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Globusphyton Wang *et al.*, an Ediacaran macroalga, crept on seafloor in the Yangtze Block, South China

YE WANG[1] AND YUE WANG[2]

[1]*School of Earth Sciences and Resources, China University of Geosciences, Beijing 100083, China*

[2]*School of Resources and Environments, Guizhou University, Guiyang 550025, China (e-mail: gzyuewang@126.com)*

Abstract. The Ediacaran genus *Globusphyton* Wang *et al*., only including one species *G. lineare* Wang *et al*., is a eukaryotic macroalga in the Wenghui biota from black shale of the upper Doushantuo Formation (*ca.* 560–551 Ma) in northeastern Guizhou, South China. It was assigned as one of significant fossils in the assemblage and biozone divisions in the middle-late Ediacaran Period. Morphologically, *Globusphyton* is composed of several structural components, displaying that it had tissue differentiation to serve various bio-functions. Its prostrate stolon, a long ribbon bundled by unbranching filaments, crept by holdfasts on the seafloor. Its pompon-like thalli, the circular to oval thallus-tuft composed of many filamentous dichotomies, may have served for photosynthesis. The fusiform ribbon-tubers, the caked and expanded segments of the ribbon, may have served to sustain the growth of the thalli and the possible holdfasts. The zigzag-shaped stolon and pompon-like thalli of *Globusphyton*, in a relatively low-energy environment, were crept on the surface of the muddy sediments and suspended in water column, respectively. When water current occurred occasionally, all or part of its body was probably suspended in the water column to

be deformed as a variable pattern.

Key words: Ediacaran Wenghui biota, macroscopic alga, pompon-like thallus, prostrate stolon, South China.

Running Head: Ediacaran macroalga crept on seafloor

Introduction

The macroscopic algae were reported in the Pre-Ediacaran (see Walter *et al.*, 1976, 1990; Du and Tian, 1985; Hofmann, 1985, 1992; Du *et al.*, 1986; Han and Runnegar, 1992; Kumar, 1995; Zhu and Chen, 1995; Yan and Liu, 1997; Sharma and Shukla, 2009; Singh *et al.*, 2009; Babu and Singh, 2011; Zhu *et al.*, 2016). However, more abundant and diverse macroscopic algal communities were found in the Ediacaran Chinese macro-biotas, including the Lantian flora from southern Anhui (Tang *et al.*, 1997; Chen *et al.*, 1994a; Yuan *et al.*, 1995, 1999, 2011), the Wenghui biota from northeastern Guizhou (Wang *et al.*, 2007, 2008, 2009, 2011, 2014, 2015a, b, 2016a; Wang and Wang, 2008, 2011; Tang *et al.*, 2008a, 2009, 2011; Zhu *et al.*, 2008), the Miaohe biota from western Hubei (Chen and Xiao, 1991; Chen *et al.*, 1994b, 2000; Steiner, 1994; Ding *et al.*, 1996; Xiao *et al.*, 2002, 2013; Tang et al., 2008b), the Wulingshan biota from western Hunan (Steiner *et al.*, 1992; Steiner, 1994; Chen *et al.*, 1999; Chen and Wang, 2002), and the Jiangchuan biota of eastern Yunnan (Tang *et al.*, 2007, 2009), in the Yangtze Block, South China (Figure 1A). The Eidacaran Wenghui biota, which has been found in black shales of the upper Doushantuo Formation in northeastern Guizhou (Figure 1B, C), is preserved as carbonaceous compressions (more than 31 genera and 33 species) (Wang *et al*., 2016a) and dominated by macroscopic algae (see Wang *et al*., 2007, 2009, 2011, 2014, 2015a, 2016a). The emergence of morphological and ecological diversities is a main characteristic of the Ediacaran macroalgae (Wang *et al*., 2011, 2015a).

The carbonaceous genus *Globusphyton* Wang *et al*. (2007) is one of many taxa in the Ediacaran Wenghui biota and was assigned as one of significant fossils in the divisions of assemblages and biozones (Wang *et al*., 2011, 2014, 2015a, 2016a). When this genus had been established by Wang *et al*. (2007), it, in morphology, was briefly discussed and considered as a macroscopic alga crept possibly on seafloor. Later, the interpretation of Wang *et al*. (2007) was cited, without discussion (Wang *et al*., 2009, 2011, 2014, 2015a). Recently, numerous specimens of *Globusphyton* have been collected from black shales of the upper Doushantuo Formation at Wenghui Village, Jingkou, Guizhou (Figure 1B). This study represents more details morphological features and discusses paleoecology and affinities of *Globusphyton* based on the newly-found specimens. Moreover, the creeping algae with prostrate stolon are living in modern seafloor (see Felicini and Perrone, 1994; Chisholm *et al*., 1996; Shimada and Masuda, 2000; Chisholm and Moulin, 2003; Tronchin and Freshwater, 2007), although there was few report about the Pre-Cambrian macroalga with prostrate stolon. Therefore, the study on the Ediacaran macroalgae with prostrate stolon is a potential significance in evolution of macroscopic algae crept on seafloor.

Stratigraphical and environmental settings

In the Wenghui section (27°50′07″ N, 109°01′20″ E), the Ediacaran Doushantuo Formation (>71 m thick) can be re-divided into four members (Figure 1C). The lowest Member I, overlying the tillites of the Nantuo Formation, is composed of dolostones (cap carbonates). The overlying Member II consists of muddy dolostones and black shales. The

Member III is composed of dolostones and muddy dolostones, with black shales. The uppermost Member IV, underlying the bedded cherts of the Liuchapo Formation, is characterized by black shales with abundant and diverse compression fossils (i.e. the Wenghui biota). In the fossiliferous black shales, not only macroscopic fossils but also filamentous rhizoids of macroalgae are well preserved, so that the previous researchers believed that this biota lived in a relatively low-energy, calm environment and was preserved *in situ* or nearby their growth position (Wang *et al*., 2007, 2009, 2010, 2011, 2014, 2015a; Wang and Wang, 2006, 2011; Cheng *et al*., 2013).

In Zigui section (Figure 1D), west Hubei, about 380 km north of Wenghui, a zircon U–Pb thermal ionization mass spectrometry ages from the top of the Doushantuo Formation is 551.1±0.7 Ma (Condon *et al*., 2005) and a Re–Os age of the base black shale of the Doushantuo Member IV is 591.1±5.3 Ma (Zhu *et al*., 2013). However, Kendall *et al*. (2015) suggested that the Re–Os age of Zhu *et al*. (2013) may reflect post-depositional alteration; and they estimated the age of the lowest Member IV as *ca*. 560 Ma (Kendall *et al*., 2015) for the beginning of extensive ocean oxygenation, after the *ca*. 580 Ma Gaskiers glaciation (Canfield *et al*., 2007; Li *et al*., 2010; Och and Shields-Zhou, 2012; Johnston *et al*., 2013; Tahata *et al*., 2013). Lithologically, many researchers considered that the Doushantuo successions can be correlated in both Wenghui and Zigui sections (Qin *et al*., 1984; Wang *et al*., 1987; Liu and Xu, 1994; Zhu *et al*., 2007; Jiang *et al*., 2011; Wang *et al*., 2012). In addition, the Miaohe biota has also been found in the upper Doushantuo black shales (the entire Member IV) at Miaohe, Zigui (see Chen and Xiao, 1991; Chen *et al*., 1994b, 2000; Steiner, 1994; Ding *et al*., 1996; Xiao *et al*., 2002, 2013), coinciding with oxygenated middle-late Ediacaran oceans (Kendall *et al*., 2015; Li *et al*., 2015). Both Miaohe and Wenghui biotas can be paleontologically correlated (Wang *et al*., 2007, 2011, 2012, 2014, 2016a; Tang *et al*., 2009; Wang and Wang, 2011), sharing many same species (e.g. *Baculiphyca taeniata*, *Beltanelliformis brunsae*, *Enteromorphites siniansis*, *Eoandromeda octobrachiata*, *Liulingjitaenia alloplecta*, *Longifuniculum dissolutum*, *Miaohephyton bifurcatum*, *Protoconites minor*, and *Zhongbaodaophyton crassa*).

Systematic Paleontology

All studied specimens preserved as carbonized compression have been collected from the lower Member IV black shales of the Ediacaran Doushantuo Formation in the Wenghui section, northeast Guizhou, and are housed in Guizhou University, China.

Genus ***Globusphyton*** Wang, Wang and Huang, 2007, emend.

Type species.—*Globusphyton lineare* Wang, Wang and Huang, 2007.

Original diagnosis.——Carbonaceous compression, like a string of beads, consisting of many thallus-tufts on a ribbon. The ribbon is tightly twisted by unbranching filaments; and the circular to oval thallus-tuft is radiately scattered dichotomous filaments from a ribbon-tuber, on the ribbon. The ribbon is distinctly knee-bent at the ribbon-tubers (Translated from Wang *et al*., 2007).

Emended diagnosis.——Carbonaceous compression with several structural components: a long ribbon, thallus-tufts, ribbon-tubers, and nodules (Figure 2). The circular to oval thallus-tuft is composed of many dichotomously branching filaments that are emanated radially from a ribbon-tuber. The ribbon-tuber is a caked and expanded segment of the ribbon and is irregularly distributed in the ribbon. The ribbon, a bundle of unbranching filaments, is distinctly knee-bent near the ribbon-tubers to show a zigzag pattern in the well-preserved specimens, or irregularly curved to form a varied preservation. The small nodule is observed near the center of the ribbon-tuber.

Discussion.——When the Ediacaran genus *Globusphyton* was established, Wang *et al.* (2007) considered that the ribbon is tightly twisted by unbranching filaments and covered up by the ribbon-tubers. After examining all specimens from the Wenghui biota, including the newly collected specimens and the collections of Wang *et al.* (2007, 2009, 2010, 2011, 2014, 2015a), the ribbon is a bundle of unbranching filaments, not twisted by unbranching filaments; and the ribbon-tuber, a three-dimensionally carbonaceous mass, is a caked and expanded segment of the ribbon, not cover on the ribbon.

The genus *Globusphyton* is similar to the Ediacaran genus *Anhuiphytom* (Chen *et al.*, 1994a, emend. Yuan *et al.*, 1999), having unbranching filaments but without ribbon-tuber and ribbon. It is characterized by the circular to oval thallus-tufts that many filamentous dichotomies scattered radially from a ribbon-tuber distributed irregularly in a long bundle of unbranching filaments, to differ from other Pre-Cambrian macroalgae.

Occurrence.——The upper Doushantuo of the Ediacaran at Wenghui, Guizhou, South China.

Globusphyton lineare Wang, Wang and Huang 2007, emend.

Figures 3–4

Globusphyton lineare Wang, Wang and Huang, 2007, p. 832, pl. I, figs. 22, 23; Wang *et al.*, 2009, no description, fig. 2.13; Wang *et al.*, 2010, no description, fig. 2J; Wang *et al.*, 2011, no description, fig. 3K; Wang *et al.*, 2014, no description, fig. 3m, n; Wang *et al.*, 2015a, no description, fig. 3L, M.

Longifuniculum dissolutum Steiner, Erdtmann and Chen, 1992; Wang et al., 2007, p. 833, pl. II, fig. 6 (on the upper-left); Wang *et al.*, 2015a, no description, fig. 4O (on the bottom-left).

Examined material.——Holotype (MH-40-0248; Figure 3A, B) assigned by Wang *et al*. (2007) and other 47 specimens housed in School of Resources and Environments, Guizhou University, China.

Emended diagnosis.——As per genus.

Description.——Carbonaceous compression with a long ribbon, thallus-tufts, ribbon-tubers, and nodules on bedding planes of black shales (Figure 2). The long ribbon, a bundle of unbranching filaments (Figures 3A, 4C, E, I, J), curled or sinuous or nearly straight, is commonly a zigzag pattern knee-bent near the ribbon-tubers in well-preserved specimens (Figures 3A–I, 4E, F), or an irregularly variable preservation (Figure 4A–D, G–J). The fusiform ribbon-tuber, a carbonaceous mass, is a caked and expanded segment of the ribbon and is irregularly distributed in the ribbon (Figures 3A, B, I, 4A, E, I, J). Near the center of the ribbon-tuber, a small nodule is vaguely observed (Figures 3D, H, 4B). The ribbon-tubers and nodules are usually the three-dimensional preservations (Figures 3A–E, H, 4A–C). The thallus-tuft is composed of many dichotomously branching filaments that are emanated radially from a ribbon-tuber (Figures 3A–I, 4A–J); and their filaments branch up to four times with dichotomies (Figures 3B, D). In the circular to oval thallus-tufts, the density of these filamentous dichotomies gradually reduces toward periphery (Figures 3A–E, G, H, 4A–C, E–J). It can be observed, in few specimens, an expanded end of the ribbon, with some short spiked-up filaments on its surface (Figure 4C, D).

Measurements.——The thallus-tuft is 8.7–19.2 mm in diameter. The ribbon-tuber is 0.3–2.3 mm in diameter and 2.4 mm to 12.8 mm in length, respectively. The ribbon varies from 0.1 mm to 0.7 mm in width. The length of the ribbon segment between two ribbon-tubers is changeable, varying from 3.2–46.7 mm. The nodule in the center of the ribbon-tuber is about 0.3 mm in diameter.

Discussion.——*Globusphyton lineare* is different from *Longifuniculum dissolutum* (Steiner *et al*., 1992) in that the latter has many loosened segments, irregularly distributed in a twisted bundle of filaments. Its expanded end of the ribbon is similar to *Gemmaphyton taoyingensis* (Wang *et al*., 2016a) and all species of *Longfengshania* (Du, 1982), but the former has many short spiked-up filaments on its surface and is expanded by a bundle of unbraching filaments, not a stipe or axis. The ribbon of *G. lineare* is different from *Liulingjitaenia alloplecta* (Chen and Xiao, 1991, emend. Steiner, 1994) in that the latter was a wider cylindrical tube with helical folds.

Locality and horizon.——The lower part of the upper Doushantuo black shales at Wenghui, Jiangkou, Guizhou, China.

Morphological features and paleoecological reconstruction

In the Wenghui section in northeastern Guizhou, the Ediacaran compression *Globusphyton* has been found in the lower part of the upper Doushantuo black shales (Figure 1C), so that it was assigned as one of significant fossils in the *Protoconites*–*Linbotulitaenia*–*Eoandromenda*–*Anomalophyton* assemblage biozone (Wang *et al*., 2016a) and the *Globusphyton* assemblage (Wang *et al*., 2011, 2014, 2015a, 2016a). Based on the brief discussions on the characteristics, Wang *et al*., (2007) considered that *Globusphyton* probably was, in morphology, a macroscopic alga crept on the sediment surface; and then this view was cited (Wang *et al*., 2009, 2010, 2011, 2014, 2005a).

The thallus-tuft of *Globusphyton lineare*, which is a circular to oval pattern in outline on the bedding plane of black shales (Figures 3A–E, G, I, 4A–C, E–J), gradually decreases the density of the dichotomous filaments toward its periphery (Figures 3A–E, G, H, 4A–C, E–J). In the thallus-tufts, the dichotomous filaments are emanated radially from a ribbon-tuber

(Figures 3A–I, 4A–J), and generally display that the shorter dichotomies cover on the longer dichotomies (Figure 3A–E). The fusiform ribbon-tuber in the three-dimension consists of a caked and expanded segment of the ribbon (Figures 3A–E, 4A–C, E); and the small nodule also is three-dimensionally preserved near the center of the ribbon-tuber (Figures 3D, H, 4B). Although it is no evidence whether the dichotomous filaments of the thallus-tufts are linked together with the small nodule, it is clearly observed that some dichotomous filaments are grown up from the fusiform ribbon-tuber (Figures 3A, D, F, 4E). In addition, these dichotomous filaments branch up to four times (Figures 3B, D, F, 4F), indicating that they were closely dependence with sunlight. Therefore, the circular to oval thallus-tuft with many filamentous dichotomies can be regarded, in life position, as a pompon-like thallus grown on an expanded ribbon-tuber, to serve for photosynthesis by the dichotomous filaments (Figure 5A).

Although the holdfast of *Globusphyton lineare* has been not discovered, it is not possible to exclude that its holdfast has not been able to separate from the filaments of the thallus-tufts or has been covered by the ribbon-tuber or only preserved its top part as the nodule. On the thin sections, it is difficult to distinguish whether the carbonaceous fibers in black shales are as parts of *G. lineare* or other macrofossils, because the macrofossil preservation in the Wenghui biota commonly is dense in the millimeter-level columnar sections (see Wang *et al*., 2014). By the reasons of the ribbon-tuber caked and expanded by the ribbon and the small nodule near the center of the ribbon-tuber, the nodule can be better interpreted as a remained top part of the holdfast of *G. lineare*. In all studied specimens from the Wenghui section in northeast Guizhou, the ribbon is either curved irregularly in the disorderly preserved specimens (Figure 4A, C, G–J), or zigzagged regularly near the ribbon-tubers in the well-preserved specimens (Figures 3A–C, G, I, 4E, F). In addition, the ribbon segment between two adjacent ribbon-tubers is more regular and straighter in the zigzag-shaped ribbon than in the disordered ribbon; and the disorder ribbon is more inflexibly bent in the ribbon-tuber segments than in other segments (Figure 4A, C, H–J). Wang and Wang (2006) and Wang *et al*. (2011, 2014, 2015a, b, 2016b) suggested that the Wenghui biota lived in a relatively low-energy environment, with occasional currents. Thus, the zigzag-shaped ribbon of *G. lineare* was probably its original nature when it lived; and the disordered ribbon can be interpreted as a deformed pattern after when it had been transformed by current. However, this originally zigzag-shaped nature means that the ribbon of *G. lineare* was fixed by some possible holdfasts to close on the sediment surface rather than suspended in the water column. The benthic organisms of the middle-late Ediacaran Wenghui biota generally have holdfast to anchor themselves to soft muddy sediments (see Wang *et al*., 2007, 2011, 2015b, 2016a, b). The Ediacaran macroalga *Anhuiphytom lineatum* (Chen *et al*., 1994a, emend. Yuan *et al*., 1999), with many unbranching filaments grown radially out an unseen center, without ribbon-tuber and holdfast, was considered that it had a possible holdfast (Yuan *et al*., 1999; Wang *et al*., 2016a). The ribbon-like compression *Grypania spiralis* (Walter *et al*., 1976, emend. Walter *et al*., 1990) from the Palaeoproterozoic to the Ediacaran (see Walter *et al*., 1976, 1990; Hofmann, 1985; Du *et al*., 1986, Han and Runnegar, 1992; Kumar, 1995; Sharama and Shukla, 2009; Wang *et al*., 2016b), which no holdfast has been discovered, also was interpreted as a benthic alga fixed to the seafloor by the innermost end of its coiled ribbon (Walter *et al*., 1990; Wang *et al*., 2016b). By comparison, *G. lineare*, with the three-dimensional ribbon-tubers and nodules and the zigzag-shaped ribbon, can be interpreted as a benthic macroalga with holdfasts.

Moreover, the interpretations about *Globusphyton lineare* with the originally zigzag-shaped nature as well as the holdfasts are able to provide supporting each other, not mutually exclusive. Namely, the zigzag-shaped ribbon, in life position, may have served as a long prostrate stolon to creep by the possible holdfasts on the sediment surface. During the Ediacaran times, there were ocean currents occasionally prevailed in the Guizhou Sea (Wang and Wang, 2006; Wang *et al*., 2011, 2014, 2015a, b); and Wang and Wang (2006) estimated that the upper Doushantuo back shales were hydrous muds with water content of 78% during deposition. Thus, the holdfasts of *G. lineare* were easily pulled out from the hydrous muds when an ocean current occurred. After removed the anchorages of holdfasts, all or part of *G. lineare*' body was suspended in the water column so that the zigzag-shaped ribbon and the fusiform ribbon-tubers were deformed and preserved as a variable pattern (Figure 5B).

At last, the expanded end of the ribbon (Figure 4C, D), with short spiked-up filaments, can also be interpreted as an embryo ribbon-tuber, a next ribbon-tuber, preparing for the growth of the thallus-tuft (pompon-like thallus) and the possible holdfast.

Given the above, *Globusphyton lineare* was a benthic macroalga, with a long prostrate stolon crept by holdfasts on the Eidacaran seafloor, the pompon-like thalli for photosynthesis, and the ribbon-tubers sustained the growth of the pompon-like thallus and the possible holdfast.

Systematic affinity of *Globusphyton*

Globusphyton in the Wenghui biota, a centimeter-scale compression fossil, is almost entirely composed of carbonaceous filaments (e.g. the thallus-tuft composed of filamentous dichotomies and the ribbon bundled by unbranching filaments). Thus, it was regarded and described as a macroscopic alga, when Wang *et al*. (2007) established the Ediacaran genus *Globusphyton*. Generally, tissue differentiation was considered as a key trait of eukaryotic alga (see Du and Tian, 1985; Yuan *et al*., 1995, 2011; Ding *et al*., 1996, Chen *et al*., 2000; Xiao *et al*., 2002; Wang and Wang, 2006; Wang *et al*., 2015b, 2016b). Some Ediacaran macroalgae with the dichotomously branching thallus (e.g. *Doushantuophyton*, *Enteromorphites*, *Miaohephyton*, and *Zhongbaodaophyton*) were generally regarded as eukaryotic algae (see

Chen and Xiao, 1991; Chen *et al*., 1994b, 2000; Steiner, 1994; Yuan *et al*., 1999, 2011; Xiao *et al*., 1998, 2002; Wang *et al*., 2007, 2014, 2015a, b). Similarly, *Globusphyton* had tissue differentiation to serve various bio-functions (see above discussions) and the filaments in the thallus-tuft branch dichotomously many times (Figures 3B, D, F, 4F). In addition, the carbonaceous ribbon-tubers were three-dimensionally preserved and inflexibly bent, meaning that they were probably to be filled by cells. Therefore, *Globusphyton*, with dichotomously thalli and a long prostrate stolon, was a high eukaryotic macroalga.

Comparatively, some modern macroscopic algae with prostrate stolon, thallus, and holdfast, such as chlorophytes *Caulerpa* (Chapman and Chapman, 1976; Boudouresque *et al*., 1995; Chisholm *et al*., 1996; Chisholm and Moulin, 2003) and rhodophytes *Pterocladiella* (Santelices, 1978; Felicini and Perrone, 1994; Shimada and Masuda, 2000; Tronchin and Freshwater, 2007), are creeping to live on seafloor. The Ediacaran macroalga *Globusphyton* has been an ecological similarity with modern algae with stolon although further examination is necessary to discuss on its phylogenetic affinity.

Conclusions

Numerous specimens of the carbonaceous compression *Globusphyton*, one of the Ediacaran genera, have been collected from of the upper Doushantuo black shale (*ca.* 560–551 Ma) in northeastern Guizhou, South China. *Globusphyton* has several structural components: thallus-tufts, ribbon-tubers, nodules, and a long ribbon, indicating that it had emerged tissue differentiation to serve various bio-functions. The circular to oval thallus-tuft, which is composed of many filamentous dichotomies clustered on the ribbon-tuber, may have served as a pompon-like thallus for photosynthesis. The three-dimensionally preserved ribbon-tuber, a caked and expanded segment of the ribbon, may have served to sustain the growth of the thallus and the possible holdfast. The ribbon, a bundle of unbranching filaments, may have served as a long prostrate stolon to close on the muddy seafloor. The small nodule near the center of the ribbon-tuber may be the top part of the possible holdfast to fix the ribbon-tuber and anchor the prostrate stolon. The Ediacaran *Globusphyton*, a eukaryotic macroalga, lived in a low-energy environment; and in life position, its zigzag-shaped stolon and pompon-like thalli were crept on the surface of the muddy sediments and suspended in water column, respectively. When water current occurred occasionally, all or part of its body was probably suspended in the water column to be deformed and preserved as a variable pattern. Nevertheless, its phylogenetic affinity requires further research owing to the compression and homogenization of the carbonaceous specimens.

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Figure 1. Location and stratigraphic positions of *Globusphyton* in the Ediacaran Dushantuo Formation, northeastern Guizhou, South China. **A,** Ediacaran palaeogeographical configuration of the Yangtze region (modified from Liu and Xu, 1994 and Jiang *et al*., 2011) and the distributions of the Ediacaran Chinese macro-biotas in South China; **B,** location of the measured section near Wenghui, Jiangkou, Guizhou, China; **C, D,** measured sections through the Doushatuo Formation at Wenghui (C) and Miaohe (D), showing the stratigraphic positions

of the *Globusphyton*-bearing intervals.

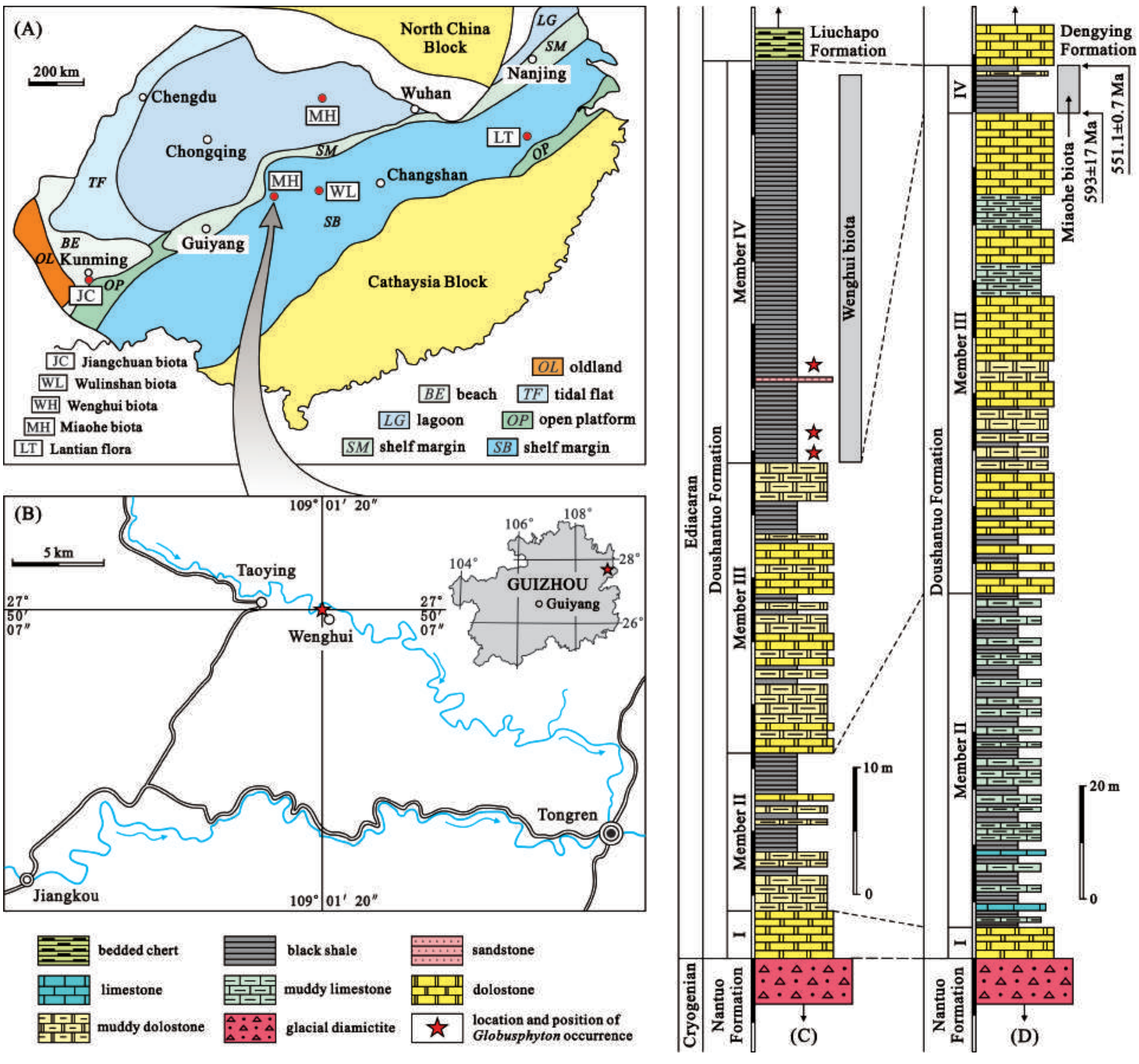
Figure 2. Drawing of the principal structures of *Globusphyton*.

Figure 3. *Globusphyton lineare* from black shales of the Ediacaran upper Doushantuo Formation, Wenghui, Guizhou, China. **A, B,** specimen MH-40-0248 (holotype); A, complete specimen; B, magnified view of A, showing the thallus-tufts grown on the three-dimensional ribbon-tubers; **C, D,** specimen WH-P-01019; C, complete specimen; D, magnified view of C, showing the dichotomous filaments grown on the fusiform ribbon-tuber; arrow shows the nodule; **E, F,** specimen WH-P-01005; E, complete specimen; F, magnified view of E, showing the dichotomous filaments grown on the ribbon-tuber; **G, H,** specimen MH-41-0730; E, complete specimen; H, magnified view of G, showing a three-dimensional nodule near the center of the ribbon-tuber; **I,** specimen WH-P-01004, showing a zigzag-shaped ribbon and the thallus-tufts on the ribbon-tubers.

Figure 4. *Globusphyton lineare* from the upper Doushantuo black shales of the Ediacaran, Wenghui, Guizhou, China. **A, B,** specimen MH-50-0004; A, complete specimen; B, magnified view of A, showing a three-dimensional nodule near the center of the ribbon-tuber; **C, D,** specimen WH-P-01022; C, complete specimen; D, magnified view of C, showing the expanded end of the ribbon, with short spiked-up filaments; **E,** specimen MH-40-0248; **F,** specimen MH-41-0713; **G,** specimen MH-48-0004; **H,** specimen MH-50-0015; **I,** specimen WH-P-02095; **J,** specimen WH-P-03035.

Figure 5. Reconstructions of the carbonaceous compression *Globusphyton*. **A,** showing that *Globusphyton* crept on the muddy sediments in a low-energy environment; **B,** showing that

the part body of *Globusphyton* was suspended in the water column when water current occurred occasionally; arrow shows the direction of flow.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JC Jiangchuan biota
WL Wulinshan biota
WH Wenghui biota
MH Miaohe biota
LT Lantian flora
OL oldland
BE beach
TF tidal flat
LG lagoon
OP open platform
SM shelf margin
SB shelf margin
(B)
109° 01′ 20″
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Taoying
27° 50′ 07″
Wenghui
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108°
104°
28°
GUIZHOU
Guiyang
26°
Tongren
Jiangkou
bedded chert
black shale
sandstone
limestone
muddy limestone
dolostone
muddy dolostone
glacial diamictite
location and position of Globusphyton occurrence
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Wenghui biota
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Member III
Member II
I
Doushantuo Formation
Ediacaran
Cryogenian
Nantuo Formation
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Dengying Formation
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Miaohe biota
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551.1±0.7 Ma
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Member II
I
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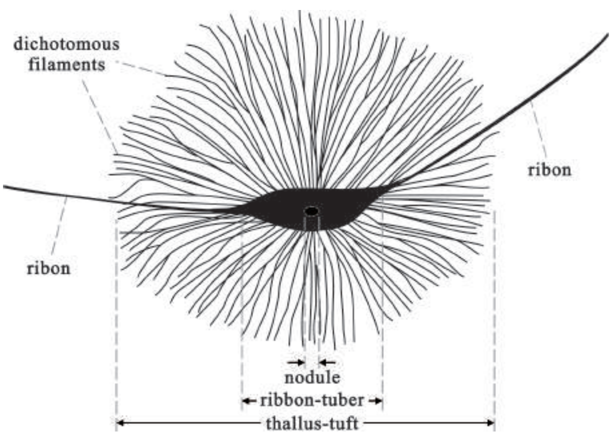
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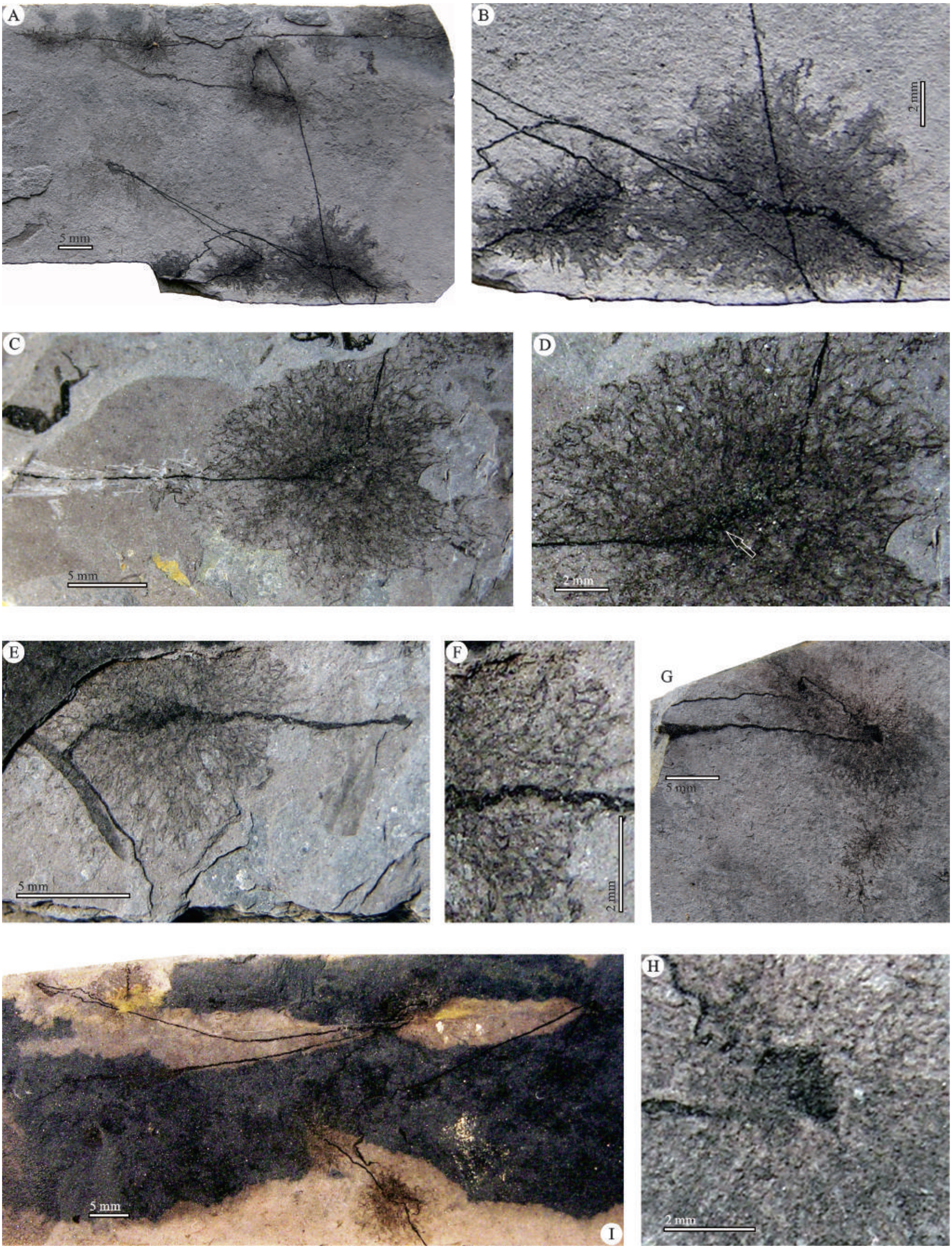
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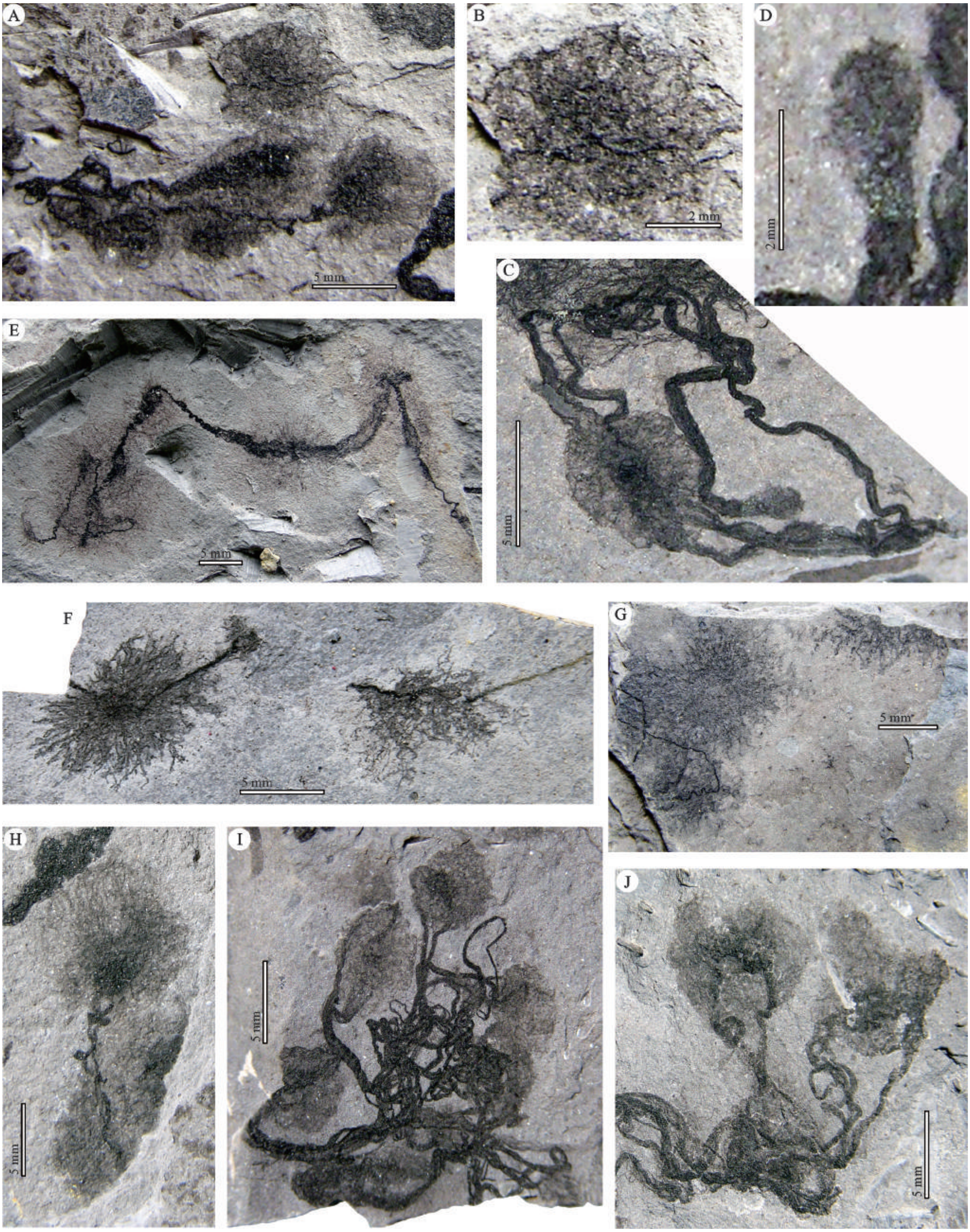
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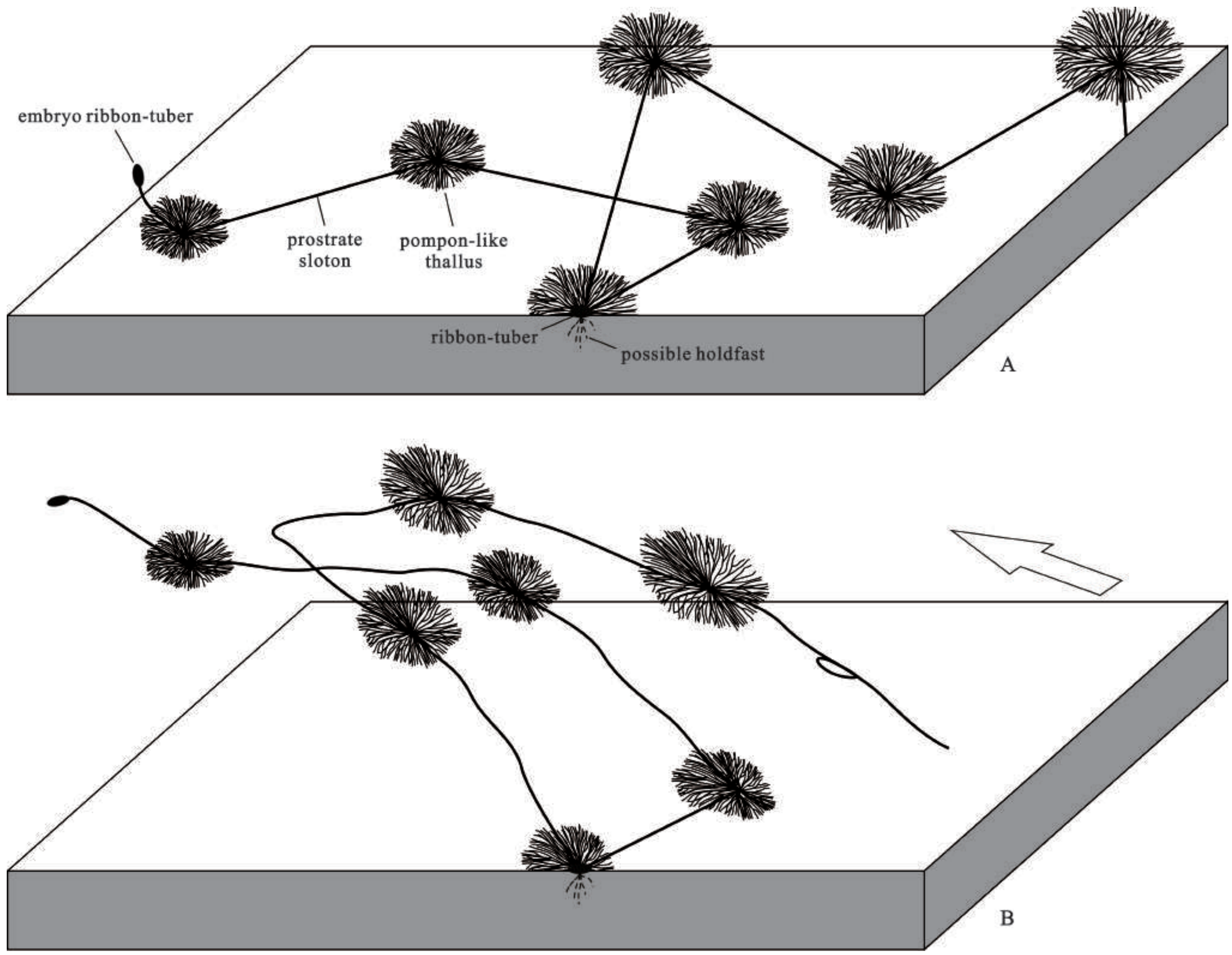
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