International Subcommission on Cambrian Stratigraphy (ISCS)
Business Meeting, Milan, Italy, 3 July 2019

1. Thank you to the general chairs (Marco Balini and Elisabetta Erba) and the scientific, organizing and field trip committees of the Strati 2019 conference, and to Gian Luigi Pillola for organizing Field trip 12 to the Cambrian of Sardinia. Thanks, too, to all the sponsors and organizations that have worked to organise this extremely successful meeting. Thank you to all who have made this meeting possible, and who have made us welcome here.

2. Introduction of officers and Voting Members (for term ending 2020): Loren Babcock (Chair), Per Ahlberg (Secretary), and Xingliang Zhang (Vice-Chair); additional VMs who are here: José-Javier Álvaro, Rodolfo Gozalo and Shanchi Peng.

   2.1. Chairs of Working Groups:
   Terreneuvian: Maoyan Zhu
   Stage 2: Michael Steiner
   Stage 3: Xingliang Zhang
   Stage 4: Jim Jago
   Stage 10: Per Ahlberg (present)
   Web page: Malgorzata Moczydlowska-Vidal (Michael Streng, webmaster)

3. Current Voting Members (for the term 2016–2020):
   1, Per Ahlberg, Lund, Sweden per.ahlberg@geol.lu.se
   2, José-Javier Álvaro, Madrid, Spain alvarobjj@cab.inta-csic.es, jj.alvaro@csic.es
   3, Loren E. Babcock, Columbus, USA babcock.5@osu.edu
   4, Gabriella Bagnoli, Pisa, Italy bagnoli@dst.unipi.it
   5, Duck K. Choi, Seoul, Korea dkchoi@snu.ac.kr
   6, Olaf Elicki, Freiberg, Germany elicki@geo.tu-freiberg.de
   7, Gerd Geyer, Germany gerd.geyer@uni-wuerzburg.de
   8, Rodolfo Gozalo, Valencia, Spain rodolfo.gozalo@uv.es
   9, James B. Jago, Mawson Lakes, Australia jim.jago@unisa.edu.au
   10, Pierre D. Kruse, Adelaide, Australia archaeo.kruse@gmail.com
   11, Linda B. McCollum, Cheney, Washington, USA lmccollum@ewu.edu
   12, Malgorzata Moczydlowska-Vidal, Sweden malgo.vidal@pal.uu.se
   13, Elena B. Naimark, Moscow, Russia naimark@paleo.ru
   14, Tatyana V. Pegel, Novosibirsk, Russia pegel@mail.ru
   15, Shanchi Peng, Nanjing China scpeng@nigpas.ac.cn
   16, Leonid Popov, Cardiff, Wales, UK leonid.popov@museumwales.ac.uk
   17, Brian R. Pratt, Saskatchewan, Canada brian.pratt@usask.ca
   18, Matthew R. Saltzman, Columbus, Ohio, USA saltzman.11@osu.edu
   19, Michael Steiner, Berlin, Germany michael.steiner@FU-Berlin.de
   20, Alexei I. Varlamov, Moscow Russia varlamov@vnigni.ru, info@vnigni.ru
   21, Mark Webster, Chicago, Illinois mwebster@geosci.uchicago.edu
   22, Xiangling Zhang, Xi'an, China xzhang69@nwu.edu.cn
   23, Maoyan Zhu, Nanjing, China myzhu@nigpas.ac.cn
   24, Anna Zylinska, Warsaw, Poland anna.zylinska@uw.edu.pl

4. Request for updated contact information (especially email addresses) from all VMs, Honorary Members, Corresponding Members.

5. In 2013–2014, the new ISCS webpage was introduced and modified. Recent information is posted there, and we will strive to keep the webpage updated. In the next few months we hope to post the names of specialists who have agreed to serve in the various Working Groups.

6. ISCS sponsored/co-sponsored meetings this year:

    6.1. NAPC in Riverside, California, 23–27 June 2019.
    6.2. Strati 2019 (this meeting).

7. Announcement of upcoming meetings.

    7.1. International Meeting on the Ediacaran and Ediacaran-Cambrian Transition Guadalupe, Extremadura, Spain - October 17–24, 2019.
    7.2. Siberia (Aldan and Lena rivers, and Khos-Neleger River) - 2020?
    7.3. If other meetings of our interest are announced we will put links to them on our web page.

8. Discussion of progress toward publication of stage and series names.
    8.1. Ratified boundaries defined by GSSPs:
        8.1.1. Furongian Series/Paibian Stage – 2004, Lethaia.
        8.1.2. Drumian Stage – 2007, Episodes.
        8.1.3. Terreneuvian Series/Fortunian Stage – 2008, Episodes.
        8.1.4. Guzhangian – 2009, Episodes.
        8.1.5. Jiangshanian – 2011; GSSP, Episodes (2012); ASSP, Episodes 2013.
        8.1.6. Miaolingian Series/Wuliuan Stage – ratified in July 2018, Episodes June 2019.

9. Discussion of work toward defining remaining stage-level GSSPs. We want to remind members of the Cambrian community that the face-to-face discussions we have concerning progress on GSSP definition takes place at our annual meetings, normally within the business meetings, but also occasionally in additional gatherings. Last year we set aside time for a separate meeting to discuss Stage 10, which is the next stage that we hope to see ratified.
    9.1. Stage 10 (*Lotagnostus americanus* level). Alternate possibility for level: *Eoconodontus notchpeakensis* level. Possibilities for a GSSP section: Siberia, South China, Kazakhstan, Utah, etc. We plan to send out a questionnaire to working group members and voting members this year asking them for their opinions on the practicality of using one level or the other as the base of Stage 10. In 2005, the voting members voted overwhelmingly in favour of using the *Lotagnostus trisectus* (= *L. americanus*) as the primary marker for the stage base. Subsequently the *E. notchpeakensis* level has been advanced as an alternative. Both levels have advantages for global correlation. One additional option is to subdivide the stage into lower and upper substages, both with GSSPs. We envision as a longer-term strategy each of the stages to be subdivided into formal substages, and Stage 10 could serve as the model to define substages. Other subcommissions have already begun the process of formally defining substages.
    9.2. Stage 2: Possible levels: *Watsonella crosbyi* or *Aldanella attleborensis*. Possibilities for a GSSP section: Siberia, South China, etc.

9.3. Stage 3 (approximately FAD trilobites): The earliest trilobites known seem to be *Profallotaspis jakutensis* in Siberia, *Hupetina antiqua* in Morocco and *Fritzaspis* in Laurentia. Potential markers of small shelly fossils: FAD of *Pelagiella subangulata*, *Microdictyon effusum* or *Mobergella radiolata*. If the level is to be identified principally through biostratigraphic means, its position also needs to be recognizable using non-biostratigraphic means.

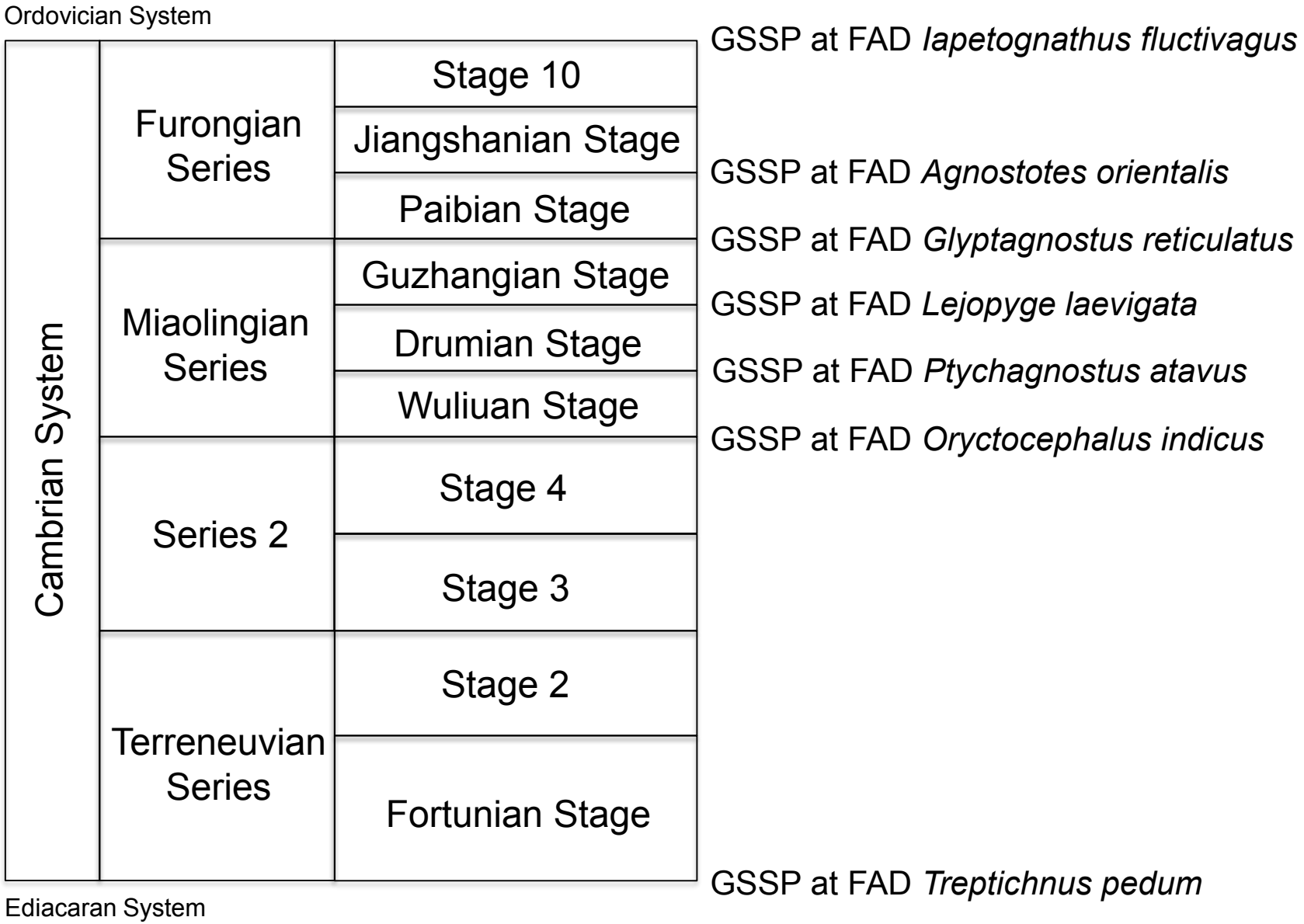
9.4. Stage 4 (approximately FAD *Olenellus/Redlichia*): ISCS favors placing stage base at FAD of a single trilobite species. Possibilities: a species of *Olenellus* (s.l.), *Redlichia* (s.l.), *Arthricocephalus chauveaui*, *Oryctocarella duyunensis*, *Judomia, Bergeroniellus,* or the *Triangulaspis-Serrodiscus-Hebediscus attleborensis* band. Such a position would be at a level roughly corresponding to the base of the Dyeran Stage of Laurentia, the base of the Duyunian of South China, and the base of the Botoman of Siberia.

10. New officers for the term 2020-2024. A slate of candidates will be proposed within a couple of months.

11. Discussion of a proposal for Cambrian substages (see below).

12. Other matters.

Cambrian System, 2019



Proposed Cambrian substages

- ***Proposal:*** *The International Subcommission on Cambrian Stratigraphy (ISCS) should recommend formal substages for most, and perhaps all, Cambrian stages.*

A working model for Cambrian substages

Ordovician System

Cambrian System	Furongian Series	Stage 10	Substage 20	GSSP at FAD *Iapetognathus fluctivagus*
			Substage 19	FAD *Eoconodontus notchpeakensis*
		Jiangshanian Stage	Substage 18	FAD *Lotagnostus americanus*
			Substage 17	?FAD *Irvingella major*
		Paibian Stage	Substage 16	GSSP at FAD *Agnostotes orientalis*
			Substage 15	?FAD *Erixanium sentum*
	Miaolingian Series	Guzhangian Stage	Substage 14	GSSP at FAD *Glyptagnostus reticulatus*
			Substage 13	FAD *Linguagnostus reconditus*
		Drumian Stage	Substage 12	GSSP at FAD *Lejopyge laevigata*
			Substage 11	FAD *Ptychagnostus punctuosus*
		Wuliuan Stage	Substage 10	GSSP at FAD *Ptychagnostus atavus*
			Substage 9	FAD *Ptychagnostus praecurrens*
	Series 2	Stage 4	Substage 8	GSSP at FAD *Oryctocephalus indicus*
			Substage 7	FAD *Ovatoryctocara granulata*
		Stage 3	Substage 6	?FAD *Arthricocephalus chauveaui*
			Substage 5	?FAD *Repinaella sibirica*
	Terreneuvian Series	Stage 2	Substage 4	?FAD *Profallotaspis jakutensis*
			Substage 3	?FAD *Mobergella radiolata*
		Fortunian Stage	Substage 2	?FAD *Watsonella crosbyi*
			Substage 1	?FAD *Anabarites trisulcatus*

GSSP at FAD *Treptichnus pedum*

Ediacaran System

Nomenclature for provisional substages

- Until a formal name is ratified, a numbering system could be adopted.
- Similar to the nomenclature the ISCS adopted for stages.

Stage 10	Substage 20
	Substage 19
Jiangshanian Stage	Substage 18
	Substage 17
Paibian Stage	Substage 16
	Substage 15
Guzhangian Stage	Substage 14
	Substage 13
Drumian Stage	Substage 12
	Substage 11
Wuliuan Stage	Substage 10
	Substage 9
Stage 4	Substage 8
	Substage 7
Stage 3	Substage 6
	Substage 5
Stage 2	Substage 4
	Substage 3
Fortunian Stage	Substage 2
	Substage 1

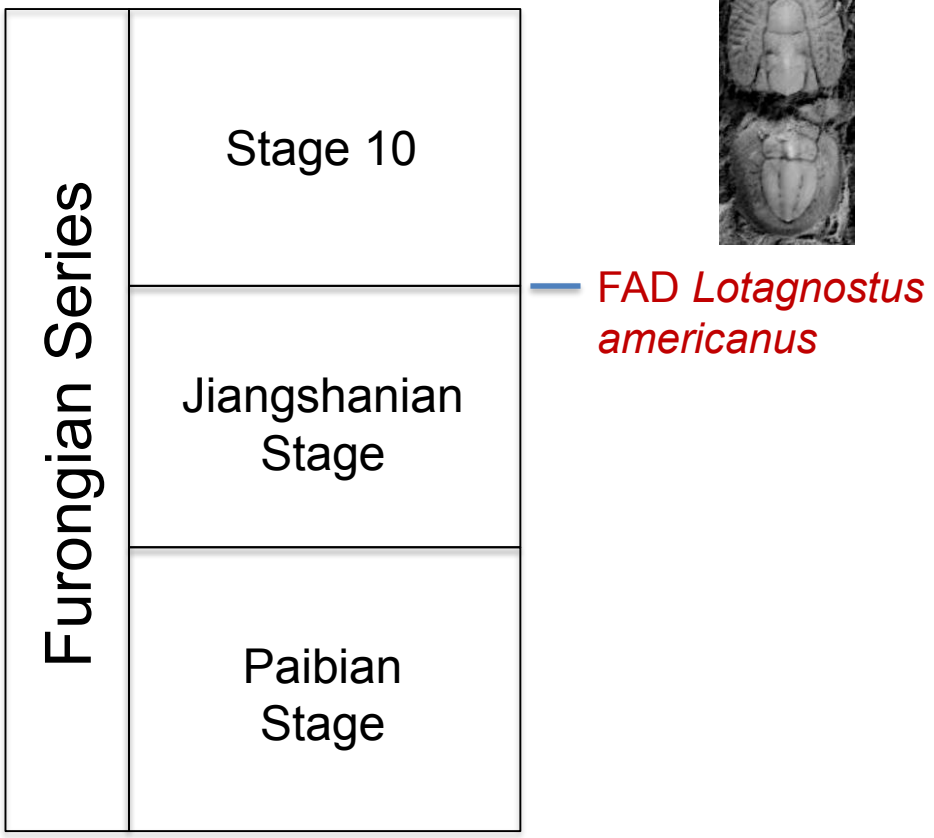
Other possibilities for provisional nomenclature

- Lower/Upper.
  - May become cumbersome.
- No provisional name designated.
- Numbers + letters?

	Options		
	Preferred:	***Alternatives:***	
Stage 10	Substage 20	Upper Stage 10 Substage	Substage 10B
	Substage 19	Lower Stage 10 Substage	Substage 10A
Jiangshanian Stage	Substage 18		Jiangshanian Substage B
	Substage 17		Jiangshanian Substage A
Paibian Stage	Substage 16	Upper Paibian Substage	Paibian Substage B
	Substage 15	Lower Paibian Substage	Paibian Substage A

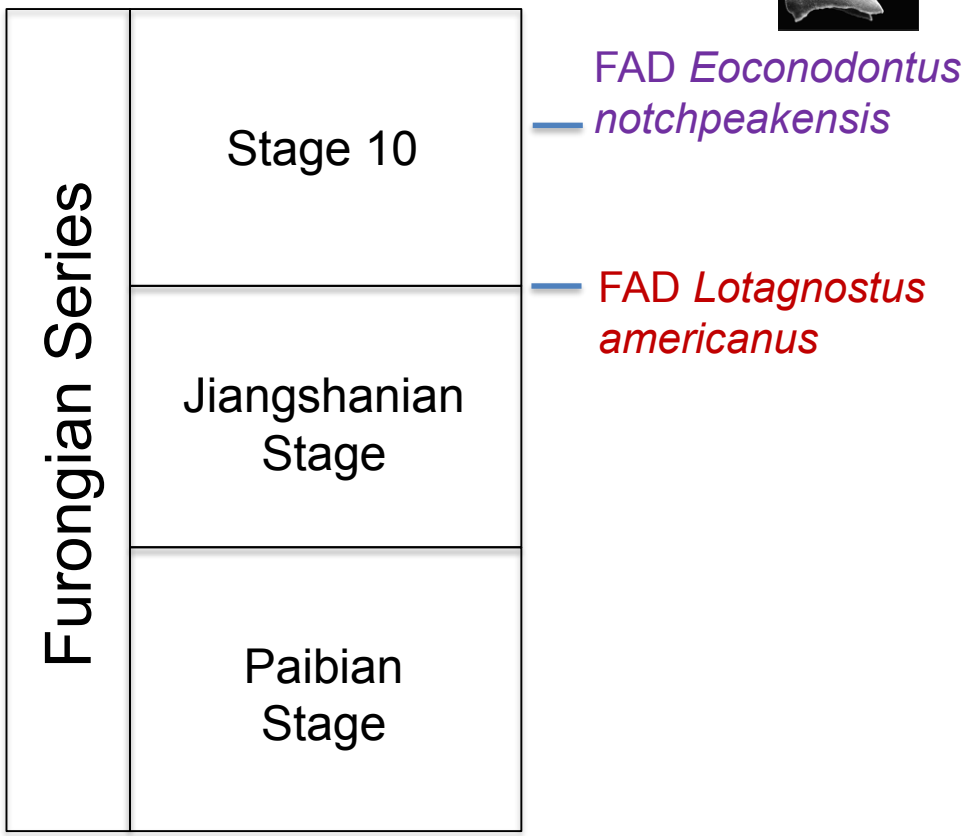
Stage 10

- Originally, the ISCS voted to use the level of *Lotagnostus trisectus* (now synonymized under *L. americanus*) as the primary stratigraphic marker.



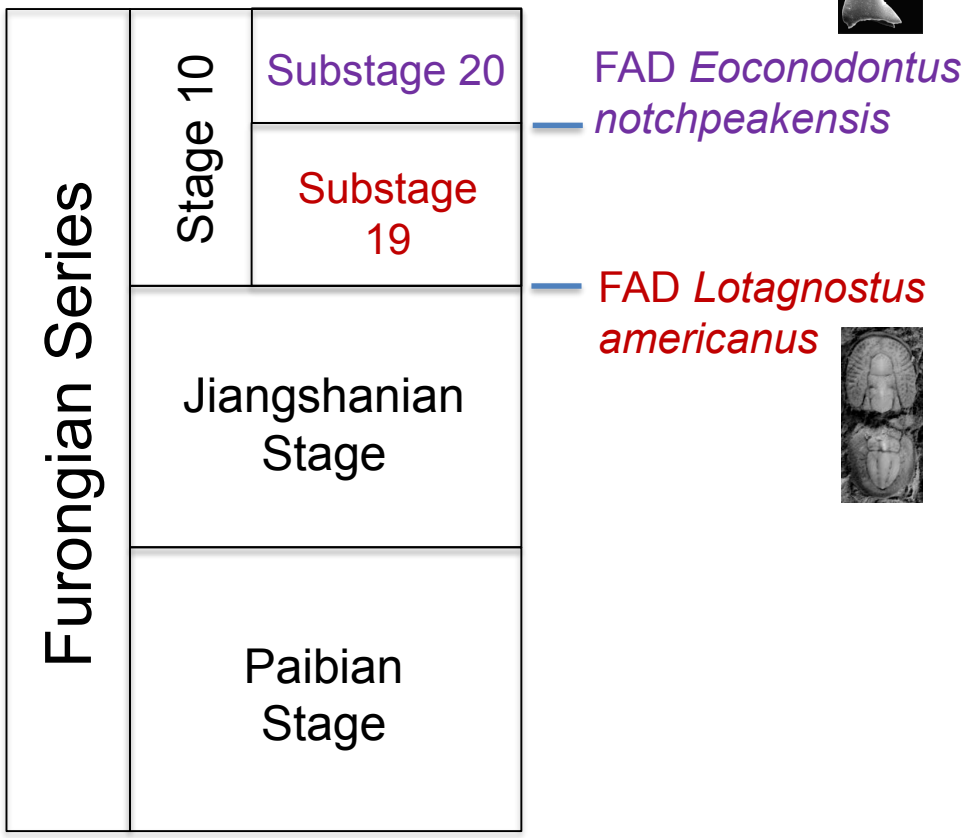
Stage 10

- Subsequently, *Eoconodontus notchpeakensis* was proposed as a marker.
- The *E. notchpeakensis* horizon is much closer to the base of the Ordovician.



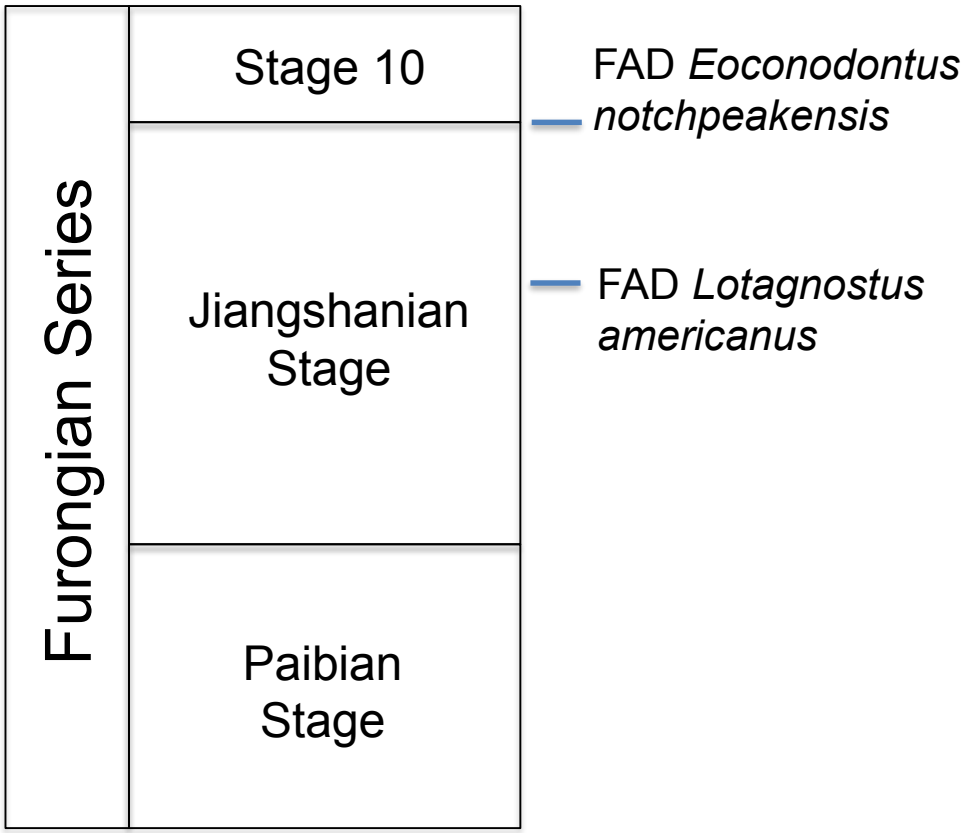
Stage 10

- Placing the stage base at the FAD of *L. americanus* would provide for two stages of subequal length.
- The FAD of *E. notchpeakensis* would provide a convenient position for subdividing Stage 10.



Alternative solution: subdividing the Jiangshanian Stage

- This option would create an exceptionally long Jiangshanian Stage.
- Stage 10 would become the shortest in the Cambrian, and among the shortest in the Paleozoic.



Multiple guide fossils are available for Stages 2, 3, 4

Series 2	Stage 4
	Stage 3
Terreneuvian Series	Stage 2
	Fortunian Stage

GSSP

Ovatoryctocara granulata

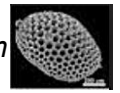
Arthricocephalus chauveaui

Oryctocarella duyunensis

Hebediscus-Calodiscus-Triangulaspis-Serrodiscus

Repinaella sibirica

Pelagiella sp.

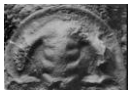


Microdictyon effusum

Pelagiella subangulata

Delgadella anabara

Profallotaspis jakutensis



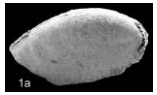
Mobergella radiolata

Lapworthella tortuosa

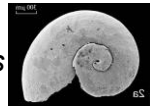
Lapworthella bella

Skiagia ornata

Watsonella crosbyi



Aldanella attleborensis



Anabarites trisulcatus

Purella antiqua

Anabarella sp.

Latouchella sp.

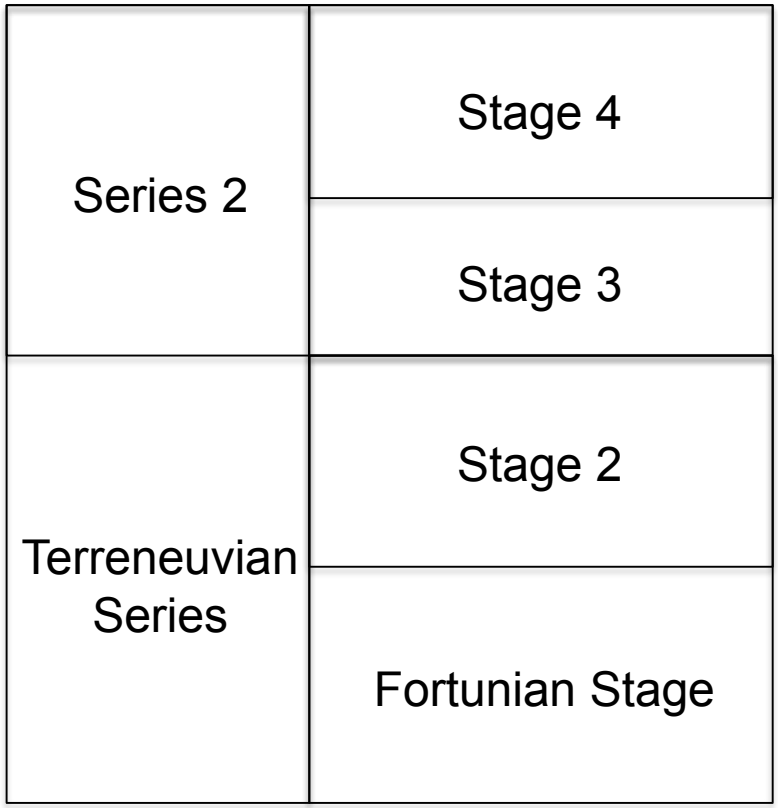
Cambrotubulus decurvatus

GSSP

A solution

Recognize stages + substages

- This option will allow us to double the number of formally recognised horizons.
  - Should simplify the process of decision-making.



Possible horizons:

GSSP

FAD *Ovatoryctocara granulata*

FAD *Arthricocephalus chauveaui*

FAD *Repinaella sibirica*

FAD *Profallotaspis jakutensis*

FAD *Mobergella radiolata*

FAD *Watsonella crosbyi*

FAD *Anabarites trisulcatus*

GSSP

Alternatives for stages 2, 3, 4