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CONOPHYTON AND OTHER COLUMNAR STROMATOLITES FROM THE UPPER PRECAMBRIAN AÇUNGUI GROUP NEAR ITAPEVA, SP, BRAZIL\*

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Abstract. Two distinct forms of columnar stromatolites occur in carbonate rocks of the Itaiacoca Formation, Açungui Group (Upper Precambrian) near Itapeva, SP, in the type area of the stromatolite Collenia itapevensis Almeida 1944. One of these is here designated Conophyton cf. C. gorganicum, and the other, a platey, smooth-walled, branching form, is yet unnamed. These forms are restricted to the Itaiacoca Formation and differ from the four unnamed forms of columnar stromatolites now known from various localities of the Capiru Formation, also in the Açungui Group, near Curitiba, PR. The Itaiacoca stromatolites seem to have formed under calm, probably subtidal conditions, whereas most of the Capiru forms appear to represent a more energetic, possibly intertidal setting. The Itaiacoca stromatolites also differ from other Brazilian Precambrian columnar stromatolites described from the Minas Supergroup and the Bambuí Group. The similarity of the Itapeva Conophyton to C. gorganicum suggests but in no way proves a possible age between 850 and 1700 m.y. for the Itaiacoca Formation.

Resumo: Duas formas distintas de estromatólitos ocorrem em calcários da Formação Itaiacoca do Grupo Açungui (Pré-Cambriano Superior), perto de Itapeva, SP, na área-tipo de estromatólito Collenia itapevensis Almeida 1944. Uma destas é aqui designada Conophyton cf. C. gorganicum; a outra, que ainda não foi classificada, apresenta um contorno transversal alongado, ramificações e uma superfície lateral lisa. Estas duas formas se encontram sómente na Formação Itaiacoca, e diferem das quatro formas, ainda não classificadas, de estromatólitos colunares que ocorrem em várias localidades, perto de Curitiba, PR, na Formação Capiru. Os estromatólitos da Formação Itaiacoca parecem ter sido formados sob condições calmas, provavelmente sub-litorais, enquanto que a maioria dos da Formação Capiru ter-se-iam formados num ambiente mais energético, possivelmente na planície de maré. Os estromatólitos da Formação Itaiacoca também diferem de outras formas colunares do

\* Pesquisa realizada com o auxílio da FAPESP e do CNPq.

Pré-Cambriano brasileiro já descritas do Supergrupo Minas e do Grupo Bambuí. A semelhança do Conophyton de Itapeva com C. giganicum sugere, não comprovando contudo, uma possível idade entre 850 e 1700 m.a., para a Formação Itaiacoca.

Introduction: In recent years, many geologists, especially those in the USSR and Australia, have turned to the study of Pre-cambrian stromatolites as a means of correlating otherwise unfossiliferous sediments, establishing approximate ages of Pre-cambrian sedimentary sequences, interpreting depositional environments, understanding the course of biospheric evolution, and unravelling problems of structural and economic geology. There still remain, however, very large gaps in our knowledge of Precambrian stromatolites, even in the relatively simple documentation of stromatolite occurrences. This is particularly true in Brazil, where modern studies of stromatolites incorporating new ideas on the taxonomy and biostratigraphic utility of these fossils really only began in 1971 with the works of Dardenne et al. and Marini and Bôsio. Nevertheless, since then only a handful of the many stromatolite localities now known from Brazil have received detailed treatment (Moeri, 1972; Cloud and Dardenne, 1973; Marchese, 1974; Dardenne and Campos Neto, 1975). In view of the proven utility of stromatolites in Precambrian research elsewhere, and given the vast extent of Brazilian Precambrian terrains, a need clearly exists for increased effort in this field. In this spirit, the author presents below the preliminary results of studies of stromatolites from the Upper Precambrian Açungui Group of southeastern São Paulo (SP) and eastern Paraná (PR).

The study of stromatolites in the Açungui Group dates from 1944 when Almeida described the first undoubted Brazilian Precambrian fossil -- the stromatolite Collenia itapevensis -- from south of Itapeva, SP. He later (1957) called attention to a series of occurrences of this fossil in an essentially continuous band of dolostones, which he called the Itaiacoca Formation, stretching from Itapeva southwest 180 km to Itaiacoca, PR (Fig. 1). In the same paper, he described a different, apparently deformed stromatolite from a younger calcareous unit in Paraná (the Água Clara Formation, Marini et al., 1967). At about the same time, Bigarel-la and Salamuni (1956) described Collenia sp. from dolostones

occurring in a SW-NE band of sediments paralleling the Itaiacoca Formation but 40 to 60 km to the southeast (Fig. 1); this band of sediments they designated the Capiru Formation. Although these two formations are nowhere in physical contact, later authors (Bigarella and Salamuni, 1959; Marini *et al.*, 1967; Marini and Bigarella, 1967) considered these two largely dolomitic bands as parts of the same formation -- the Capiru Formation -- partly on the basis of the supposed occurrence in both of "Collenia".

During recent restudy of almost all of the stromatolite localities of Almeida (1944, 1957), Bigarella and Salamuni (1956), and Marini and Bōsio (1971), plus several new localities (Fig. 1, Table 1), the author noted that (1) stromatolites, including two paratypes deposited in the Instituto de Geociências, USP, from the area studied by Almeida in 1944 can no longer be maintained in the group Collenia ("group" and "form" are stromatolite taxonomy's equivalents of "genus" and "species") in view of both the creation of numerous new stromatolite groups and the concomitant restriction of the taxonomic concept of Collenia since C. itapevensis was described; (2) at least two different groups of columnar stromatolites -- one being Conophyton -- occur in this region and were figured by Almeida (1944); (3) the stromatolites of the Itaiacoca Formation differ not only from those of the Capiru Formation, as Marini and Bōsio (1971) first noted, but also from columnar stromatolites described from other parts of Brazil.

Regional Geologic Setting: The Açuñui Group consists of folded and faulted Upper Precambrian rocks of relatively low-grade metamorphic facies that crop out extensively in southeastern São Paulo and eastern Paraná. According to Fuck *et al.* (1971), the group includes four formations, the thicknesses and stratigraphic relationships of which are imprecisely known because of structural complexities. At the base of the group is the Capiru Formation, made up predominantly of dolostones (with stromatolites) and quartzites in its lower part and finer-grained clastic rocks in its upper part. Lithologically similar to, and possibly contemporaneous with, this formation is the stromatolitic Itaiacoca Formation, which is predominantly dolomitic but also contains abundant quartzite and lesser volumes of arkose, siltstone,

and metabasite.

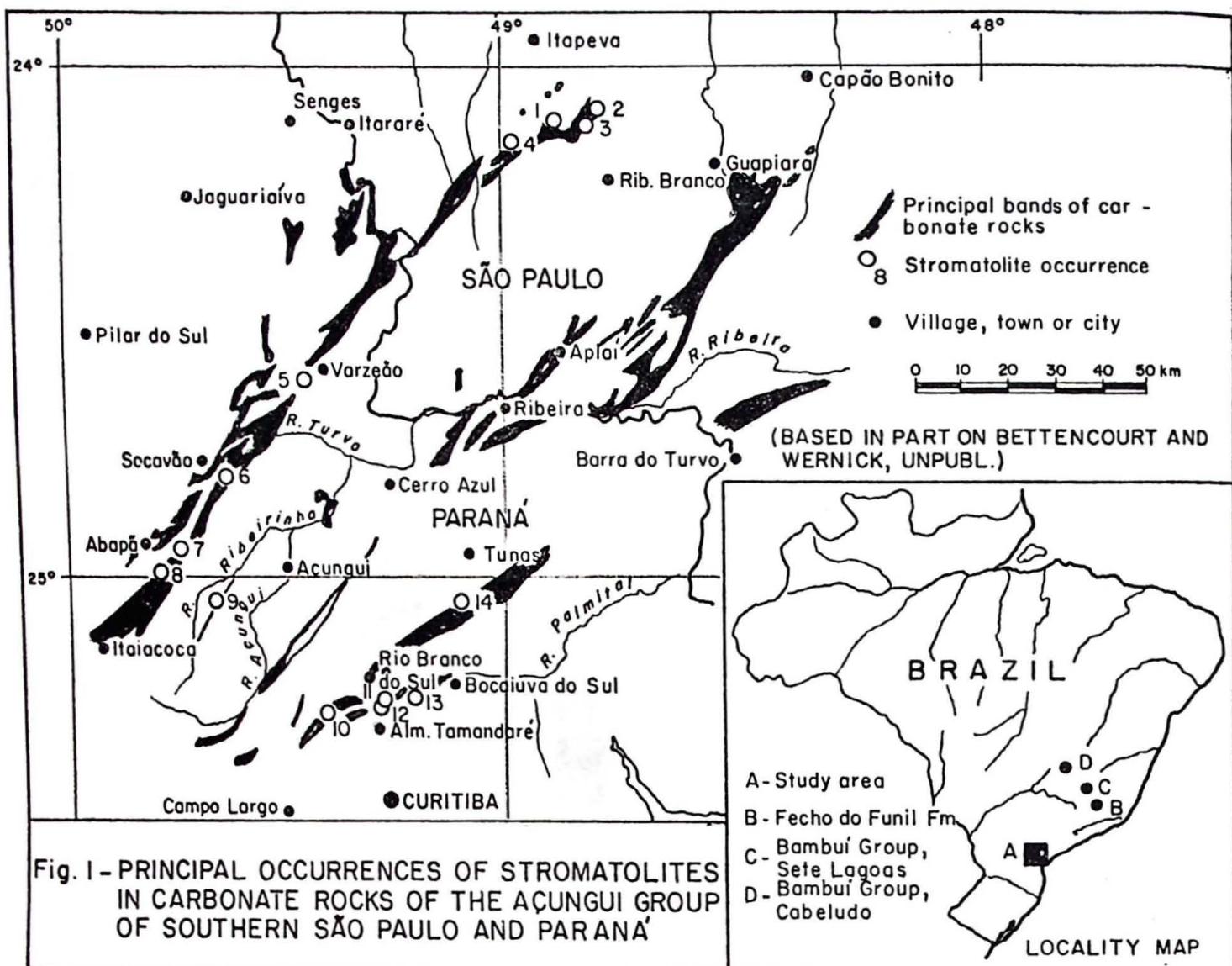


Fig. 1 - PRINCIPAL OCCURRENCES OF STROMATOLITES IN CARBONATE ROCKS OF THE AÇUNGUI GROUP OF SOUTHERN SÃO PAULO AND PARANÁ

The Votuverava Formation is possibly synchronous with both of the above formations and consists mostly of rhythmic, fine-grained sediments, but also includes quartzites, conglomerates, and non-stromatolitic limestones. Overlying the Votuverava Formation in apparent unconformity is the Água Clara Formation, made up mainly of calc-schists and limestones with minor phyllites and quartzites; from this formation, Almeida reported deformed stromatolites (1957). A fifth formation, the Setuva Formation (quartzites, mica-schists, and gneisses), was considered the basal unit of the Açuñui Group until Fuck *et al.* (1971) separated it from the group because of significant lithologic and metamorphic differences. High-grade migmatites comprise the Crystalline Complex which represents the basement complex for all these formations.

The Açuñui Group suffered greenschist facies metamorphism during the Brazilian geotectonic cycle (1000-500 m.y. ago). Syn-

tectonic granites intruding the upper units of the group have yielded minimum ages of 600-650 m.y. both by K-Ar methods (Cordani and Bittencourt, 1967) and by Rb-Sr methods (Cordani and Kawashita, 1971). Without offering supportive evidence, Fuck *et al.* (1971) suggest a probable age of 1300 to 2300 m.y. for the Crystalline Complex. More recent data tend to support this suggestion (M. Hama, oral comm., 1977). Present evidence thus indicates an age somewhere between 650 and 1300 m.y. for the Açungui Group.

Description of the stromatolites south of Itapeva: Almeida (1944) described the stromatolite Collenia itapevensis from light-colored dolostones at three localities (area of locs. 1, 2, Fig. 1a) south of Itapeva, SP. His original description may be summarized in more modern terms as follows: Very closely spaced, mostly parallel, very smooth-walled, columnar stromatolites up to 1.5 m high, with circular, elliptical, sub-prismatic, or less regular transverse outlines up to 50 cm in diameter, and with slightly to steeply convex or parabolic laminae. The stromatolites, he noted, are grouped together in "reefs" up to several meters thick.

Recently the author has studied two of Almeida's paratypes (Sample no. GP/3T80, Paleontology Collection, Instituto de Geociências, USP; figured specimens in this paper are also included in this collection) together with new material from his Campina do Veadó and Lavrinha localities as well as from other nearby localities (Fig. 1a). It is now evident that Almeida's concept of Collenia itapevensis includes at least two forms of columnar stromatolites, the more common one belonging to Conophyton Maslov and the other as yet unnamed. According to Hofmann (Table 16, fig. 22, 1969), the group name Collenia apparently should be used only for certain oncolitic stromatolites; oncolites are stromatolites resembling large pisolites. Thus, the two forms of columnar stromatolites from Itapeva do not belong in Collenia.

The Itapeva Conophyton (Figs. 2a-c, 3a,b) occurs in both Almeida localities visited by the author and is figured in Almeida's Pl. III, fig. 1 (1944). This stromatolite form is non-branching, columnar, and up to 85 cm high (Fig. 3b) and has a circular to elliptical transverse outline (Fig. 3a) up to 70 cm in diameter. Like all forms of Conophyton, it has conical

TABLE 1. Description of localities shown in Fig. 1a.

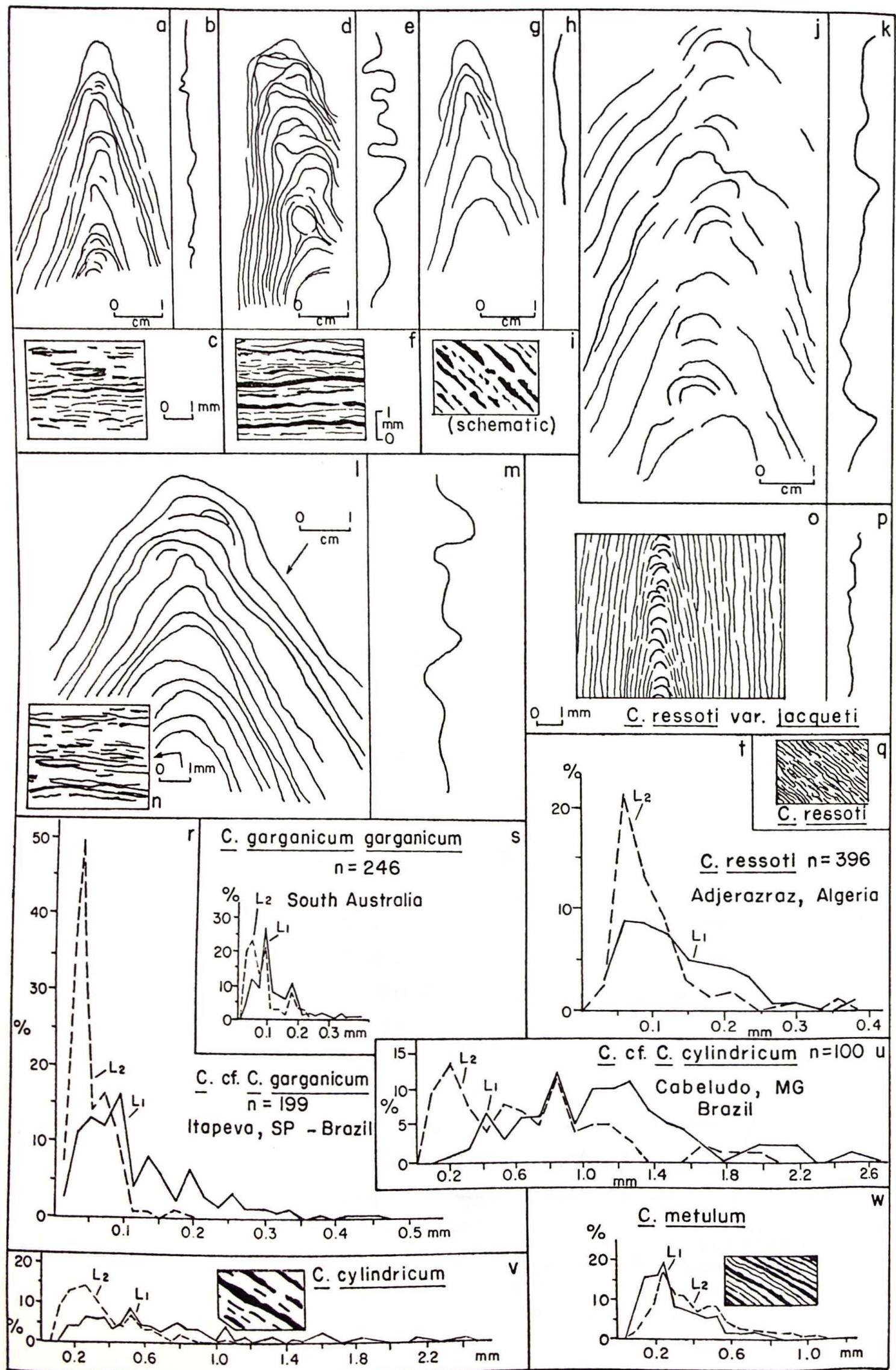
No.	Fm <sup>1</sup>	Locality <sup>2</sup>	
1	I	Abandoned quarry, 3 km S35W of <u>Campina do Veado</u> , or 17 km S15Km of Itapeva, SP.	17
2	I	<u>Lavrinha</u> (quarries of Industrias Votorantim and Bran- cal <sup>3</sup> ), 13 km SE of Itapeva, SP.	
3	I	<u>Indumine</u> <sup>4</sup> quarry (Cia. de Cimento Portland Maringá) and quarry <sup>4</sup> of "Chiquinho de Barros", 15 km S10E of Itape- va, SP.	
4	I	<u>Itanguá</u> <sup>5</sup> kiln and quarry, 20 km S30W of Itapeva, SP.	
5	I	Headwater region of the Rio Claro, <u>Varzeão</u> <sup>3</sup> District, Cerro Azul Municipality, PR.	
6	I	Outcrop, 6.5 km S13E of <u>Socavão</u> , PR.	
7	I	Outcrop, near the <u>Rio do Palmito</u> , PR, 3.25 km N60E from intersection of accessory road to E with PR 090 (Estrada do Cerne) at km 98.1.	
8	I	Outcrop, <u>Areia do Meio</u> , PR, 2.5 km S50W from intersec- tion of accessory road to SW with PR 090 at km 97.5.	
9	AC	Outcrop near <u>Erval</u> , PR, 7.4 km along road heading NE from PR 090 at km 79.9.	
10	C	Quarry of <u>Itabranca</u> , 5 km WNW of main intersection of PR 092 in Tranqueira, PR.	
11	C	Abandoned quarry, 900 m S75E of main intersection of PR 092 in <u>Tranqueira</u> , PR.	
12	C	Abandoned quarry of <u>Irmãos Busato</u> , 400 m E of km 18, PR 092.	
13	C	Large boulders at road side, 7.5 km N20E of Colombo, PR, near the <u>Gruta de Bacaetava</u> .	
14	C	Quarry, 200 m E of km 68.5, BR 476 (Estrada da Ribeira), 9.6 km S of <u>Tunas</u> , PR.	

<sup>1</sup>: Fm = Formation; I= Itaiacoca, AC= Água Clara, C= Capiru. <sup>2</sup>:Co  
mmon names for the localities are underlined; SP= São Paulo, PR=  
Paraná. <sup>3</sup>: Locality not checked by author. <sup>4</sup>: These quarries, un-  
like the other localities, are in limestone, not dolostone. <sup>5</sup>:  
Apparently different from the stromatolite locality of "Minera-  
ção Itanguá" near Bonsucesso, SP, reported by Petri and Suguio ,  
1969.

laminae with a narrow, central axial zone defined by the vertical, coaxial stacking of the apical thickenings in the laminae (Figs. 2a, d, g, j, l, o, 3b). In the four best studied Itapeva specimens (the largest being 14 cm in diameter), the laminae are steeply conical, the axial zones very narrow (less than 1 cm across), and midpoints of successive apical thickenings occasionally slightly off-center (Fig. 2b). The light (organic-poor) and dark (organic-rich) layers that comprise the stromatolite are very thin, generally 20 to 100  $\mu\text{m}$  and 20 to 40  $\mu\text{m}$ , respectively (Fig. 2r), and thicken only slightly in the axial zone. Microscopically, the lamination appears "striated" (Fig. 2c) due to the thinness and discontinuity of the dark laminae.

The combination of microstructural details of both the axial zone and lamination of this form clearly places it within the C. garganicum "subgroup" of Conophyton forms that have relatively con-

FIG. 2 (Next page): a-q: Tracings of axial long sections (a,d,g,j,l,o); lines connecting midpoints of thickened portions of laminae in the axial zones (b,e,h,k,m,p); and representative tracings (c,f,n) and schematic configurations (i,q,v,w) of laminae of examples of Conophyton. r-w: Percent frequency vs. lamina thickness for forms of Conophyton;  $L_1$  = light laminae,  $L_2$  = dark laminae. a-c: Conophyton cf. C. garganicum Korolyuk, south of Itapeva, SP (loc. 2, Fig. 1a, Table 1); thin sections GP/3T539-A, -B. d-f: C. metulum Kirichenko, Lagamar, MG; thin section GP/3T540-A. g-i, u: C. cf. C. cylindricum Maslov, Cabeludo, MG (loc. D, Fig. 1b); g, h traced from pl. II, fig. 4, i after fig. 6C, and u after fig. 6A of Moeri, 1972. j-k: "C. aff. C. metulum", Cabeludo, MG (loc. D, Fig. 1b); traced from fig. 2A, Cloud and Dardenne, 1973. l-n, s: C. garganicum Korolyuk, Paratoo, South Australia; l,m traced from fig. 12a, n from fig. 11e, and s after fig. 1h, Preiss, 1973. o,p: C. ressoti var. jacqueti Bertrand-Sarfati, Atar, Mauritania; after fig. 21b, Bertrand-Sarfati, 1972. q: Schematic microstructure of C. ressoti Menchikov, Africa; after fig. 2, Cloud and Semikhato, 1969. t: C. ressoti, Adjerazraz, Algeria; after fig. 19, Bertrand-Sarfati, 1972. v, w: Comparison of lamina thicknesses and schematic microstructures of C. cylindricum and C. metulum, respectively; after fig. 2, Cloud and Semikhato, 1969.



tinuous, smooth-bordered laminae generally thinner than  $150 \mu\text{m}$  (Walter, 1972). Of the members of this subgroup for which descriptions have been available, C. gorganicum Korolyuk (Fig. 21-n, s) and C. ressoti Menchikov (Fig. 2 o-q, t) (See Bertrand-Sarfati, 1972) are the most similar to the Itapeva form, especially with respect to the thickness and configuration of the organic-rich laminae. The dark laminae of the one statistically treated Itapeva specimen of Conophyton are more closely comparable to those of C. gorganicum than to those of C. ressoti (Compare Fig. 2r with Fig. 2s and t, and Fig. 2c with Fig. 2n and q). Hence, given the importance of laminar microstructure in Conophyton taxonomy, this form is here informally designated Conophyton cf. C. gorganicum.

The Itapeva Conophyton is easily distinguished from C. cf. C. cylindricum Maslov (Fig. 2g-i, see also Fig. 2v) (Moeri, 1972) from the Bambuí Group at Cabeludo, Minas Gerais (loc. D, Fig. 1b), by its laminar thickness and configuration, and from C. metulum Kirichenko (Fig. 2d-f, see also Fig. 2w) (Dardenne and Campos Neto, 1976), also from the Bambuí Group, Lagamar, MG (SE of loc. D, Fig. 1b), by its axial zone and laminar configuration. The specimen from Cabeludo figured by Cloud and Dardenne (1973, fig. 2A; see Fig. 2j, k, this paper), and tentatively identified as C. aff. C. metulum, is now considered by Dardenne (Oral comm., 1977) to be C. cylindricum; this specimen has a significantly broader and somewhat less regular axial zone than the Itapeva form.

The possibility that the Itapeva Conophyton may prove to be unquestionable C. gorganicum brings with it potential biostratigraphic consequences, for this form has been found on other continents only in rocks of early Late Riphean (inferred from Preiss, 1973, and Cooper and Compston, 1971) to Early Riphean age (Cloud and Semikhatov, 1969), that is, in rocks about 850 to 1700 m.y. old. On the other hand, should the resemblance to the North African specimens of C. ressoti (Bertrand-Sarfati, 1972) be more than fortuitous, then the age for the Itapeva Conophyton might be Late to Middle Riphean, that is, less than 1300 m.y. (Preiss, 1976b), and probably between 600 to 1000 m.y. (inferred from Bertrand-Sarfati and Raaben, 1970, Cloud and Semikhatov, 1969, and Preiss, 1976b). The possible age ranges suggested by these two forms, therefore, would lie within the present radiometric limits for

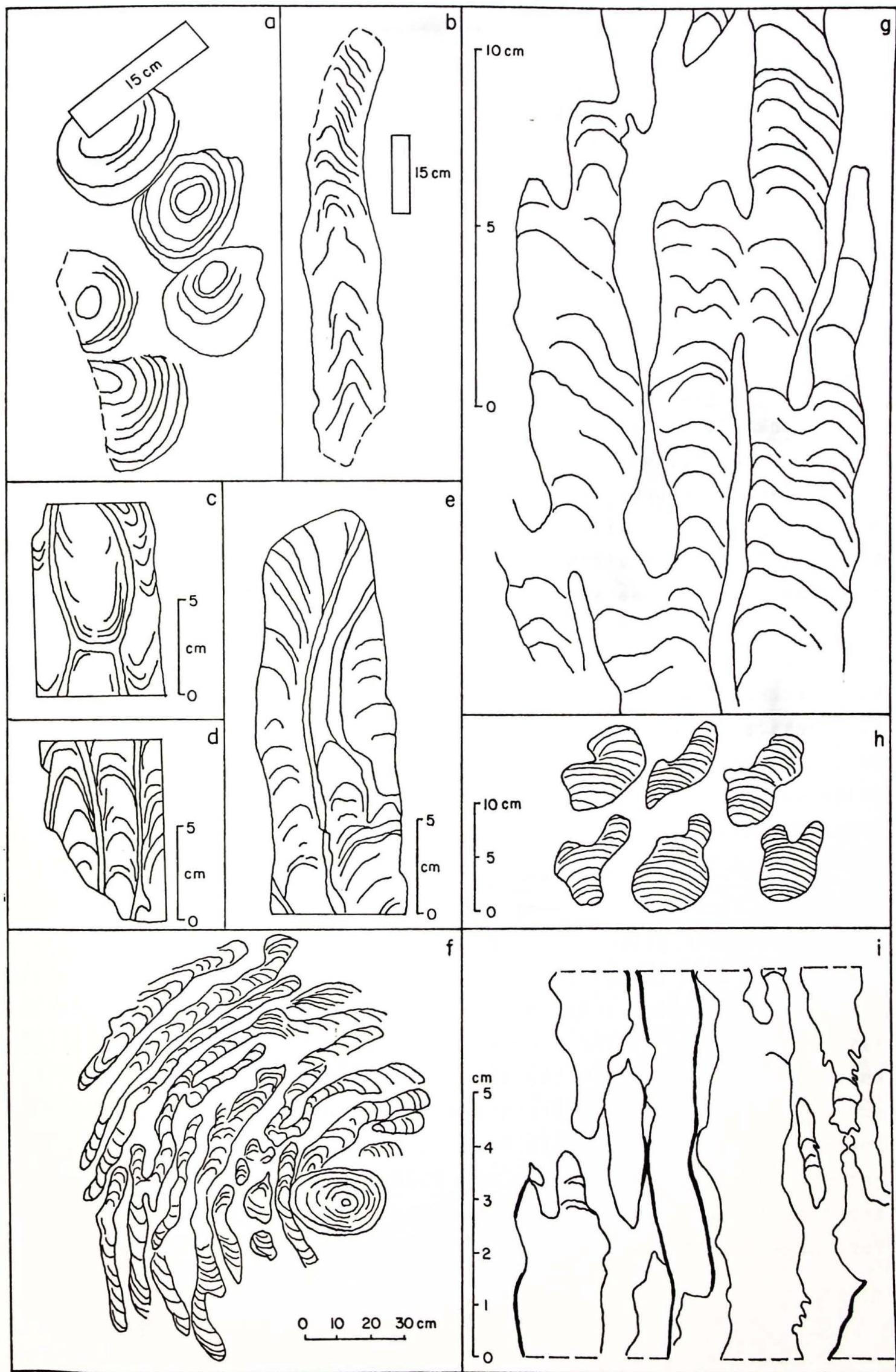
the age of the Açungui Group.

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FIG. 3 (Next page): a, b: Transverse and longitudinal sections, respectively of Conophyton cf. C. gorganicum Korolyuk from the Itaiacoca Formation, south of Itapeva, S.P. (loc. 2, Fig. 1a, Table 1); traced from photographs; dashed lines indicate broken margins of samples. c-e: Transverse (c) and longitudinal (d,e) sections traced from cut specimens of an unnamed, platey columnar stromatolite, Itaiacoca Formation, south of Itapeva, S.P., c and d from loc. 2 (Fig. 1a, Table 1) (sample GP/3T541); e is a paratype of Collenia itapevensis Almeida of unspecified provenance south of Itapeva (sample GP/3T80). f: Transverse section of Jacutophyton from Atar, Mauritania (after fig. 35g, Bertrand-Sarfati, 1972), showing Conophyton-like core and concentric, platey columnar stromatolites that have branched off the core at lower levels. Compare the concentric branches with c, above. g: "Gymnosolenid" stromatolites, Sete Lagoas Formation, Bambuí Group, west of Sete Lagoas, M.G. (loc. C, Fig. 1b). Note parallel branching and common coalescing of columns. Drawn from 35 mm slide. h, i: "Tungussid" and "kussiellid" stromatolites, respectively, Fecho do Funil Formation, Minas Supergroup, south of Cachoeira do Campo, M.G. (loc. B, Fig. 1b). h: after fig. 4, Dardenne and Campos Neto, 1975; i traced from cut specimen (sample GP/3T542). Note parallel branching and sheared stromatolite margins (heavy lines in i).

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The second columnar stromatolite form (Fig. 3c-e) included in Almeida's Collenia itapevensis is typified by its elongate, sub-prismatic transverse cross-section and by its smooth, sharply defined, walled margins. In the three samples available for study, including the paratype of Collenia itapevensis shown in Fig. 3e, individual columns range up to 25 cm in height and 20 cm in length but are commonly only 2-4 cm in width (Fig. 3c). The laminae are characteristically very convex to parabolic, although some are only slightly convex. They curve to meet the column margins almost tangentially, thereby forming a "wall", several laminae thick, that parallels the margin. The columns are very closely spaced (generally less than 2 cm apart) but not linked laterally. Branching appears



to be relatively common, with the branches arising as lateral projections or as projections in niches re-entrant within the column (Fig. 3e).

It is not yet possible to place this stromatolite within an established taxonomic group. However, its transversely elongate habit, close packing, and association with Conophyton (The author has seen this form only as loose blocks within a quarry where Conophyton is also found) are reminiscent of, but apparently not identical to, the platey, concentric branches that surround the Conophyton-like core of the Middle to Early Riphean (950-1700 m.y.) Jacutophyton Shapovalova (Fig. 3f).

Geographic distribution of stromatolites in the Itaiacoca Formation: Although the platey columnar stromatolite is known from only two localities in the Itaiacoca Formation (locs. 1, 2, Fig. 1a, Table 2), Conophyton has now been found in five of the six abundantly stromatolitic Itaiacoca localities (locs. 1-3, 7, 8, Fig. 1a, Table 2) that the author has visited. Conophyton, therefore, characterizes the stromatolite assemblage of the Itaiacoca Formation. In addition to the Itapeva forms, closely spaced, broad (to 50 cm), tall (to 50 cm), partly linked, non-branching stromatolites occur in the formation at the Socavão and Rio do Palmito localities; and Marini and Bósio (1971) have described laterally linked, hemispherical stromatolites up to tens of centimeters in diameter and up to 30 cm in height from near the Conophyton-bearing Areia do Meio locality.

Comparison of the stromatolites of the Itaiacoca, Capiru and Água Clara Formations: Marini and Bósio (1971) were the first to note differences between stromatolites of the Itaiacoca and Capiru Formations, even though only a single form from each formation was available for their study. Although space here does not permit detailed discussion of the four forms of columnar stromatolites now known from localities in the Capiru Formation (Fig. 1a, Table 2), summary descriptions are presented in Table 2, and representative specimens are illustrated in Fig. 4. Even so, the differences between the Capiru assemblage and that of the Itaiacoca Formation are clearly evident: Neither Conophyton nor the platey columnar form have been found in the Capiru Formation; moreover, the predo-

minantly sub-parallel to slightly divergent habit of branching (Fig. 4d-g) distinguishes most of the Capiru stromatolites from the Itaiacoca forms.

The deformed, relatively large dolomitic stromatolites occurring within a calcitic matrix in the Água Clara Formation (Fig. 1a, Tables 1, 2) are very strange structures that are too poorly known to be fairly compared with other stromatolites in the Açuñ-gui Group at this time.

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FIG. 4. -- Columnar stromatolites from the Capiru Formation, Açuñ-gui Group, north of Curitiba, Paraná. Dashed lines indicate margins of samples and uncertain limits of stromatolites. a-c: Non-bran-ching or infrequently branching, smooth-margined columnar stromato-lite from near Tranqueira, PR (loc. 11, Fig. 1a, Table 1); a drawn from 35 mm slide; b is traced from sectioned sample and shows lon-gitudinal (left) and transverse(right) sections (sample GP/3T543, loc. 12, Fig. 1a, Table 1). c is a graphic reconstruction of part of the column shown in transverse section in b and was constructed by a method modified from Hofmann (1976) and Preiss (1976a) (Sam-ple GP/3T543, faces IIIb to VIIa); the horizontal and vertical li-lines are equally spaced, though on different scales, in order to convey an idea of the three-dimensional configuration of the column. This is the first published graphic reconstruction of a South American stromatolite. Marini and Bósio (1971) illustrate other examples of this form. d-g: Branching, columnar stromatolites from north of Colombo, PR (loc. 13, Fig. 1a, Table 1) d and e are from the same large, loose block and show relatively smooth-walled stromatolites with slightly divergent branching. Flat-laminated bed separates the two stromatolite levels in d. f illustrates a slightly more divergently branching stromatolite with less regular margins, and g shows a form with slightly divergent, unequal bran-ches. d-f traced from photographs. g drawn from 35 mm slide of sam-ple GP/3T544.

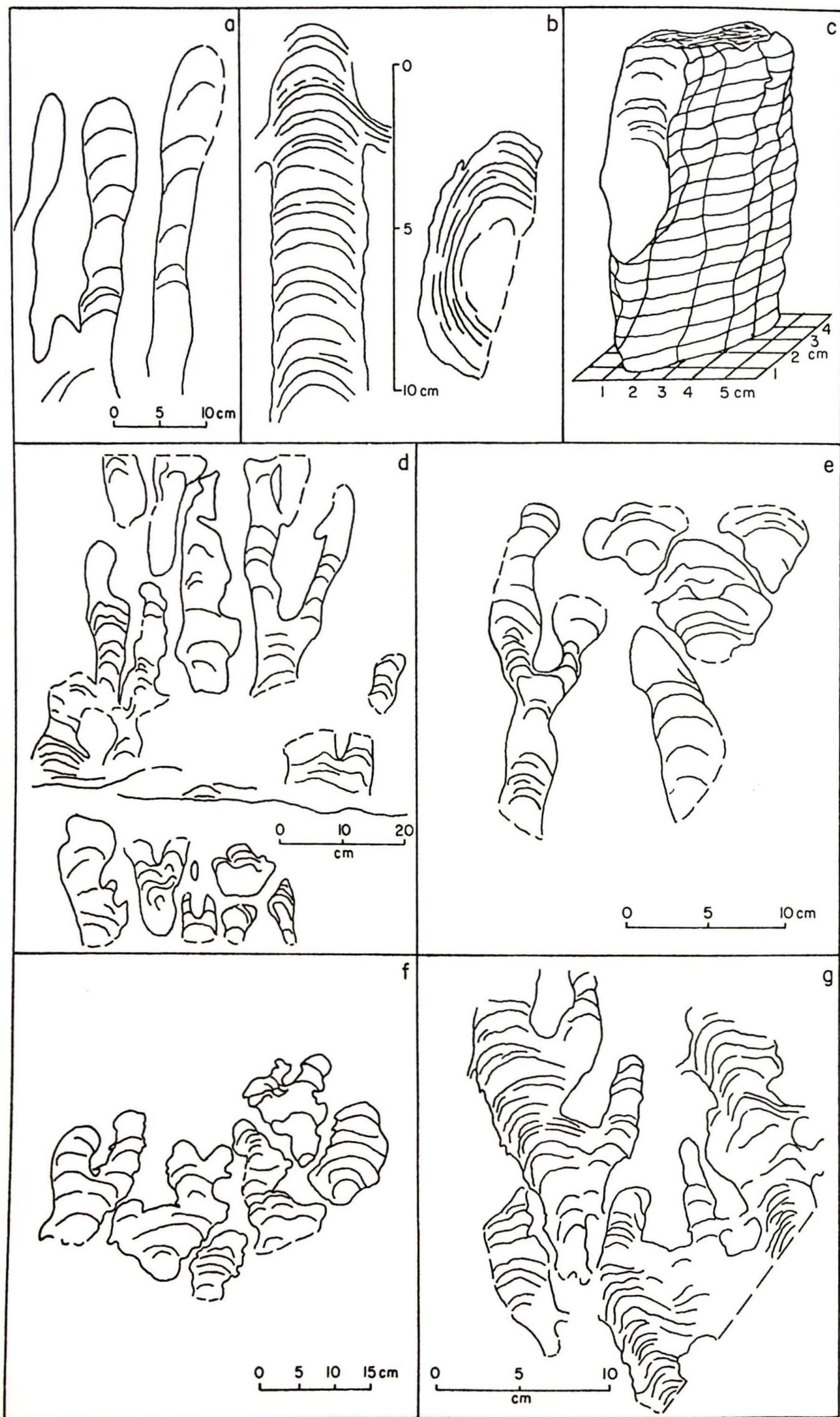


TABLE 2. Preliminary description and distribution of kinds of stromatolites in the Açungui Group.

Description	Distribution (Formation: locality numbers of Fig 1a and Table 1).
1. " <u>Collenia itapevensis</u> " reported by Almeida, 1957 .....	Itaiacoca: 1,2,3,5,6,7
2. <u>Conophyton</u> cf. <u>C. gorganicum</u> (*) and other unstudied samples of <u>Conophyton</u> (Figs. 2a-c, 3a,b) .....	Itaiacoca: 1,2*,3*,7,8
3. Platey, branching columnar stromatolites with distinct walls (Fig. 3c-e) .....	Itaiacoca: 1,2
4. Broad, closely spaced, partly linked, non-branching stromatolites with slightly convex laminae .....	Itaiacoca: 6,7
5. Irregular, undulatory bedding = stromatolites? .....	Itaiacoca: 4
6. Apparently deformed, branching(?) dolomitic stromatolites separated by calcitic interareas .....	Agua Clara: 9
7. Straight, non-branching, smooth, columnar stromatolites with possible walls (Fig. 4a-c) .....	Capiru: 11,12,14?
8. Parallel to slightly divergently branching, columnar stromatolites, occasionally expanding upwards), with smooth(walled?) margins(Fig. 4d-e) .....	Capiru: 10,11?,13,14?
9. Columnar stromatolites with slightly divergent, unequal branching and slightly ragged edges(Fig.4g). Capiru: 11,13	
10. Relatively short, broad, divergently branching, columnar stromatolites with slightly ragged margins (Fig. 4f) .....	Capiru: 11,13

Significance of the differences between the stromatolites of the Itaiacoca and Capiru Formations: The lack of columnar stromatolites common to both the Itaiacoca and Capiru Formations suggests either or both of two possibilities: (1) the two formations are of different ages, and/or (2) they represent different environments of deposition.

Evidence supportive of at least the latter possibility is contained in the stromatolites themselves. For example, the very fine, uniform, and continuous lamination in Conophyton cf. C. ganganicum suggests that this stromatolite must have formed in a relatively calm, completely submerged (probably subtidal) environment away from the harsh conditions of the intertidal zone. Erosional "micro-unconformities", which apparently form under conditions of energetic wave action and periodic desiccation such as occur on tidal flats, are lacking in the Itapeva stromatolites but are present in at least one form of Capiru stromatolite (no. 10, Table 2). Moreover, at the Itabranca locality in the Capiru Formation, small intraformational clasts occur between stromatolite columns and attest to nearby conditions of probable desiccation and reworking of penecontemporaneous sediments. Such clasts are not known between stromatolite columns in the Itaiacoca Formation. Thus, preliminary evidence suggests generally more energetic environmental conditions for the Capiru stromatolites than for the Itaiacoca forms. Whether the two assemblages also differ in age may become clear once forms from both have been thoroughly analyzed.

Comparison with stromatolites of the Minas Supergroup and the Bambuí Group: Although stromatolites have been found in more than 30 localities in the Brazilian Precambrian outside the Açu-gui Group, the only columnar forms whose biostratigraphic potential has been discussed are the following: (1) tectonized "tungussid" (Fig. 3h) and "kussiellid" (Fig. 3i) forms from the more than 1.8 b.y.-old (U.G. Cordani, oral comm., 1977) Fecho do Funil Formation of the Minas Supergroup (loc. B, Fig. 1b) (Dardenne and Campos Neto, 1975); (2) "gymnosolenid" stromatolites (Fig. 3g) from the Sete Lagoas Formation, Bambuí Group (loc. C, Fig. 1b) (Marchese, 1974); and (3) forms of Conophyton (Fig. 2 d-k), discussed here in a previous section, from the Bambuí Group (area of loc. D, fig. 1b) (Dardenne et al., 1971; Moeri, 1972; Cloud and Dardenne, 1973; Dar-

denne and Campos Neto, 1976). Comparison of the sketches of the platey Itapeva stromatolite (Fig. 3c-e) with those of the "gymnosolenid" (Fig. 3g), "tungussid" (Fig. 3h), and "kussiellid" (Fig. 3i) stromatolites reveals at a glance significant differences in laminar and columnar shapes, marginal outlines, and branch habits.

Conclusions: Preliminary results of a study of stromatolites from the Upper Precambrian Açungui Group of southeast Brazil suggest the following conclusions:

(1) Included in the original concept of Collenia itapevensis Almeida 1944 from the Itaiacoca Formation are two forms of columnar stromatolites -- one assignable to Conophyton cf. C. garginicum and the other not yet named--that can no longer be maintained within the group Collenia.

(2) Of the stromatolites occurring in the Itaiacoca Formation, the most widespread and distinctive is Conophyton. In contrast, the stromatolite assemblage of the Capiru Formation lacks Conophyton and is, in fact, quite distinct from the Itaiacoca assemblage. The differences between the assemblages seem to be at least partly environmental in origin, the Itaiacoca assemblage representing a calm, probably subtidal environment and the Capiru assemblage representing a more energetic, possibly partly intertidal setting. Whether the two assemblages also differ in age is not known at present.

(3) The above observations support other geologic evidence favoring the maintenance of the Itaiacoca and Capiru Formations as separate stratigraphic units.

(4) The columnar stromatolites of the Itaiacoca Formation also differ from older stromatolites in the Minas Supergroup and from forms in the Bambuí Group.

(5) It is premature to attempt to assign an absolute age to the Açungui Group on the basis of its stromatolites. Nevertheless, the following observation may be made: The age of the Itaiacoca Formation could lie between 850 to 1700 m.y. or 600 to 1000 m.y. depending upon whether future research confirms the tentative identification of the Itapeva Conophyton as C. garginicum (the favored hypothesis) or as C. ressoti, respectively.

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