Species Are Structures[1]

Louis M. Guenin
guenin@harvard.edu
November 19, 2007

1. Definition of species

A *biological species* is a structure $\mathbb{S} = \langle S, R_1, R_2, \ldots, R_i, \ldots, R_n \rangle$ where S, the *population*, is an underlying set of creatures, and each R_i is a relation, which may be time-indexed, on S. Where $\mathbb{R}$ is the set of real numbers, we define functions $f: S \rightarrow \mathbb{R}$ and $g: S \rightarrow \mathbb{R}$ such that for any $x \in S$, $f(x)$ is the time at which x's life begins and $g(x)$ is the time at which x's life ends. Let $\trianglelefteq$ be the weak linear ordering on S given for $x, y \in S$ by

$$x \trianglelefteq y \leftrightarrow f(x) \leq f(y),$$

where $\leq$ is the natural ordering on $\mathbb{R}$. For any $j \in S$, we define the *segment* of $\mathbb{S}$ up to j as

$$\mathbb{S}^j = \langle \{x \in S \mid x \trianglelefteq j\}, R_1{}^j, R_2{}^j, \ldots, R_i{}^j, \ldots, R_n{}^j \rangle$$

where $R_i{}^j \subset R_i$ for $i = 1, 2, \ldots, n$.

$\mathbb{S}^j$ is a structure whose underlying set is a subset of S endowed with subsets of the R_i. The population of $\mathbb{S}^j$ consists of all members of S whose lives began before or at the same time as j's. To the history of the species, there corresponds a finite succession of segments $\mathbb{S}^a \subset \mathbb{S}^b \subset \ldots \mathbb{S}^j \ldots \subset \mathbb{S}^N = \mathbb{S}$, for $a \trianglelefteq b \trianglelefteq \ldots \trianglelefteq j \trianglelefteq \ldots \trianglelefteq N$, where N is the last member of the species to originate. The last of the segments is identical to the species. The population of the species is determined as of extinction.

The *inhabitation* of $\mathbb{S}$ as of time t is

$$\mathbb{S}_t = \langle \{x \in S \mid f(x) \leq t < g(x)\}, R_{1t}, R_{2t}, \ldots, R_{it}, \ldots, R_{nt} \rangle$$

where $R_{it} \subset R_i$.

$\mathbb{S}_t$ is populated by all members of S alive at t. The lives of members of the population occur within one or more bounded regions of space and within a bounded time interval. A *chain* is a set of creatures linearly ordered by 'descendant of.' A *lineage* is a set of chains originating at a common speciation event.

2. Species as mereoposums

Within extensional mereology, 'part of' is a transitive, reflexive, antisymmetric relation, i.e., a weak partial ordering.

A *mereoposum* is the unique sum of things partially ordered by 'part of,' as

---

[1] Portions hereof are excerpted from my *The Morality of Embryo Use* (Cambridge University Press).

given by

$$\sigma_{\phi(u)} = \iota\sigma\forall x(\sigma \circ x \equiv \exists u[\phi(u) \wedge x \circ u]),$$

where '$\phi(u)$' is a well-formed formula, '$\circ$' denotes overlap, and 'ι' is the definite description operator signifying a unique σ.

A *colligation* is a concrete composite composed of multiple closely resembling constituent substances tied together in some nontrivial spatiotemporal, causal agency, or sociolegal relationship.

3. Species as mereotiersums

Within a nonextensional mereology in which 'part of' is transitive, reflexive, and nonsymmetric, i.e., a weak partial tiering, a *mereotiersum* is a sum of things partially tiered by 'part of.' For synchronic 'part of,' chosen to accommodate change in continuants, a mereotiersum is definable thus:

$$\xi_{\phi(u)} = \xi\forall x\forall t(\xi \circ_t x \equiv \exists u[\phi_t(u) \wedge x \circ_t u]).$$

4. Speciointegrationism

5. Ramifications of species as structures

6. Taxa

Where X is a set partially ordered by the superset relation $\supset$,[2] an element M is a *minimal element* of X if and only if M is not a superset of any element of X. A structure is a superset of another structure if the former's underlying set is a superset of the latter's underlying set.

A *biological taxonomic tree* Λ is a finite set such that

(i) each $\mathbb{T} \in \Lambda$ is a structure of the form $<T, R_1, R_2, \ldots, R_i, \ldots, R_n>$,

(ii) in each $\mathbb{T} \in \Lambda$, T is an underlying set of creatures, and each R_i is a relation on T,

(iii) Λ is partially ordered by $\supset$,

(iv) for any $\mathbb{T} \in \Lambda$, the set of $\mathbb{T}$'s predecessors under $\supset$ (i.e., $\{X \in \Lambda \mid X \supset \mathbb{T}\}$ is well-ordered by $\supset$, and

(v) Λ contains two or more minimal elements.

An element $\mathbb{T}$ of Λ is a *taxon*. A linearly ordered subset of Λ is a *branch*. A minimal element of Λ is a *leaf*.

---

[2] $A \supset B \equiv B \subset A$.