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Taphonomic history of the *Homo erectus* site at Trinil, Java

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The Indonesian site of Trinil, located along today's Solo River in eastern Java, marks the place where in 1891 Eugene Dubois discovered the first *Homo erectus* fossils. Although tens-of-thousands of other vertebrate and invertebrate fossils were recovered from this meter-thick conglomeratic bonebed, earlier studies of the non-hominin material focused on the taxonomy and biostratigraphy. Despite the importance that the discoveries at Trinil have had in documenting the presence of *Homo erectus* in Java, no detailed taphonomic analysis of the collection has been conducted to address the formation of the site, including possible involvement of *Homo erectus* in site generation. Collections from excavations at Trinil are mostly housed in two places, reflecting both Dubois' initial work at the site (1891-1900), and the Selenka Expedition's subsequent excavation (1906-1908): the Dubois collection in the Naturalis Biodiversity Center, Leiden and the bulk of the Selenka collection in the Museum für Naturkunde, Berlin. The Dubois collection is much larger and has over 4000 cataloged specimens. The smaller Selenka collection has an additional almost 1400 specimens. Our investigation of the material has been limited with two week's analysis in Leiden and a week in Berlin.

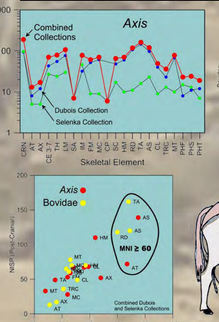
Collections and Sample Size

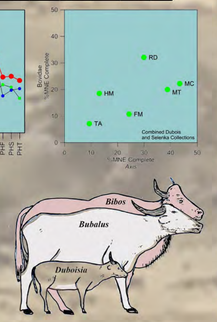
In order to develop a systematic overview of the assemblage in a limited amount of time, we have used a multi-level approach to faunal coding. First, we have done comprehensive taphonomic analysis (including attributes such as weathering, abrasion, breakage, biological damage, general surface visibility, adhering or in-filling matrix, bone surface color, fracture surface color, maximum length, width, and thickness) on a single skeletal element (humeri) for all species. A total of 243 specimens (4.4% of the combined assemblage) have been given this **full coding**. In addition we have done a more rapid scan of cervid and bovid bones, which make up the bulk of the assemblage, and while coding basic attributes of skeletal element, portion, segment, side, and skeletal age class, we also looked for distinctive surface modification attributes. This **basic coding** has been completed for 3736 specimens (68.1% if the combined assemblage). Information in this poster is an overview of the results of both the full and basic coding.

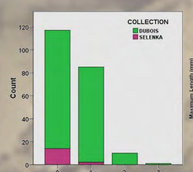
Trinil Vertebrate Faunal Collections	Analysis Catalog NISP		Basic Coding NISP		Full Coding NISP	
	N	%	N	%	N	%
Dubois: Naturalis Biodiversity Center, Leiden	4105	74.8	2578	62.8	200	4.9
Selenka: Museum für Naturkunde, Berlin	1385	25.2	1158	83.6	43	3.1
Totals	**5490**	***100***	**3736**	***68.1***	**243**	***4.4***

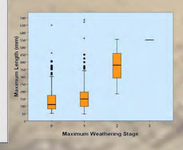
Selected Skeletal Element Frequencies

Postcranial Skeletal Element	*Axis*				Bovidae			
	Dubois NISP	Selenka NISP	NISPt	MNI	Dubois NISP	Selenka NISP	NISPt	MNI
AT	8	5	13	11	64	8	72	67
AX	12	5	17	16	46	6	52	48
CE 3-7	43	27	70	-	236	26	262	-
TH	55	24	79	-	209	35	244	-
LM	77	30	107	-	124	41	165	-
SA	7	-	7	-	15	2	17	-
SC	48	17	65	23	52	7	59	26
HM	60	10	70	37	90	20	110	44
RD	107	11	118	60	51	16	67	28
CP	0	6	6	-	32	5	37	-
MC	61	9	70	27	15	13	28	24
IM	32	46	78	-	45	9	54	-
FM	52	9	61	25	38	15	53	24
TA	146	16	162	68	37	12	49	15
AS	97	23	120	69	121	18	139	75
CL	40	9	49	31	62	6	68	39
TRC	23	13	36	21	59	8	67	36
MT	68	10	78	26	24	9	33	8
PHF	8	15	23	-	12	8	20	-
PHS	11	13	24	-	35	7	42	-
PHT	12	7	19	-	51	16	67	-









MAXIMUM WEATHERING STAGE
Behrensmeyer 1978 stages

Abrasion/ Rounding	N	%
0	188	77.4
1	41	16.9
2	12	4.9
3	2	.8
Total	**243**	**100.0**

Abrasion codes: Fiorillo 1988

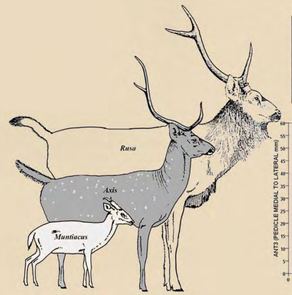
Weathering, Surface Condition, Abrasion, Adhering Sediment, and Breakage

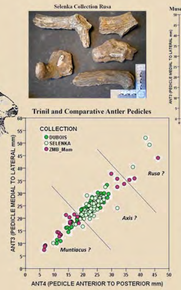
The assemblage consists primarily of disarticulated elements of large terrestrial herbivores, some fresh-water taxa, and rare taxa including carnivores and hominins. The material is notable for the large body-size diversity represented, a limited amount of pre-burial weathering and transportation damage, spiral long-bone fracturing, rare crocodile-tooth marks, and uniform fossilization. Skeletal element frequencies are tabulated for the most abundant cervids (*Axis sp*.) and the combined large Bovidae (*Bubalus palaeokerabau* and *B. bubalus*, and *Bibos paleosondonicus)*, which are difficult to distinguish post-cranially. The smaller bovid species, *Duboisia*, is not included in the counts presented here. Maximum post-cranial MNI estimate for the *Axis* deer is 69 and for the large bovids is 75, with both estimates based on astragali. Note that a cranial MNI for *Axis* is greater, with 102 individuals represented by frontal/pedicle fragments.

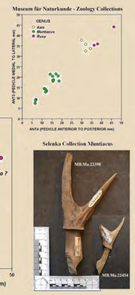
Bone weathering is minimal with most of the fully coded bones being unweathered. There is a tendency for larger bones (both in terms of maximum length, and in weathering profile height) to exhibit slightly more advanced weathering than smaller bones. In general, bones also have minimal rounding or abrasion with most surfaces sharp and clearly defined. The most common breakage on all specimens is the result of recent (excavation, collection, transport, curation) damages. A number of the large bovid bones show spiral fractures, but with none having distinct points of impact characteristic of percussion breakage.

Sediment on the interior of long bone shafts and on break surfaces provides another source of information on timing of fractures. On long bones that were complete when in situ, sediment infilling is often incomplete and very fine grained. For bones with older breaks, filling or adhering sediment is coarser-grained and usually more uniform. In both cases the sediments are un- to slightly weathered volcanoclastics that are clearly derived from the excavation unit.

Assemblage Characteristics: Age and Sex

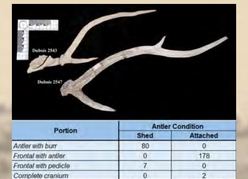




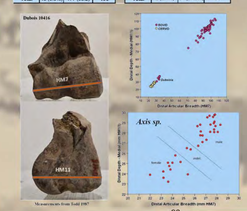


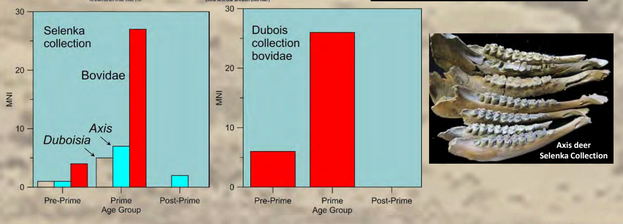
Side	Frontal with Pedicle: Antler Shed	Frontal with Pedicle: Antler Attached	Total
left	7	95	102
right	6	82	88
Total	13 (6.8%)	177 (93.2)	190

Side	Frontal with Pedicle: Antler Shed	Frontal with Pedicle: Antler Attached	Total
left	2	53	55
right	0	41	41
Total	2 (2.1%)	94 (97.9%)	96



Portion	Antler Condition: Shed	Antler Condition: Attached
Antler with burr	80	0
Frontal with antler	0	178
Frontal with pedicle	7	0
Complete cranium	0	2
Total	**87 (32.6%)**	**180 (67.4%)**





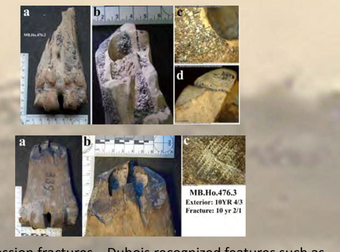
Metric and additional descriptive data collection on selected skeletal element groups of the cervids and bovids provide additional insights into the population characteristics of the faunal assemblage in the Trinil main bonebed. By far and away the most abundant single item in the large mammal collections are frontals with antlers or pedicles and shed antlers or antler beam fragments. While three genera are represented (*Axis*, *Rusa*, and *Muntiacus*) that represent markedly different body sizes and behavioral ecology, the majority of the antlers and cranial fragments are from axis deer. Of the specimens where the ontogenetic status of the antlers can be determined, 67.4% were fully formed and attached to the cranium at the animal's death and only 32.6% are shed antlers. Given the difficulty of recognizing female crania among the fragments, it is likely that the male-dominated estimate of axis deer representation is suspect. Plots of measurements of axis deer distal humeri indicated two distinct body size classes, which is indicative that females (and likely juveniles) as well as male axis are present in the assemblage.

Both collections contain numerous isolated teeth and complete or partial dentary rows belonging to axis deer, *Duboisia*, and large bovids that are amendable to age-frequency analysis. Unfortunately, the resolution of these data is relatively coarse due primarily to the presence of adhering sediment on many tooth surfaces. Despite this issue, documentation of eruption and occlusal wear patterns of bovid lower dentitions in the Dubois collection and of axis deer, *Dubosia*, and bovid lower dentitions in the Selenka collection indicate that these samples are dominated by individuals that died in the prime of life with healthy teeth in regular wear. Some animals died before they reached the prime of life, as indicated by incomplete eruption and wear. Only several *Axis* dentitions in the Selenka collection display characteristic expressions of senescence, including advanced wear of occlusal surfaces, short crown heights, severe malocclusions, dentine pegs, antemortem tooth loss, and resorption of alveolar bone. In summary, all indications are of catastrophic rather than attritional mortality patterns.

Bone Modifications

As part of the report on the Selenka expedition, Carthaus (1911) described a number of specimens as exhibiting "spuren von möglicherweise menschlicher Tätigkeit" (evidence of possible human activity). Each of the specimens he illustrated (1911 Plate 30 Figures 1-10) are in the Berlin collections, and along with several other pieces cataloged as exhibiting possible human modification, have been reexamined as part of this project. While, with the exception on MB.Ho.476.3, which appears to have been broken after it was mineralized (note color difference between shaft and break surface), all of the fractures are ancient. A second attribute common to nearly all of the specimens that had been sorted into the "possible tool" category, is that they have tend to be more heavily abraded and rounded than the majority of bones in the collections and this rounding is often uniform over the entire bone surface rather than being localized (e.g., specimens MB.Ho.397.1-3 & MB.Ho.476.2 b and d). The distal metacarpal illustrated as Figure 10 in Carhart's Plate 30 (MB.Ho.476.1) had originally been selected because the darker color of the proximal shaft portion suggested burning, but was later attributed to iron sulphide staining (Carhart 1911:234). Features of this specimen not noted by Carhart are compression fracture points on the proximal shaft (MB.Ho.476.1 c and d).

The single specimen that is relatively unabraded is the conjoining segments of *Stegodon* tusk (MB.Ho.391.1 and 391.2). These pieces were clearly broken while the tusk was fresh, and the fracture surface are coated with characteristic bonebed volcanoclastic sediment. Striations, which might indicate use, are not however clustered near edges of the piece, but are scattered over the exterior surface (MB.Ho.391.1 b) suggestive of modifications that may have accumulated during the animal's life.



One distinctive damage type is circular compression fractures. Dubois recognized features such as these as crocodile tooth marks (and crocodile predation as a key part of the taphonomy of the bonebed). Stemme (1911:146) noted similar damage to bones from the Selenka collection and suggested that the punctures most likely were the result of predation and consumption by crocodiles such as the exceptionally well preserved specimen recovered from the main bonebed at Trinil (MB.R.1959). Although rare, such punctures most likely produced by crocodiles, are present on bones recovered both by Dubois and on other specimens in the Selenka collections (MB.Ho.476.1 above and Dubois 1860 and MB.Ma22309 at left). While not as clearly defined, and much less conclusive, compression damage suggestive of a similar origin are present on the proximal end of *Homo erectus* Femur 1 from the site. Dubois (1926) concluded that this damage feature and others on the femur were from crocodiles.

Conclusions

Discussion of the discovery and associational context of the *Homo erectus* remains from Trinil has almost exclusively focused on the hominin femora and cranium with little reference to the much larger faunal assemblage from the main bonebed level. We have begun this more comprehensive taphonomic contextual analysis and although we've only been able to complete detailed coding of just under 5 percent of the combined Dubois/Selenka collections, we can offer the following preliminary observations:

- Although there is a tendency for bones from the larger body-sized animals to be slightly more weathered, in general bones and antlers from the main bonebed are unweathered and their accumulation does not seem to represent an aggregate time averaged assemblage that represents a wide range of post-mortem exposure histories.
- Sediments encasing the main bonebed materials collected by both Dubois and Selenka are of uniform size and identical volcanoclastic composition, and are identical to the matrix in the *Homo erectus* cranium.
- Although a number of the bones exhibit peri-mortem fracture morphologies, no distinctive percussion impact origin points have been observed. In fact, all cases where fracture initiation points can be identified, the force seems to have been of compressive rather than percussive origin.
- No clear evidence of use of bone tools is indicated.
- We see no indication that all bones recovered from within the main bonebed investigated by both Dubois and Selenka do not share the same general taphonomic history. The processes of accumulation, sedimentation, and preservation seem uniform for the Cervidae, Bovidae, and the seven specimens (cranium and six femora) attributed to *Homo erectus*.
- Over the years questions have been raised about the provenience of the Dubois fossils because photography was rarely used to document fossil recovery. The situation improved only slightly 10 years later, but the crocodile cranium (MB.R.1959) shown here was photographed in situ (Openoorth, fig. 22, in Selenka and Blanckenhorn, 1911), thus providing evidence that this fossil came from the bonebed and that this was the unit that was excavated.
- Given the lithological and paleontological features at Trinil, the bone bed most likely accumulated from muddy flood waters that originated as a lahar floe on an active stratovolcano tens of kilometers to the south and represents a catastrophic accumulation of a mass death. We see no evidence that *Homo erectus* played any role in carcass collection and modification at Trinil.

Copies of this poster available at:
http://grsle.org/taphonomy/Hill_et_al_2015.pdf

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