Shared Vocabulary

The Biotic Interactions in deep TimE (BITE) working group is a large team of researchers working in a broad range of fossil Biotic Interactions (fBI). During an in-person meeting, we identified that domain specific language needed to be replaced with unambiguous formal definitions with applications broad enough to encompass all biotic interactions in both modern and fossil research. The terms presented here are internally consistent within our review, and will be deployed as the formal vocabulary and ontologies of the future BITE database.

Specific nomenclature, ontologies, and vocabulary are unavoidable and so the BITE database (see Supplemental 2) will formalise the term-matching begun here. This will be done by allowing users, data enterers, and maintainers free text entry which the database curators will collate and then algorithmically and/or manually match. Terms, changes, synonymies will be stored and contribute to the 'living' glossary (version controlled).

An example format for establishing shared language and a database structure that captures relations (i.e. the interactions of 2 actors in a single occurrence or sample):

Smith, B., Ceusters, W., Klagges, B. et al. Relations in biomedical ontologies. Genome Biol 6, R46 (2005). https://doi.org/10.1186/gb-2005-6-5-r46

Table 1 : Glossary of terms

	Definition	Examples
Type of Interaction	The characterisation of the contact between two or more actors based upon positive evidence (direct or inferred)	Predation, Herbivory, competition, non-participant, and symbiosis (parasitism, mutualism, commensalism).
Specimen	The identified evidence held within/on the physical sample.	Within a rock or unconsolidated sample, the fossilised bivalve shell would be recorded as the specimen. One rock may host many specimens.
Sample	A subset of a larger population or group, selected to represent the characteristics	Many specimens can build toward a representative sample.
Evidence of Interaction	The attribution of observation and facts to a type of interaction (present through either direct observation or inference) .	Observations from specimens, morphology, biomechanics, functional traits, taxonomy, or phylogenetic position.
Evidence of interaction *Direct*	Traces, marks and signs located on the specimen itself that constitute the strongest circumstantial evidence	Direct evidence of interaction can include cases where both actors of an interaction are preserved together in a direct association suggesting an interaction during life such as *frozen behaviours* (fish prey lock in the arms of exceptionally preserved cephalopod; beetle larvae in the grasp of a wasp in amber) as well as cases where only one partner is preserved directly while the other is represented as a sign it being a trace, marks, pathology including injury marks on body fossil (e.g., predation), consumed prey or intestinal parasitic remains in a biogenic object (coprolite, bromalite) which cannot be confused with organisms that entered after the interaction or trace fossils in a position and associations which cannot be explained when not interacting directly
Evidence of interaction *Inferred*	Traces, marks and signs located on the specimen itself that require additional proxies and evidence to interpret.	Inferred evidence of interaction can include proximity (e.g. pollen occurring in the close vicinity of a compression/impression insect mouth-part for pollination), injury marks on a body fossil (e.g. boreholes on a mollusc shell which may be

		predation/parasitism or decomposer depending if the mollusc was alive), other remains in a biogenic object (coprolite, bromalite), trace fossils (tetrapod footprints and nests), etc.
Evidence of Interaction Secondary	Evidence attributed to the specimen based on phylogeny, traits, morphology, etc.	Phylogenetic position (e.g. carnivore family tree), organism trait (e.g. sexual dimorphism), modern analogue. functional morphological comparison (e.g. crocodile and ambush predation an temnospondyls)
Direction of interaction	The direction relates to the assumed impact of the interaction on an individual organism's fitness. **+** : *the actor gains a positive impact from interaction.* **-** : *the actor is negatively impacted by the interaction.* **0** : *the actor is neither positively nor negatively impacted by the interaction*.	The instantaneous outcome for the actors, for example the survival direction: successful predation is positive for the predator (actor 1) and negative for the prey (actor 2). This definition *does not* relate to evolutionary or adaptive impacts of biotic interactions.
Actors	An organism (*actor 1)* that engaged in any manner with another organism or biogenic object (such as the remains or excrement of another organism; *actor 2*).	Actors can be both present and inferred in a specimen; e.g. a drill hole in a mollusc shell specimen does not preserve the drilling predator but only the borehole indicating its predation upon the mollusc (Fig. 2).
Discriminant	An interaction that has evidence of preferential selection by the initiating actor within an interaction type.	For example, within predation, a drillhole by predatory gastropod may be observed more frequently than random chance upon juvenile molluscs with thinner shells.
Indiscriminate	An interaction that lacks evidence of preferential selection by the initiating actor within an interaction type.	For example, within predation, generalist crocodilians attempt to consume any prey or carcass within range.
Obligate	An interaction where one or more of the actors are restricted to a particular function or mode of life.	Symbionts that cannot adopt a free-living life mode in the absence of their host.

Facultative	An interaction wherein 1 or more of the actors are capable of engaging in the interaction but are not restricted to a particular function or mode of life.	Symbionts that can adopt a free-living life mode in the absence of their host.
Evolutionary outcome	Evolutionary consequences of interaction and the movement toward the control and/or exploitation of resources through behaviour, learning, and/or morphology.	All interactions that impact fitness have evolutionary outcomes; in order to maintain fitness an herbivore may develop traits to increase the range of plants able to be eaten (e.g. grazers), or specialise to ensure maximum gain from few plant types or plant body parts (e.g. frugivores).