Macro-evolutionary process of termite tunneling

The statement of work

1. Purpose

**Background**

I have studied the evolution of tunneling behavior in termites since 2018, obtaining grants for my JSPS and DECRA. I have obtained videos of tunneling behavior in 12 species, 11 genera, 5 families (Coptotermes formosanus, Cryptotermes domesticus, Glyptotermes satsumensis, fuscus, Hodotermopsis sjostedti, Incisitermes schwarzi, Mastotermes darwiniensis, Neotermes sugioi, Porotermes andarsoni, Reticulitermes speratus, Stolotermes victoriensis, Zootermopsis nevadensis) with 2D tunneling time developments. This could be enough to write a strong paper(s). However, I want to maximize the quality of outputs and think about what else I will need to add. Also, I want to publish these papers as a corresponding author + senior author position to be established in a field. So, I want my students to add more data to make them their own work + much stronger. The research questions include

1. What looks like the ancestor of Kalotermitidae? Previous studies think that extreme one-piece nesters, such as Cryptotermes, are similar to the ancestor of termites. If Cryptotermes derives one-piece nesting from the ancestor, the ancestor of Kalotermitidae must look like the Cryptotermes. However, I would like to show that this is not true, by using the following narratives:
   1. Extreme one-piece nesters, such as Cryptotermes, have smaller body sizes than others and are the ancestor of Kalotermitidae. This indicates that they were morphologically modified to be adapted to the tree branches, which is different from the ancestor of termites.
   2. Extreme one-piece nesters, such as Cryptotermes, lose the ability to excavate underground tunnels into the soil. However, this is exceptional in Kalotermitidae, where many other species (with larger body size) retain this potential and the ancestor was also estimated to have this potential.
   3. The evolution of extreme one-piece nesters occurs several times independently, rather than derived from the ancestor.
2. Identify behavioral components responsible for the emergence of complex structures (separate nesters or highly branching tunnels). Mizumoto et al., 2020 AmNat showed that termite tunneling can be either mandible-carrying or leg-kicking budget brigade. I hypothesized that the mandible-carrying is important as it allows termites to manipulate materials better. For this purpose, I will try to look at the evolution of behavioral tactics on the termite phylogeny. Preliminal data shows that ancestor is leg-kicking, and mandible transport evolved closely somewhere in Rhinotermitidae. Need to look into Hodotermitidae.

I will write a grant proposal based on this to NSF.