

## Responses to review

15<sup>th</sup> February 2023

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Title: The emergence of the tropical rainforest biome in the Cretaceous

Journal: Biogeosciences

### **Reply to comments - Reviewer#RC1 (in blue):**

- All comments and annotated suggestions as well as linguistic and stylistic suggestions have been already taken into consideration and marked in a different **blue** colour in the revised MS.

- comes 24 I'm not familiar with the numbers given in the text.

**This happened due to an unintended overlap between the text and line numbers.**

- Did this author work on the Campanian palynology of Egypt? His/her publications are related to other disciplines rather than palynology.

**Yes, but he introduced some ideas that are relevant to our work. To avoid any type of inconvenience, the reference (Wycisk, 1994) in the MS has been modified in the new version to (Wycisk, 1994 and references therein) to show that the obtained results were taken from his but also others' results.**

- WHY is this reference abbreviated?

**All references in the MS were updated in full and no more abbreviated.**

- is that correct? or Australia.

**Yes, it is correct and written as is it in the original citation.**

- This publication is not abbreviated, so please pay attention to all, either to abbreviate or edit in full.

**Done as suggested.**

- some of these line drawings are very faint. I recommend high-resolution line drawings, which make the plate a high-quality one.

**This has been considered in the updated version.**

**Reply to comments - Reviewer#RC2 (in blue):**

- This is an excellent paper that provides the best evidence to date on an important controversy on the age of the tropical rainforest (TRF) biome, based on fossil leaf floras from the Campanian of Egypt and Sudan, which were near the equator at the time. Since the 1980s, many paleobotanists have argued that typical TRF did not appear until the Paleocene, but since the 1990s molecular phylogenetic dating analyses of extant plants have indicated that many lines now characteristic of the TRF go back to near the beginning of the Late Cretaceous. Probably some readers of earlier brief descriptive papers on these NE African floras thought "this looks like tropical rainforest!" (I know I did), but the present paper is the first to state this conclusion so explicitly and test it with a variety of up-to-date analytical methods. It promises to be a landmark in understanding of the origin of this uniquely diverse and threatened biome.

I see no major substantive issues with the data and reasoning in this paper. Somewhere it should be noted that Egypt and Sudan were near or on the equator in paleogeographic reconstructions for the Campanian, which makes the presence of TRF here more plausible. This is alluded to in the final discussion (p. 13, lines 4-7), but only obliquely. The rationale and results of the rarefaction analysis need some explanation to be more intelligible to non-specialists (see notes on p. 8, line 3; p. 9, line 23; p. 10, lines 2-3).

Done as suggested.

- Most of the following detailed comments and suggestions refer to minor stylistic and technical problems that are easily corrected.

All comments and annotated suggestions as well as linguistic and stylistic suggestions have been already taken into consideration and marked in a different blue colour in the revised MS.

p. 2, lines 3-4: "we test" would be more idiomatic.

Done as suggested.

- line 7: don't you mean "conclude" rather than "assume"?

Done as suggested.

- lines 8-9: "based on fossil leaves" might be better placed at the beginning of the sentence or after "conclude."

Done as suggested.

- line 11: "nearly complete absence" would be more logical and idiomatic.

Done as suggested.

p. 3, line 5: this implies that the closed canopy is stratified, when the closed canopy is one several layers, including emergents and lower strata.

This sentence has been inserted upon your suggestion.

- line 6: what does "at least in the understory" mean? Woody angiosperms are usually dominant, not just present, in the canopy and the emergent layer (except for conifers in some regions), while the lower strata include both woody angiosperms and non-woody tree ferns and palms.

Deleted as suggested.

- line 7: "Molecular phylogenetic studies of modern plants..." might make the situation clearer.

Edited as suggested.

- line 9: "its" instead of "their"?

Done as suggested.

- line 10: "has not": subject is "TRF."

Done as suggested.

- line 14: Wolfe and Upchurch (1987. North American nonmarine climates and vegetation during the Late Cretaceous. *Palaeogeogr. Palaeoclimatol. Palaeoecol.* 61: 33-77, p. 48) did interpret the early Cenomanian flora at the Fort Harker locality in the Dakota Fm. as physiognomically TRF.

Edited as suggested; as it could fit tropical base on MAT but likely had stronger seasonal temperature variation.

- lines 15-16: "most previous information"; hyphen and space after "mid."

Done as suggested.

- lines 17-18: "Nevertheless" isn't idiomatic here: "However, relevant material... was collected" (subject is "material").

Done as suggested.

- line 20: "were preliminarily..."

Done as suggested.

- lines 21-22: "However" would be more idiomatic than "Nonetheless"; "focused on only a few..."

Replaced as suggested.

- p. 4, line 1: "seven other..." Check numbers against p. 6, lines 7-11.

Yes, they are eight, and already changed throughout the whole MS.

- line 3: no "a" before "fossil" (OK before "habitat").

Done as suggested.

- line 4: "fossil assemblages" to make sure that "contemporary" isn't taken to mean "Recent."

Done as suggested.

- line 5: colon rather than period at end?

Done as suggested.

- line 6: comma after "physiognomy" for consistency with the next points.

Done as suggested.

- line 7: comma after "C" and "1500 mm," space before ">."

Done as suggested.

- lines 9, 10: capitalize "A" for consistency.

Done as suggested.

- line 15: "sometimes" or "often" rather than "partly"?

'sometimes' is used as suggested.

- line 16: "comprise" present tense, as in line 14.

Edited as suggested.

- line 21: "has also been ascribed" would be more idiomatic.

Done as suggested.

- line 22: no "the" before "fluvial."

Done as suggested.

- line 23: "products into a shallow..."? "Whereas" doesn't make sense here; better to delete and change "but" to "although" in the next line.

deleted as suggested.

p. 5, line 5: "despite rare" isn't grammatical; better to say "although rare" after "Quseir Fm."

Done as suggested.

- line 8: "might have" is superfluous and could be deleted.

deleted as suggested.

- line 11: "which have been" would be more idiomatic.

Done as suggested.

- line 13: "that wildfires could also be ignited within ever-wet TRF" would be more idiomatic word order.

Done as suggested.

- line 18: "op. cit." is rarely used in scientific writing, and "2003" would be shorter.

Replaced as suggested.

- line 20: "subordinate": this is an adjective modifying "habitats," not an adverb modifying "drier."

Done as suggested.

- line 21: "plants grew" would be more idiomatic; no comma at end.

Done as suggested.

p. 6, line 4: "comprise"; comma before "which" clause.

Done as suggested.

- line 5: "collected" would be more idiomatic than "gathered."

Done as suggested.

- line 6: comma before "which"; "has been dated"; delete redundant "age."

Done as suggested.

- lines 7-11: this is confusingly written, such that the numbers don't seem to add up. In line 7, "addition," "additional," and "also" are rather repetitive: "Eight [if I'm counting right] smaller assemblages were also studied, of which four are from Egypt, including three from..., and one from the Qena area... The other four assemblages are from Sudan..."?

Yes, they are eight, and already changed throughout the whole MS, and 'additional' were synonymized into 'further.'

- line 14: do you mean "1987), all of which are from..."?

Yes

- line 15: "a lower age boundary is defined by a regional hiatus..."?

Done as suggested.

- line 17: comma before "which."

Inserted as suggested.

- line 18: "age boundary is defined by a transgression that..."

Done as suggested.

- line 21: "to plant megafossils..."

Done as suggested.

- line 22: "and" before "crocodiles."

Inserted as suggested.

- p. 7, line 4: "a literature survey": none has been mentioned so far.

The determinations being done in former publications, i.e., Klitzsch and Lejal-Nicol (1984), Lejal-Nicol (1987), and Kahlert et al. (2009), are included afterward.

- lines 5-6: "differs from all others... described by Ellis et al. (2009) in their manual of leaf architecture"?  
The present wording seems to give this publication near-biblical status.

Done as suggested.

- line 8: "at an obtuse angle to the midvein"?

Done as suggested.

- line 9: "corded" should presumably be "cordate."

Done as suggested.

- line 11: "orders" plural.

Done as suggested.

- line 12-13: semicolon after "proxies"; comma after "parameter."

Both are inserted as suggested.

- line 14: what does "giving" mean here? Delete?

Deleted as suggested.

- line 18: reverse citations to keep them in chronological order.

Edited as suggested.

- lines 22-23: "data set, which considers" would be more idiomatic.

Done as suggested.

p. 8, line 1: delete "Supplementary material;" in parentheses.

Deleted as suggested.

- line 3: what does "rarified diversity" mean, and just what role does it play in rarefaction analysis? This may be because I'm not familiar enough with this sort of analysis, but it could also mean that a few more details, or at least a reference, are needed.

“, i.e. the diversity expected for a subsample of the collection,” is inserted to make it clearer.

- line 6: comma before "which" clause.

Inserted as suggested.

- line 11: the "Hunco" locality is better known as "Laguna del Hunco"; check later mentions.

Done as suggested throughout the whole MS.

- line 12: what does "as material given" mean?

Deleted to avoid inconvenience.

- line 15: "were produced"?

Done as suggested.

- lines 20-21: comma belongs after "taxa," not "specimens." Later in this manuscript the taxonomically obsolete term "dicots" is used for "nonmonocotyledonous angiosperms"; maybe "(dicots)" could be inserted here for readers not familiar with the change in terminology.

Done as suggested.

- line 23: "occurring" is redundant when you've said "present."

Done as suggested.

p. 9, line 6: "with a preserved margin" would be more idiomatic.

Done as suggested.

- line 8: it might be helpful to indicate ">25°C:" in the reference to Wolfe. "Furthermore" might make more sense than "Whereas."

Replaced as suggested.

- line 9: what are Wing et al. being cited for? Their method of estimating leaf area? The present wording implies that they made the 69 cm<sup>2</sup> estimate.

Edited upon your request.

- line 10: "an estimate": only a single estimate is given. "2609 mm, which is comparable to >1500 mm" would be more idiomatic.

Done as suggested.

- line 13: "favors" would be more idiomatic than "advocates."

Done as suggested.

- lines 14-15: replace semicolons with commas, move second parenthesis after "21°C."

Done as suggested.

- line 15: "reflects" rather than "is reflected by."

Done as suggested.

- line 17: comma before "while."

Done as suggested.

- line 23; p. 10, line 2: is "rarified" standard terminology? What does it mean? It's not intuitively obvious to a non-specialist. Looking at Fig. 5, I might guess that the curve for NE Africa would level off at about twice the observed number of species. More explanation is needed.

Edited as suggested and become clearer in the updated version of the MS.

- line 24: "appears": subject is "diversity."

Done as suggested.

- p. 10, line 1: "and is richer"?

Done as suggested.



- lines 2-3: which assemblages "rarified" at 20 specimens? The rest of the sentence needs work; do you mean "when the remaining assemblages from NE Africa are included, in order to maximize sampling, they rarify at a similar point"? Or what? See also p. 26, lines 3-4.

Done as suggested, as previously noted.

- line 7: "African Campanian" would be more idiomatic word order.

Edited as suggested.

- line 8: "angiosperms, which account for" would be smoother.

Done as suggested.

- line 9: comma after "angiosperms."

Inserted as suggested.

- line 12: comma at end of line. Is the name "Guaduas" or "Guadas" (p. 11, line 8)? Check and correct throughout.

Guaduas is the correct one and edited throughout the whole MS.

- line 14: see note on p. 8, lines 20-21 on "dicots." You could say "of both monocots and other angiosperms."

Done as suggested.

- line 17: "support a closer affinity of the NE African vegetation with younger TRF than with coeval subtropical vegetation" might make the contrast clearer.

Done as suggested.

- line 22: "mid-latitude floras." The point concerning Araceae is unclear without more explanation: "Araceae, which are abundant in NE Africa, also occur at Grünbach, but..."

Done as suggested.

- line 23: delete "the" at end of line.

Deleted as suggested.

p. 11, line 1: "Considering its relation to" might go better with the rest of the sentence.

Done as suggested.

- line 2: for clarification, insert "Guaduas morphotype" before "GD05." If this isn't correct, it just shows that more explanation is needed.

Edited as suggested and getting clearer.

- line 4: "of which the latter have not been observed in NE Africa"?

Done as suggested.

- line 5: "have possible araceous affinities, but neither of them..."

Done as suggested.

- line 6: what does "introduced the exclusive occurrence" mean? It seems to say the flora consists only of palms.

This has been edited completely to avoid such inconvenience, as follows " However, palynological evidence highlighted its occurrence in the Campanian in North Africa (Jardiné and Magloire, 1965; Meon, 1990; Mahmoud, 2003). The majority of palm and palm-like records in the Campanian (and Maastrichtian) are from coastal regions of western, northern, and eastern Africa (Somalia), e.g., Schrank (1994). These records also occurred in tropical south America and, to a lesser extent, in southeast Asia, forming the core of the Late Cretaceous Palmae Province (Herngreen et al., 1996; Morley, 2000; Pan et al., 2006).".

- line 9: "to that at Baris"? "not only Zingiberales" (to anticipate "but also"); "especially morphotype CJ49"

Done as suggested.

- lines 10-11: this list is confusing; am I right in assuming that Montrichardia is the Correjon colocasioid? If it is, move "Montrichardia (CJ3)" up after "but also" and before "a colocasioid member of Araceae" (Araceae is plural, so "a... Araceae" is ungrammatical).

Edited as suggested.

- lines 10, 11, 12: comma, not period, after "Mohr."

Done as suggested.

- line 11: "and a member of Araceae..."

Done as suggested.

- line 13: "terrestrial Araceae at Baris"; "Afrocasia is a member of Aroideae..."

Done as suggested.

- lines 14-15: "that are usually found... but also occur in warm..."

Done as suggested.

- line 16: "both genera that belong to groups restricted to..."

Done as suggested.

- line 17-18: this sentence doesn't make sense as written. Do you mean Lejalia has compound leaves resembling those of Aroideae that grow in seasonal tropical vegetation, or are you talking about something else?

Edited as suggested.

- line 18: "dicot morphotypes..."

Done as suggested.

- line 23: are these salicoid teeth of Hickey & Wolfe (1975)? No need to mention, but does support identification with Salicaceae.

Done as suggested.

p. 12, lines 6, 11; p. 13, line 14: "NE African Campanian" would be a more idiomatic order of adjectives.

Done as suggested.

- line 7: "comparable to that of modern" would be more grammatical; capitalize "Late."

Done as suggested.

- line 8: "increased precipitation" by itself seems nearly tautological; "models predicting increased"? "global proxy evidence for"? or what?

Edited as suggested as become clearer.

- line 9: "overlap" is unclear: can you find a more precise word?

This word was used by Spicer and Ziegler, however, we have replaced it with 'intersecting', hopefully, it works better.

- line 11, p. 13, line 15: "aroids" is often used as a common name for Araceae, but it has the disadvantage of seeming to refer to the subfamily Aroideae. Depending on what you mean, "Araceae" or "Aroideae" would be preferable.

Done as suggested.

- line 12: "that the Late..."

Inserted as suggested.

- line 14: "an apparent conflict": this explanation doesn't address all such conflicts.

Done as suggested.

- line 15: "almost complete absence" would be more idiomatic.

Done as suggested.

- line 18: this might be a good place to mention where Guaduas is.

"from the central Andes of Colombia" is inserted to answer where Guaduas is.

- line 19: I'd like to see more evidence before accepting that the Crato flora may be Barremian; its palynological correlatives in Gabon/Congo are increasingly well dated as Aptian (Eldrett, J.S., Bergman, S.C., Heine, C., Edwards, P., Jakeman, M., Miles, N., Hambach, B., Bohaty, S., Wilding, M.R., 2022. Integrated bio- and chemo-stratigraphy for Early Cretaceous strata offshore Gabon: Additional constraints on the timing of salt deposition and rifting of the South Atlantic. Marine Petrol. Geol. 148: 106037).

Edited to be only Aptian, as suggested.

- line 21: "angiosperm" or "angiospermous" component; "that of younger..."

Done as suggested.

- line 22: "magnoliids" lower case, as for anglicized taxon names in general.

Done as suggested.

- line 23: "of tropical vegetation..."

Done as suggested.

- p. 13, line 2: "floras" plural; "although new..." would be more idiomatic than "despite that."

Done as suggested.

- lines 4-5: "climate, and it has rather low diversity..."

Done as suggested.

- line 7: "extending" rather than "expanding," which means increasing in area or volume.

Done as suggested.

- line 8: comma before "which" clause.

Done as suggested.

- line 12: "collections obtained from..."

Done as suggested.

- line 13: "imply" or "indicate" rather than "infer," which means to draw conclusions from; "comparable to that of modern..."

Done as suggested.

References: I have not gone over these in detail, but I note a lot of inconsistencies in abbreviation of journal titles (compare Abu-Kheir 2020 and Barazi 1985), capitalization of words in article titles (e.g., Mohr & Friis 2000; only first words and proper nouns should be capitalized), inclusion of issue numbers (e.g., Belcher et al. 2010, Coiffard & Mohr 2016; normally not indicated unless each issue is paginated separately), and omission of diacritical marks (Lejal-Nicol 1987).

All references were checked and edited as suggested.

- In page 17, line 21, there is confusion in listing of authors' initials.

Yes, and edited correctly.

- p. 20, line 1: with "All," these two sentences contradict each other.

Done as suggested.

- line 15: add "cited in the text" after "researchers"?

Inserted as suggested.

- p. 21, line 2: "Locations of the fossil assemblages studied"?

Done as suggested.

- line 3: "was created"?

Done as suggested.

p. 22, line 1: maybe add "(non-monocotyledonous angiosperm)" after "dicot" in this first leaf figure.

Done as suggested.

p. 24, line 1: "monocot, conifer..., and fern..." (singular) when used as modifiers of "morphotypes."

Done as suggested.

p. 25, line 1: semicolon or period after "curves."

Done as suggested.