. Many of the columns are more cylindrical and even than in L. ukka, and thereby resemble L. simica Krylov from the Southern Urals, but lack the ribs of Krylov's (1967) holotype. More adequate material will be required to make a firm identification at form level.

Distribution: The uppermost beds of the Wonoka Formation, western margin of the Willouran Ranges, South Australia. (Approximate coordinates 137°38'E, 30°00'S.

Age: Late Adelaidean. On general stratigraphic grounds, the Wonoka Formation is probably to be correlated with part of the Vendian of the USSR.

GROUP TUNGUSSIA Semikhatov

Collenia suchotungussica Semikhatov (1960, p.1481)

Tungussia Semikhatov (1962, p.205).

Type form: Tungussia nodosa Semikhatov, from the Sukhotungusin Suite, Yenisei Mountains, USSR.

Diagnosis: Tuberous to subcylindrical, horizontal to vertical columns with frequent, multiple, markedly divergent branching; margin structure is smooth or with small peaks, and at least locally with a wall.

Content: T. nodosa Semikhatov, T. confusa Semikhatov, T. sibirica Nuzhnov, T. inna Walter, T. erecta Walter, T. etina Preiss and T. wilkatanna Preiss.

Age: Middle to Late Riphean, probably also Vendian, in the USSR. Adelaidean in Australia.

Tungussia inna Walter (1971, in press).
Figs. 3,4,33,34,35,36.

Material: One large specimen from the one occurrence known from South Australia.

Description:

Mode of occurrence: The stromatolites were observed in only one outcrop, where they occur as a single bioherm 30cm thick, 70cm wide resting upon and completely surrounded by dark grey oolitic limestone (Figs. 3 & 4). The bioherm is of ellipsoidal shape, and consists of a dendritic array of markedly divergent columns. The substrate is predominantly oolitic but contains minor fine intraclasts and unevenly laminated micrite bands. The contact with the overlying oolitic limestone is obscured by stylolites but it may have originally been erosional.

Column shape and arrangement: Columns are dendritic in arrangement, radiating from a complex central core which contains numerous surfaces of erosion and regrowth, variously oriented in different planes. Columns are variously inclined, frequently sub-horizontal, especially near the base and margins (Fig. 34). In the upper part columns tend to become vertical; away from the central core they become more or less discrete, but still coalesce in places. The columns are tuberous, irregular, rarely sub-cylindrical (Fig.33). Transverse sections are rarely circular, but more frequently rounded polygonal or lobate, or elongated in various directions.

Branching: Branching is frequent, dendritic, slightly to markedly divergent, dichotomous to multiple; five to ten columns may arise from one point in the central core. Rarely, branches are in the form of short pointed projections. Frequently columns branch and then coalesce again after short intervals.

Margin structure: Column margins are markedly bumpy with rounded protrusions 1-2cm wide and up to 5mm in amplitude. Rarely, laminae overhang the column margin to form short peaks and cornices. Bridging and coalescing of adjacent columns is very frequent, especially if they are closely spaced. Where columns are discrete, they bear a patchy wall of varying thickness; in many areas, the laminae simply abut against the column margins, but elsewhere they are downturned and coat the margins for a distance of up to 2cm. Frequently the wall is obscured by secondary recrystallization, so that its contact with the interspace sediment is difficult to locate, and the number of laminae participating cannot be determined.

Lamina shape: Lamina shape is highly variable from gently to steeply convex, most laminae being complexly wavy and multilobate in longitudinal section (Fig.35). The wavelength of undulations varies from 2mm to 2cm, amplitude from 1mm to 1cm. Lamina shape changes abruptly over a short vertical distance. The thickness of laminae pinches and swells markedly. Of 77 laminae measured, 25% have the modal value of h/d, between 0.4 and 0.5 (Fig.36). The distribution may be bimodal, with a secondary mode at 0.7 to 0.8 (12%), the latter corresponding to the laminae of the narrower walled columns.

Microstructure: The lamination is indistinct and lenticular, but frequently laminae are emphasized by dolomitization. All gradations exist between dark and light laminae. Where least altered and most distinct, dark laminae 0.1 to 0.2 mm thick, alternate with paler, silty microspar laminae. The dark laminae, which frequently have sharp bases and grade up into light laminae, consist of partially recrystallized micrite of grain size ranging from 0.003 to 0.01mm. Both lamina types may pinch out laterally, or may contain lenticular swellings up to 3mm thick. The pale, silty laminae consist of hypidiotopic calcite ranging in grain size from 0.03 to 0.06mm, with scattered corroded rounded quartz grains of similar size. In many parts of columns the laminae of both types are much less distinct, and broader laminae contain traces of a thinner internal lamination and grade into one another. In places are scattered round or ovoid ooids and micritic pellets 0.1 to 1.1mm in diameter, mostly in the pale silty laminae. Ooids are commonly replaced, except for their micritic rims, by sparry calcite; some contain authigenic feldspar.

Interspaces: Columns are closely spaced, never more than 1cm apart. Interspaces are filled predominantly with partially recrystallized micrite and silty micrite, frequently containing matrix-supported ooids and rarely intraclasts. Ooids are rarely preserved in their entirety; most commonly their nuclei have been partially or wholly replaced by idiotopic sparry calcite. Some ooids have laminae coating detrital carbonate grains as nuclei, while others have micritic nuclei rich in organic matter as suggested by their brownish colour in transmitted light. The outer laminae of ooids are 0.008 to 0.03 mm thick, and up to six laminae may be preserved. The laminae consist of alternating paler and darker brownish calcite, sometimes with a slight radial orientation of crystals or of concentrations of organic matter. The consistency of the ovoid shape and the probable organic content of these grains could be used to argue for an interpretation as oncolites of algal origin, but such an interpretation should be made with caution; many examples of oncolites figured in Russian literature (e.g. Zhuravleva, 1964; Semikhatov, Komar & Serebryakov, 1970) could equally be interpreted as inorganic ooids. Compound structures occur locally, incorporating two or more grains (ooids, pellets or detrital grains) within the outer laminae.

The interspace sediment contains more micrite than the ooid and pellet grainstones surrounding the bioherm. This suggests that the bioherm grew under relatively lower energy conditions, then with increased agitation, the surrounding winnowed grainstone sediment accumulated.

Secondary Alteration: The whole rock has been subjected to varying degrees of dolomitization. Dolomite is most prominently developed in the micritic laminae, and is broadly concordant with these, but it is patchy and lenticular, sometimes terminating abruptly and sometimes cutting obliquely across the lamination. The dolomite consists of more or less scattered rhombs of grain size 0.004 to 0.008mm. Stylolites are common, and cut across the rock without preferred orientation. Very rarely fine incipient stylolites follow the stromatolitic lamination. Stylolites probably post-date dolomitization; they may be related to the formation of solution cavities. Solution effects are evident within and around many ooid grains, whose nuclei may be dissolved out or dislodged, or whose outer laminae may be partly collapsed. In addition, large patches of sparry idiotopic calcite, grading from fine at their margins to coarse at their centres, probably due to recrystallization, apparently post-date the stylolites, and contain re-distributed dolomite rhombs.

Comparisons: The presence of markedly divergent, multiple branching, the dendritic arrangement of the columns and the presence of a patchy wall, allow assignment to the group Tungussia. In having highly variable lamina shape, with markedly wavy laminae, the stromatolite differs from T. confusa Semikhatov, T. nodosa Semikhatov, T. bassa Krylov (a marginal variant of Linella ukka), T. erecta Walter and T. wilkatanna Preiss. It closely resembles T. inna Walter from the Amadeus Basin in column shape and arrangement and lamina shape, but is not as well preserved. In addition it lacks the laminae composed entirely of ooid grainstone characteristic of the type specimen from the Amadeus Basin. This difference is interpreted to be due to a lack of supply of ooids during stromatolite growth in the Wonoka Formation; interspaces here are filled with micrite and wackestone, in distinction to the grainstone interspaces in the type specimens. The wall is less well developed than in the holotype. Recrystallization has largely obscured the wall structure and the distinction between lamina types. The Wonoka Formation specimen also partly resembles T. etina Preiss, but has more irregular, wavy laminae and dendritic arrangement of columns. It is assigned to T. inna Walter, but possibly grew in a lower energy environment than the holotype.

Distribution: Ringwood Member of the Pertatataka Formation, Central Australia; top of the Wonoka Formation, Bunyeroo Gorge, Central Flinders Ranges.

Age: Late Adelaidean. On general stratigraphic grounds, the Wonoka Formation is to be correlated with part of the Vendian of the USSR.

Miscellaneous descriptions

Other stromatolites and stromatolite-like structures which were examined but cannot be described formally here are discussed below.

(1) Linella munyallina Preiss (Figs, 11,12,13) has been described (Preiss, 1971a). Specimens from West Mount Hut were collected by Mr. B. Murrel, but had not been studied in the field hitherto. The stromatolites form small bioherms up to 50cm thick, 1 to 1.5m wide; they are spaced about 12m apart, and separated laterally by flat-laminated sandy limestones (in Fig. 11 the sandy laminae are seen to weather in relief). Sandy limestone also forms a thin substrate to the stromatolites, and laps up against the bioherm margins. There are also compaction effects as the laminae of the sandy limestone are upturned at the margins.

The stromatolites are of irregular subcylindrical to tuberous shape, closely spaced at the base but up to 2cm apart at the top. Transverse sections vary from round to oval to irregularly lobate (Fig.12).

(2) Acaciella augusta, Preiss. It was shown in an earlier report (No.71/91) and Preiss, 1972) that columnar stromatolites originally described as Linella munyallina from the Wundowie Limestone at Wundowie Bore are better assigned to Acaciella augusta. Identical stromatolites occur in the Wundowie Limestone at Copley (locality 17); here the lowest band is primarily stromatolitic. A specimen collected (WP 21) is inadequate for re-

construction, and is poorly preserved with stylolite-bounded columns.

The stromatolites form tabular beds, possibly biostromes, of unknown total extent (outcrop is discontinuous). In one place a biohermal swelling was observed (Fig. 16), in which a zone of discrete columns overlies a wrinkly-laminated cumulus (below the hammer head). Elsewhere, at the base of the bed, there is a zone of 30cm thick of broad, beta-to gamma-parallel to slightly divergent branching columns, varying in width from 2 to 10cm (most are 2 to 3cm). Column margins are slightly bumpy, but the ubiquitous presence of stylolites at column margins makes the primary structure uncertain (Fig.15). Columns are truncated at the top by a stylolitic surface, overlain by irregularly undulose stromatolites with concordant stylolites, intercalated with zones of 5cm high columns. The uppermost zone of short frequently bridged and coalesced columns is characterized by a consistent south-easterly elongation of columns. Orientations measured were 125°, 130°, 121°, 118°, 121°, 123°. In the biohermal swelling, an extremely recrystallized zone separates the columns from the basal cumulus, and their mutual relationships are not clear.

(3) Indeterminate stromatolite (specimen WP 15), Upper Callanna Beds, east of Kingston Dam (locality 12). A thin dark grey dolomite contains bulbous and laterally linked stromatolites with occasional short columns separated by patches of interspace sediment. (Fig.37). The laminae are smooth, chiefly gently convex, and relatively indistinct. The most distinct laminae are continuous across the width of the columns or pseudocolumns, but thinner streaky laminae also occur. The thickness of laminae

varies from 0.1 to 2.0mm and they consist of 0.01 to 0.03mm grain size dolomite of hypidiotropic texture. The darker laminae are sometimes finer and contain scattered opaques. The boundaries of all laminae are diffuse. Scattered acicular crystals, probably of tremolite, suggest low-grade metamorphism. Although the stromatolite superfically resembles some of the pseudocolumnar and laterally-linked variants of Baicalia burra, the microstructure is not as distinctly banded.

(4) Slump breccia, west of Chintapanna Dam (WP 12). This breccia consists of spar-cemented dolomite clasts, generally sub-rounded to angular, ranging from sand size to several centimetres in diameter. The clasts are randomly oriented, and generally show internal lamination. Rounded quartz grit, and finer carbonate clasts, but though the sediment is poorly sorted there is a notable absence of mud matrix.

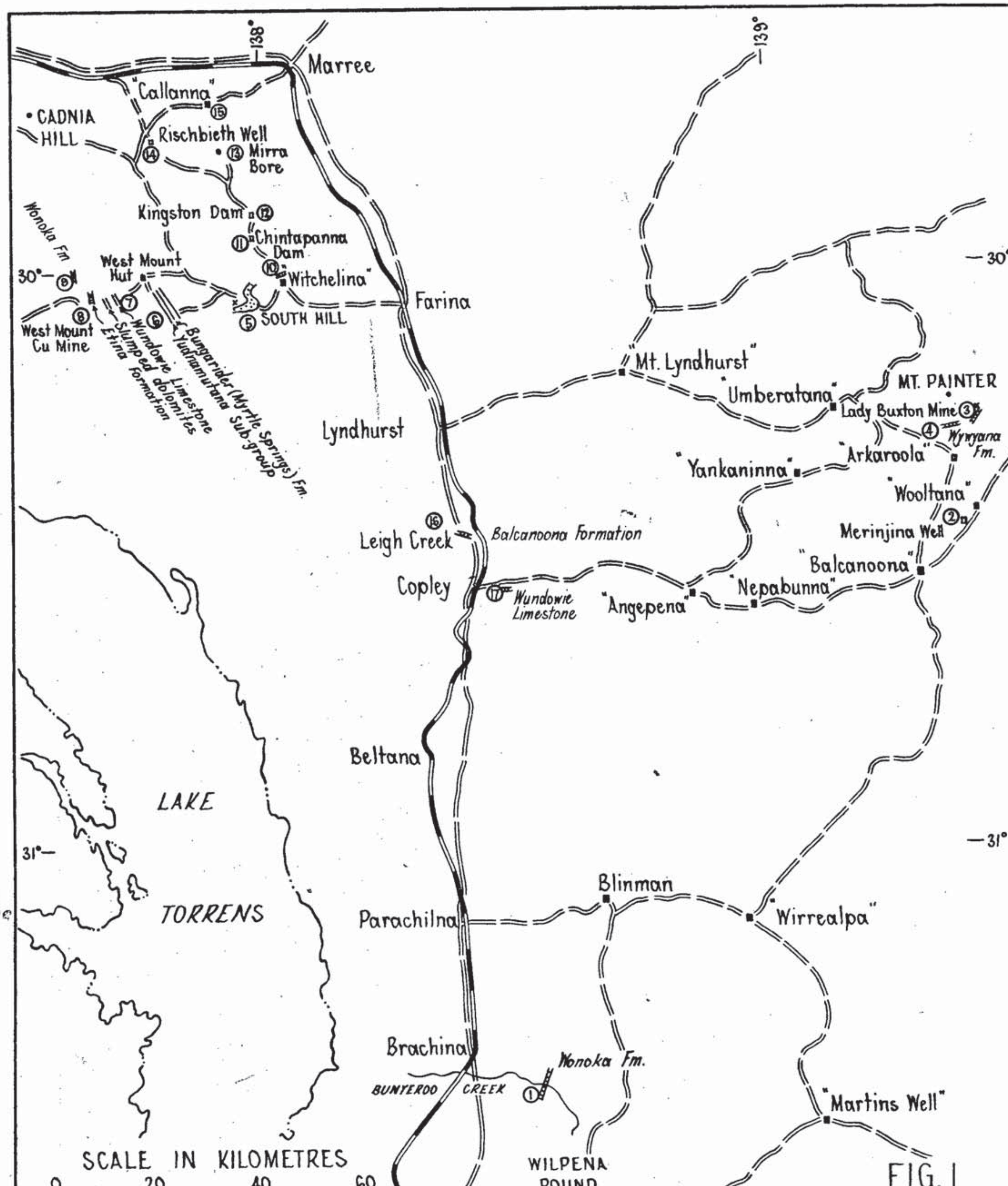


FIG. 1

| | | |
|---|---|---|
| PALAEONTOLOGY SECTION | DEPARTMENT OF MINES – SOUTH AUSTRALIA | Scale: As shown |
| Compiled: W.V. Preiss | NORTHERN FLINDERS & WILLOURAN RANGES | Date: 22 Oct 1971 |
| Drn. R.H. Ckd. | LOCALITY MAP | Drg. No. S9541 Ccd |

IM–2.70 A1810

Fig. 2. Detailed section of the uppermost approximately 20m of the Wonoka Formation, Bunyeroo Gorge, showing the position of the stromatolitic bioherm.

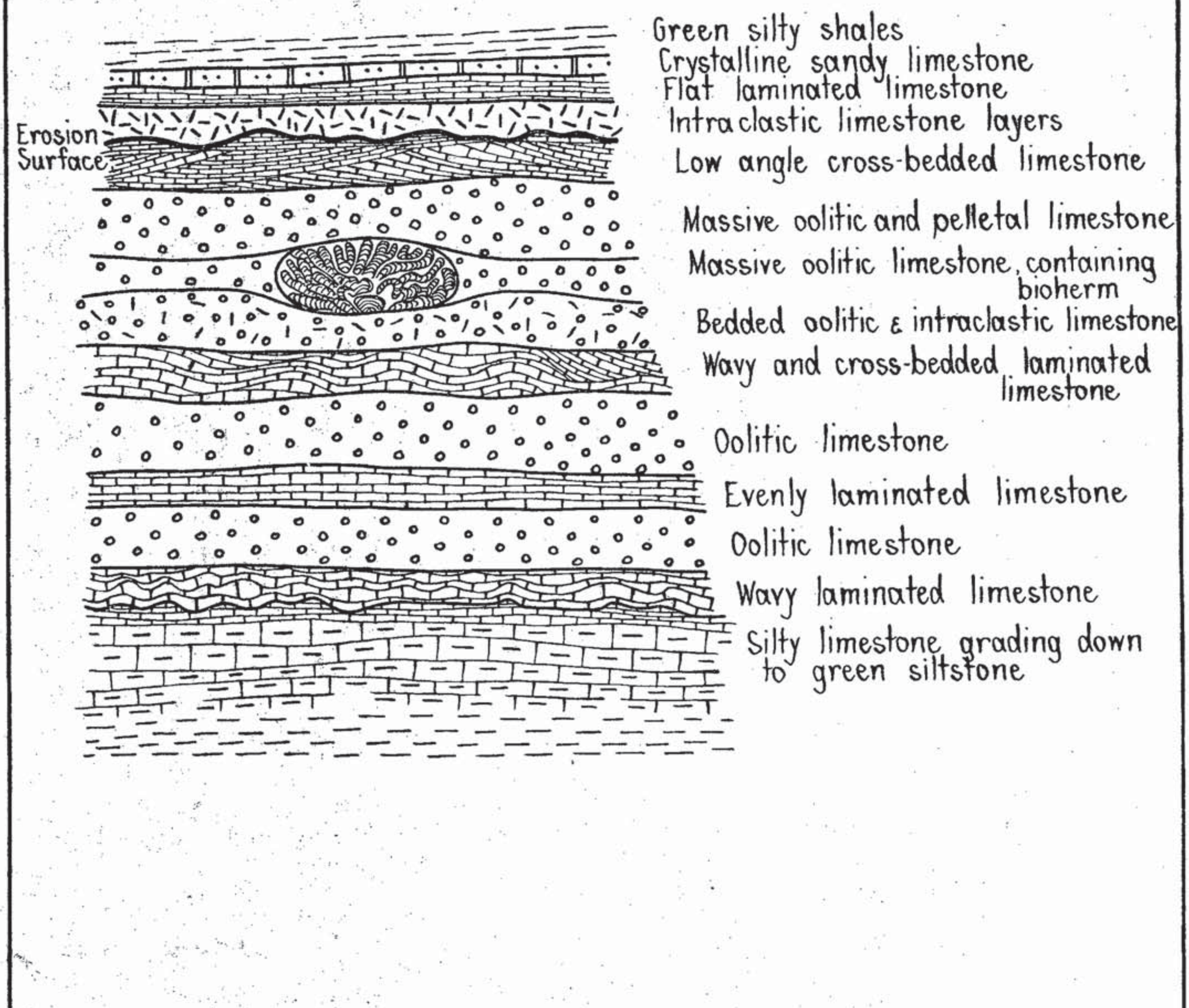


FIG. 2

| | | |
|---|---|---|
| PALAEONTOLOGY SECTION | DEPARTMENT OF MINES – SOUTH AUSTRALIA | Scale: Diagrammatic |
| Compiled: W.Y. Preiss | WONOKA FORMATION – BUNYEROO GORGE | Date: 25 Oct 1971 |
| Drn. R.H. Ckd. | DETAILED SECTION OF UPPERMOST 20M. | Drg. No. S9542 Fa5 |

1M–2.70 A1810

Fig. 3. Longitudinal section of part of bioherm of _Tungussia inna_, Wonoka Formation, exposed in Bunyeroo Gorge. Scale is 30cm long.

Fig. 4. Transverse section of the same part of the bioherm.

Fig. 3

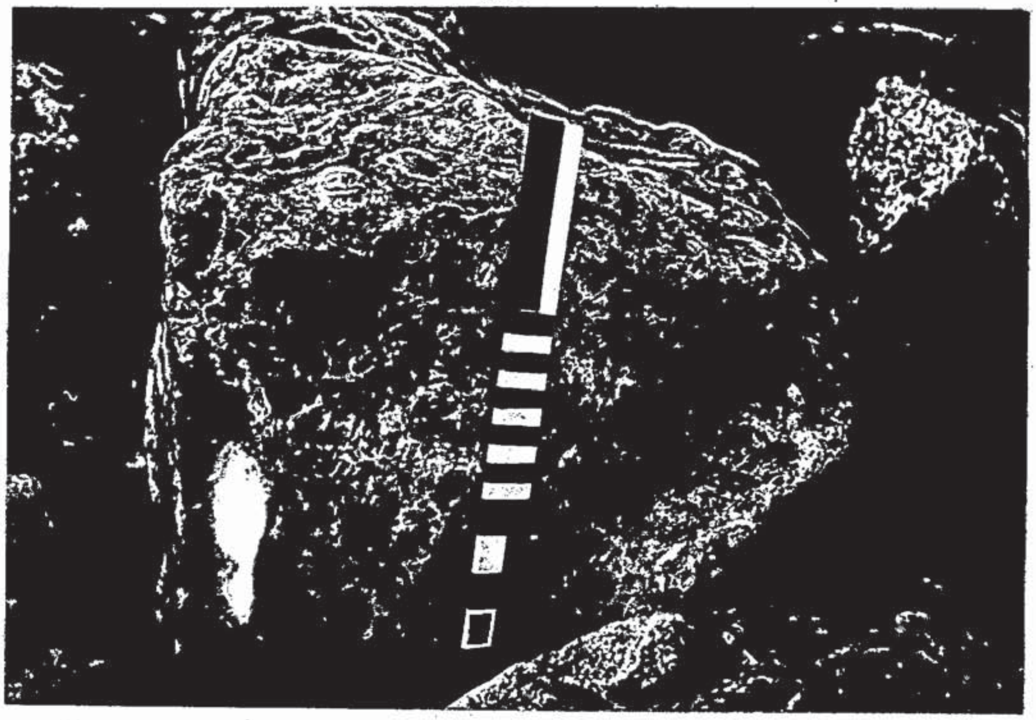

Fig. 4

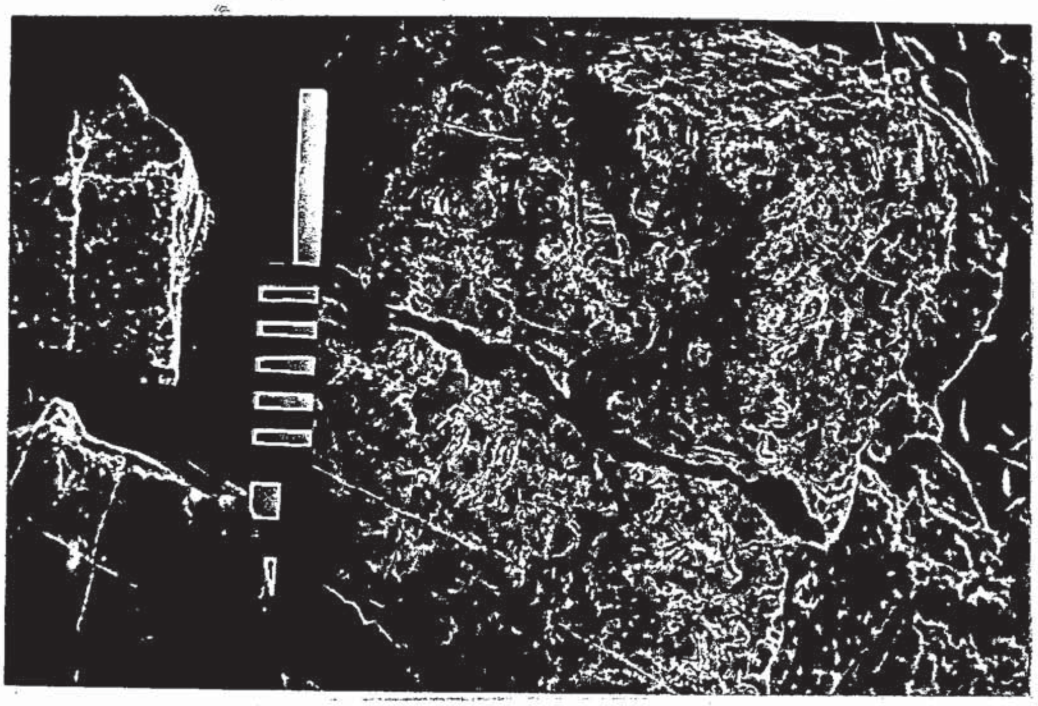

Fig. 5. Cross-bedding in the Witchelina Quartzite, north of South Hill, Willouran Ranges, confirming the westerly facing of the beds in this area. Scale is 30cm long.

Fig. 6. Oblique section of columns of Baicalia blastophora, lower member of the Skillogalee Dolomite, near South Hill.

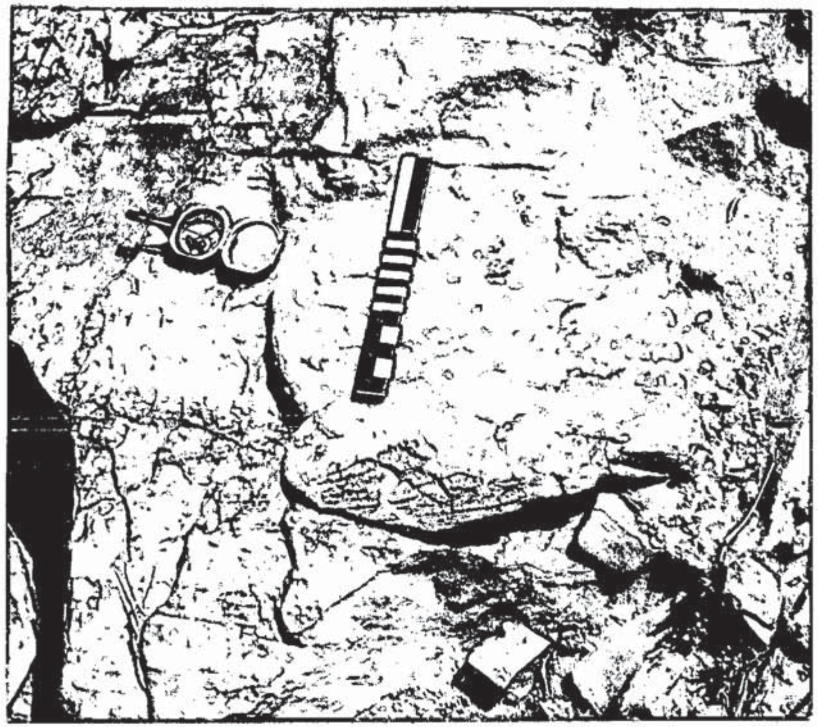

Fig. 5

Fig. 6

Fig. 7. Longitudinal section of stromatolitic bed, Baicalia blastophora, showing poorly laminated base and discrete, parallel columns in the upper part (upper right corner). Scale is 30cm long.

Fig. 8. Longitudinal section of poorly preserved ( partially silicified) columns, showing rare branching and short outgrowths.

Fig. 7

Fig. 8

Fig. 9. Close up view of parallel columns, _Baicalia blastophora_. Scale is 30cm long.

Fig. 10. Dolomite breccia forming the substrate to the stromatolites in Fig. 9. Note the large dolomite clasts.

Fig. 9

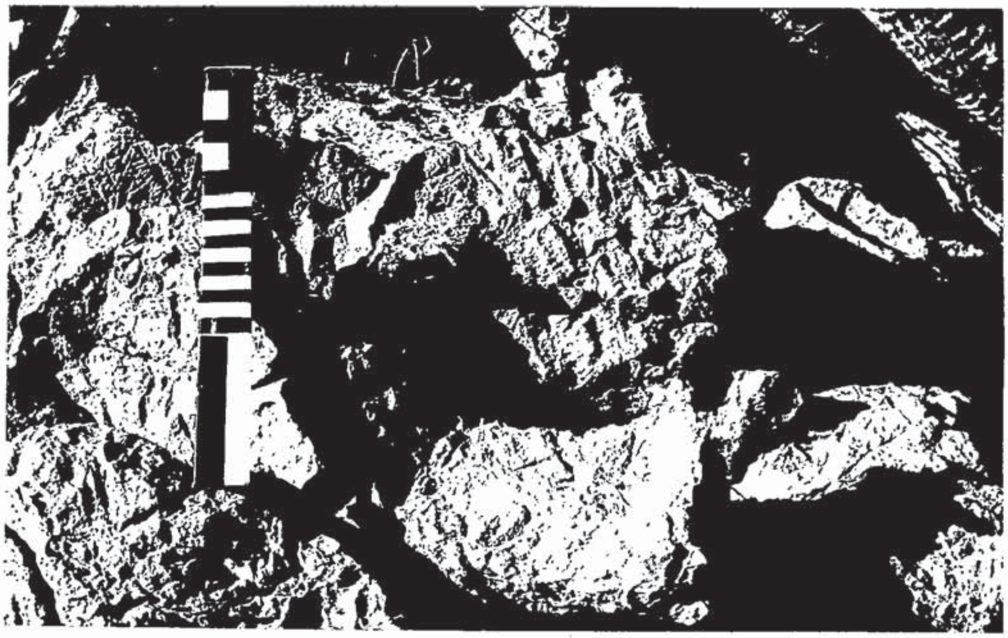

Fig. 10

Fig. 11. Part of a small bioherm of *Linella munyallina*. The laminated sandy limestone surrounding the bioherm lapped onto its margin; the up-turning at the upper left is probably due to compaction. Scale is 30cm long.

Fig. 12. Transverse section of the same bioherm, showing the irregular sectional shapes of the columns.

Fig. 11

Fig.12

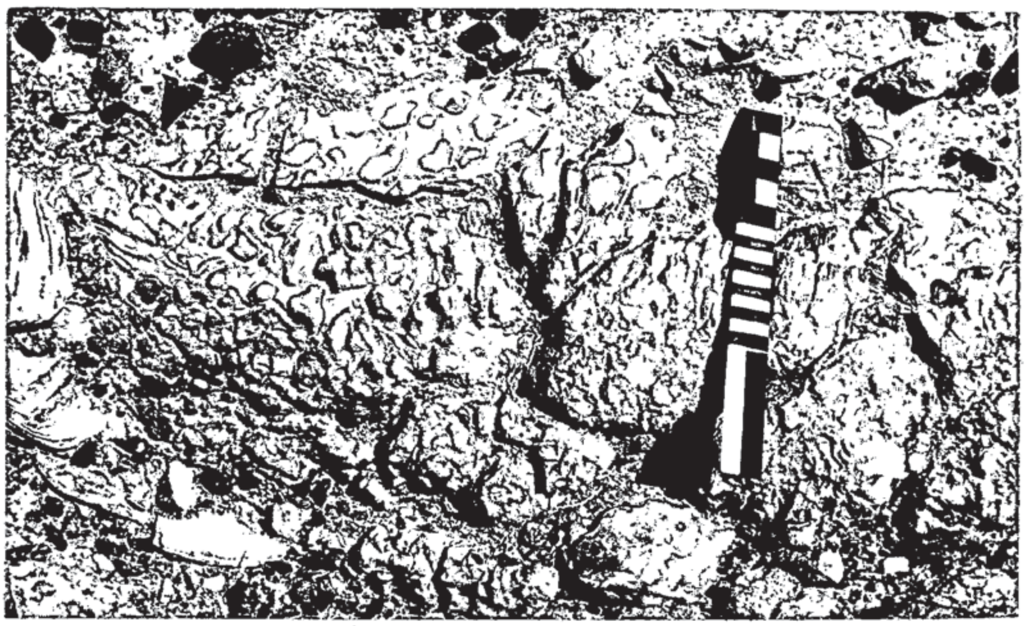

Fig. 13. Another bioherm of *Linella munyallina*, in the same horizon as that in Fig. 12. Scale is 30cm long.

Fig. 14. Part of a stromatolitic bed (probable *Acaciella augusta*), Wundowie Limestone, Copley. Hammer is 30cm long.

Fig. 13

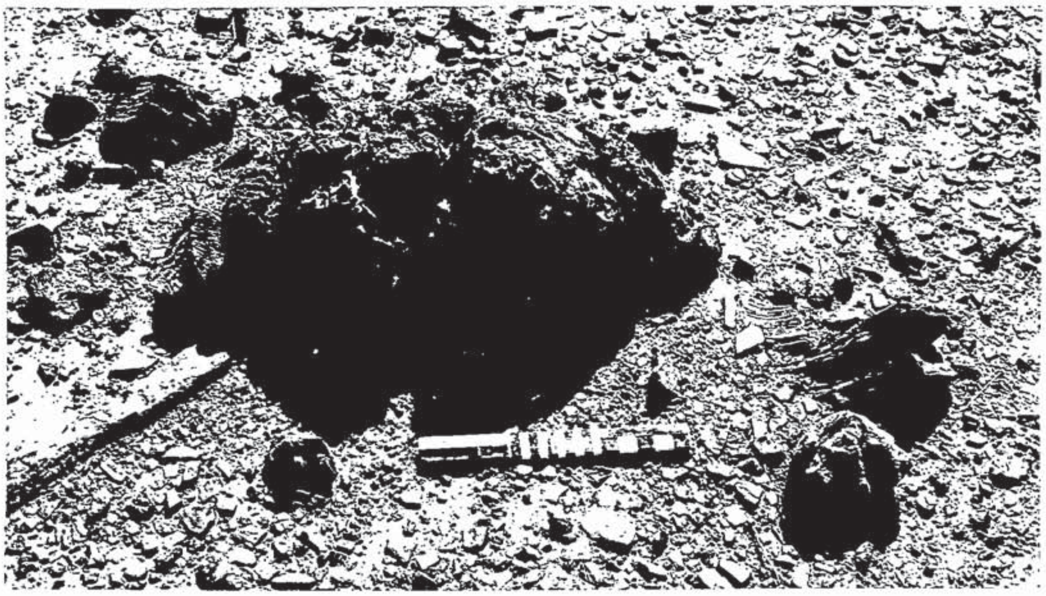

Fig. 14

Fig. 15. Erect parallel columns, bounded by stylolites, overlain by wavy-laminated stromatolites with very frequent concordant stylolites. _Acaciella augusta_, Wundowie Limestone, Copley. Hammer is 30cm long.

Fig. 16. A biohermal swelling in the same bed. The core of the structure is a wrinkly-laminated cumulus, which formed a base for further growth.

Fig. 15

Fig.16

Fig. 17. Part of a poorly exposed stromatolitic dolomite bed, _Linella_ f. indet., top of the Wonoka Formation, western margin of the Willouran Ranges. Scale is 30cm long.

Figs. 18 & 19. Oblique sections of the same stromatolites.

Figs.17 - 19

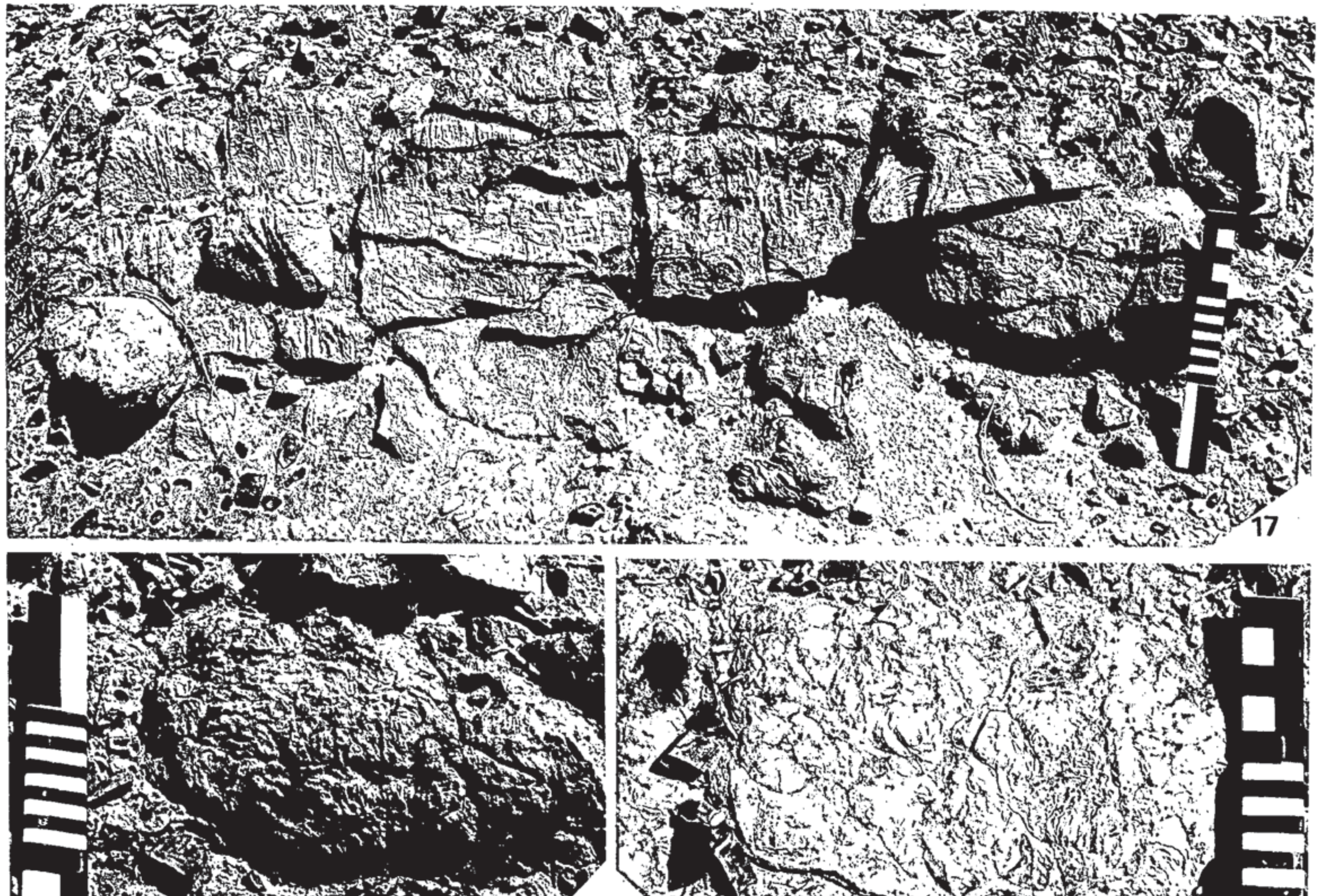

Fig. 20. Thin section of Baicalia burra, Myrtle Springs (Bungarider) Formation, near West Mount Hut, Willouran Ranges (WP (16)).

Fig. 21. Weathered surface of the same specimen, illustrating the banded lamination.

Fig.20

Fig.21

Fig. 22. Reconstructions of *Baicalia blastophora* Skillogalee Dolomite, South Hill. Note the sub-parallel column arrangement, rare branching, ragged and bumpy columns and frequent rounded projections.

Fig. 22

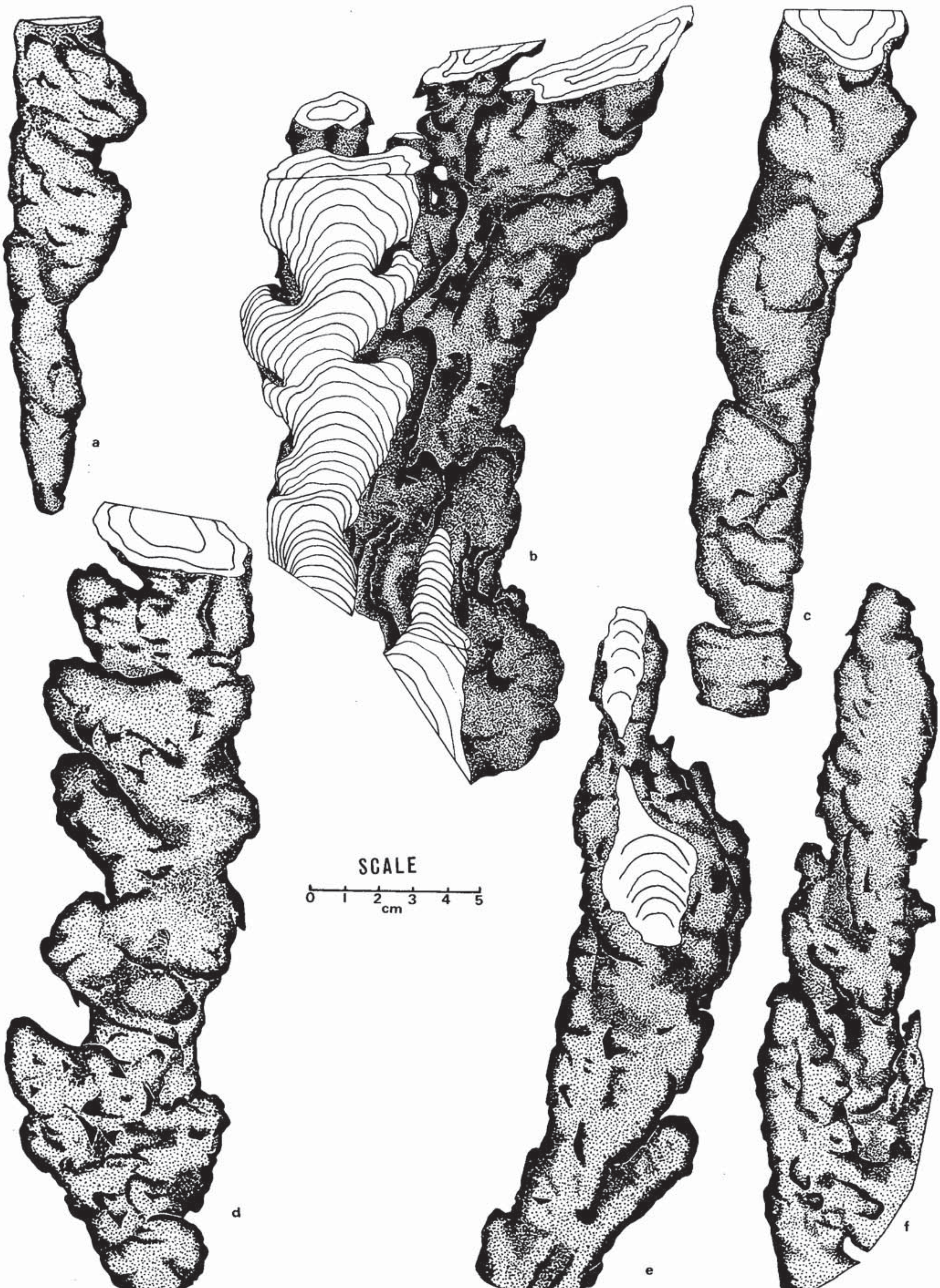

Fig. 23. Lamina shapes of _Baicalia blastophora_.

Fig. 24. Histogram of lamina convexities, _Baicalia_ _blastophora_.

Fig. 23

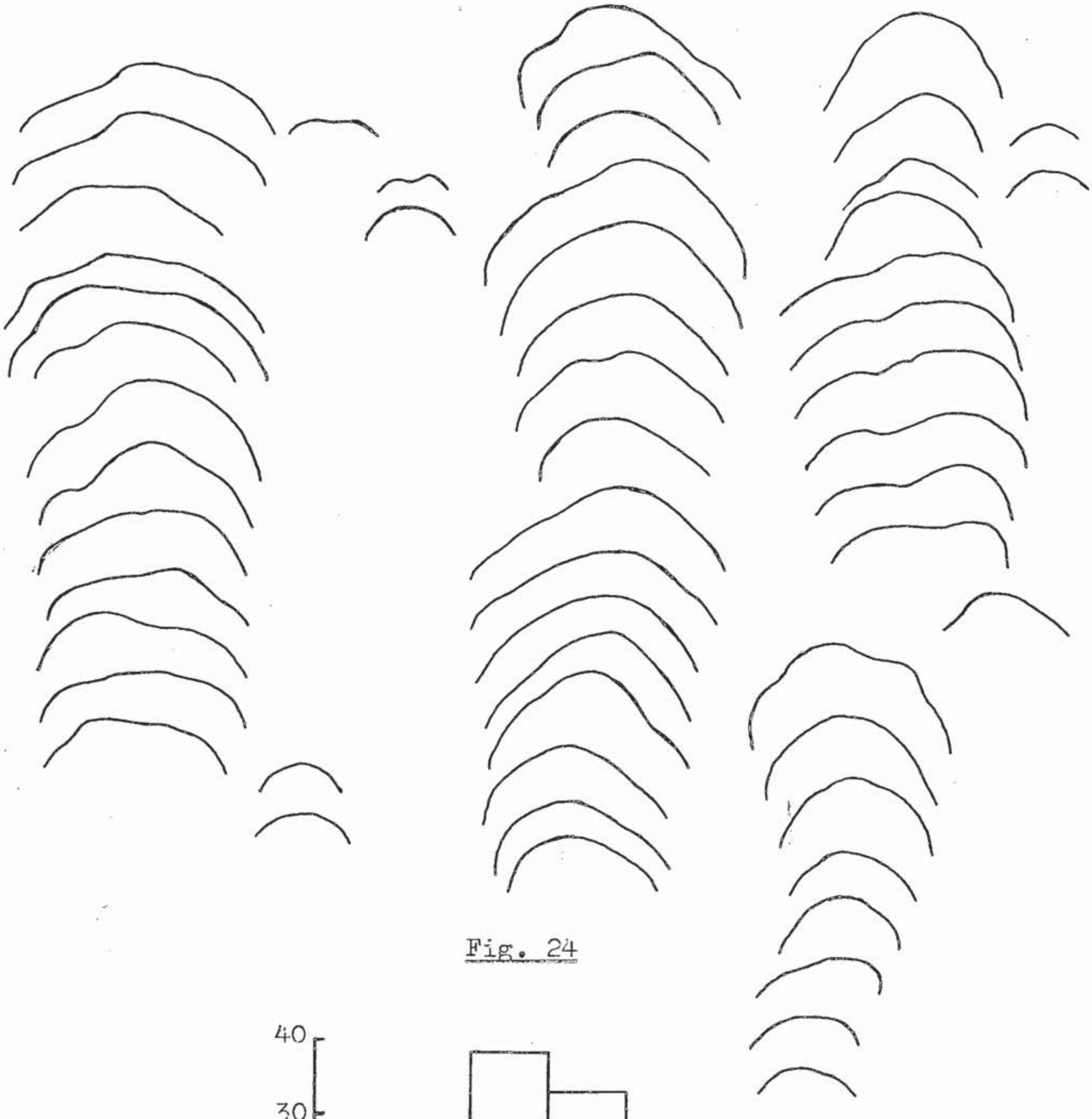

Fig. 24

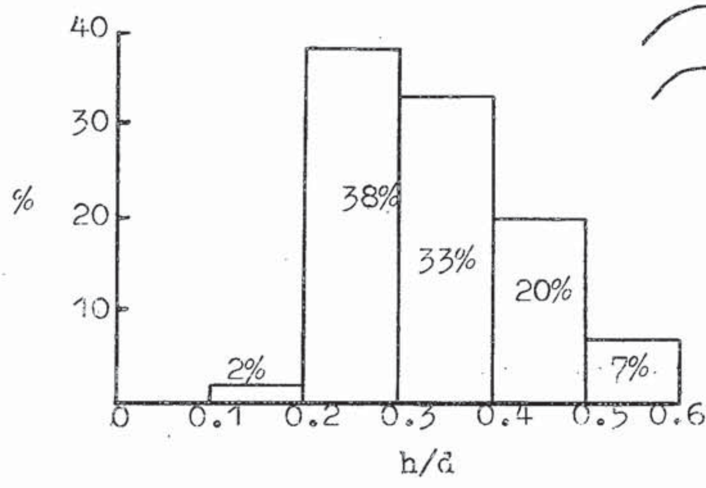

Fig. 25. Cut slab, _Baicalia blastophora_. The darker, laminated areas are longitudinal sections of columns. The homogeneous fractured rock is interspace sediment.

Fig. 26. Longitudinal thin section of _Baicalia blastophora_, illustrating the indistinctly banded microstructure and rounded projections.

Fig. 25

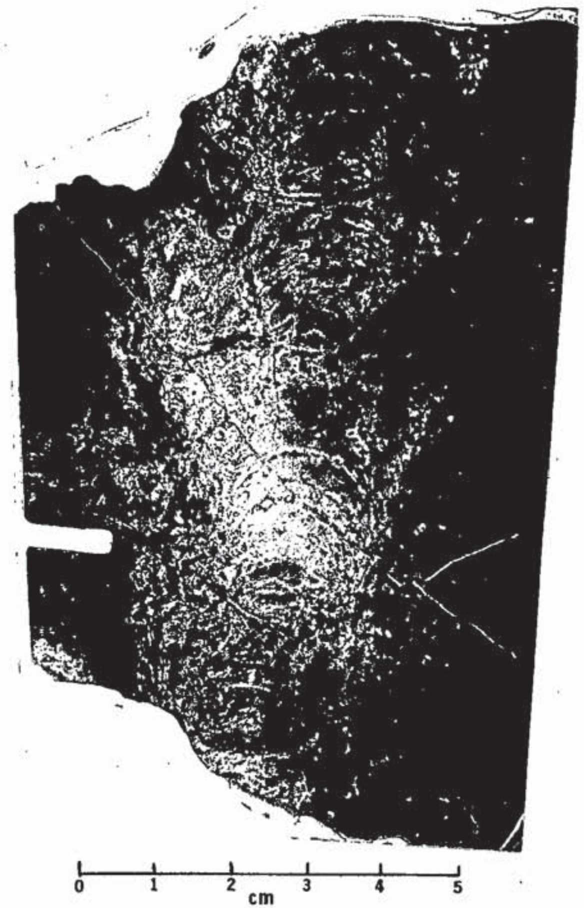


Fig. 26

Fig. 27

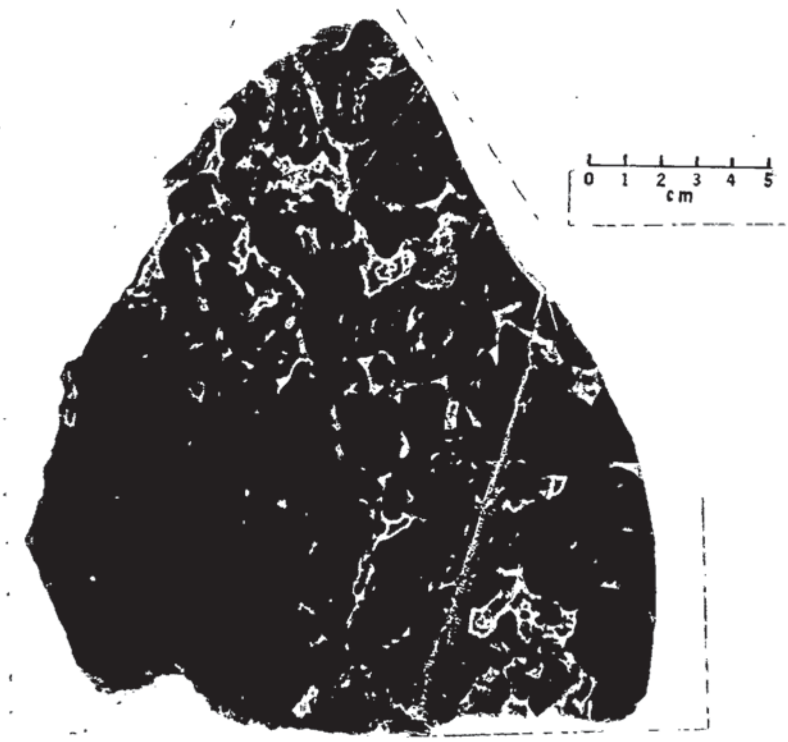


Fig. 28

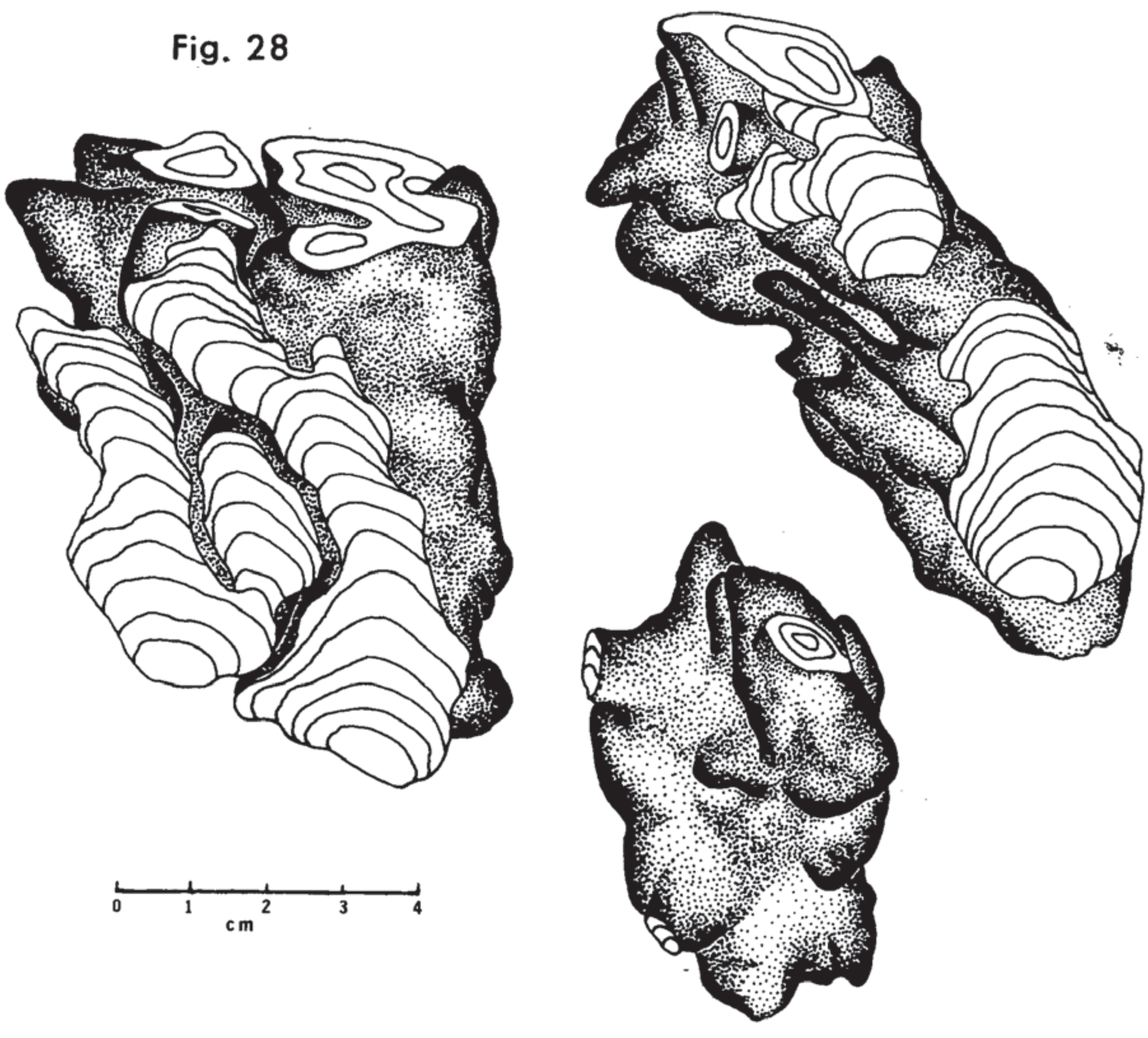

Fig. 29

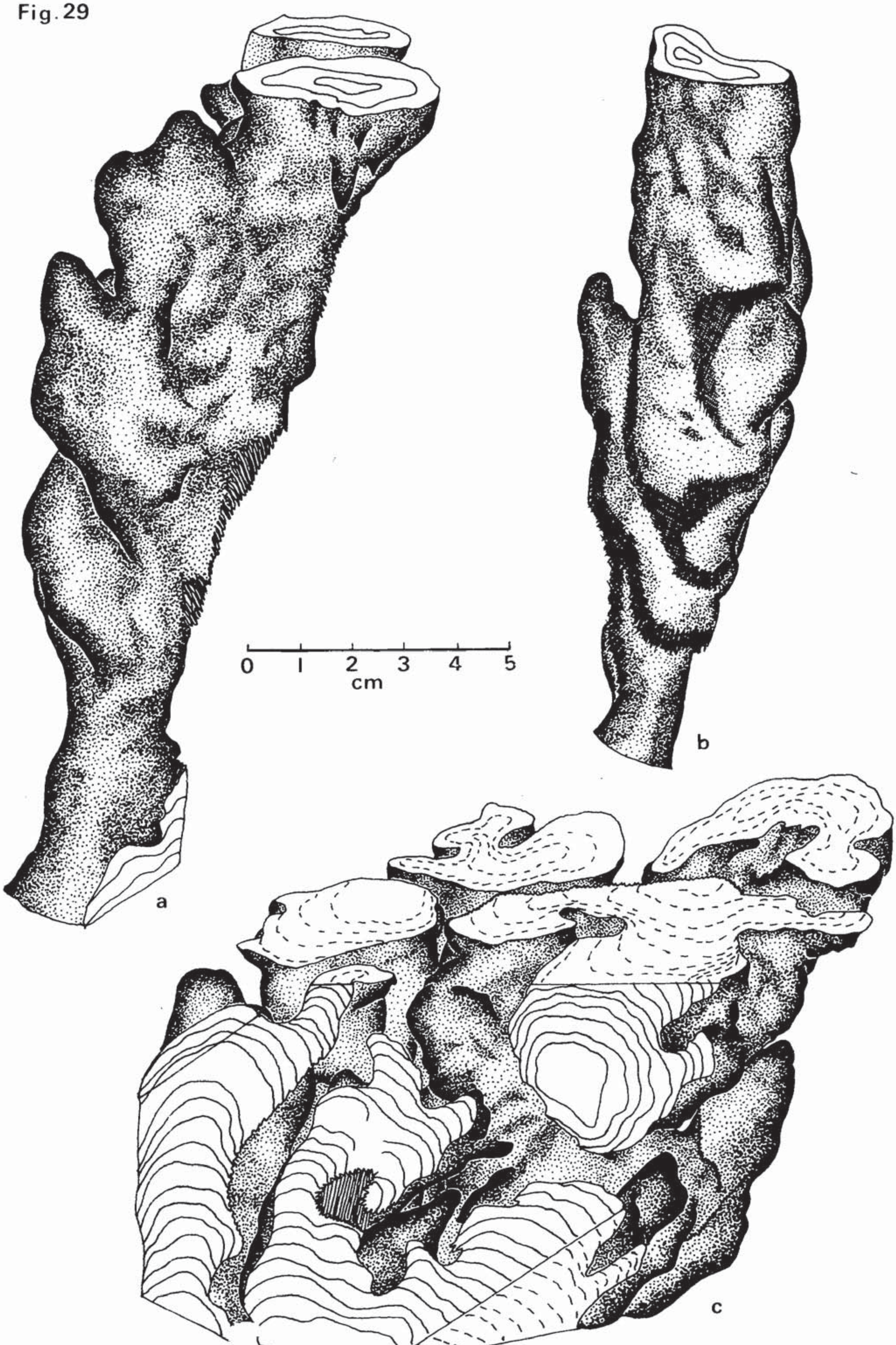

Fig. 30

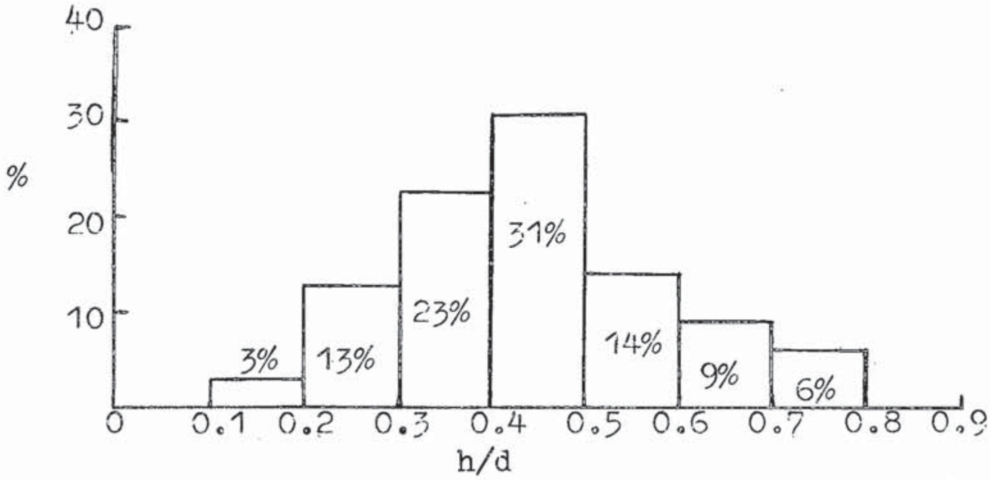


Fig. 31

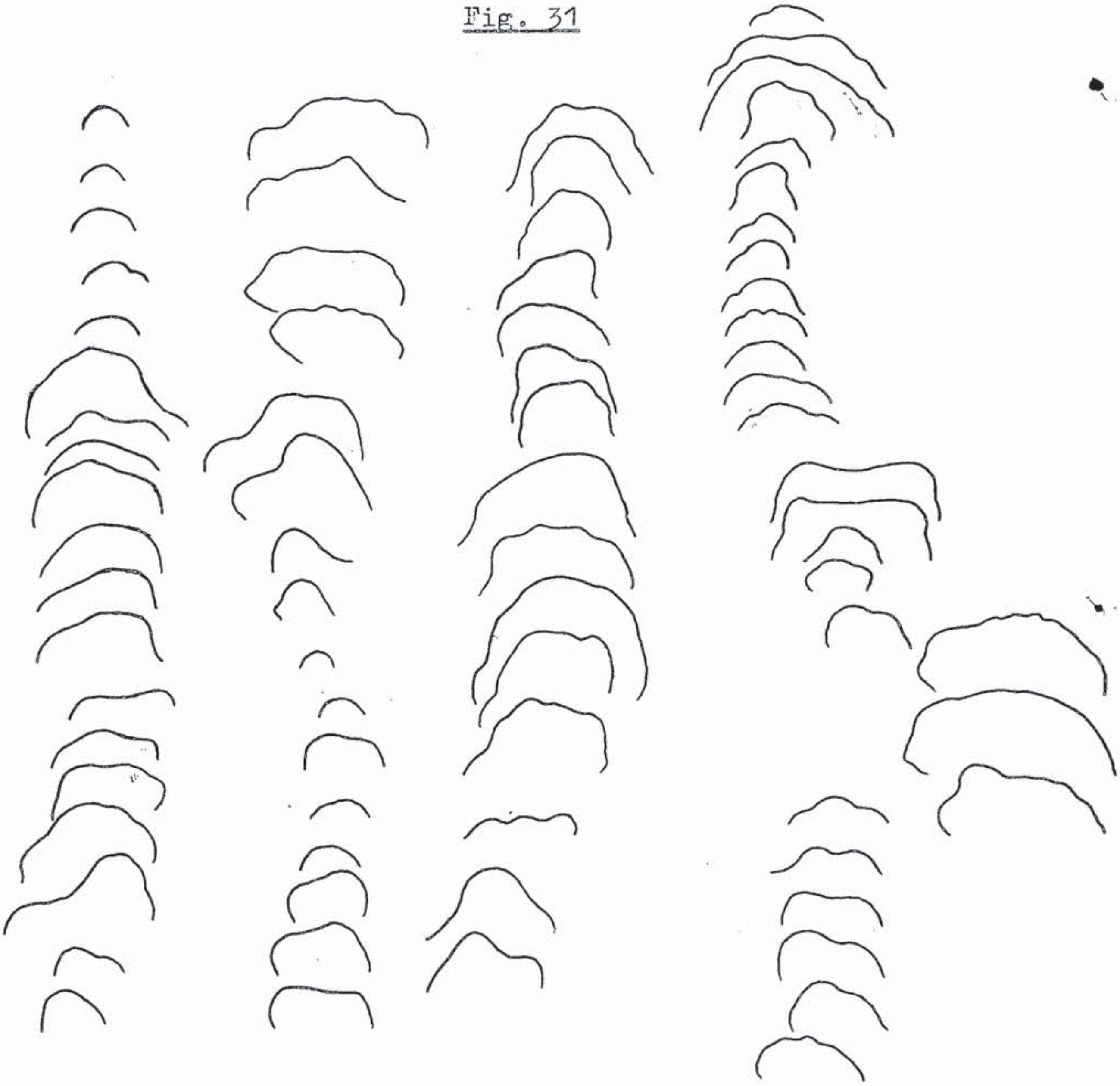

Fig. 32. Thin section Linella f. indet.

Fig. 33. Reconstruction of Tungussia inna, Wonoka Formation, Bunyeroo Gorge.

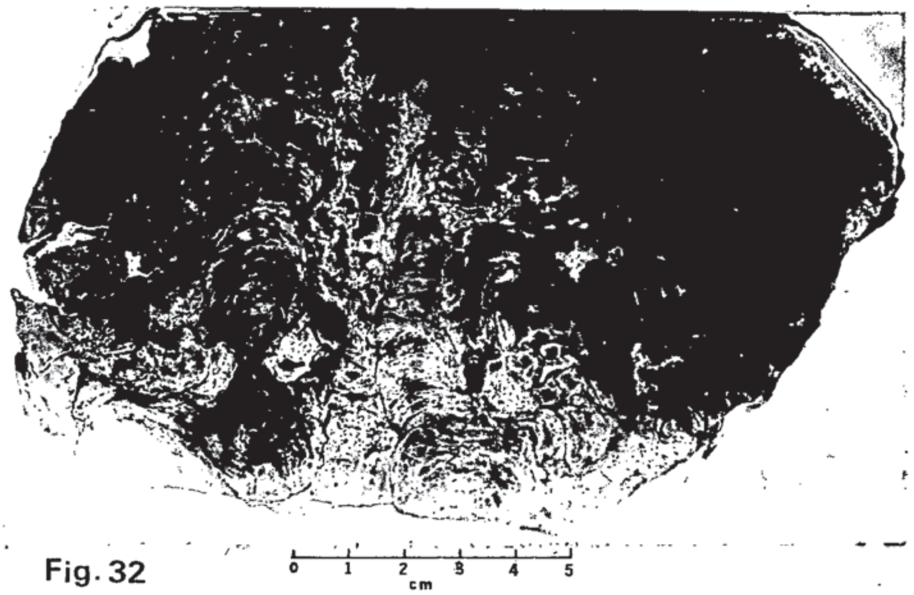


Fig. 32

Fig. 33

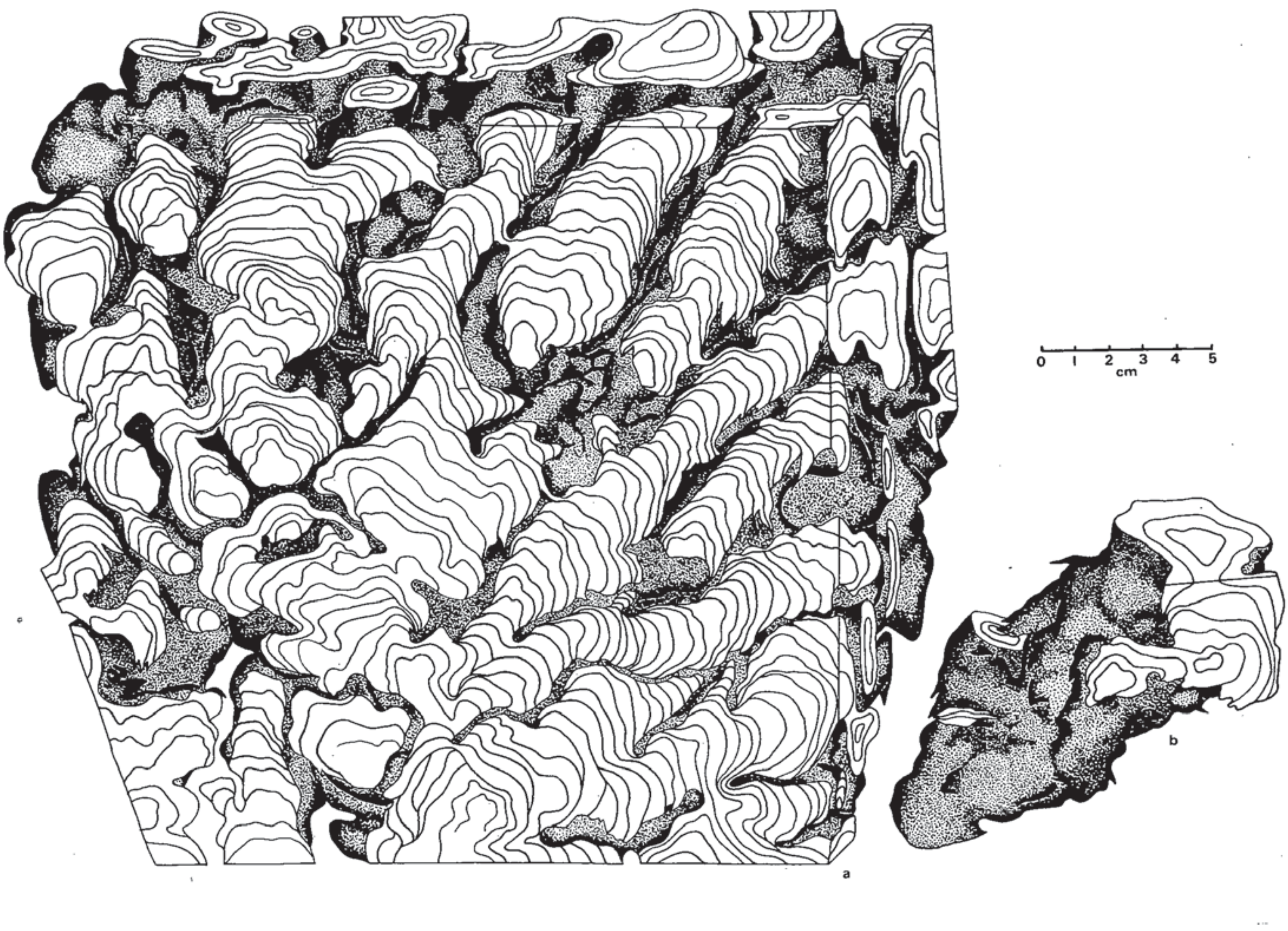

Fig. 34. Cut and etched slab of _Tungussia_ _inna_. The pale grey areas are dolomitized laminae; irregular white patches are spar-filled solution voids.

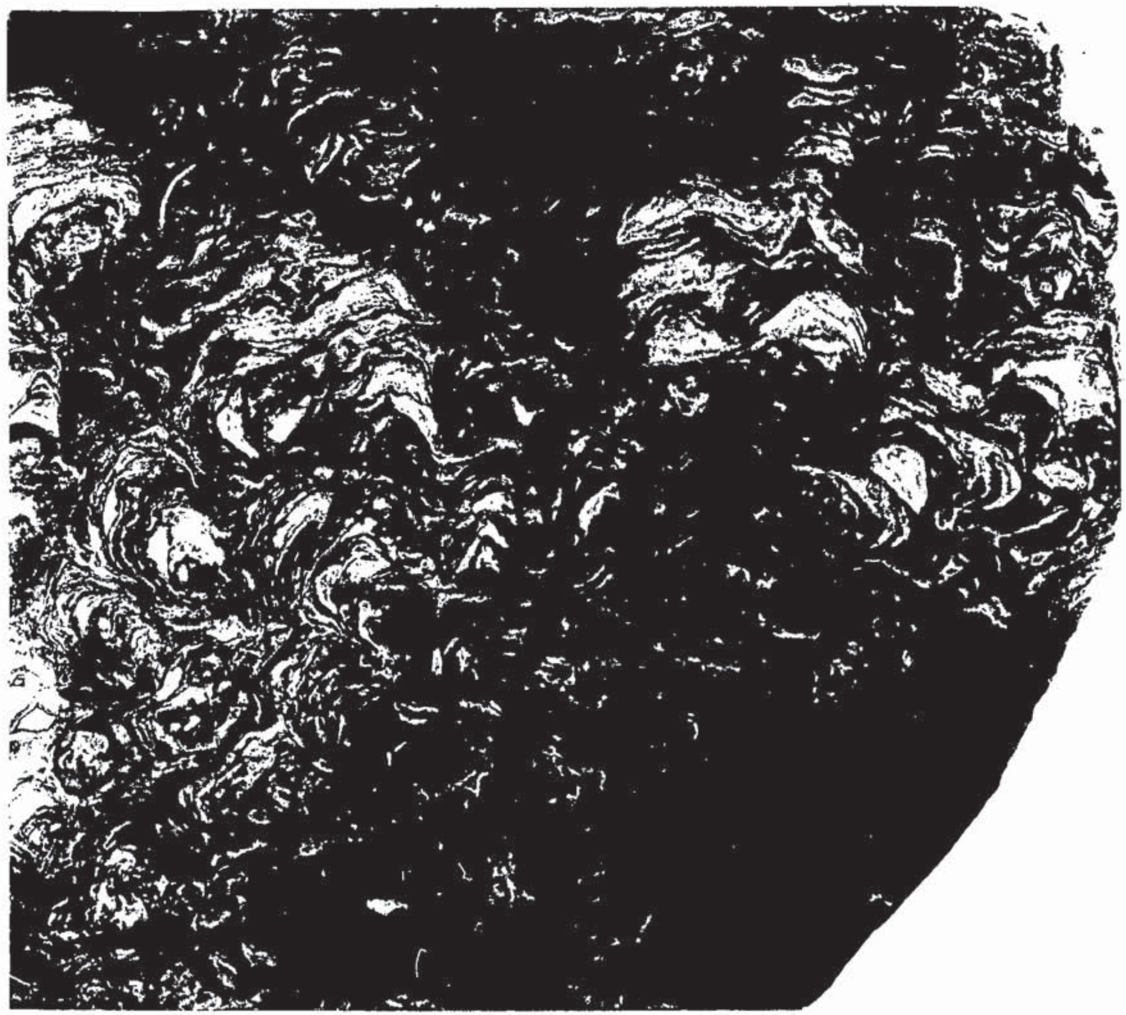

Fig. 34

0 1 2 3 4 5 6 7
cm

Fig. 35

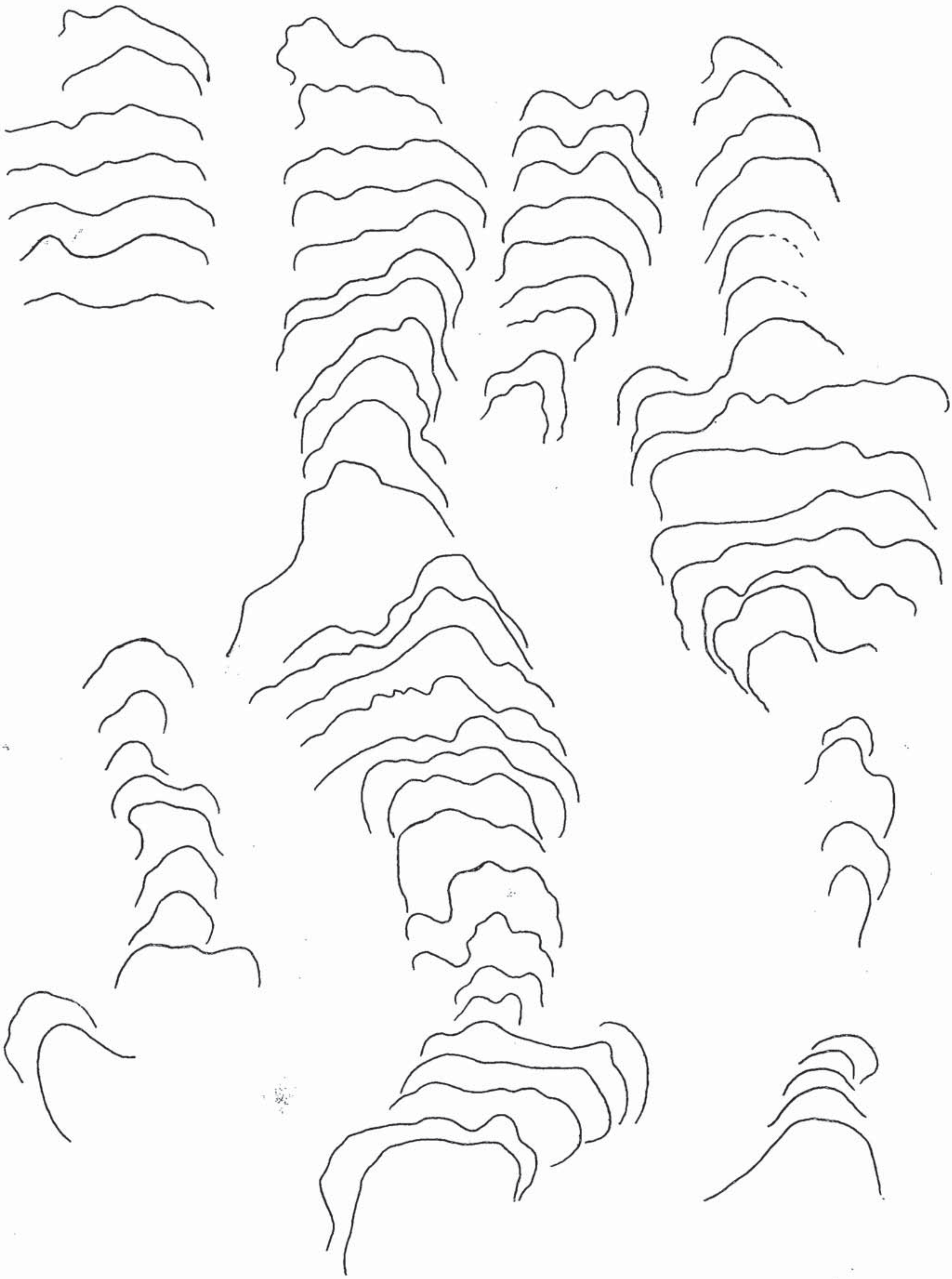

Fig. 36. Histograms of lamina convexities, Tungussia inna.

Fig. 37. Thin section of an indeterminate stromatolite, Upper Callanna Peds, near Kingston Bore.

Fig. 36

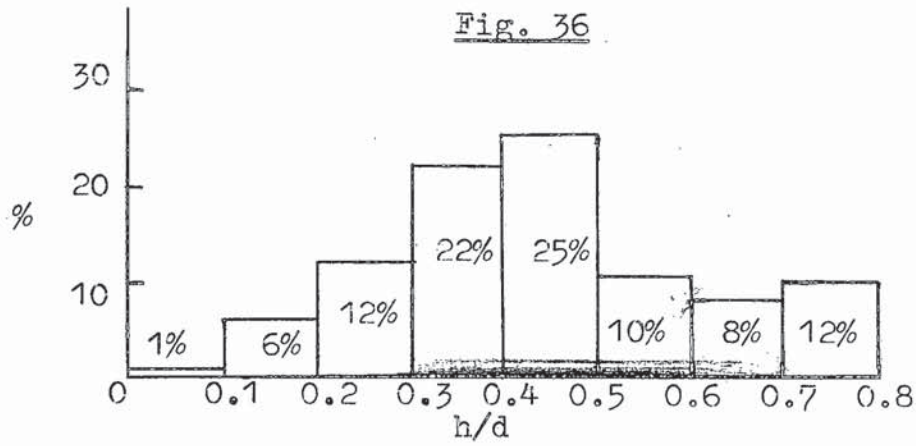


Fig. 37

Fig. 37