Awkward Assemblages and Points of Confusion: Understanding "Typologically Awkward" Final Palaeolithic Assemblages

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Introduction

The Late Glacial, defined as occurring from the first pronounced warming following the Last Glacial Maximum (LGM) to the beginning of the Holocene (c. 16,000-11,700 cal BP), is traditionally viewed as a period of great cultural diversity in northern Europe, with groups belonging to the Magdalenian and Epigravettian beginning to migrate northwards (Gamble et al. 2005; Riede, 2014; Wygal and Heidenreich, 2014). During this phase, groups occupying particular regions in northern Europe began to develop consistent differences in their toolkits, with variances in shouldered points (e.g. the Hamburgian: Burdukiewicz, 1986), backed points (e.g. the Federmessergruppen and Azilian: Schild, 1996), large tanged points (e.g. the Bromme: Taute, 1968) and small tanged points (e.g. the Ahrensburgian and Swiderian: Taute, 1968; Kobusiewicz, 2002). As highlighted by Ivanovaite et al. (2019), these regional cultural entities provide the framework for understanding and inferring patterns and processes of migration, adaptation, and potentially even emerging ethnicity for this period. Cultural units are not static, and once their attendant territories are defined, cultures can move around, their economic focus can change, and cultures can interact. It is for this reason that the identification of robust archaeological taxonomic units are a fundamental precondition in our archaeological understanding of this period; without these units, the goal of understanding such past processes cannot be realised (Roberts and Vander Linden, 2011).

Yet, techno-typological classifications for the European Palaeolithic (and further afield) have been repeatedly critiqued (Otte and Keeley, 1990; Neeley and Barton, 1994; Barton and Neeley, 1996; Felgenhauer, 1996; Clark, 1999, Vasil'ev, 2001; 2009; Tomášková, 2013; Clark and Riel-Salvatore, 2006; Shea, 2014; Lisitsyn, 2017; Ivanovaitė and Riede, 2018; Riede et al. 2019; Reynolds and Riede, 2019; Ivanovaite et al. 2019). Otte and Keeley (1990) note that many of the taxonomic units for the Final Palaeolithic, the *fossils directeurs* for ethno-geographic variability, are usually rooted in early antiquarian excavations, consisting of only a few key sites (as reflected in the practice of naming archaeological units after *loci classici*), while Sauer and Riede (2019) have highlighted that, for the Final Palaeolithic of Central Europe, units appear to reflect differing research histories more than empirical variation between assemblages. A more acerbic critique has been voiced by Houtsma et al. 1996: 143), arguing that '[o]nly when researchers of the Late Palaeolithic habitation of the Northwest European Plain escape the constraints of contemporary national borders and the paradigmatic straight-jackets of provincialism and regional chauvinism, which lead to insularity, will we be in a position to gain analytical control of the totality of extant data partitioned into uniform and mutually comparable sets of demonstrably relevant attributes' (Houtsma et al. 1996: 143). With a lack of genetic material available to contribute to the understanding of the chronologies, movements and behaviours of Final Palaeolithic communities, stone tool variants remain the premier proxies for inferring population structure.

Attempts are currently underway to provide a more objective framework for the Final Palaeolithic, founded on conceptualising material culture as an underwritten system of information transmission across generations, through the production of reproducible, objective phylogenetic assessments of archaeological taxonomic units (Riede et al. 2019; Ivanovaite et al. 2019). This article, through the same theoretical framework, considers

this problem on a micro-level, specifically that of 'typologically awkward' assemblages, i.e. archaeological contexts with multiple techno-typological identifiers and reflecting one cultural units. In considering the Final Palaeolithic contexts of Häcklingen and Bienenbuttel (Germany), this article will highlight how an empirical technological and phylogenetic assessment can shed light on their positioning within the wider landscape and context, and further highlight some of the issues in techno-typological classifications.

Site Overviews: Häcklingen and Bienenbuttel

Bienenbüttel FStNr. 15 (Lower Saxony, Germany)

Bienenbüttel-15 is situated on the north-east bank of the Ilmenau river, between the villages of Bienenbüttel and Wichmannsburg, and is approximately 11km to the south-east of Häcklingen (discussed below). Following test cuttings in autumn 1997, a more detailed investigation commenced in 1998 by the Bezirksarchiiologie Lüneburg Ausgrabungen (Lüneburg Distict Archaeological Unit), following proposed building development in the area.

Excavations revealed a wealth of Neolithic material including post features, ceramic material in addition to a cooking pit; later prehistoric material from the Bronze Age was also recovered (Richter 2001). Below, a number of backed points were identified, in addition a number of scrapers, blade cores, burins and blades. A number of fragmented and complete Federmesser and Creswellian points (Figure 1) were identified in addition to three Zonhoven points (sensu Schwabedissen 1954), blades typical of the Ahrensburgian featuring sloping retouched tips. One Hamburgian point, belonging to the Havelte Group (sensu Bohmers 1956 and Stapert 1997) was also identified among the assemblage. A clear temporal separation between the Final Palaeolithic and Neolithic material was acknowledged, with little mechanical redeposition assumed, however an absolute chronometric framework was not generated.

Richter (2001) first supposed, through the identification of retouched tips, and the end-scraper component of the assemblage that elements from the both Wehlen and Tjonger Federmesser sub-groups (*sensu* Schwabedissen 1954) are identified. However, with the clear presence of Creswellian (and Ahrensburg and Hamburgian elements), Richter (2001) queried the pre-existing framework, following similar doubts by Paddaya (1971) and Ikinger (1998), and stressed the lack of precise qualitative and quantitative analyses in understanding group structure (Richter, 2001: 34).

For further details on the site of Bienenbüttel FStNr. 15 please refer to Richter (2001).

Häcklingen FStNr. 19 (Lower Saxony, Germany)

Excavations close to the village of Häcklingen, situated near the town of Lüneburg (Lower Saxony, Germany), first began from 1983-1985, following the identification of Palaeolithic and Neolithic material during routine surface inspection (Assendorp, 1997). Following the identification of Neolithic pit features, ceramic material, burned bone fragments and hazelnut shells, student excavations led by the University of Hamburg and University of Prague were undertaken towards the end of the twentieth century.

With ice wedge formations thought to have occurred at this site, as described elsewhere for northern Germany (Clausen, 1995, 1997; Zoller, 1981), and artefacts separated from discoloured areas in the soil, a vertical shift in archaeological material is hypothesised (Richter, 2001). This is evident in the examination of the Final Palaeolithic material, with patination and minor edge damage contrasting the fresh-edged and unrelocated Neolithic material, and contrasts the sequence at Bienenbüttel-15.

Among the Final Palaeolithic material were a variety of tanged point and backed point forms, including Ahrensburgian, Lyngby and Chwalibogowice tanged points, in addition to a number of Penknife backed points (see Figure 1). Richter (2002) notes that classically (*sensu* Schwabedissen 1954) Häcklingen can be attributed to the Rissener sub-group of the Federmessergruppen, before highlighting that the Rissener categorisation, and the sub-categories of the Federmesser more generally, are unsatisfactory (Ikinger, 1998; Richter, 2001). This led to Richter (2002) questioning its place within the Tolk-Sprenge subdivision of the Lyngby culture (*sensu* Taute 1968), comparable with the Segebro-Bromme culture in Scandinavia: despite

the presence of backed form variants, these are thought to occur (in their minority) within the Tolk-Sprenge (see Taute 1968 and Ikinger 1998). However, with a distinct chronometric framework lacking (similarly to Bienenbüttel), and as a result of mechanical taphonomic processes at Häcklingen, it is unknown whether the Final Palaeolithic material represents one or multiple occupation events.

Despite cross-contamination in layers, the typologically perspective awkward admixture of tanged and backed point variants at Häcklingen are particularly relevant to the robustness of these artefacts, and the combination of them as archaeological taxonomic units.

For further details on the site of Häcklingen FStNr. 19 please refer to Richter (2002).

[Figure 1: Select Backed and Tanged Points from Häcklingen FStNr. 19 and Bienenbüttel FStNr. 15 (redrawn after Richter 2001 and Richter 2002)]

Techno-typological Classifications and Points of Contention

The sites of Häcklingen and Bienenbüttel represent just two of a number of contexts, with a lack of chronometric dating, and known to feature a wealth of different named artefact units commonly thought to represent specific taxonomic groups. Others include XXXXXXX (FELIX ADD HERE). (ADD HERE WHY ITS IMPORTANT THAT THIS IS CLARIFIED)

Materials and Methods

To better understand the technological positioning of Häcklingen and Bienenbüttel, an empirical quantitative and qualitative analysis is performed on technological and morphological variables on a number of previously classified Federmesser and Bromme material. For this analysis, the following contexts (in addition to Häcklingen and Bienenbüttel) are considered:

Previously classified Federmesser material

3) **Rietberg (1/2/5/Other/Spoil)** (North Rhine-Westphalia, Germany): (ADD HERE)
4) **Rothenkirchen** (Hesse, Germany): (ADD HERE)

Previously classified Bromme material

5) **Brümmerhof (FStNr. 16)** (Lower Saxony, Germany): (ADD HERE)
6) **Højgård** (Zealand, Denmark): (ADD HERE)
7) **Sassenholz (FStNr. 78/82)** (Lower Saxony, Germany): (ADD HERE)
8) **Skovmosen I** (Zealand, Denmark): A Final Palaeolithic assemblage comprising of tanged points, scrapers, burins, and primary reduction products including blades and cores (Boye, 2006; Hilgart, 2003; Eggers-Kaas et al. 2019). Can be traditionally placed within the Bromme culture (Hilgart, 2003; Boye, 2006; Brinch Petersen, 2009), however caution has been noted in its classification (Eggers-Kaas et al. 2019).
9) **Søvind** (Jutland, Denmark): (ADD HERE)
10) **Segebro** (Malmö, Sweden): (ADD HERE)

Both Häcklingen and Bienenbüttel will be first categorised as Federmesser (the default judged unit), and then explored further.

In understanding the underlying *chaînes opératoires*, and in adopting a common terminology for identifying technological signatures and characteristics, attributes originate from the Nordic Blade Technology Network (REFERENCE). Minor amendments, and the extension of categories in a small number of instances were necessary to reflect Final Palaeolithic variability e.g. dorsal scar directionality. First, technological and morphological characteristics are first examined through **visual and descriptive summaries of data**. The significance of differences in the distribution of continuous variables across assemblages were assessed

using **pairwise Mann–Whitney** testing (with Bonferroni-corrected p values). A **Gini-Simpson** index is then employed to examine intrasite variability while a **Morisita-Horn diversity index** is used to examine inter-assemblage dissimilarity; past applications in Crema (2014), Maiorano et al. (2020) and Leplongeon et al. (2020). **Multiple Correspondence Analysis (MCA)** is then employed for all categorical technological data, and for each data type (core, blade, backed point, tanged point); this will examine the degree of association between individual contexts and their technological make-up. **Principal Component Analysis (PCA)** is performed for all quantitative (morphometric) data, again for each data type; this will also examine individual contexts and their classification. PCA is analogous to MCA but for quantitative variables.

(WHAT PHYLOGENETIC ANALYSIS SHOULD BE EMPLOYED: ML FOR QUANTITIVE VARIABLES AND PARSIMONY ANALYSES FOR QUALITATIVE?!)

All ordination methods in this analysis were conducted using the FactoMiner (Le et al. 2008), factoextra (Kassambara and Mundt, 2020) and the tidymodels packages (Kuhn et al. 2020), while diversity measures were calculated using the diverse (Guevara et al. 2016) and vegan (Oksanan et al. 2020) packages. A number of other packages were used to aid data wrangling, transformation and visualising, including rio (Chan et al. 2018), tidyverse (Wickham et al. 2019), gt (Iannone et al. 2020), broom (Robinson et al. 2020), tidytext (Silge and Robinson, 2016) and doBy (Højsgaard and Halekoh, 2020). All data, R code and supporting material (including figures) in this article can be found on the Open Science Framework (doi https://osf.io/3h2rq/)

Table 1. Artefact Breakdown

	Context			
Context	Backed Point	Blade	Core	Tanged Point
Bienenbüttel (FStNr. 15)	5	15	1	NA
Brümmerhof (FStNr. 16)	13	6	NA	3
Häcklingen (FStNr. 19)	9	43	8	7
Rietberg (1)	4	61	5	NA
Rietberg (2)	2	11	NA	NA
Rothenkirchen	4	11	2	NA
Sassenholz (FStNr. 78)	36	102	22	21
Højgård	NA	2	1	NA
Rietberg (5)	NA	21	2	NA
Rietberg (Other)	NA	3	NA	NA
Sassenholz (FStNr. 82)	NA	31	5	1
Segebro	NA	24	11	4
Søvind	NA	88	5	NA
Rietberg (Spoil)	NA	NA	2	NA
Skovmosen	NA	NA	6	1

Table 2. Artefact Breakdown

	Technology			
Classification	Backed Point	Blade	Core	Tanged Point
Bromme	49	253	50	30
Federmesser	24	165	20	7

Technological attributes

The following attributes are recorded for all artefacts:

Attribute	Variable(s)
ID	Catalogue Number / Identification Number
CODE	Site Code
CONTEXT	Archaeological Context
COUTNRY	Country
LONGITUDE	Longitude
LATITUDE	Latitude
RECOVERY METHOD	Recovery Method - 1: **Excavation**; 2: **Surface Collection**
CLASSIFICATION	Taxonomic Unit e.g. Bromme
BP_ASSOCIATION	Association of backed points - 1: **Yes**; 2: **No**
TP_ASSOCIATION	Association of tanged points - 1: **Yes**; 2: **No**
POINT_TYPE	Point type - 1: **Backed Point**; 2: **Tanged Point**
NAMED_ARTEFACT_TYPE	Classification e.g. Federmesser Point
ABS_DATE_METHOD	Absolute dating method (if provided)
ABS_DATE	Absolute date (as provided)
ABS_DATE_STD	Absolute date standard deviation (as provided)
RELAT_DATE_METHOD	Relative dating method (if provided)
RELAT_DATE_CHRONO	Relative date (as provided)
RAW_MAT	Raw material e.g. flint

The following additional attributes are recorded for all **blades**:

Attribute	Variable(s)
WEIGHT	Weight (g)
WIDTH	Width (mm)
THICKNESS	Thickness (mm)
PLAT_DEPTH	Platform Depth (mm)
DORS_BLADE_PROF	Dorsal blade characterisation - 1: **Full Cortical Dorsal Face (FC)**; 2: **Two Dorsal Faces - One Cortex (TDOC)**; 3: **Three Dorsal Faces - One Cortex (THDOC)**; 4: **Two Dorsal Faces - No Cortex (TDNC)**; 5: **Three Dorsal Faces - No Cortex (THDNC)**; 6: **Multiple Dorsal Faces (MDF)**; 7: **Bilateral Crested Blade (BCB)**; 8: **Crested Blade - One Flaked And One Uncortical (CBOU)**; 9: **Crested Blade - Three Flaked Faces (CBTHF)**; 10: **Crested Blade - One Flaked And One Cortical (CBOFOC)**; 11: **Crested Blade - Flaked And Trimmed (CBFT)**
BLADE_DET	Blade determination - 1: **Ideal (ID)**; 2: **Feathered (FE)**; 3: **Plunged (PL)**; 4: **Hinged (HI)**
BLADE_CURV	Blade curvature - 1: **Straight (ST)**; 2: **Distal (DI)**; 3: **Even (EV)**; 4: **Ventral 'Belly' (VB)**
DORSAL_PATTERN	Dorsal scar pattern - 1: **Centripetal (CE)**; 2: **3-Way Centripetal (TWC)**; 3: **Bidirectional (BI)**; 4: **Convergent (CON)**; 5: **Convergent And Bidirectional (CONBI)**; 6: **Convergent And Perpendicular (CONPE)**; 7: **Double Perpendicular (DP)**; 8: **Straight And Perpendicular (SAP)**; 9: **Unidirectional (UNI)**; 10: **Undetermined (UND)**
BULB_MORPH	Bulb and lip characteristics - 1: **Bulb Formation (BF)**; 2: **Pronounced Bulb Formation (PBF)**; 3: **Bulb And Lip Formation (BLF)**; 4: **Lip Formation (LF)**; 5: **Pronounced Lip Formation (PLF)**; 6: **Diffused Bulb (DB)**; 7: **No Bulb Or Lip (NBOL)**

Attribute	Variable(s)
CONUS_FORM	Cone Formation - 1: **No Formation (NFO)**; 2: **Ring Crack On Butt (RCB)**; 3: **Ring Crack And Ventral Fissures (RCVF)**; 4: **Detached Bulb (DB)**
BUTT_MORPH	Butt morphology - 1: **Large And Thick Butt (LTB)**; 2: **Large Oval Butt (LOB)**; 3: **Thin Oval Butt (TOB)**; 4: **Small Thick Butt (STB)**; 5: **Small Butt (SB)**; 6: **Punctiform Butt (PUNB)**; 7: **Broken/Absent Butt (BAB)**
BUTT_PREP_1	Butt preparation #1 - 1: **Plain (PLA)**; 2: **Facetted With Two Scars (FTS)**; 3: **Facetted With Greater Than Two Scars (FGTTS)**; 4: **Broken (B)**
BUTT_PREP_2	Butt preparation #2 - 1: **Cortical Unprepared (CU)**; 2: **Non-Cortical Unprepared (NCU)**; 3: **Dorsal Trimming (DT)**; 4: **Dorsal Abrasion (DA)**; 5: **Dorsal Abrasion And Grinding (DAG)**; 6; **Dorsal Abrasion And Trimming (DATR)**; 7: **Dorsal Abrasion, Trimming And Grinding (DATG)**; 8: **Broken (B)**

Note: Blades are here defined as any previously assigned or reclassified material with an elongation index of 2:1, exhibits parallel lateral edges and appears to be derived from a scheme of stereotyped elongation production.

The following additional attributes are recorded for all **cores**:

Attribute	Variable(s)
WEIGHT	Weight (g)
CORE_LENGTH	Core length (mm) as oriented on morphological axis (max length) and flaking surface (most blade removals)
CORE_WIDTH	Core width (mm) as oriented on morphological axis (max length) and flaking surface (most blade removals)
CORE_BREADTH	Core breadth (mm) as oriented on morphological axis (max length) and flaking surface (most blade removals)
CORE_MORPH	Platform count: 1: **One Platform (OP)**; 2: **Two Platforms (TP)**
PLAT_REJUV	Platform description: 1: **Single Smooth (SS)**; 2: **Double Smooth (DS)**; 3: **Single Facetted/Flaked (SF)**; 4: **Double Facetted/Flaked (DF)**; 5: **Single Systematic (SSY)**; 6: **Double Systematic (DSY)**; 7: **Double Smooth And Facetted (DSF)**; 8: **Double Smooth And Systematic (DSS)**; 9: **Double Facetted And Systematic (DFSY)**
CORE_METHOD	Core exploitation method - 1: **Semi-Rotating (SRO)**; 2: **Full-Rotating (FURO)**; 3: **Frontal (FRO)**; 4: **Facial (FAC)**; 5: **Multi-Facial (MFAC)**
CORE_DIRECTIONALITY	Scar directionality - 1: **Unidirectional (CUNI)**; 2: **Bidirectional (CBI)**; 3: **Mixed (CM)**
CORE_TABLET_REJUV	Evidence for core tablet removals – 1) **Yes (Y)**; 2) **No (N)**
CORE_FLAKE_REJUV	Evidence for preparatory flake rejuvenation – 1) **Yes (Y)**; 2) **No (N)**
CORE_FRONT_REJUV	Evidence for core frontal rejuvenation – 1) **Yes (Y)**; 2) **No (N)**
CORE_DIST_REJUV	Evidence for core distal rejuvenation – 1) **Yes (Y); 2) No (N)**
CORE_SIDE_REJUV	Evidence for core lateral rejuvenation – 1) **Yes (Y); 2) No (N)**

Note: Blade cores are here defined as material which exhibits the production of stereotyped elongated material around the core's circumference.

The following additional attributes are recorded for all **tanged and backed points**:

Attribute	Variable(s)
WEIGHT	Weight (g)
LENGTH	Length (mm)
WIDTH	Width (mm)
THICKNESS	Thickness (mm)
ELONGATION	Elongation Index (Length/Width)
TANG_ORIENTATION	Orientation of tang or base - 1) **Proximal**; 2) **Distal**; 3) **Lateral**
TCSA	Maximum tip cross-sectional area (mm^2) *sensu* Shea (2006)
TCSP	Maximum tip cross-sectional perimeter (mm) *sensu* Shea (2006)
BURINATION	Presence of burination – 1) **Yes (Y)**; 2) **No (N)**

Analysis: Blades (exc. Crested Blades and Broken Pieces)

Visual and Descriptive Summaries of Data

Table 3. Descriptive Statistics: Blade Weight (g)

CONTEXT	n_obs	min	max	mean	med	sd	var
Bienenbüttel (FStNr. 15)	12	1.34	8.17	4.76	4.70	2.27	5.13
Brümmerhof (FStNr. 16)	5	3.92	14.94	6.73	4.32	4.68	21.89
Häcklingen (FStNr. 19)	34	0.43	18.69	5.59	4.74	4.03	16.23
Højgård	2	4.47	50.82	27.64	27.64	32.77	1074.16
Rietberg (1)	46	0.28	11.80	2.66	1.71	2.72	7.42
Rietberg (2)	7	1.33	10.54	4.39	3.93	3.13	9.80
Rietberg (5)	11	0.43	8.56	2.82	1.56	2.97	8.82
Rietberg (Other)	2	5.60	19.72	12.66	12.66	9.98	99.69
Rothenkirchen	9	0.78	30.83	9.92	3.92	11.61	134.72
Sassenholz (FStNr. 78)	86	0.97	127.48	21.73	15.54	20.90	436.82
Sassenholz (FStNr. 82)	22	4.35	88.61	20.84	17.81	17.17	294.88
Segebro	23	3.57	55.26	23.02	18.95	15.60	243.27
Søvind	69	0.52	62.31	10.78	7.70	11.01	121.31

Table 4. Descriptive Statistics: Blade Length (mm)

CONTEXT	n_obs	min	max	mean	med	sd	var
Bienenbüttel (FStNr. 15)	12	37.05	72.81	54.38	51	12.18	148.29
Brümmerhof (FStNr. 16)	5	29.12	33.17	31.20	31	1.82	3.32
Häcklingen (FStNr. 19)	34	23.33	71.76	52.66	53	11.47	131.56
Højgård	2	61.52	83.37	72.45	72	15.45	238.71
Rietberg (1)	46	20.73	72.56	39.72	36	12.22	149.41
Rietberg (2)	7	37.03	59.61	46.74	48	8.56	73.31
Rietberg (5)	11	23.63	59.64	39.85	37	11.75	138.06
Rietberg (Other)	2	56.10	80.43	68.26	68	17.20	295.97
Rothenkirchen	9	27.49	81.14	50.26	43	18.14	328.96
Sassenholz (FStNr. 78)	86	22.60	105.32	53.33	52	16.18	261.88
Sassenholz (FStNr. 82)	22	27.43	70.58	50.56	52	10.28	105.78
Segebro	23	43.73	96.15	73.46	75	13.13	172.37
Søvind	69	25.29	121.34	61.37	57	19.56	382.57

Table 5. Descriptive Statistics: Blade Width (mm)

CONTEXT	n_obs	min	max	mean	med	sd	var
Bienenbüttel (FStNr. 15)	12	11.62	21.32	16.09	15.72	3.27	10.67
Brümmerhof (FStNr. 16)	5	11.42	11.86	11.59	11.48	0.20	0.04
Häcklingen (FStNr. 19)	34	7.12	29.74	16.99	16.30	5.35	28.60
Højgård	2	17.12	40.37	28.74	28.74	16.44	270.28
Rietberg (1)	46	6.08	26.09	13.78	13.64	4.36	18.99
Rietberg (2)	7	11.37	26.96	18.53	17.19	5.85	34.26
Rietberg (5)	11	7.66	24.37	13.24	11.50	5.72	32.74
Rietberg (Other)	2	17.34	32.44	24.89	24.89	10.68	114.00
Rothenkirchen	9	6.62	33.23	18.83	18.39	8.75	76.53
Sassenholz (FStNr. 78)	86	5.30	40.14	17.14	17.09	6.60	43.50
Sassenholz (FStNr. 82)	22	7.04	35.55	16.13	16.19	5.57	31.06
Segebro	23	12.39	49.09	29.01	27.88	9.21	84.89
Søvind	69	8.73	39.48	22.74	22.55	6.49	42.10

Table 6. Descriptive Statistics: Blade Elongation Index (L/W)

CONTEXT	n_obs	min	max	mean	med	sd	var
Bienenbüttel (FStNr. 15)	12	2.31	5.72	3.46	3.28	0.91	0.82
Brümmerhof (FStNr. 16)	5	2.54	2.80	2.69	2.71	0.12	0.01
Häcklingen (FStNr. 19)	34	1.99	4.90	3.25	3.36	0.74	0.55
Højgård	2	2.07	3.59	2.83	2.83	1.08	1.17
Rietberg (1)	46	1.59	5.26	3.00	2.84	0.76	0.58
Rietberg (2)	7	1.98	3.26	2.64	2.53	0.55	0.30
Rietberg (5)	11	2.42	4.77	3.18	3.07	0.69	0.48
Rietberg (Other)	2	2.48	3.24	2.86	2.86	0.53	0.29
Rothenkirchen	9	2.16	4.15	2.87	2.60	0.67	0.45
Sassenholz (FStNr. 78)	86	2.02	6.79	3.35	3.09	0.99	0.97
Sassenholz (FStNr. 82)	22	1.90	5.93	3.34	3.06	0.95	0.90
Segebro	23	1.28	5.27	2.76	2.70	0.92	0.85
Søvind	69	1.35	5.41	2.78	2.60	0.75	0.57

Table 7. Descriptive Statistics: Blade Thickness (mm)

CONTEXT	n_obs	min	max	mean	med	sd	var
Bienenbüttel (FStNr. 15)	12	2.70	12.02	6.48	5.54	2.53	6.41
Brümmerhof (FStNr. 16)	5	3.92	5.90	4.74	4.21	0.95	0.91
Häcklingen (FStNr. 19)	34	2.42	11.21	5.58	5.52	1.90	3.60
Højgård	2	6.90	17.79	12.34	12.34	7.70	59.30
Rietberg (1)	46	1.72	51.18	7.19	4.45	9.71	94.35
Rietberg (2)	7	3.06	9.52	6.23	6.10	2.09	4.38
Rietberg (5)	11	2.62	6.84	4.35	4.38	1.44	2.06
Rietberg (Other)	2	7.43	9.31	8.37	8.37	1.33	1.77
Rothenkirchen	9	5.31	8.42	6.64	6.53	1.17	1.36
Sassenholz (FStNr. 78)	86	1.44	51.29	6.94	5.90	5.60	31.31
Sassenholz (FStNr. 82)	22	3.05	11.90	6.10	5.52	2.35	5.53
Segebro	23	4.92	11.43	7.52	7.10	1.90	3.62
Søvind	69	3.20	18.45	7.78	7.42	2.97	8.83

Table 8. Descriptive Statistics: Blade Platform Depth (mm)

CONTEXT	n_obs	min	max	mean	med	sd	var
Bienenbüttel (FStNr. 15)	12	1.17	5.13	3.37	3.40	1.32	1.75
Brümmerhof (FStNr. 16)	5	1.12	2.74	1.68	1.27	0.71	0.51
Häcklingen (FStNr. 19)	34	1.02	9.69	3.61	2.88	2.14	4.57
Højgård	2	4.01	6.88	5.44	5.44	2.03	4.12
Rietberg (1)	46	1.02	4.93	2.45	2.32	0.98	0.96
Rietberg (2)	7	1.51	5.41	2.91	2.24	1.30	1.69
Rietberg (5)	11	1.25	5.03	2.31	2.11	1.10	1.21
Rietberg (Other)	2	3.15	3.24	3.20	3.20	0.06	0.00
Rothenkirchen	9	1.26	9.53	3.44	2.75	2.70	7.27
Sassenholz (FStNr. 78)	86	0.88	10.93	3.37	2.88	1.91	3.65
Sassenholz (FStNr. 82)	22	1.06	7.18	2.83	2.30	1.57	2.48
Segebro	23	2.35	15.74	6.83	5.53	3.35	11.23
Søvind	69	1.03	11.62	4.67	3.92	2.34	5.49

Table 9. Descriptive Statistics: Blade Weight (g)

CLASSIFICATION	n_obs	min	max	mean	med	sd	var
Bromme	207	0.52	127.48	17.82	11.66	17.69	312.88
Federmesser	121	0.28	30.83	4.51	3.11	4.90	23.97

Table 10. Descriptive Statistics: Blade Length (mm)

CLASSIFICATION	n_obs	min	max	mean	med	sd	var
Bromme	207	22.60	121.34	57.60	55	18.15	329.55
Federmesser	121	20.73	81.14	46.48	45	13.89	192.95

Table 11. Descriptive Statistics: Blade Width (mm)

CLASSIFICATION	n_obs	min	max	mean	med	sd	var
Bromme	207	5.30	49.09	20.20	19.25	8.03	64.41
Federmesser	121	6.08	33.23	15.69	15.06	5.62	31.53

Table 12. Descriptive Statistics: Blade Elongation Index (L/W)

CLASSIFICATION	n_obs	min	max	mean	med	sd	var
Bromme	207	1.28	6.79	3.07	2.84	0.93	0.86
Federmesser	121	1.59	5.72	3.10	2.96	0.76	0.57

Table 13. Descriptive Statistics: Blade Thickness (mm)

CLASSIFICATION	n_obs	min	max	mean	med	sd	var
Bromme	207	1.44	51.29	7.19	6.52	4.22	17.78

Federmesser	121	1.72	51.18	6.33	5.31	6.19	38.34

Table 14. Descriptive Statistics: Blade Platform Depth (mm)

CLASSIFICATION	n_obs	min	max	mean	med	sd	var
Bromme	207	0.88	15.74	4.11	3.47	2.51	6.30
Federmesser	121	1.02	9.69	2.97	2.71	1.66	2.74

125
100
75
50
25
Length (mm)
BIEN
BRUM
HACK
HOJG
RIET
ROTH
SASS
SEGE
SOVI
Taxonomic Unit
Bromme
Federmesser

50
40
30
20
10
Width (mm)
BIEN
BRUM
HACK
HOJG
RIET
ROTH
SASS
SEGE
SOVI
Taxonomic Unit
Bromme
Federmesser

Elongation (L/W)
7
6
5
4
3
2
BIEN
BRUM
HACK
HOJG
RIET
ROTH
SASS
SEGE
SOVI
Taxonomic Unit
Bromme
Federmesser

Thickness (mm)
50
40
30
20
10
0
BIEN
BRUM
HACK
HOJG
RIET
ROTH
SASS
SEGE
SOVI
Taxonomic Unit
Bromme
Federmesser

Platform Depth (mm)
16
12
8
4
BIEN
BRUM
HACK
HOJG
RIET
ROTH
SASS
SEGE
SOVI
Taxonomic Unit
Bromme
Federmesser

Blade Length (mm)
100
50
0
0
20
40
60
Blade Width (mm)
CLASSIFICATION
Bromme
Federmesser

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  blade_data_clean$WEIGHT and blade_data_clean$CODE
##
##      BIEN    BRUM    HACK    HOJG    RIET    ROTH    SASS    SEGE
## BRUM 1.00000 -       -       -       -       -       -       -
## HACK 1.00000 1.00000 -       -       -       -       -       -
## HOJG 1.00000 1.00000 1.00000 -       -       -       -       -
## RIET 0.35987 0.72058 0.00882 1.00000 -       -       -       -
## ROTH 1.00000 1.00000 1.00000 1.00000 1.00000 -       -       -
## SASS 0.00059 0.49425 3.5e-08 1.00000 < 2e-16 0.51462 -       -
## SEGE 0.00185 0.59119 1.2e-05 1.00000 3.3e-09 0.42879 1.00000 -
## SOVI 0.73250 1.00000 0.12008 1.00000 1.1e-09 1.00000 3.9e-05 0.00208
##
## P value adjustment method: bonferroni
```

```
##
```

```
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  blade_data_clean$LENGTH and blade_data_clean$CODE
##
##      BIEN    BRUM    HACK    HOJG    RIET    ROTH    SASS    SEGE
## BRUM 0.06745 -       -       -       -       -       -       -
## HACK 1.00000 0.05457 -       -       -       -       -       -
## HOJG 1.00000 1.00000 1.00000 -       -       -       -       -
## RIET 0.06446 1.00000 0.00081 0.92140 -       -       -       -
## ROTH 1.00000 0.84278 1.00000 1.00000 1.00000 -       -       -
## SASS 1.00000 0.03288 1.00000 1.00000 1.3e-05 1.00000 -       -
## SEGE 0.02229 0.02261 4.0e-05 1.00000 5.7e-09 0.10519 6.5e-06 -
## SOVI 1.00000 0.01486 1.00000 1.00000 3.8e-09 1.00000 0.13915 0.03768
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  blade_data_clean$WIDTH and blade_data_clean$CODE
##
##      BIEN    BRUM    HACK    HOJG    RIET    ROTH    SASS    SEGE
## BRUM 0.13487 -       -       -       -       -       -       -
## HACK 1.00000 0.56572 -       -       -       -       -       -
## HOJG 1.00000 1.00000 1.00000 -       -       -       -       -
## RIET 1.00000 1.00000 0.70212 1.00000 -       -       -       -
## ROTH 1.00000 1.00000 1.00000 1.00000 1.00000 -       -       -
## SASS 1.00000 0.75059 1.00000 1.00000 0.31717 1.00000 -       -
## SEGE 0.00384 0.02261 9.7e-05 1.00000 1.9e-07 0.42879 1.7e-06 -
## SOVI 0.02019 0.02600 0.00083 1.00000 2.0e-10 1.00000 8.6e-07 0.14072
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  blade_data_clean$ELONGATION and blade_data_clean$CODE
##
##      BIEN    BRUM    HACK    HOJG    RIET    ROTH    SASS    SEGE
## BRUM 1.00000 -       -       -       -       -       -       -
## HACK 1.00000 1.00000 -       -       -       -       -       -
## HOJG 1.00000 1.00000 1.00000 -       -       -       -       -
## RIET 1.00000 1.00000 1.00000 1.00000 -       -       -       -
## ROTH 1.00000 1.00000 1.00000 1.00000 1.00000 -       -       -
## SASS 1.00000 1.00000 1.00000 1.00000 0.53416 1.00000 -       -
## SEGE 0.56601 1.00000 0.45117 1.00000 1.00000 1.00000 0.16536 -
## SOVI 0.11637 1.00000 0.05423 1.00000 1.00000 1.00000 0.00022 1.00000
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  blade_data_clean$THICKNESS and blade_data_clean$CODE
##
```

```
##      BIEN    BRUM    HACK    HOJG    RIET    ROTH    SASS    SEGE
## BRUM 1.00000 -       -       -       -       -       -       -
## HACK 1.00000 1.00000 -       -       -       -       -       -
## HOJG 1.00000 1.00000 1.00000 -       -       -       -       -
## RIET 1.00000 1.00000 1.00000 1.00000 -       -       -       -
## ROTH 1.00000 1.00000 1.00000 1.00000 0.43354 -       -       -
## SASS 1.00000 1.00000 1.00000 1.00000 0.12718 1.00000 -       -
## SEGE 1.00000 0.24957 0.02029 1.00000 0.00097 1.00000 0.39456 -
## SOVI 1.00000 0.21032 0.00300 1.00000 2.4e-06 1.00000 0.02855 1.00000
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  blade_data_clean$PLAT_DEPTH and blade_data_clean$CODE
##
##      BIEN    BRUM    HACK    HOJG    RIET    ROTH    SASS    SEGE
## BRUM 0.96348 -       -       -       -       -       -       -
## HACK 1.00000 0.75059 -       -       -       -       -       -
## HOJG 1.00000 1.00000 1.00000 -       -       -       -       -
## RIET 0.76016 1.00000 0.34861 1.00000 -       -       -       -
## ROTH 1.00000 1.00000 1.00000 1.00000 1.00000 -       -       -
## SASS 1.00000 1.00000 1.00000 1.00000 0.70248 1.00000 -       -
## SEGE 0.01960 0.02814 0.00197 1.00000 9.3e-09 0.13769 2.2e-06 -
## SOVI 1.00000 0.07195 0.43372 1.00000 1.9e-08 1.00000 0.00048 0.14273
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  blade_data_clean$WEIGHT and blade_data_clean$CLASSIFICATION
##
##             Bromme
## Federmesser <2e-16
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  blade_data_clean$LENGTH and blade_data_clean$CLASSIFICATION
##
##             Bromme
## Federmesser 4.6e-08
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  blade_data_clean$WIDTH and blade_data_clean$CLASSIFICATION
##
##             Bromme
## Federmesser 1.6e-07
```

```
##
## P value adjustment method: bonferroni
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  blade_data_clean$ELONGATION and blade_data_clean$CLASSIFICATION
##
##             Bromme
## Federmesser 0.35
##
## P value adjustment method: bonferroni
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  blade_data_clean$THICKNESS and blade_data_clean$CLASSIFICATION
##
##             Bromme
## Federmesser 5.5e-06
##
## P value adjustment method: bonferroni
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  blade_data_clean$PLAT_DEPTH and blade_data_clean$CLASSIFICATION
##
##             Bromme
## Federmesser 2.3e-05
##
## P value adjustment method: bonferroni
```

Raw Material
Count
90
60
30
0
BIEN
BRUM
HACK
HOJG
RIET
ROTH
SASS
SEGE
SOVI
Type
Chert
Flint
Ludite

Dorsal Blade Profile
Count
50
40
30
20
10
0
BIEN
BRUM
HACK
HOJG
RIET
ROTH
SASS
SEGE
SOVI
Attribute
MDF
TDNC
TDOC
THDNC
THDOC

Blade Determination Profile
Count
0
10
20
30
40
BIEN
BRUM
HACK
HOJG
RIET
ROTH
SASS
SEGE
SOVI
Attribute
FE
HI
ID
PL

Blade Curvature
Count
0
10
20
30
40
BIEN
BRUM
HACK
HOJG
RIET
ROTH
SASS
SEGE
SOVI
Attribute
DI
EV
ST
VB

Dorsal Pattern Profile
Count
0
10
20
30
40
BIEN
BRUM
HACK
HOJG
RIET
ROTH
SASS
SEGE
SOVI
Attribute
BI
CE
CON
CONBI
CONPE
SAP
TWC
UND
UNI

Bulb Morphology
Count
0
20
40
BIEN
BRUM
HACK
HOJG
RIET
ROTH
SASS
SEGE
SOVI
Attribute
BF
BLF
LF
NBOL
PBF
PLF

Butt Preparation Method #1
Count
75
50
25
0
BIEN
BRUM
HACK
HOJG
RIET
ROTH
SASS
SEGE
SOVI
Attribute
FGTTS
FTS
PLA

Butt Preparation Method #2
Count
30
20
10
0
BIEN
BRUM
HACK
HOJG
RIET
ROTH
SASS
SEGE
SOVI
Attribute
CU
DA
DAG
DATG
DATR
DT
NCU

Raw Material
Count
200
150
100
50
0
Bromme
Federmesser
Type
Chert
Flint
Ludite

Dorsal Blade Profile
Count
75
50
25
0
Bromme
Federmesser
Attribute
MDF
TDNC
TDOC
THDNC
THDOC

Blade Determination Profile
Count
75
50
25
0
Bromme
Federmesser
Attribute
FE
HI
ID
PL

Blade Curvature
Count
100
75
50
25
0
Bromme
Federmesser
Attribute
DI
EV
ST
VB

Dorsal Pattern Profile
Count
100
75
50
25
0
Bromme
Federmesser
Attribute
BI
CE
CON
CONBI
CONPE
SAP
TWC
UND
UNI

Bulb Morphology
Count
90
60
30
0
Bromme
Federmesser
Attribute
BF
BLF
LF
NBOL
PBF
PLF

Butt Preparation Method #1
Count
150
100
50
0
Bromme
Federmesser
Attribute
FGTTS
FTS
PLA

Butt Preparation Method #2
Count
60
40
20
0
Bromme
Federmesser
Attribute
CU
DA
DAG
DATG
DATR
DT
NCU

Gini-Simpson and Morisita-Horn diversity indices

Blade Curvature
Gini Simpson Index
1.00
0.75
0.50
0.25
0.00
BIEN
BRUM
HACK
HOJG
RIET
ROTH
SASS
SEGE
SOVI

Dorsal Pattern
Gini Simpson Index
1.00
0.75
0.50
0.25
0.00
BIEN
BRUM
HACK
HOJG
RIET
ROTH
SASS
SEGE
SOVI

Bulb Morphology
Gini Simpson Index
1.00
0.75
0.50
0.25
0.00
BIEN
BRUM
HACK
HOJG
RIET
ROTH
SASS
SEGE
SOVI

Conus Formation
Gini Simpson Index
1.00
0.75
0.50
0.25
0.00
BIEN
BRUM
HACK
HOJG
RIET
ROTH
SASS
SEGE
SOVI

Butt Morphology
Gini Simpson Index
1.00
0.75
0.50
0.25
0.00
BIEN
BRUM
HACK
HOJG
RIET
ROTH
SASS
SEGE
SOVI

Butt Preparation #1
Gini Simpson Index
1.00
0.75
0.50
0.25
0.00
BIEN
BRUM
HACK
HOJG
RIET
ROTH
SASS
SEGE
SOVI

Butt Preparation #2
Gini Simpson Index
1.00
0.75
0.50
0.25
0.00
BIEN
BRUM
HACK
HOJG
RIET
ROTH
SASS
SEGE
SOVI

Dorsal Profile
Gini Simpson Index
1.00
0.75
0.50
0.25
0.00
Bromme
Federmesser

Blade Determination Profile
Gini Simpson Index
1.00
0.75
0.50
0.25
0.00
Bromme
Federmesser

Blade Curvature
Gini Simpson Index
1.00
0.75
0.50
0.25
0.00
Bromme
Federmesser

Dorsal Pattern
Gini Simpson Index
1.00
0.75
0.50
0.25
0.00
Bromme
Federmesser

Bulb Morphology
Gini Simpson Index
1.00
0.75
0.50
0.25
0.00
Bromme
Federmesser

Conus Formation
Gini Simpson Index
1.00
0.75
0.50
0.25
0.00
Bromme
Federmesser

Butt Morphology
Gini Simpson Index
1.00
0.75
0.50
0.25
0.00
Bromme
Federmesser

Butt Preparation #1
Gini Simpson Index
1.00
0.75
0.50
0.25
0.00
Bromme
Federmesser

Butt Preparation #2
Gini Simpson Index
1.00
0.75
0.50
0.25
0.00
Bromme
Federmesser

Dorsal Profile: Morisita-Horn Index

	BIEN	BRUM	HACK	HOJG	RIET	ROTH	SASS	SEGE	SOVI
SOVI	0	0.1	0.1	0.5	0	0.4	0	0.4	0
SEGE	0.5	0.3	0.6	0.7	0.5	0.4	0.3	0	0.4
SASS	0	0	0.2	0.6	0	0.3	0	0.3	0
ROTH	0.3	0.5	0.5	0.5	0.4	0	0.3	0.4	0.4
RIET	0	0	0.1	0.5	0	0.4	0	0.5	0
HOJG	0.4	0.5	0.2	0	0.5	0.5	0.6	0.7	0.5
HACK	0.2	0.2	0	0.2	0.1	0.5	0.2	0.6	0.1
BRUM	0.1	0	0.2	0.5	0	0.5	0	0.3	0.1
BIEN	0	0.1	0.2	0.4	0	0.3	0	0.5	0

Distance: 0.0, 0.2, 0.4, 0.6

Blade Determination Profile: Morisita-Horn Index

	BIEN	BRUM	HACK	HOJG	RIET	ROTH	SASS	SEGE	SOVI
SOVI	0	0	0.1	0.2	0.3	0.1	0.1	0.5	0
SEGE	0.6	0.7	0.4	0.9	0.1	0.6	0.3	0	0.5
SASS	0.1	0.2	0	0.3	0.1	0.1	0	0.3	0.1
ROTH	0	0.1	0	0.1	0.4	0	0.1	0.6	0.1
RIET	0.3	0.5	0.2	0.7	0	0.4	0.1	0.1	0.3
HOJG	0.1	0.2	0.3	0	0.7	0.1	0.3	0.9	0.2
HACK	0	0.2	0	0.3	0.2	0	0	0.4	0.1
BRUM	0.1	0	0.2	0.2	0.5	0.1	0.2	0.7	0
BIEN	0	0.1	0	0.1	0.3	0	0.1	0.6	0

Distance: 0.00, 0.25, 0.50, 0.75

Blade Curvature: Morisita-Horn Index
SOVI 0.2 0.5 0 0.2 0 0.1 0.1 0.1 0
SEGE 0.1 0.6 0 0.4 0.1 0 0.2 0 0.1
SASS 0.4 0.2 0.2 0.3 0.1 0.3 0 0.2 0.1
ROTH 0.1 0.8 0 0.3 0.1 0 0.3 0 0.1
RIET 0.3 0.5 0.1 0.2 0 0.1 0.1 0.1 0
HOJG 0.5 0.7 0.2 0 0.2 0.3 0.3 0.4 0.2
HACK 0.1 0.7 0 0.2 0.1 0 0.2 0 0
BRUM 0.7 0 0.7 0.7 0.5 0.8 0.2 0.6 0.5
BIEN 0 0.7 0.1 0.5 0.3 0.1 0.4 0.1 0.2
BIEN BRUM HACK HOJG RIET ROTH SASS SEGE SOVI
Distance
0.6
0.4
0.2
0.0

Dorsal Pattern: Morisita-Horn Index
SOVI 0 0 0 0.1 0 0.3 0 0.2 0
SEGE 0.1 0.4 0.1 0.3 0.2 0.4 0.3 0 0.2
SASS 0.1 0 0.1 0.1 0.1 0.3 0 0.3 0
ROTH 0.3 0.3 0.3 0.4 0.3 0 0.3 0.4 0.3
RIET 0 0.1 0 0.1 0 0.3 0.1 0.2 0
HOJG 0.1 0.1 0.2 0 0.1 0.4 0.1 0.3 0.1
HACK 0 0.1 0 0.2 0 0.3 0.1 0.1 0
BRUM 0.1 0 0.1 0.1 0.1 0.3 0 0.4 0
BIEN 0 0.1 0 0.1 0 0.3 0.1 0.1 0
BIEN BRUM HACK HOJG RIET ROTH SASS SEGE SOVI
Distance
0.4
0.3
0.2
0.1
0.0

Bulb Morphology: Morisita-Horn Index

	BIEN	BRUM	HACK	HOJG	RIET	ROTH	SASS	SEGE	SOVI
SOVI	0.4	0.1	0.2	0.1	0.1	0.3	0.1	0.2	0
SEGE	0.2	0.4	0.1	0.5	0.1	0.4	0.2	0	0.2
SASS	0.4	0.1	0.3	0.2	0	0.2	0	0.2	0.1
ROTH	0.4	0.1	0.4	0.5	0.1	0	0.2	0.4	0.3
RIET	0.3	0.1	0.1	0.3	0	0.1	0	0.1	0.1
HOJG	0.6	0.2	0.4	0	0.3	0.5	0.2	0.5	0.1
HACK	0.1	0.4	0	0.4	0.1	0.4	0.3	0.1	0.2
BRUM	0.6	0	0.4	0.2	0.1	0.1	0.1	0.4	0.1
BIEN	0	0.6	0.1	0.6	0.3	0.4	0.4	0.2	0.4

Distance: 0.0, 0.2, 0.4, 0.6

Conus Formation: Morisita-Horn Index

	BIEN	BRUM	HACK	HOJG	RIET	ROTH	SASS	SEGE	SOVI
SOVI	0.1	0.2	0.1	0.2	0.1	0.2	0.1	0.2	0
SEGE	0.5	0.5	0.4	0.5	0.4	0.5	0.5	0	0.2
SASS	0	0.2	0	0	0	0	0	0.5	0.1
ROTH	0	0.2	0	0	0.1	0	0	0.5	0.2
RIET	0	0.1	0	0.1	0	0.1	0	0.4	0.1
HOJG	0	0.2	0	0	0.1	0	0	0.5	0.2
HACK	0	0.1	0	0	0	0	0	0.4	0.1
BRUM	0.1	0	0.1	0.2	0.1	0.2	0.2	0.5	0.2
BIEN	0	0.1	0	0	0	0	0	0.5	0.1

Distance: 0.0, 0.1, 0.2, 0.3, 0.4, 0.5

Butt Morphology: Morisita-Horn Index

	BIEN	BRUM	HACK	HOJG	RIET	ROTH	SASS	SEGE	SOVI
SOVI	0.5	0	0.1	0.1	0.4	0.6	0.2	0.1	0
SEGE	0.7	0.2	0.2	0.2	0.6	0.7	0.4	0	0.1
SASS	0.2	0.1	0.1	0.5	0.2	0.2	0	0.4	0.2
ROTH	0.1	0.4	0.4	0.7	0.5	0	0.2	0.7	0.6
RIET	0.2	0.4	0.2	0.7	0	0.5	0.2	0.6	0.4
HOJG	0.8	0.2	0.3	0	0.7	0.7	0.5	0.2	0.1
HACK	0.3	0.2	0	0.3	0.2	0.4	0.1	0.2	0.1
BRUM	0.5	0	0.2	0.2	0.4	0.4	0.1	0.2	0
BIEN	0	0.5	0.3	0.8	0.2	0.1	0.2	0.7	0.5

Distance: 0.0, 0.2, 0.4, 0.6

Butt Preparation #1: Morisita-Horn Index

	BIEN	BRUM	HACK	HOJG	RIET	ROTH	SASS	SEGE	SOVI
SOVI	0.3	0.6	0	0	0	0	0	0	0
SEGE	0.4	0.7	0	0	0	0	0	0	0
SASS	0.3	0.6	0	0	0	0	0	0	0
ROTH	0.3	0.6	0	0	0	0	0	0	0
RIET	0.2	0.5	0	0.1	0	0	0	0	0
HOJG	0.4	0.7	0	0	0.1	0	0	0	0
HACK	0.3	0.6	0	0	0	0	0	0	0
BRUM	0.1	0	0.6	0.7	0.5	0.6	0.6	0.7	0.6
BIEN	0	0.1	0.3	0.4	0.2	0.3	0.3	0.4	0.3

Distance: 0.0, 0.2, 0.4, 0.6

Principal Component Analysis (PCA)

Note: Crested blades and broken/indistinguishable butts and bulbs are omitted from this analysis.

```
## # A tibble: 6 x 4
##   rowname eigenvalue variance cumulative
##   <chr>        <dbl>    <dbl>      <dbl>
## 1 Dim.1       2.95     49.2         49.2
## 2 Dim.2       1.14     19.0         68.1
## 3 Dim.3       0.848    14.1         82.3
## 4 Dim.4       0.608    10.1         92.4
## 5 Dim.5       0.411     6.84        99.2
## 6 Dim.6       0.0456    0.760      100
```

Contribution of Variables
Dimension 1
Dimension 2
Dimension 3
Dimension 4
Dimension 5
WIDTH
WEIGHT
THICKNESS
PLAT_DEPTH
LENGTH
ELONGATION
Variable
0 25 50 75
Contribution (%)

PCA 1 vs. PCA 2 (Classification)
ELONGATION
LENGTH
WEIGHT
THICKNESS
WIDTH
FLAT_DEPTH
2
0
-2
-4
0
4
8
Dimension 2 (18.97%)
Dimension 1 (49.16%)
Groups
Bromme
Federmesser

PCA 2 vs. PCA 3 (Classification)
Dimension 3 (14.13%)
Dimension 2 (18.97%)
6
3
0
-3
-2
0
2
THICKNESS
WEIGHT
LENGTH
ELONGATI
Groups
Bromme
Federmesser

PCA 1 vs. PCA 2 (Context)
ELONGATION
LENGTH
WEIGHT
THICKNESS
WIDTH
PLAT_DEPTH
Dimension 2 (18.97%)
Dimension 1 (49.16%)
2
0
-2
-4
0
4
8
Groups
BIEN
BRUM
HACK
HOJG
RIET
ROTH
SASS
SEGE
SOVI

PCA 2 vs. PCA 3 (Classification)
THICKNESS
ELONGATI
ENGTH
Dimension 3 (14.13%)
Dimension 2 (18.97%)
5
0
-2
0
2
Groups
BIEN
BRUM
HACK
HOJG
RIET
ROTH
SASS
SEGE
SOVI

PCA 1:5 (Classification)
Value
6
3
0
-3
Dimension 1
Dimension 2
Dimension 3
Dimension 4
Dimension 5
Classification
Bromme
Federmesser

Multiple Correspondence Analysis (MCA)

Note: for MCA all crested blades and broken butts were omitted from the analysis.

```
## # A tibble: 39 x 4
##    rowname eigenvalue variance cumulative
##    <chr>        <dbl>    <dbl>      <dbl>
##  1 Dim.1        0.212     4.90       4.90
##  2 Dim.2        0.187     4.32       9.22
##  3 Dim.3        0.178     4.11      13.3
##  4 Dim.4        0.176     4.07      17.4
##  5 Dim.5        0.166     3.83      21.2
##  6 Dim.6        0.158     3.66      24.9
##  7 Dim.7        0.153     3.54      28.4
##  8 Dim.8        0.151     3.49      31.9
##  9 Dim.9        0.143     3.30      35.2
## 10 Dim.10       0.139     3.20      38.4
## # ... with 29 more rows
```

Percentage of explained variances
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10
Dimensions

Key acronyms for responses in *Axis 1*:

DB: Diffused bulb (**Bulb Morph**)
NBOL: No bulb or lip (**Bulb Morph**)
CU: Cortical unprepared (**Butt Prep #2**)
PUNB: Punctiform butt (**Butt Morph**)
MDF: Multiple dorsal faces (**Dorsal Blade Prof**)

Key acronyms for responses in *Axis 2*:
NBOL: No bulb or lip (**Bulb Morph**)

DT: Dorsal trimming (**Butt Prep #2**)
DB: Diffused bulb (**Bulb Morph**)
VB: Ventral 'belly' (**Blade Curv**)
FE: Feathered (**Blade Determ**)

```
## Warning: Removed 1 row(s) containing missing values (geom_path).
```

```
## Warning: Removed 1 row(s) containing missing values (geom_path).
```

MCA 2 vs. MCA 3 (Code)
1.5
1.0
0.5
0.0
-0.5
-1.0
Dimension 3 (4.11%)
-2
-1
0
1
Dimension 2 (4.31%)
CODE
BIEN
HACK
RIET
SASS
SOVI
BRUM
HOJG
ROTH
SEGE

MCA 1:5 (Classification)
Value
1
0
-1
Dimension 1
Dimension 2
Dimension 3
Dimension 4
Dimension 5
Classification
Bromme
Federmesser

Analysis: Cores

Visual and Descriptive Summaries of Data

Table 15. Descriptive Statistics: Blade Core Weight (g)

CONTEXT	n_obs	min	max	mean	med	sd	var
Bienenbüttel (FStNr. 15)	1	21.08	21.08	21.08	21.08	NA	NA
Häcklingen (FStNr. 19)	8	18.48	200.52	65.13	42.56	58.36	3405.98
Højgård	1	137.41	137.41	137.41	137.41	NA	NA
Rietberg (1)	5	28.15	158.24	86.73	63.69	61.19	3744.46
Rietberg (5)	2	68.69	132.74	100.72	100.72	45.29	2051.20
Rietberg (Spoil)	2	9.20	87.95	48.58	48.58	55.68	3100.78
Rothenkirchen	2	32.56	48.18	40.37	40.37	11.05	121.99
Sassenholz (FStNr. 78)	22	30.24	294.40	155.48	150.86	74.28	5517.01
Sassenholz (FStNr. 82)	5	43.29	124.54	79.98	78.42	36.06	1300.45
Segebro	11	60.00	253.00	136.87	112.59	60.55	3666.74
Skovmosen	6	33.06	109.94	61.48	52.89	29.55	872.97
Søvind	5	40.96	230.60	96.74	61.25	76.87	5908.81

Table 16. Descriptive Statistics: Blade Core Length (mm)

CONTEXT	n_obs	min	max	mean	med	sd	var

Bienenbüttel (FStNr. 15)	1	39.61	39.61	39.61	40	NA	NA
Häcklingen (FStNr. 19)	8	31.72	75.30	44.99	42	13.30	176.91
Højgård	1	67.86	67.86	67.86	68	NA	NA
Rietberg (1)	5	41.64	68.13	52.57	50	10.23	104.72
Rietberg (5)	2	56.61	66.31	61.46	61	6.86	47.05
Rietberg (Spoil)	2	32.62	54.69	43.66	44	15.61	243.54
Rothenkirchen	2	46.64	49.36	48.00	48	1.92	3.70
Sassenholz (FStNr. 78)	22	28.96	78.24	48.53	48	13.79	190.12
Sassenholz (FStNr. 82)	5	30.04	34.56	33.09	34	1.77	3.14
Segebro	11	42.05	84.14	63.35	59	14.92	222.59
Skovmosen	6	20.61	69.63	42.92	43	17.93	321.66
Søvind	5	37.67	119.52	66.16	52	32.45	1053.27

Table 17. Descriptive Statistics: Blade Core Width (mm)

CONTEXT	n_obs	min	max	mean	med	sd	var
Bienenbüttel (FStNr. 15)	1	15.72	15.72	15.72	15.72	NA	NA
Häcklingen (FStNr. 19)	8	17.54	31.55	24.58	25.29	5.25	27.54
Højgård	1	43.98	43.98	43.98	43.98	NA	NA
Rietberg (1)	5	15.88	45.25	30.60	31.87	11.54	133.08
Rietberg (5)	2	29.05	55.26	42.16	42.16	18.53	343.48
Rietberg (Spoil)	2	14.53	36.33	25.43	25.43	15.41	237.62
Rothenkirchen	2	21.54	23.21	22.38	22.38	1.18	1.39
Sassenholz (FStNr. 78)	22	13.10	42.60	25.75	24.75	7.94	63.03
Sassenholz (FStNr. 82)	5	17.18	32.44	23.23	23.92	6.16	37.97
Segebro	11	16.20	74.32	47.26	42.53	19.44	377.87
Skovmosen	6	22.55	59.37	41.72	40.81	12.80	163.92
Søvind	5	34.40	58.29	49.09	51.66	9.12	83.22

Table 18. Descriptive Statistics: Blade Core Breadth (mm)

CONTEXT	n_obs	min	max	mean	med	sd	var
Bienenbüttel (FStNr. 15)	1	19.41	19.41	19.41	19.41	NA	NA
Häcklingen (FStNr. 19)	8	17.54	31.22	23.22	21.78	4.67	21.79
Højgård	1	51.50	51.50	51.50	51.50	NA	NA
Rietberg (1)	5	33.79	54.66	40.89	36.31	9.08	82.38
Rietberg (5)	2	36.45	39.80	38.12	38.12	2.37	5.61
Rietberg (Spoil)	2	14.73	34.75	24.74	24.74	14.16	200.40
Rothenkirchen	2	22.85	25.67	24.26	24.26	1.99	3.98
Sassenholz (FStNr. 78)	22	15.62	51.78	34.80	33.59	10.12	102.48
Sassenholz (FStNr. 82)	5	16.71	32.19	25.09	25.65	5.90	34.79
Segebro	11	14.30	65.88	41.14	40.29	16.73	279.75
Skovmosen	6	22.12	49.48	33.89	32.14	10.45	109.26
Søvind	5	25.04	45.54	34.29	33.68	7.31	53.40

Table 19. Descriptive Statistics: Blade Core Elongation (L/W)

CONTEXT	n_obs	min	max	mean	med	sd	var
Bienenbüttel (FStNr. 15)	1	2.52	2.52	2.52	2.52	NA	NA

Häcklingen (FStNr. 19)	8	1.17	2.44	1.86	1.83	0.46	0.21
Højgård	1	1.54	1.54	1.54	1.54	NA	NA
Rietberg (1)	5	1.25	2.93	1.88	1.81	0.63	0.40
Rietberg (5)	2	1.20	1.95	1.57	1.57	0.53	0.28
Rietberg (Spoil)	2	1.51	2.25	1.88	1.88	0.52	0.27
Rothenkirchen	2	2.01	2.29	2.15	2.15	0.20	0.04
Sassenholz (FStNr. 78)	22	0.90	3.43	2.02	1.84	0.72	0.51
Sassenholz (FStNr. 82)	5	1.07	1.93	1.50	1.37	0.39	0.15
Segebro	11	1.11	3.31	1.52	1.26	0.65	0.42
Skovmosen	6	0.35	1.98	1.16	1.26	0.61	0.37
Søvind	5	0.80	2.05	1.32	1.35	0.48	0.23

Table 20. Descriptive Statistics: Blade Core Weight (g)

CLASSIFICATION	n_obs	min	max	mean	med	sd	var
Bromme	50	30.24	294.40	126.32	111.26	70.87	5022.81
Federmesser	20	9.20	200.52	67.76	47.43	52.58	2765.09

Table 21. Descriptive Statistics: Blade Core Length (mm)

CLASSIFICATION	n_obs	min	max	mean	med	sd	var
Bromme	50	20.61	119.52	51.72	51	18.77	352.40
Federmesser	20	31.72	75.30	48.43	47	11.69	136.59

Table 22. Descriptive Statistics: Blade Core Width (mm)

CLASSIFICATION	n_obs	min	max	mean	med	sd	var
Bromme	50	13.10	74.32	34.85	32.42	15.64	244.46
Federmesser	20	14.53	55.26	27.26	25.29	10.39	108.02

Table 23. Descriptive Statistics: Blade Core Breadth (mm)

CLASSIFICATION	n_obs	min	max	mean	med	sd	var
Bromme	50	14.30	65.88	35.40	33.24	11.98	143.47
Federmesser	20	14.73	54.66	29.19	27.20	10.27	105.56

Table 24. Descriptive Statistics: Blade Core Elongation (L/W)

CLASSIFICATION	n_obs	min	max	mean	med	sd	var
Bromme	50	0.35	3.43	1.67	1.54	0.69	0.48
Federmesser	20	1.17	2.93	1.90	1.86	0.48	0.23

Core Weight (g)
300
200
100
0
BIEN
HACK
HOJG
RIET
ROTH
SASS
SEGE
SKOV
SOVI
Taxonomic Unit
Bromme
Federmesser

Core Length (mm)
100
75
50
25
BIEN
HACK
HOJG
RIET
ROTH
SASS
SEGE
SKOV
SOVI
Taxonomic Unit
Bromme
Federmesser

Core Width (mm)
60
40
20
BIEN
HACK
HOJG
RIET
ROTH
SASS
SEGE
SKOV
SOVI
Taxonomic Unit
Bromme
Federmesser

Core Breadth (mm)
60
50
40
30
20
BIEN
HACK
HOJG
RIET
ROTH
SASS
SEGE
SKOV
SOVI
Taxonomic Unit
Bromme
Federmesser

Core Elongation Index
3
2
1
BIEN
HACK
HOJG
RIET
ROTH
SASS
SEGE
SKOV
SOVI
Taxonomic Unit
Bromme
Federmesser

125
100
75
50
25
0
Core Length (mm)
0
20
40
60
Core Width (mm)
CLASSIFICATION
Bromme
Federmesser

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  core_data_clean$WEIGHT and core_data_clean$CODE
##
##      BIEN HACK HOJG RIET ROTH SASS SEGE SKOV
## HACK 1.00 -    -    -    -    -    -    -
## HOJG 1.00 1.00 -    -    -    -    -    -
## RIET 1.00 1.00 1.00 -    -    -    -    -
## ROTH 1.00 1.00 1.00 1.00 -    -    -    -
## SASS 1.00 0.26 1.00 1.00 1.00 -    -    -
## SEGE 1.00 0.26 1.00 1.00 1.00 1.00 -    -
## SKOV 1.00 1.00 1.00 1.00 1.00 0.45 0.37 -
## SOVI 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00
##
## P value adjustment method: bonferroni
```

```
##
```

```
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  core_data_clean$CORE_LENGTH and core_data_clean$CODE
##
##      BIEN  HACK  HOJG  RIET  ROTH  SASS  SEGE  SKOV
## HACK 1.000 -     -     -     -     -     -     -
## HOJG 1.000 1.000 -     -     -     -     -     -
## RIET 1.000 1.000 1.000 -     -     -     -     -
## ROTH 1.000 1.000 1.000 1.000 -     -     -     -
## SASS 1.000 1.000 1.000 1.000 1.000 -     -     -
## SEGE 1.000 0.424 1.000 1.000 1.000 0.099 -     -
## SKOV 1.000 1.000 1.000 1.000 1.000 1.000 1.000 -
## SOVI 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  core_data_clean$CORE_WIDTH and core_data_clean$CODE
##
##      BIEN  HACK  HOJG  RIET  ROTH  SASS  SEGE  SKOV
## HACK 1.000 -     -     -     -     -     -     -
## HOJG 1.000 1.000 -     -     -     -     -     -
## RIET 1.000 1.000 1.000 -     -     -     -     -
## ROTH 1.000 1.000 1.000 1.000 -     -     -     -
## SASS 1.000 1.000 1.000 1.000 1.000 -     -     -
## SEGE 1.000 0.535 1.000 1.000 1.000 0.072 -     -
## SKOV 1.000 0.609 1.000 1.000 1.000 0.197 1.000 -
## SOVI 1.000 0.155 1.000 1.000 1.000 0.039 1.000 1.000
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  core_data_clean$CORE_BREADTH and core_data_clean$CODE
##
##      BIEN HACK HOJG RIET ROTH SASS SEGE SKOV
## HACK 1.00 -    -    -    -    -    -    -
## HOJG 1.00 1.00 -    -    -    -    -    -
## RIET 1.00 0.29 1.00 -    -    -    -    -
## ROTH 1.00 1.00 1.00 1.00 -    -    -    -
## SASS 1.00 0.36 1.00 1.00 1.00 -    -    -
## SEGE 1.00 0.53 1.00 1.00 1.00 1.00 -    -
## SKOV 1.00 1.00 1.00 1.00 1.00 1.00 1.00 -
## SOVI 1.00 0.37 1.00 1.00 1.00 1.00 1.00 1.00
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  core_data_clean$CORE_ELONGATION and core_data_clean$CODE
##
```

```
##      BIEN HACK HOJG RIET ROTH SASS SEGE SKOV
## HACK 1    -    -    -    -    -    -    -
## HOJG 1    1    -    -    -    -    -    -
## RIET 1    1    1    -    -    -    -    -
## ROTH 1    1    1    1    -    -    -    -
## SASS 1    1    1    1    1    -    -    -
## SEGE 1    1    1    1    1    1    -    -
## SKOV 1    1    1    1    1    1    1    -
## SOVI 1    1    1    1    1    1    1    1
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  core_data_clean$WEIGHT and core_data_clean$CLASSIFICATION
##
##             Bromme
## Federmesser 0.00053
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  core_data_clean$CORE_LENGTH and core_data_clean$CLASSIFICATION
##
##             Bromme
## Federmesser 0.65
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  core_data_clean$CORE_WIDTH and core_data_clean$CLASSIFICATION
##
##             Bromme
## Federmesser 0.07
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  core_data_clean$CORE_BREADTH and core_data_clean$CLASSIFICATION
##
##             Bromme
## Federmesser 0.068
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  core_data_clean$CORE_ELONGATION and core_data_clean$CLASSIFICATION
```

```
##
##              Bromme
## Federmesser 0.055
##
## P value adjustment method: bonferroni
```

Core Morphology
Count
15
10
5
0
BIEN
HACK
HOJG
RIET
ROTH
SASS
SEGE
SKOV
SOVI
Attribute
OP
TP

Platform Profile
Count
8
6
4
2
0
BIEN
HACK
HOJG
RIET
ROTH
SASS
SEGE
SKOV
SOVI
Attribute
DF
DS
DSF
DSY
SF
SS
SSY

Core Reduction Strategy
Count
0
3
6
9
BIEN
HACK
HOJG
RIET
ROTH
SASS
SEGE
SKOV
SOVI
Attribute
FAC
FRO
FURO
MFAC
SRO

Core Directionality
Count
0
5
10
15
BIEN
HACK
HOJG
RIET
ROTH
SASS
SEGE
SKOV
SOVI
Attribute
CBI
CM
CUNI

Core Tablet Rejuvenation
Count
0
5
10
15
BIEN
HACK
HOJG
RIET
ROTH
SASS
SEGE
SKOV
SOVI
Attribute
N
Y

Preparatory Flake Rejuvenation
Count
0
5
10
15
BIEN
HACK
HOJG
RIET
ROTH
SASS
SEGE
SKOV
SOVI
Attribute
N
Y

Frontal Rejuvenation
Count
25
20
15
10
5
0
BIEN
HACK
HOJG
RIET
ROTH
SASS
SEGE
SKOV
SOVI
Attribute
N
Y

Distal Rejuvenation
Count
15
10
5
0
BIEN
HACK
HOJG
RIET
ROTH
SASS
SEGE
SKOV
SOVI
Attribute
N
Y

Lateral Rejuvenation
Count
15
10
5
0
BIEN
HACK
HOJG
RIET
ROTH
SASS
SEGE
SKOV
SOVI
Attribute
N
Y

Raw Material
Count
50
40
30
20
10
0
Bromme
Federmesser
Type
Flint

Core Morphology
Count
20
10
0
Bromme
Federmesser
Attribute
OP
TP

Core Platform Profile
Count
25
20
15
10
5
0
Bromme
Federmesser
Attribute
DF
DS
DSF
DSY
SF
SS
SSY

Core Reduction Strategy
Count
15
10
5
0
Bromme
Federmesser
Attribute
FAC
FRO
FURO
MFAC
SRO

Core Directionality
Count
20
10
0
Bromme
Federmesser
Attribute
CBI
CM
CUNI

Core Tablet Rejuvenation
Count
40
30
20
10
0
Bromme
Federmesser
Attribute
N
Y

Preparatory Flake Rejuvenation
Count
40
30
20
10
0
Bromme
Federmesser
Attribute
N
Y

Frontal Rejuvenation
Count
40
30
20
10
0
Bromme
Federmesser
Attribute
N
Y

Core Distal Rejuvenation
Count
30
20
10
0
Bromme
Federmesser
Attribute
N
Y

Gini-Simpson and Morisita-Horn diversity indices

Core Platform Profile
Gini Simpson Index
1.00
0.75
0.50
0.25
0.00
BIEN
HACK
HOJG
RIET
ROTH
SASS
SEGE
SKOV
SOVI

Core Reduction Strategy
Gini Simpson Index
1.00
0.75
0.50
0.25
0.00
BIEN
HACK
HOJG
RIET
ROTH
SASS
SEGE
SKOV
SOVI

Core Directionality
Gini Simpson Index
1.00
0.75
0.50
0.25
0.00
BIEN
HACK
HOJG
RIET
ROTH
SASS
SEGE
SKOV
SOVI

Core Tablet Rejuvenation
Gini Simpson Index
1.00
0.75
0.50
0.25
0.00
BIEN
HACK
HOJG
RIET
ROTH
SASS
SEGE
SKOV
SOVI

Preparatory Flake Rejuvenation
Gini Simpson Index
1.00
0.75
0.50
0.25
0.00
BIEN
HACK
HOJG
RIET
ROTH
SASS
SEGE
SKOV
SOVI

Frontal Rejuvenation
Gini Simpson Index
1.00
0.75
0.50
0.25
0.00
BIEN
HACK
HOJG
RIET
ROTH
SASS
SEGE
SKOV
SOVI

Core Distal Rejuvenation
Gini Simpson Index
1.00
0.75
0.50
0.25
0.00
BIEN
HACK
HOJG
RIET
ROTH
SASS
SEGE
SKOV
SOVI

Core Lateral Rejuvenation
Gini Simpson Index
1.00
0.75
0.50
0.25
0.00
BIEN
HACK
HOJG
RIET
ROTH
SASS
SEGE
SKOV
SOVI

Core Morphology
Gini Simpson Index
1.00
0.75
0.50
0.25
0.00
Bromme
Federmesser

Core Platform Profile
Gini Simpson Index
1.00
0.75
0.50
0.25
0.00
Bromme
Federmesser

Core Reduction Strategy
Gini Simpson Index
1.00
0.75
0.50
0.25
0.00
Bromme
Federmesser

Core Directionality
Gini Simpson Index
1.00
0.75
0.50
0.25
0.00
Bromme
Federmesser

Core Tablet Rejuvenation
Gini Simpson Index
1.00
0.75
0.50
0.25
0.00
Bromme
Federmesser

Preparatory Rejuvenation
Gini Simpson Index
1.00
0.75
0.50
0.25
0.00
Bromme
Federmesser

Frontal Rejuvenation
Gini Simpson Index
1.00
0.75
0.50
0.25
0.00
Bromme
Federmesser

Core Distal Rejuvenation
Gini Simpson Index
1.00
0.75
0.50
0.25
0.00
Bromme
Federmesser

Core Lateral Rejuvenation
Gini Simpson Index
1.00
0.75
0.50
0.25
0.00
Bromme
Federmesser

Core Morphology: Morisita-Horn Index
SOVI 0.2 0.1 0.2 0.1 0.2 0 0.1 0 0
SKOV 0.1 0.1 0.1 0 0.1 0 0.2 0 0
SEGE 0.5 0.4 0.5 0.3 0.5 0.1 0 0.2 0.1
SASS 0.3 0.2 0.3 0.1 0.3 0 0.1 0 0
ROTH 0 0 0 0.1 0 0.3 0.5 0.1 0.2
RIET 0.1 0 0.1 0 0.1 0.1 0.3 0 0.1
HOJG 0 0 0 0.1 0 0.3 0.5 0.1 0.2
HACK 0 0 0 0 0 0.2 0.4 0.1 0.1
BIEN 0 0 0 0.1 0 0.3 0.5 0.1 0.2
BIEN HACK HOJG RIET ROTH SASS SEGE SKOV SOVI
Distance
0.5
0.4
0.3
0.2
0.1
0.0

Core Platform Profile: Morisita-Horn Index

	BIEN	HACK	HOJG	RIET	ROTH	SASS	SEGE	SKOV	SOVI
SOVI	0	0.2	0	0.3	0.3	0.4	0	0	0
SKOV	0.1	0.2	0.1	0.2	0.4	0.3	0	0	0
SEGE	0.1	0.1	0.1	0.2	0.3	0.2	0	0	0
SASS	0.5	0.2	0.5	0.1	0.3	0	0.2	0.3	0.4
ROTH	0.3	0.1	0.3	0.2	0	0.3	0.3	0.4	0.3
RIET	0.5	0.1	0.5	0	0.2	0.1	0.2	0.2	0.3
HOJG	0	0.3	0	0.5	0.3	0.5	0.1	0.1	0
HACK	0.3	0	0.3	0.1	0.1	0.2	0.1	0.2	0.2
BIEN	0	0.3	0	0.5	0.3	0.5	0.1	0.1	0

Distance: 0.5, 0.4, 0.3, 0.2, 0.1, 0.0

Core Reduction Strategy: Morisita-Horn Index

	BIEN	HACK	HOJG	RIET	ROTH	SASS	SEGE	SKOV	SOVI
SOVI	0.8	0.6	0	0.2	0.8	0.4	0.6	0	0
SKOV	0.8	0.6	0.1	0.1	0.8	0.3	0.5	0	0
SEGE	0.3	0	0.7	0.5	0.3	0.3	0	0.5	0.6
SASS	0.4	0.2	0.6	0.1	0.4	0	0.3	0.3	0.4
ROTH	0	0.3	1	0.7	0	0.4	0.3	0.8	0.8
RIET	0.7	0.4	0.3	0	0.7	0.1	0.5	0.1	0.2
HOJG	1	0.8	0	0.3	1	0.6	0.7	0.1	0
HACK	0.3	0	0.8	0.4	0.3	0.2	0	0.6	0.6
BIEN	0	0.3	1	0.7	0	0.4	0.3	0.8	0.8

Distance: 1.00, 0.75, 0.50, 0.25, 0.00

Core Directionality: Morisita-Horn Index

	BIEN	HACK	HOJG	RIET	ROTH	SASS	SEGE	SKOV	SOVI
SOVI	0	0.1	0	0.7	0.3	0.6	0	0.1	0
SKOV	0.1	0	0.1	0.3	0.1	0.2	0.1	0	0.1
SEGE	0.1	0	0.1	0.6	0.2	0.5	0	0.1	0
SASS	0.6	0.3	0.6	0	0.1	0	0.5	0.2	0.6
ROTH	0.3	0.1	0.3	0.1	0	0.1	0.2	0.1	0.3
RIET	0.7	0.4	0.7	0	0.1	0	0.6	0.3	0.7
HOJG	0	0.1	0	0.7	0.3	0.6	0.1	0.1	0
HACK	0.1	0	0.1	0.4	0.1	0.3	0	0	0.1
BIEN	0	0.1	0	0.7	0.3	0.6	0.1	0.1	0

Distance: 0.6, 0.4, 0.2, 0.0

Core Tablet Rejuvenation: Morisita-Horn Index

	BIEN	HACK	HOJG	RIET	ROTH	SASS	SEGE	SKOV	SOVI
SOVI	0	0.3	0	0.6	0.3	0.1	0	0	0
SKOV	0	0.3	0	0.6	0.3	0.1	0	0	0
SEGE	0	0.3	0	0.6	0.3	0.1	0	0	0
SASS	0.1	0.1	0.1	0.2	0.1	0	0.1	0.1	0.1
ROTH	0.3	0	0.3	0.1	0	0.1	0.3	0.3	0.3
RIET	0.6	0.1	0.6	0	0.1	0.2	0.6	0.6	0.6
HOJG	0	0.3	0	0.6	0.3	0.1	0	0	0
HACK	0.3	0	0.3	0.1	0	0.1	0.3	0.3	0.3
BIEN	0	0.3	0	0.6	0.3	0.1	0	0	0

Distance: 0.5, 0.4, 0.3, 0.2, 0.1, 0.0

Preparatory Flake Rejuvenation: Morisita-Horn Index

	BIEN	HACK	HOJG	RIET	ROTH	SASS	SEGE	SKOV	SOVI
SOVI	0	0.1	0	0.3	0	0.1	0	0	0
SKOV	0	0.1	0	0.3	0	0.1	0	0	0
SEGE	0	0.1	0	0.3	0	0.1	0	0	0
SASS	0.1	0	0.1	0	0.1	0	0.1	0.1	0.1
ROTH	0	0.1	0	0.3	0	0.1	0	0	0
RIET	0.3	0.1	0.3	0	0.3	0	0.3	0.3	0.3
HOJG	0	0.1	0	0.3	0	0.1	0	0	0
HACK	0.1	0	0.1	0.1	0.1	0	0.1	0.1	0.1
BIEN	0	0.1	0	0.3	0	0.1	0	0	0

Distance: 0.25, 0.20, 0.15, 0.10, 0.05, 0.00

Frontal Rejuvenation: Morisita-Horn Index

	BIEN	HACK	HOJG	RIET	ROTH	SASS	SEGE	SKOV	SOVI
SOVI	0	0	0	0	0	0	0	0	0
SKOV	0	0	0	0	0	0	0	0	0
SEGE	0	0	0	0	0	0	0	0	0
SASS	0	0	0	0	0	0	0	0	0
ROTH	0	0	0	0	0	0	0	0	0
RIET	0	0	0	0	0	0	0	0	0
HOJG	0	0	0	0	0	0	0	0	0
HACK	0	0	0	0	0	0	0	0	0
BIEN	0	0	0	0	0	0	0	0	0

Distance: 0.010, 0.005, 0.000

Principal Component Analysis (PCA)

```
## # A tibble: 5 x 4
##   rowname eigenvalue variance cumulative
##   <chr>        <dbl>    <dbl>      <dbl>
## 1 Dim.1       2.83      56.7        56.7
## 2 Dim.2       1.35      27.0        83.7
## 3 Dim.3       0.477      9.54       93.2
## 4 Dim.4       0.282      5.65       98.8
## 5 Dim.5       0.0579     1.16      100.
```

Percentage of explained variances
50
40
30
20
10
0
1
2
3
4
5
Dimension

Contribution of Variables
Dimension 1
Dimension 2
Dimension 3
Dimension 4
Dimension 5
WEIGHT
CORE_WIDTH
CORE_LENGTH
CORE_ELONGATION
CORE_BREADTH
Variable
0 20 40 60
Contribution (%)

PCA 1 vs. PCA 2 (Classification)
CORE_ELONGATION
CORE_LENGTH
WEIGHT
CORE_BREADTH
CORE_WIDTH
2
0
-2
Dimension 2 (26.98%)
-2.5
0.0
2.5
5.0
Dimension 1 (56.67%)
Groups
Bromme
Federmesser

PCA 2 vs. PCA 3 (Classification)
CORE_LENGTH
CORE_WIDTH
CORE_ELONGATIO
CORE_BREADTH
WEIGHT
Dimension 3 (9.53%)
Dimension 2 (26.98%)
2
1
0
-1
-2
-2
0
2
Groups
Bromme
Federmesser

PCA 1 vs. PCA 2 (Context)
CORE_ELONGATION
CORE_LENGTH
WEIGHT
CORE_BREADTH
CORE_WIDTH
3
0
-3
-6
-5
0
5
Dimension 2 (26.98%)
Dimension 1 (56.67%)
Groups
BIEN
HACK
HOJG
RIET
ROTH
SASS
SEGE
SKOV
SOVI

PCA 2 vs. PCA 3 (Context)
Dimension 3 (9.53%)
Dimension 2 (26.98%)
4
2
0
-2
-6
-3
0
3
CORE_LENGTH
CORE_WIDTH
CORE_ELONGATION
CORE_BREADTH
WEIGHT
Groups
BIEN
HACK
HOJG
RIET
ROTH
SASS
SEGE
SKOV
SOVI

PCA 1:5 (Classification)
Value
6
3
0
-3
Dimension 1
Dimension 2
Dimension 3
Dimension 4
Dimension 5
Classification
Bromme
Federmesser

Multiple Correspondence Analysis (MCA)

```
## # A tibble: 18 x 4
##    rowname eigenvalue variance cumulative
##    <chr>        <dbl>    <dbl>      <dbl>
##  1 Dim.1       0.291    14.5         14.5
##  2 Dim.2       0.247    12.4         26.9
##  3 Dim.3       0.190     9.51        36.4
##  4 Dim.4       0.163     8.14        44.6
##  5 Dim.5       0.138     6.90        51.5
##  6 Dim.6       0.126     6.31        57.8
##  7 Dim.7       0.121     6.04        63.8
##  8 Dim.8       0.110     5.51        69.3
##  9 Dim.9       0.100     5.01        74.3
## 10 Dim.10      0.0925    4.63        79.0
## 11 Dim.11      0.0840    4.20        83.2
## 12 Dim.12      0.0834    4.17        87.3
## 13 Dim.13      0.0765    3.83        91.2
## 14 Dim.14      0.0583    2.92        94.1
## 15 Dim.15      0.0419    2.09        96.2
## 16 Dim.16      0.0370    1.85        98.0
## 17 Dim.17      0.0264    1.32        99.3
## 18 Dim.18      0.0134    0.670      100
```

Percentage of explained variances
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10
Dimensions

Key acronyms for responses in *Axis 1*:

CORE_FLAKE_REJUV_Y: Preparatory flake rejuvenation: positive response (**Core Flake Rejuv**)
CORE_SIDE_REJUV_Y: Lateral rejuvenation: positive response (**Core Side Rejuv**)
CORE_TABLET_REJUV_Y: Core tabletting: positive response (**Core Tablet Rejuv**)
DSF: Double smooth and facetted core platforms (**Plat Rejuv**)
CBI: Bidirectional blade scars (**Core Directionality**)

Key acronyms for responses in *Axis 2*:
TP: Two platforms (**Core Morph**)

SF: Single facetted and/or flaked platforms (**Plat Rejuv**)
DS: Double smooth platforms (**Plat Rejuv**)
OP: One platform (**Core Morph**)
CORE_TABLET_REJUV_Y: Core tabletting: positive response(**Core Tablet Rejuv**)

```
## Warning: Removed 3 row(s) containing missing values (geom_path).
```

```
## Warning: Removed 3 row(s) containing missing values (geom_path).
```

MCA 2 vs. MCA 3 (Code)
Dimension 3 (9.51%)
Dimension 2 (12.36%)
1
0
-1
-1
0
1
CODE
BIEN
HOJG
ROTH
SEGE
SOVI
HACK
RIET
SASS
SKOV

MCA 1:5 (Classification)
Value
1
0
-1
Dimension 1
Dimension 2
Dimension 3
Dimension 4
Dimension 5
Classification
Bromme
Federmesser

Analysis: Backed Points (exc. burinated pieces)

Note: Backed pieces categorised as "Creswellian/Penknife Point", "Kent Point" and "Penknife Point" have, for the purposes of this analysis been redefined as "Creswellian Point".

Visual and Descriptive Summaries of Data

Table 25. Descriptive Statistics: Backed Point Weight (g)

CONTEXT	n_obs	min	max	mean	med	sd	var
Bienenbüttel (FStNr. 15)	5	1.19	3.11	2.06	1.89	0.91	0.82
Brümmerhof (FStNr. 16)	9	3.57	19.21	8.68	4.89	6.46	41.67
Häcklingen (FStNr. 19)	9	0.86	6.33	2.58	1.40	2.15	4.61
Rietberg (1)	2	1.05	3.29	2.17	2.17	1.58	2.51
Rietberg (2)	1	3.69	3.69	3.69	3.69	NA	NA
Rothenkirchen	4	0.36	1.75	0.80	0.54	0.64	0.41
Sassenholz (FStNr. 78)	26	0.98	19.53	5.73	4.93	3.58	12.84

Table 26. Descriptive Statistics: Backed Point Length (mm)

CONTEXT	n_obs	min	max	mean	med	sd	var
Bienenbüttel (FStNr. 15)	5	33.81	49.28	40.46	40	6.36	40.41
Brümmerhof (FStNr. 16)	9	29.28	59.12	41.82	38	10.17	103.46

Häcklingen (FStNr. 19)	9	34.17	56.50	42.96	42	6.65	44.25
Rietberg (1)	2	33.37	61.91	47.64	48	20.18	407.27
Rietberg (2)	1	40.62	40.62	40.62	41	NA	NA
Rothenkirchen	4	21.79	30.80	26.43	27	3.68	13.56
Sassenholz (FStNr. 78)	26	19.13	55.12	36.42	36	7.51	56.36

Table 27. Descriptive Statistics: Backed Point Width (mm)

CONTEXT	n_obs	min	max	mean	med	sd	var
Bienenbüttel (FStNr. 15)	5	11.66	14.97	13.03	12.96	1.37	1.87
Brümmerhof (FStNr. 16)	9	6.41	19.76	12.03	10.42	4.90	24.04
Häcklingen (FStNr. 19)	9	7.90	24.92	13.41	11.38	5.46	29.83
Rietberg (1)	2	9.69	13.39	11.54	11.54	2.62	6.85
Rietberg (2)	1	21.89	21.89	21.89	21.89	NA	NA
Rothenkirchen	4	7.51	11.54	8.78	8.04	1.90	3.60
Sassenholz (FStNr. 78)	26	5.01	17.66	10.85	10.95	2.81	7.88

Table 28. Descriptive Statistics: Backed Point Elongation Index (L/W)

CONTEXT	n_obs	min	max	mean	med	sd	var
Bienenbüttel (FStNr. 15)	5	2.61	3.75	3.11	2.96	0.43	0.19
Brümmerhof (FStNr. 16)	9	2.92	5.81	3.75	3.31	1.01	1.01
Häcklingen (FStNr. 19)	9	1.68	4.58	3.53	3.73	0.93	0.87
Rietberg (1)	2	3.44	4.62	4.03	4.03	0.83	0.70
Rietberg (2)	1	1.86	1.86	1.86	1.86	NA	NA
Rothenkirchen	4	2.56	3.54	3.07	3.09	0.53	0.28
Sassenholz (FStNr. 78)	26	2.22	4.96	3.47	3.48	0.70	0.49

Table 29. Descriptive Statistics: Backed Point Elongation Index (L/W)

CONTEXT	n_obs	min	max	mean	med	sd	var
Bienenbüttel (FStNr. 15)	5	1.84	2.54	2.15	2.01	0.31	0.09
Brümmerhof (FStNr. 16)	9	3.08	6.23	4.63	4.47	1.20	1.44
Häcklingen (FStNr. 19)	9	1.54	7.12	4.76	5.40	1.96	3.83
Rietberg (1)	2	3.42	4.77	4.10	4.10	0.95	0.91
Rietberg (2)	1	7.45	7.45	7.45	7.45	NA	NA
Rothenkirchen	4	3.85	4.21	4.00	3.96	0.16	0.02
Sassenholz (FStNr. 78)	26	2.11	6.32	4.29	4.34	1.16	1.35

Table 30. Descriptive Statistics: Tip Cross-Sectional Area (TCSA)

CONTEXT	n_obs	min	max	mean	med	sd	var
Bienenbüttel (FStNr. 15)	5	10.73	19.01	14.14	12.57	3.48	12.09
Brümmerhof (FStNr. 16)	9	12.32	60.27	29.98	18.86	19.35	374.32
Häcklingen (FStNr. 19)	9	7.28	67.78	33.55	30.29	21.33	454.83
Rietberg (1)	2	16.57	31.94	24.26	24.26	10.87	118.12
Rietberg (2)	1	81.54	81.54	81.54	81.54	NA	NA
Rothenkirchen	4	14.53	24.29	17.64	15.88	4.58	20.99

Sassenholz (FStNr. 78)	26	7.52	43.89	23.60	23.85	9.40	88.33

Table 31. Descriptive Statistics: Tip Cross-Sectional Perimeter (TCSP)

CONTEXT	n_obs	min	max	mean	med	sd	var
Bienenbüttel (FStNr. 15)	5	17.77	22.87	19.88	19.72	2.10	4.42
Brümmerhof (FStNr. 16)	9	11.91	31.37	19.67	16.76	7.43	55.27
Häcklingen (FStNr. 19)	9	13.92	38.52	21.81	19.01	8.12	65.88
Rietberg (1)	2	15.62	21.61	18.61	18.61	4.24	17.94
Rietberg (2)	1	35.13	35.13	35.13	35.13	NA	NA
Rothenkirchen	4	12.93	18.68	14.73	13.65	2.72	7.39
Sassenholz (FStNr. 78)	26	10.49	27.79	17.86	17.90	4.11	16.93

Table 32. Descriptive Statistics: Backed Point Weight (g)

CLASSIFICATION	n_obs	min	max	mean	med	sd	var
Bromme	35	0.98	19.53	6.49	4.89	4.58	20.96
Federmesser	21	0.36	6.33	2.13	1.40	1.66	2.76

Table 33. Descriptive Statistics: Backed Point Length (mm)

CLASSIFICATION	n_obs	min	max	mean	med	sd	var
Bromme	35	19.13	59.12	37.81	37	8.46	71.51
Federmesser	21	21.79	61.91	39.55	41	9.73	94.62

Table 34. Descriptive Statistics: Backed Point Width (mm)

CLASSIFICATION	n_obs	min	max	mean	med	sd	var
Bromme	35	5.01	19.76	11.15	10.92	3.42	11.72
Federmesser	21	7.51	24.92	12.66	11.66	4.57	20.87

Table 35. Descriptive Statistics: Backed Point Elongation Index (L/W)

CLASSIFICATION	n_obs	min	max	mean	med	sd	var
Bromme	35	2.22	5.81	3.54	3.43	0.78	0.61
Federmesser	21	1.68	4.62	3.31	3.44	0.81	0.66

Table 36. Descriptive Statistics: Backed Point Elongation Index (L/W)

CLASSIFICATION	n_obs	min	max	mean	med	sd	var
Bromme	35	2.11	6.32	4.38	4.47	1.16	1.36
Federmesser	21	1.54	7.45	4.06	4.01	1.82	3.31

Table 37. Descriptive Statistics: Tip Cross-Sectional Area (TCSA)

CLASSIFICATION	n_obs	min	max	mean	med	sd	var
Bromme	35	7.52	60.27	25.24	22.98	12.69	161.03
Federmesser	21	7.28	81.54	27.30	17.08	20.52	420.95

Table 38. Descriptive Statistics: Tip Cross-Sectional Perimeter (TCSP)

CLASSIFICATION	n_obs	min	max	mean	med	sd	var
Bromme	35	10.49	31.37	18.32	17.83	5.11	26.1
Federmesser	21	12.93	38.52	20.33	18.68	6.91	47.8

Table 39. Descriptive Statistics: Backed Point Weight (g)

SUB_CATEGORY	n_obs	min	max	mean	med	sd	var
Backed Point (Reclassified)	7	2.35	19.21	8.10	4.55	6.69	44.72
Backed Point (Unclassified)	42	0.36	19.53	4.78	4.58	3.87	14.98
Creswellian Point	5	0.86	2.89	1.61	1.22	0.81	0.65
Federmesser Point	2	3.11	3.29	3.20	3.20	0.13	0.02

Table 40. Descriptive Statistics: Backed Point Length (mm)

SUB_CATEGORY	n_obs	min	max	mean	med	sd	var
Backed Point (Reclassified)	7	26.75	59.12	39.73	37	12.70	161.34
Backed Point (Unclassified)	42	19.13	56.50	37.56	38	7.96	63.42
Creswellian Point	5	33.81	49.28	39.22	35	6.96	48.39
Federmesser Point	2	40.33	61.91	51.12	51	15.26	232.85

Table 41. Descriptive Statistics: Backed Point Width (mm)

SUB_CATEGORY	n_obs	min	max	mean	med	sd	var
Backed Point (Reclassified)	7	9.33	19.76	14.20	12.91	4.02	16.16
Backed Point (Unclassified)	42	5.01	24.92	11.19	10.67	4.02	16.17
Creswellian Point	5	8.19	14.97	11.93	11.85	2.47	6.09
Federmesser Point	2	13.39	13.69	13.54	13.54	0.21	0.04

Table 42. Descriptive Statistics: Backed Point Elongation Index (L/W)

SUB_CATEGORY	n_obs	min	max	mean	med	sd	var
Backed Point (Reclassified)	7	2.22	3.52	2.81	2.87	0.45	0.20
Backed Point (Unclassified)	42	1.68	5.81	3.56	3.52	0.81	0.66
Creswellian Point	5	2.61	4.17	3.36	3.29	0.62	0.39
Federmesser Point	2	2.95	4.62	3.78	3.78	1.19	1.41

Table 43. Descriptive Statistics: Backed Point Elongation Index (L/W)

SUB_CATEGORY	n_obs	min	max	mean	med	sd	var
Backed Point (Reclassified)	7	2.44	6.10	3.95	3.56	1.46	2.13
Backed Point (Unclassified)	42	1.54	7.45	4.55	4.61	1.34	1.79
Creswellian Point	5	1.84	4.01	2.47	2.01	0.90	0.82
Federmesser Point	2	2.41	4.77	3.59	3.59	1.67	2.78

Table 44. Descriptive Statistics: Tip Cross-Sectional Area (TCSA)

SUB_CATEGORY	n_obs	min	max	mean	med	sd	var
Backed Point (Reclassified)	7	11.38	60.27	30.05	22.98	18.86	355.83
Backed Point (Unclassified)	42	7.28	81.54	26.84	24.38	16.22	263.23
Creswellian Point	5	10.73	19.01	14.13	12.57	3.46	12.00
Federmesser Point	2	16.50	31.94	24.22	24.22	10.92	119.20

Table 45. Descriptive Statistics: Tip Cross-Sectional Perimeter (TCSP)

SUB_CATEGORY	n_obs	min	max	mean	med	sd	var
Backed Point (Reclassified)	7	14.59	31.37	22.35	20.28	6.37	40.58
Backed Point (Unclassified)	42	10.49	38.52	18.50	17.22	6.07	36.83
Creswellian Point	5	13.92	22.87	18.48	18.11	3.25	10.56
Federmesser Point	2	20.95	21.61	21.28	21.28	0.47	0.22

Length (mm)
60
50
40
30
20
BIEN
BRUM
HACK
RIET
ROTH
SASS
Taxonomic Unit
Bromme
Federmesser

Width (mm)
25
20
15
10
5
BIEN
BRUM
HACK
RIET
ROTH
SASS
Taxonomic Unit
Bromme
Federmesser

Elongation (L/W)
6
5
4
3
2
BIEN
BRUM
HACK
RIET
ROTH
SASS
Taxonomic Unit
Bromme
Federmesser

Thickness (mm)
6
4
2
BIEN
BRUM
HACK
RIET
ROTH
SASS
Taxonomic Unit
Bromme
Federmesser

Tip Cross-Sectional Area (TCSA)
80
60
40
20
BIEN
BRUM
HACK
RIET
ROTH
SASS
Taxonomic Unit
Bromme
Federmesser

Tip Cross-Sectional Area (TCSP)
30
20
10
BIEN
BRUM
HACK
RIET
ROTH
SASS
Taxonomic Unit
Bromme
Federmesser

Weight (g)
20
15
10
5
0
Backed Point (Reclassified)
Backed Point (Unclassified)
Creswellian Point
Federmesser Point

Length (mm)
60
50
40
30
20
Backed Point (Reclassified)
Backed Point (Unclassified)
Creswellian Point
Federmesser Point

Width (mm)
25
20
15
10
5
Backed Point (Reclassified)
Backed Point (Unclassified)
Creswellian Point
Federmesser Point

Elongation (L/W)
6
5
4
3
2
Backed Point (Reclassified)
Backed Point (Unclassified)
Creswellian Point
Federmesser Point

Thickness (mm)
6
4
2
Backed Point (Reclassified)
Backed Point (Unclassified)
Creswellian Point
Federmesser Point

Tip Cross-Sectional Area (TCSA)
80
60
40
20
Backed Point (Reclassified)
Backed Point (Unclassified)
Creswellian Point
Federmesser Point

Tip Cross-Sectional Area (TCSP)
30
20
10
Backed Point (Reclassified)
Backed Point (Unclassified)
Creswellian Point
Federmesser Point

80
60
40
20
0
Backed Point Length (mm)
0
10
20
30
40
Backed Point Width (mm)
CLASSIFICATION
Bromme
Federmesser

80
60
40
20
0
Backed Point Length (mm)
0
10
20
30
40
Backed Point Width (mm)
CODE
BIEN
HACK
ROTH
BRUM
RIET
SASS

80
60
40
20
0
Backed Point Length (mm)
0
10
20
30
40
Backed Point Width (mm)
SUB_CATEGORY
Backed Point (Reclassified)
Backed Point (Unclassified)
Creswellian Point
Federmesser Point
CODE
BIEN
BRUM
HACK
RIET
ROTH
SASS

80
60
40
20
0
Backed Point Length (mm)
0
10
20
30
40
Backed Point Width (mm)
CLASSIFICATION
Bromme
Federmesser
SUB_CATEGORY
Backed Point (Reclassified)
Backed Point (Unclassified)
Creswellian Point
Federmesser Point

50
40
30
20
10
0
TCSP (mm)
0
25
50
75
100
TCSA (mm²)
CLASSIFICATION
Bromme
Federmesser

50
40
30
20
10
0
TCSP (mm)
0
25
50
75
100
TCSA (mm²)
CODE
BIEN
HACK
ROTH
BRUM
RIET
SASS

50
40
30
20
10
0
TCSP (mm)
0
25
50
75
100
TCSA (mm²)
SUB_CATEGORY
Backed Point (Reclassified)
Backed Point (Unclassified)
Creswellian Point
Federmesser Point
CODE
BIEN
BRUM
HACK
RIET
ROTH
SASS

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  bp_data_excb_clean$WEIGHT and bp_data_excb_clean$CODE
##
##      BIEN  BRUM  HACK  RIET  ROTH
## BRUM 0.050 -     -     -     -
## HACK 1.000 0.201 -     -     -
## RIET 1.000 0.398 1.000 -     -
## ROTH 0.993 0.104 0.806 1.000 -
## SASS 0.043 1.000 0.093 0.866 0.031
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  bp_data_excb_clean$LENGTH and bp_data_excb_clean$CODE
```

```
##
##      BIEN BRUM HACK RIET ROTH
## BRUM 1.00 -    -    -    -
## HACK 1.00 1.00 -    -    -
## RIET 1.00 1.00 1.00 -    -
## ROTH 0.30 0.16 0.10 0.78 -
## SASS 1.00 1.00 0.10 1.00 0.14
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  bp_data_excb_clean$WIDTH and bp_data_excb_clean$CODE
##
##      BIEN BRUM HACK RIET ROTH
## BRUM 1.00 -    -    -    -
## HACK 1.00 1.00 -    -    -
## RIET 1.00 1.00 1.00 -    -
## ROTH 0.30 1.00 1.00 1.00 -
## SASS 0.44 1.00 1.00 1.00 1.00
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  bp_data_excb_clean$ELONGATION and bp_data_excb_clean$CODE
##
##      BIEN BRUM HACK RIET ROTH
## BRUM 1    -    -    -    -
## HACK 1    1    -    -    -
## RIET 1    1    1    -    -
## ROTH 1    1    1    1    -
## SASS 1    1    1    1    1
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  bp_data_excb_clean$THICKNESS and bp_data_excb_clean$CODE
##
##      BIEN  BRUM  HACK  RIET  ROTH
## BRUM 0.050 -     -     -     -
## HACK 1.000 1.000 -     -     -
## RIET 0.553 1.000 1.000 -     -
## ROTH 0.299 1.000 1.000 1.000 -
## SASS 0.014 1.000 1.000 1.000 1.000
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  bp_data_excb_clean$TCSA and bp_data_excb_clean$CODE
```

```
##
##      BIEN BRUM HACK RIET ROTH
## BRUM 1.00 -    -    -    -
## HACK 1.00 1.00 -    -    -
## RIET 1.00 1.00 1.00 -    -
## ROTH 1.00 1.00 1.00 1.00 -
## SASS 0.51 1.00 1.00 1.00 1.00
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  bp_data_excb_clean$TCSP and bp_data_excb_clean$CODE
##
##      BIEN BRUM HACK RIET ROTH
## BRUM 1.00 -    -    -    -
## HACK 1.00 1.00 -    -    -
## RIET 1.00 1.00 1.00 -    -
## ROTH 0.99 1.00 0.81 1.00 -
## SASS 1.00 1.00 1.00 1.00 1.00
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  bp_data_excb_clean$WEIGHT and bp_data_excb_clean$CLASSIFICATION
##
##             Bromme
## Federmesser 1.1e-06
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  bp_data_excb_clean$LENGTH and bp_data_excb_clean$CLASSIFICATION
##
##             Bromme
## Federmesser 0.31
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  bp_data_excb_clean$WIDTH and bp_data_excb_clean$CLASSIFICATION
##
##             Bromme
## Federmesser 0.24
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
```

```
##
## data:  bp_data_excb_clean$ELONGATION and bp_data_excb_clean$CLASSIFICATION
##
##             Bromme
## Federmesser 0.55
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  bp_data_excb_clean$THICKNESS and bp_data_excb_clean$CLASSIFICATION
##
##             Bromme
## Federmesser 0.4
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  bp_data_excb_clean$TCSA and bp_data_excb_clean$CLASSIFICATION
##
##             Bromme
## Federmesser 0.6
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  bp_data_excb_clean$TCSP and bp_data_excb_clean$CLASSIFICATION
##
##             Bromme
## Federmesser 0.35
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  bp_data_excb_clean$WEIGHT and bp_data_excb_clean$SUB_CATEGORY
##
##                             Backed Point (Reclassified)
## Backed Point (Unclassified) 1.000
## Creswellian Point           0.056
## Federmesser Point           1.000
##                             Backed Point (Unclassified) Creswellian Point
## Backed Point (Unclassified) -                           -
## Creswellian Point           0.131                       -
## Federmesser Point           1.000                       0.488
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
```

```
##
## data:  bp_data_excb_clean$LENGTH and bp_data_excb_clean$SUB_CATEGORY
##
##                             Backed Point (Reclassified)
## Backed Point (Unclassified) 1.0
## Creswellian Point           1.0
## Federmesser Point           1.0
##                             Backed Point (Unclassified) Creswellian Point
## Backed Point (Unclassified) -                           -
## Creswellian Point           1.0                         -
## Federmesser Point           0.9                         1.0
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  bp_data_excb_clean$WIDTH and bp_data_excb_clean$SUB_CATEGORY
##
##                             Backed Point (Reclassified)
## Backed Point (Unclassified) 0.23
## Creswellian Point           1.00
## Federmesser Point           1.00
##                             Backed Point (Unclassified) Creswellian Point
## Backed Point (Unclassified) -                           -
## Creswellian Point           1.00                        -
## Federmesser Point           0.90                        1.00
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  bp_data_excb_clean$ELONGATION and bp_data_excb_clean$SUB_CATEGORY
##
##                             Backed Point (Reclassified)
## Backed Point (Unclassified) 0.075
## Creswellian Point           1.000
## Federmesser Point           1.000
##                             Backed Point (Unclassified) Creswellian Point
## Backed Point (Unclassified) -                           -
## Creswellian Point           1.000                       -
## Federmesser Point           1.000                       1.000
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  bp_data_excb_clean$THICKNESS and bp_data_excb_clean$SUB_CATEGORY
##
##                             Backed Point (Reclassified)
## Backed Point (Unclassified) 1.000
## Creswellian Point           0.441
## Federmesser Point           1.000
```

```
##                             Backed Point (Unclassified) Creswellian Point
## Backed Point (Unclassified) -                           -
## Creswellian Point           0.028                       -
## Federmesser Point           1.000                       1.000
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  bp_data_excb_clean$TCSA and bp_data_excb_clean$SUB_CATEGORY
##
##                             Backed Point (Reclassified)
## Backed Point (Unclassified) 1.00
## Creswellian Point           0.44
## Federmesser Point           1.00
##                             Backed Point (Unclassified) Creswellian Point
## Backed Point (Unclassified) -                           -
## Creswellian Point           0.20                        -
## Federmesser Point           1.00                        1.00
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  bp_data_excb_clean$TCSP and bp_data_excb_clean$SUB_CATEGORY
##
##                             Backed Point (Reclassified)
## Backed Point (Unclassified) 0.6
## Creswellian Point           1.0
## Federmesser Point           1.0
##                             Backed Point (Unclassified) Creswellian Point
## Backed Point (Unclassified) -                           -
## Creswellian Point           1.0                         -
## Federmesser Point           1.0                         1.0
##
## P value adjustment method: bonferroni
```

Base Location
Count
15
10
5
0
BIEN
BRUM
HACK
RIET
ROTH
SASS
Type
DISTAL
PROXIMAL

Base Location
Count
20
10
0
Bromme
Federmesser
Type
DISTAL
PROXIMAL

Principal Component Analysis (PCA)

```
## # A tibble: 7 x 4
##   rowname eigenvalue variance cumulative
##   <chr>        <dbl>    <dbl>      <dbl>
## 1 Dim.1     4.37     62.4           62.4
## 2 Dim.2     1.33     19.0           81.3
## 3 Dim.3     0.707    10.1           91.4
## 4 Dim.4     0.512     7.31          98.7
## 5 Dim.5     0.0719    1.03          99.8
## 6 Dim.6     0.0163    0.232        100.
## 7 Dim.7     0.000139  0.00199      100
```

Percentage of explained variances
50
40
30
20
10
0
1
2
3
4
5
6
7
Dimension

Contribution of Variables
Dimension 1
Dimension 2
Dimension 3
Dimension 4
Dimension 5
Variable
WIDTH
WEIGHT
THICKNESS
TCSP
TCSA
LENGTH
ELONGATION
0 20 40 60 80
Contribution (%)

PCA 1 vs. PCA 2 (Classification)
ELONGATION
LENGTH
THICKNESS
WEIGHT
TCSA
TCSP
WIDTH
2
0
-2
-6
-3
0
3
6
Dimension 2 (18.96%)
Dimension 1 (62.35%)
Groups
Bromme
Federmesser

PCA 2 vs. PCA 3 (Classification)
LENGTH
WIDTH
WEIGHT
TCSP
ELONGATION
TCSA
THICKNESS
2
0
-2
-2
0
2
Dimension 3 (10.10%)
Dimension 2 (18.96%)
Groups
Bromme
Federmesser

PCA 1 vs. PCA 2 (Code)
ELONGATION
LENGTH
THICKNESS
WEIGHT
TCSA
TCSP
WIDTH
Dimension 2 (18.96%)
Dimension 1 (62.35%)
4
2
0
-2
-5
0
5
10
Groups
BIEN
BRUM
HACK
RIET
ROTH
SASS

PCA 2 vs. PCA 3 (Code)
LENGTH
WIDTH
WEIGHT
TCSP
ELONGATION
TCSA
THICKNESS
Dimension 3 (10.10%)
Dimension 2 (18.96%)
2
0
-2
-2
0
2
4
Groups
BIEN
HACK
ROTH
BRUM
RIET
SASS

PCA 1 vs. PCA 2 (Backed Point Variant)
ELONGATION
LENGTH
THICKNESS
WEIGHT
TCSA
TCSP
WIDTH
Dimension 2 (18.96%)
Dimension 1 (62.35%)
3
2
1
0
-1
-2
-2
0
2
4
Groups
Backed Point (Reclassified)
Backed Point (Unclassified)
Creswellian Point
Federmesser Point

PCA 2 vs. PCA 3 (Backed Point Variant)
LENGTH
WIDTH
WEIGHT
TCSP
ELONGATION
TCSA
THICKNESS
Dimension 3 (10.10%)
Dimension 2 (18.96%)
1
0
-1
-2
-2
-1
0
1
2
Groups
Backed Point (Reclassified)
Backed Point (Unclassified)
Creswellian Point
Federmesser Point

PCA 1:5 (Classification)
Value
4
2
0
-2
Dimension 1
Dimension 2
Dimension 3
Dimension 4
Dimension 5
Classification
Bromme
Federmesser

PCA 1:5 (Classification)
Value
4
2
0
-2
Dimension 1
Dimension 2
Dimension 3
Dimension 4
Dimension 5
Classification
BIEN
BRUM
HACK
RIET
ROTH
SASS

Analysis: Backed Points (inc. burinated pieces)

Visual and Descriptive Summaries of Data

Table 46. Descriptive Statistics: Backed Point Weight (g)

CONTEXT	n_obs	min	max	mean	med	sd	var
Bienenbüttel (FStNr. 15)	5	1.19	3.11	2.06	1.89	0.91	0.82
Brümmerhof (FStNr. 16)	13	3.57	19.21	8.52	5.15	5.52	30.48
Häcklingen (FStNr. 19)	9	0.86	6.33	2.58	1.40	2.15	4.61
Rietberg (1)	4	1.05	4.91	2.84	2.70	1.66	2.75
Rietberg (2)	2	3.23	3.69	3.46	3.46	0.33	0.11
Rothenkirchen	4	0.36	1.75	0.80	0.54	0.64	0.41
Sassenholz (FStNr. 78)	36	0.98	19.53	5.56	4.92	3.28	10.74

Table 47. Descriptive Statistics: Backed Point Length (mm)

CONTEXT	n_obs	min	max	mean	med	sd	var
Bienenbüttel (FStNr. 15)	5	33.81	49.28	40.46	40	6.36	40.41
Brümmerhof (FStNr. 16)	13	29.28	59.12	41.02	38	8.95	80.08
Häcklingen (FStNr. 19)	9	34.17	56.50	42.96	42	6.65	44.25
Rietberg (1)	4	33.37	61.91	44.36	41	13.19	173.86
Rietberg (2)	2	40.62	67.02	53.82	54	18.67	348.48

Rothenkirchen	4	21.79	30.80	26.43	27	3.68	13.56
Sassenholz (FStNr. 78)	36	19.13	55.12	36.32	36	7.62	58.05

Table 48. Descriptive Statistics: Backed Point Width (mm)

CONTEXT	n_obs	min	max	mean	med	sd	var
Bienenbüttel (FStNr. 15)	5	11.66	14.97	13.03	12.96	1.37	1.87
Brümmerhof (FStNr. 16)	13	6.41	20.06	12.83	11.74	4.61	21.22
Häcklingen (FStNr. 19)	9	7.90	24.92	13.41	11.38	5.46	29.83
Rietberg (1)	4	9.69	17.09	14.18	14.97	3.41	11.62
Rietberg (2)	2	16.59	21.89	19.24	19.24	3.75	14.05
Rothenkirchen	4	7.51	11.54	8.78	8.04	1.90	3.60
Sassenholz (FStNr. 78)	36	2.91	17.66	10.56	10.52	2.89	8.35

Table 49. Descriptive Statistics: Backed Point Elongation Index (L/W)

CONTEXT	n_obs	min	max	mean	med	sd	var
Bienenbüttel (FStNr. 15)	5	2.61	3.75	3.11	2.96	0.43	0.19
Brümmerhof (FStNr. 16)	13	2.25	5.81	3.44	3.17	0.98	0.97
Häcklingen (FStNr. 19)	9	1.68	4.58	3.53	3.73	0.93	0.87
Rietberg (1)	4	2.12	4.62	3.24	3.10	1.07	1.15
Rietberg (2)	2	1.86	4.04	2.95	2.95	1.54	2.39
Rothenkirchen	4	2.56	3.54	3.07	3.09	0.53	0.28
Sassenholz (FStNr. 78)	36	2.22	7.50	3.62	3.52	0.94	0.88

Table 50. Descriptive Statistics: Backed Point Elongation Index (L/W)

CONTEXT	n_obs	min	max	mean	med	sd	var
Bienenbüttel (FStNr. 15)	5	1.84	2.54	2.15	2.01	0.31	0.09
Brümmerhof (FStNr. 16)	13	3.08	6.23	4.76	4.61	1.07	1.14
Häcklingen (FStNr. 19)	9	1.54	7.12	4.76	5.40	1.96	3.83
Rietberg (1)	4	3.42	7.59	5.73	5.96	1.98	3.91
Rietberg (2)	2	3.58	7.45	5.52	5.52	2.74	7.49
Rothenkirchen	4	3.85	4.21	4.00	3.96	0.16	0.02
Sassenholz (FStNr. 78)	36	2.01	6.32	4.18	4.10	1.14	1.29

Table 51. Descriptive Statistics: Tip Cross-Sectional Area (TCSA)

CONTEXT	n_obs	min	max	mean	med	sd	var
Bienenbüttel (FStNr. 15)	5	10.73	19.01	14.14	12.57	3.48	12.09
Brümmerhof (FStNr. 16)	13	12.32	60.27	31.91	32.41	16.38	268.44
Häcklingen (FStNr. 19)	9	7.28	67.78	33.55	30.29	21.33	454.83
Rietberg (1)	4	16.57	64.86	43.13	45.56	22.80	520.04
Rietberg (2)	2	29.70	81.54	55.62	55.62	36.66	1343.69
Rothenkirchen	4	14.53	24.29	17.64	15.88	4.58	20.99
Sassenholz (FStNr. 78)	36	3.30	43.89	22.64	23.51	9.47	89.76

Table 52. Descriptive Statistics: Tip Cross-Sectional Perimeter (TCSP)

CONTEXT	n_obs	min	max	mean	med	sd	var
Bienenbüttel (FStNr. 15)	5	17.77	22.87	19.88	19.72	2.10	4.42
Brümmerhof (FStNr. 16)	13	11.91	31.37	20.89	19.58	6.86	47.00
Häcklingen (FStNr. 19)	9	13.92	38.52	21.81	19.01	8.12	65.88
Rietberg (1)	4	15.62	28.52	23.31	24.55	5.96	35.55
Rietberg (2)	2	25.62	35.13	30.38	30.38	6.72	45.22
Rothenkirchen	4	12.93	18.68	14.73	13.65	2.72	7.39
Sassenholz (FStNr. 78)	36	5.61	27.79	17.37	17.46	4.32	18.68

Table 53. Descriptive Statistics: Backed Point Weight (g)

CLASSIFICATION	n_obs	min	max	mean	med	sd	var
Bromme	49	0.98	19.53	6.35	4.93	4.15	17.20
Federmesser	24	0.36	6.33	2.29	1.82	1.66	2.76

Table 54. Descriptive Statistics: Backed Point Length (mm)

CLASSIFICATION	n_obs	min	max	mean	med	sd	var
Bromme	49	19.13	59.12	37.57	37	8.17	66.74
Federmesser	24	21.79	67.02	40.82	41	10.80	116.70

Table 55. Descriptive Statistics: Backed Point Width (mm)

CLASSIFICATION	n_obs	min	max	mean	med	sd	var
Bromme	49	2.91	20.06	11.16	10.92	3.52	12.42
Federmesser	24	7.51	24.92	13.17	12.41	4.48	20.06

Table 56. Descriptive Statistics: Backed Point Elongation Index (L/W)

CLASSIFICATION	n_obs	min	max	mean	med	sd	var
Bromme	49	2.22	7.50	3.57	3.36	0.94	0.89
Federmesser	24	1.68	4.62	3.27	3.40	0.82	0.67

Table 57. Descriptive Statistics: Backed Point Elongation Index (L/W)

CLASSIFICATION	n_obs	min	max	mean	med	sd	var
Bromme	49	2.01	6.32	4.33	4.47	1.14	1.29
Federmesser	24	1.54	7.59	4.31	4.01	1.94	3.78

Table 58. Descriptive Statistics: Tip Cross-Sectional Area (TCSA)

CLASSIFICATION	n_obs	min	max	mean	med	sd	var

Bromme	49	3.30	60.27	25.10	24.48	12.23	149.66
Federmesser	24	7.28	81.54	30.29	21.65	21.50	462.43

Table 59. Descriptive Statistics: Tip Cross-Sectional Perimeter (TCSP)

CLASSIFICATION	n_obs	min	max	mean	med	sd	var
Bromme	49	5.61	31.37	18.30	17.84	5.28	27.83
Federmesser	24	12.93	38.52	21.19	19.37	6.87	47.15

Table 60. Descriptive Statistics: Backed Point Weight (g)

SUB_CATEGORY	n_obs	min	max	mean	med	sd	var
Backed Point (Reclassified)	9	2.35	19.21	7.39	4.91	5.96	35.52
Backed Point (Unclassified)	57	0.36	19.53	5.00	4.83	3.66	13.43
Creswellian Point	5	0.86	2.89	1.61	1.22	0.81	0.65
Federmesser Point	2	3.11	3.29	3.20	3.20	0.13	0.02

Table 61. Descriptive Statistics: Backed Point Length (mm)

SUB_CATEGORY	n_obs	min	max	mean	med	sd	var
Backed Point (Reclassified)	9	26.75	59.12	40.24	37	11.33	128.34
Backed Point (Unclassified)	57	19.13	67.02	37.90	37	8.70	75.66
Creswellian Point	5	33.81	49.28	39.22	35	6.96	48.39
Federmesser Point	2	40.33	61.91	51.12	51	15.26	232.85

Table 62. Descriptive Statistics: Backed Point Width (mm)

SUB_CATEGORY	n_obs	min	max	mean	med	sd	var
Backed Point (Reclassified)	9	9.33	19.76	14.03	12.91	3.94	15.53
Backed Point (Unclassified)	57	2.91	24.92	11.41	10.98	4.04	16.32
Creswellian Point	5	8.19	14.97	11.93	11.85	2.47	6.09
Federmesser Point	2	13.39	13.69	13.54	13.54	0.21	0.04

Table 63. Descriptive Statistics: Backed Point Elongation Index (L/W)

SUB_CATEGORY	n_obs	min	max	mean	med	sd	var
Backed Point (Reclassified)	9	2.22	3.77	2.91	2.87	0.51	0.26
Backed Point (Unclassified)	57	1.68	7.50	3.56	3.44	0.96	0.91
Creswellian Point	5	2.61	4.17	3.36	3.29	0.62	0.39
Federmesser Point	2	2.95	4.62	3.78	3.78	1.19	1.41

Table 64. Descriptive Statistics: Backed Point Elongation Index (L/W)

SUB_CATEGORY	n_obs	min	max	mean	med	sd	var

Backed Point (Reclassified)	9	2.44	7.59	4.48	3.56	1.76	3.10
Backed Point (Unclassified)	57	1.54	7.45	4.49	4.54	1.32	1.75
Creswellian Point	5	1.84	4.01	2.47	2.01	0.90	0.82
Federmesser Point	2	2.41	4.77	3.59	3.59	1.67	2.78

Table 65. Descriptive Statistics: Tip Cross-Sectional Area (TCSA)

SUB_CATEGORY	n_obs	min	max	mean	med	sd	var
Backed Point (Reclassified)	9	11.38	64.86	33.36	25.09	20.23	409.07
Backed Point (Unclassified)	57	3.30	81.54	26.97	24.72	15.59	243.02
Creswellian Point	5	10.73	19.01	14.13	12.57	3.46	12.00
Federmesser Point	2	16.50	31.94	24.22	24.22	10.92	119.20

Table 66. Descriptive Statistics: Tip Cross-Sectional Perimeter (TCSP)

SUB_CATEGORY	n_obs	min	max	mean	med	sd	var
Backed Point (Reclassified)	9	14.59	31.37	22.43	20.28	6.24	38.89
Backed Point (Unclassified)	57	5.61	38.52	18.75	17.84	6.10	37.23
Creswellian Point	5	13.92	22.87	18.48	18.11	3.25	10.56
Federmesser Point	2	20.95	21.61	21.28	21.28	0.47	0.22

Length (mm)
60
50
40
30
20
BIEN
BRUM
HACK
RIET
ROTH
SASS
Taxonomic Unit
Bromme
Federmesser

Width (mm)
25
20
15
10
5
BIEN
BRUM
HACK
RIET
ROTH
SASS
Taxonomic Unit
Bromme
Federmesser

Elongation (L/W)
6
4
2
BIEN
BRUM
HACK
RIET
ROTH
SASS
Taxonomic Unit
Bromme
Federmesser

Thickness (mm)
6
4
2
BIEN
BRUM
HACK
RIET
ROTH
SASS
Taxonomic Unit
Bromme
Federmesser

Tip Cross-Sectional Area (TCSA)
80
60
40
20
0
BIEN
BRUM
HACK
RIET
ROTH
SASS
Taxonomic Unit
Bromme
Federmesser

Tip Cross-Sectional Area (TCSP)
40
30
20
10
BIEN
BRUM
HACK
RIET
ROTH
SASS
Taxonomic Unit
Bromme
Federmesser

Weight (g)
20
15
10
5
0
Backed Point (Reclassified)
Backed Point (Unclassified)
Creswellian Point
Federmesser Point

Length (mm)
60
50
40
30
20
Backed Point (Reclassified)
Backed Point (Unclassified)
Creswellian Point
Federmesser Point

Width (mm)
25
20
15
10
5
Backed Point (Reclassified)
Backed Point (Unclassified)
Creswellian Point
Federmesser Point

Elongation (L/W)
6
4
2
Backed Point (Reclassified)
Backed Point (Unclassified)
Creswellian Point
Federmesser Point

Thickness (mm)
2
4
6
Backed Point (Reclassified)
Backed Point (Unclassified)
Creswellian Point
Federmesser Point

Tip Cross-Sectional Area (TCSA)
0
20
40
60
80
Backed Point (Reclassified)
Backed Point (Unclassified)
Creswellian Point
Federmesser Point

Tip Cross-Sectional Area (TCSP)
40
30
20
10
Backed Point (Reclassified)
Backed Point (Unclassified)
Creswellian Point
Federmesser Point

50
40
30
20
10
0
TCSP (mm)
0
25
50
75
100
TCSA (mm²)
CLASSIFICATION
Bromme
Federmesser

50
40
30
20
10
0
TCSP (mm)
0
25
50
75
100
TCSA (mm²)
CODE
BIEN
HACK
ROTH
BRUM
RIET
SASS

50
40
30
20
10
0
TCSP (mm)
0
25
50
75
100
TCSA (mm²)
SUB_CATEGORY
Backed Point (Reclassified)
Backed Point (Unclassified)
Creswellian Point
Federmesser Point
CODE
BIEN
BRUM
HACK
RIET
ROTH
SASS

50
40
30
20
10
0
TCSP (mm)
0
25
50
75
100
TCSA (mm²)
CLASSIFICATION
Bromme
Federmesser
SUB_CATEGORY
Backed Point (Reclassified)
Backed Point (Unclassified)
Creswellian Point
Federmesser Point

80
60
40
20
0
Backed Point Length (mm)
0
10
20
30
40
Backed Point Width (mm)
CLASSIFICATION
Bromme
Federmesser

80
60
40
20
0
Backed Point Length (mm)
0
10
20
30
40
Backed Point Width (mm)
CODE
BIEN
HACK
ROTH
BRUM
RIET
SASS

80
60
40
20
0
Backed Point Length (mm)
0
10
20
30
40
Backed Point Width (mm)
SUB_CATEGORY
Backed Point (Reclassified)
Backed Point (Unclassified)
Creswellian Point
Federmesser Point
CODE
BIEN
BRUM
HACK
RIET
ROTH
SASS

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  bp_data_incb_clean$WEIGHT and bp_data_incb_clean$CODE
##
##      BIEN  BRUM  HACK  RIET  ROTH
## BRUM 0.024 -     -     -     -
## HACK 1.000 0.050 -     -     -
## RIET 1.000 0.065 1.000 -     -
## ROTH 0.993 0.058 0.806 0.378 -
## SASS 0.030 1.000 0.085 0.252 0.022
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  bp_data_incb_clean$LENGTH and bp_data_incb_clean$CODE
```

```
##
##      BIEN  BRUM  HACK  RIET  ROTH
## BRUM 1.000 -     -     -     -
## HACK 1.000 1.000 -     -     -
## RIET 1.000 1.000 1.000 -     -
## ROTH 0.299 0.083 0.104 0.213 -
## SASS 1.000 1.000 0.110 1.000 0.125
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  bp_data_incb_clean$WIDTH and bp_data_incb_clean$CODE
##
##      BIEN BRUM HACK RIET ROTH
## BRUM 1.00 -    -    -    -
## HACK 1.00 1.00 -    -    -
## RIET 1.00 1.00 1.00 -    -
## ROTH 0.30 1.00 1.00 0.38 -
## SASS 0.30 1.00 1.00 0.11 1.00
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  bp_data_incb_clean$ELONGATION and bp_data_incb_clean$CODE
##
##      BIEN BRUM HACK RIET ROTH
## BRUM 1    -    -    -    -
## HACK 1    1    -    -    -
## RIET 1    1    1    -    -
## ROTH 1    1    1    1    -
## SASS 1    1    1    1    1
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  bp_data_incb_clean$THICKNESS and bp_data_incb_clean$CODE
##
##      BIEN  BRUM  HACK  RIET  ROTH
## BRUM 0.024 -     -     -     -
## HACK 1.000 1.000 -     -     -
## RIET 0.122 1.000 1.000 -     -
## ROTH 0.299 1.000 1.000 1.000 -
## SASS 0.016 1.000 1.000 1.000 1.000
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  bp_data_incb_clean$TCSA and bp_data_incb_clean$CODE
```

```
##
##      BIEN BRUM HACK RIET ROTH
## BRUM 0.35 -    -    -    -
## HACK 1.00 1.00 -    -    -
## RIET 0.21 1.00 1.00 -    -
## ROTH 1.00 1.00 1.00 0.64 -
## SASS 0.66 1.00 1.00 0.23 1.00
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  bp_data_incb_clean$TCSP and bp_data_incb_clean$CODE
##
##      BIEN BRUM HACK RIET ROTH
## BRUM 1.00 -    -    -    -
## HACK 1.00 1.00 -    -    -
## RIET 1.00 1.00 1.00 -    -
## ROTH 0.99 1.00 0.81 0.38 -
## SASS 1.00 1.00 1.00 0.11 1.00
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  bp_data_incb_clean$WEIGHT and bp_data_incb_clean$CLASSIFICATION
##
##             Bromme
## Federmesser 1.3e-07
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  bp_data_incb_clean$LENGTH and bp_data_incb_clean$CLASSIFICATION
##
##             Bromme
## Federmesser 0.18
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  bp_data_incb_clean$WIDTH and bp_data_incb_clean$CLASSIFICATION
##
##             Bromme
## Federmesser 0.088
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
```

```
##
## data:  bp_data_incb_clean$ELONGATION and bp_data_incb_clean$CLASSIFICATION
##
##             Bromme
## Federmesser 0.38
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  bp_data_incb_clean$THICKNESS and bp_data_incb_clean$CLASSIFICATION
##
##             Bromme
## Federmesser 0.8
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  bp_data_incb_clean$TCSA and bp_data_incb_clean$CLASSIFICATION
##
##             Bromme
## Federmesser 0.92
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  bp_data_incb_clean$TCSP and bp_data_incb_clean$CLASSIFICATION
##
##             Bromme
## Federmesser 0.13
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  bp_data_incb_clean$WEIGHT and bp_data_incb_clean$SUB_CATEGORY
##
##                             Backed Point (Reclassified)
## Backed Point (Unclassified) 1.000
## Creswellian Point           0.031
## Federmesser Point           0.753
##                             Backed Point (Unclassified) Creswellian Point
## Backed Point (Unclassified) -                           -
## Creswellian Point           0.054                       -
## Federmesser Point           1.000                       0.488
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
```

```
##
## data:  bp_data_incb_clean$LENGTH and bp_data_incb_clean$SUB_CATEGORY
##
##                             Backed Point (Reclassified)
## Backed Point (Unclassified) 1.00
## Creswellian Point           1.00
## Federmesser Point           1.00
##                             Backed Point (Unclassified) Creswellian Point
## Backed Point (Unclassified) -                           -
## Creswellian Point           1.00                        -
## Federmesser Point           0.89                        1.00
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  bp_data_incb_clean$WIDTH and bp_data_incb_clean$SUB_CATEGORY
##
##                             Backed Point (Reclassified)
## Backed Point (Unclassified) 0.31
## Creswellian Point           1.00
## Federmesser Point           1.00
##                             Backed Point (Unclassified) Creswellian Point
## Backed Point (Unclassified) -                           -
## Creswellian Point           1.00                        -
## Federmesser Point           1.00                        1.00
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  bp_data_incb_clean$ELONGATION and bp_data_incb_clean$SUB_CATEGORY
##
##                             Backed Point (Reclassified)
## Backed Point (Unclassified) 0.16
## Creswellian Point           1.00
## Federmesser Point           1.00
##                             Backed Point (Unclassified) Creswellian Point
## Backed Point (Unclassified) -                           -
## Creswellian Point           1.00                        -
## Federmesser Point           1.00                        1.00
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  bp_data_incb_clean$THICKNESS and bp_data_incb_clean$SUB_CATEGORY
##
##                             Backed Point (Reclassified)
## Backed Point (Unclassified) 1.000
## Creswellian Point           0.196
## Federmesser Point           1.000
```

```
##                             Backed Point (Unclassified) Creswellian Point
## Backed Point (Unclassified) -                           -
## Creswellian Point           0.027                       -
## Federmesser Point           1.000                       1.000
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  bp_data_incb_clean$TCSA and bp_data_incb_clean$SUB_CATEGORY
##
##                             Backed Point (Reclassified)
## Backed Point (Unclassified) 1.00
## Creswellian Point           0.20
## Federmesser Point           1.00
##                             Backed Point (Unclassified) Creswellian Point
## Backed Point (Unclassified) -                           -
## Creswellian Point           0.16                        -
## Federmesser Point           1.00                        1.00
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  bp_data_incb_clean$TCSP and bp_data_incb_clean$SUB_CATEGORY
##
##                             Backed Point (Reclassified)
## Backed Point (Unclassified) 0.53
## Creswellian Point           1.00
## Federmesser Point           1.00
##                             Backed Point (Unclassified) Creswellian Point
## Backed Point (Unclassified) -                           -
## Creswellian Point           1.00                        -
## Federmesser Point           1.00                        1.00
##
## P value adjustment method: bonferroni
```

Base Location
Count
20
10
0
BIEN
BRUM
HACK
RIET
ROTH
SASS
Type
DISTAL
PROXIMAL

Base Location
Count
30
20
10
0
Bromme
Federmesser
Type
DISTAL
PROXIMAL

Principal Component Analysis (PCA)

```
## # A tibble: 7 x 4
##   rowname eigenvalue variance cumulative
##   <chr>        <dbl>    <dbl>      <dbl>
## 1 Dim.1     4.41     63.1           63.1
## 2 Dim.2     1.10     15.7           78.8
## 3 Dim.3     0.778    11.1           89.9
## 4 Dim.4     0.564     8.06          97.9
## 5 Dim.5     0.129     1.85          99.8
## 6 Dim.6     0.0149    0.213        100.
## 7 Dim.7     0.000134  0.00191      100
```

Percentage of explained variances
50
40
30
20
10
0
1
2
3
4
5
6
7
Dimension

Contribution of Variables
Dimension 1
Dimension 2
Dimension 3
Dimension 4
Dimension 5
WIDTH
WEIGHT
THICKNESS
TCSP
TCSA
LENGTH
ELONGATION
Variable
0 20 40 60 80
Contribution (%)

PCA 1 vs. PCA 2 (Classification)
ELONGATION
LENGTH
WEIGHT
THICKNESS
TCSA
TCSP
WIDTH
Dimension 2 (15.56%)
Dimension 1 (62.99%)
2
1
0
-1
-2
-3
-4
0
4
Groups
Bromme
Federmesser

PCA 2 vs. PCA 3 (Classification)
THICKNESS
TCSA
ELONGATION
WEIGHT
TCSP
WIDTH
LENGTH
2
0
-2
-3
-2
-1
0
1
2
Dimension 3 (11.42%)
Dimension 2 (15.56%)
Groups
Bromme
Federmesser

PCA 1 vs. PCA 2 (Code)
ELONGATION
LENGTH
WEIGHT
THICKNESS
TCSA
TCSP
WIDTH
3
0
-3
-5
0
5
10
Dimension 2 (15.56%)
Dimension 1 (62.99%)
Groups
BIEN
BRUM
HACK
RIET
ROTH
SASS

PCA 2 vs. PCA 3 (Code)
6
3
0
-3
Dimension 3 (11.42%)
-3
0
3
Dimension 2 (15.56%)
THICKNESS
TCSA
ELONGATION
WEIGHT
TCSP
WIDTH
LENGTH
Groups
BIEN
BRUM
HACK
RIET
ROTH
SASS

PCA 1 vs. PCA 2 (Backed Point Variant)
ELONGATION
LENGTH
WEIGHT
THICKNESS
TCSA
TCSP
WIDTH
Dimension 2 (15.56%)
Dimension 1 (62.99%)
2
1
0
-1
-2
-3
0
3
Groups
Backed Point (Reclassified)
Backed Point (Unclassified)
Creswellian Point
Federmesser Point

PCA 2 vs. PCA 3 (Backed Point Variant)
THICKNESS
TCSA
ELONGATION
WEIGHT
TCSP
WIDTH
LENGTH
Dimension 3 (11.42%)
Dimension 2 (15.56%)
1
0
-1
-2
-2
-1
0
1
2
Groups
Backed Point (Reclassified)
Backed Point (Unclassified)
Creswellian Point
Federmesser Point

PCA 1:5 (Classification)
Value
3
0
-3
Dimension 1
Dimension 2
Dimension 3
Dimension 4
Dimension 5
Classification
Bromme
Federmesser

PCA 1:5 (Classification)
Value
3
0
-3
Dimension 1
Dimension 2
Dimension 3
Dimension 4
Dimension 5
Classification
BIEN
BRUM
HACK
RIET
ROTH
SASS

Analysis: Tanged Points (exc. burinated pieces)

Visual and Descriptive Summaries of Data

Table 66. Descriptive Statistics: Tanged Point Weight (g)

CONTEXT	n_obs	min	max	mean	med	sd	var
Brümmerhof (FStNr. 16)	2	7.89	11.76	9.82	9.82	2.74	7.49
Häcklingen (FStNr. 19)	7	0.53	7.16	3.39	2.48	2.43	5.93
Sassenholz (FStNr. 78)	10	4.21	19.21	12.00	10.61	5.89	34.70
Segebro	4	2.81	7.31	5.03	5.00	2.34	5.48
Skovmosen	1	4.52	4.52	4.52	4.52	NA	NA

Table 67. Descriptive Statistics: Tanged Point Length (mm)

CONTEXT	n_obs	min	max	mean	med	sd	var
Brümmerhof (FStNr. 16)	2	39.95	56.56	48.26	48	11.75	137.95
Häcklingen (FStNr. 19)	7	30.44	56.06	42.98	40	10.36	107.35
Sassenholz (FStNr. 78)	10	29.54	62.14	50.65	51	9.88	97.71
Segebro	4	43.73	65.32	58.33	62	10.04	100.83
Skovmosen	1	53.28	53.28	53.28	53	NA	NA

Table 68. Descriptive Statistics: Tanged Point Width (mm)

CONTEXT	n_obs	min	max	mean	med	sd	var
Brümmerhof (FStNr. 16)	2	10.04	14.42	12.23	12.23	3.10	9.59
Häcklingen (FStNr. 19)	7	8.09	23.01	15.02	14.76	5.27	27.82
Sassenholz (FStNr. 78)	10	13.19	20.53	16.56	16.05	2.44	5.93
Segebro	4	15.42	19.21	17.24	17.16	1.58	2.50
Skovmosen	1	17.75	17.75	17.75	17.75	NA	NA

Table 69. Descriptive Statistics: Tanged Point Elongation Index (L/W)

CONTEXT	n_obs	min	max	mean	med	sd	var
Brümmerhof (FStNr. 16)	2	3.92	3.98	3.95	3.95	0.04	0.00
Häcklingen (FStNr. 19)	7	2.44	3.76	2.99	2.82	0.51	0.26
Sassenholz (FStNr. 78)	10	1.87	3.98	3.09	3.12	0.61	0.38
Segebro	4	2.84	3.85	3.37	3.40	0.41	0.17
Skovmosen	1	3.00	3.00	3.00	3.00	NA	NA

Table 70. Descriptive Statistics: Tanged Point Elongation Index (L/W)

CONTEXT	n_obs	min	max	mean	med	sd	var
Brümmerhof (FStNr. 16)	2	5.12	7.18	6.15	6.15	1.46	2.12
Häcklingen (FStNr. 19)	7	1.65	4.52	3.43	3.74	1.07	1.16
Sassenholz (FStNr. 78)	10	3.12	6.12	5.00	5.15	0.91	0.83
Segebro	4	4.81	6.28	5.76	5.96	0.68	0.46
Skovmosen	1	6.03	6.03	6.03	6.03	NA	NA

Table 71. Descriptive Statistics: Tip Cross-Sectional Area (TCSA)

CONTEXT	n_obs	min	max	mean	med	sd	var
Brümmerhof (FStNr. 16)	2	36.04	36.92	36.48	36.48	0.62	0.39
Häcklingen (FStNr. 19)	7	6.67	52.00	27.58	25.47	15.87	252.00
Sassenholz (FStNr. 78)	10	24.68	59.95	41.93	39.67	12.05	145.17
Segebro	4	46.20	54.46	49.27	48.20	3.59	12.91
Skovmosen	1	53.52	53.52	53.52	53.52	NA	NA

Table 72. Descriptive Statistics: Tip Cross-Sectional Perimeter (TCSP)

CONTEXT	n_obs	min	max	mean	med	sd	var
Brümmerhof (FStNr. 16)	2	18.80	23.26	21.03	21.03	3.15	9.95
Häcklingen (FStNr. 19)	7	12.46	35.37	23.31	22.50	7.99	63.90
Sassenholz (FStNr. 78)	10	21.19	32.34	26.26	25.34	3.72	13.85
Segebro	4	25.36	29.95	27.63	27.61	1.95	3.82
Skovmosen	1	28.48	28.48	28.48	28.48	NA	NA

Table 73. Descriptive Statistics: Tanged Point Weight (g)

CLASSIFICATION	n_obs	min	max	mean	med	sd	var
Bromme	17	2.81	19.21	9.66	7.89	5.61	31.45
Federmesser	7	0.53	7.16	3.39	2.48	2.43	5.93

Table 74. Descriptive Statistics: Tanged Point Length (mm)

CLASSIFICATION	n_obs	min	max	mean	med	sd	var
Bromme	17	29.54	65.32	52.33	53	9.77	95.40
Federmesser	7	30.44	56.06	42.98	40	10.36	107.35

Table 75. Descriptive Statistics: Tanged Point Width (mm)

CLASSIFICATION	n_obs	min	max	mean	med	sd	var
Bromme	17	10.04	20.53	16.28	16.12	2.62	6.87
Federmesser	7	8.09	23.01	15.02	14.76	5.27	27.82

Table 76. Descriptive Statistics: Tanged Point Elongation Index (L/W)

CLASSIFICATION	n_obs	min	max	mean	med	sd	var
Bromme	17	1.87	3.98	3.25	3.14	0.57	0.33
Federmesser	7	2.44	3.76	2.99	2.82	0.51	0.26

Table 77. Descriptive Statistics: Tanged Point Elongation Index (L/W)

CLASSIFICATION	n_obs	min	max	mean	med	sd	var
Bromme	17	3.12	7.18	5.38	5.23	0.95	0.91
Federmesser	7	1.65	4.52	3.43	3.74	1.07	1.16

Table 78. Descriptive Statistics: Tip Cross-Sectional Area (TCSA)

CLASSIFICATION	n_obs	min	max	mean	med	sd	var
Bromme	17	24.68	59.95	43.70	46.20	10.31	106.35
Federmesser	7	6.67	52.00	27.58	25.47	15.87	252.00

Table 79. Descriptive Statistics: Tip Cross-Sectional Perimeter (TCSP)

CLASSIFICATION	n_obs	min	max	mean	med	sd	var
Bromme	17	18.80	32.34	26.10	25.51	3.65	13.3
Federmesser	7	12.46	35.37	23.31	22.50	7.99	63.9

Table 80. Descriptive Statistics: Tanged Point Weight (g)

SUB_CATEGORY	n_obs	min	max	mean	med	sd	var
Ahrensburgian Point	3	0.53	4.21	2.25	2.01	1.85	3.43
Bromme Point	6	4.52	19.21	12.42	13.81	6.61	43.69
Chwalibogowice Point	1	1.39	1.39	1.39	1.39	NA	NA
Swidry Point	1	10.12	10.12	10.12	10.12	NA	NA
Tanged Point (Unclassified)	13	2.48	19.10	7.32	6.77	4.46	19.85

Table 81. Descriptive Statistics: Tanged Point Length (mm)

SUB_CATEGORY	n_obs	min	max	mean	med	sd	var
Ahrensburgian Point	3	29.54	39.59	33.19	30	5.56	30.92
Bromme Point	6	49.99	62.14	55.33	54	5.40	29.15
Chwalibogowice Point	1	33.84	33.84	33.84	34	NA	NA
Swidry Point	1	52.45	52.45	52.45	52	NA	NA
Tanged Point (Unclassified)	13	36.28	65.32	51.74	53	9.47	89.59

Table 82. Descriptive Statistics: Tanged Point Width (mm)

SUB_CATEGORY	n_obs	min	max	mean	med	sd	var
Ahrensburgian Point	3	8.09	15.82	12.89	14.76	4.19	17.56
Bromme Point	6	14.10	20.53	17.41	17.04	2.44	5.96
Chwalibogowice Point	1	9.28	9.28	9.28	9.28	NA	NA
Swidry Point	1	13.19	13.19	13.19	13.19	NA	NA
Tanged Point (Unclassified)	13	10.04	23.01	16.63	16.78	3.17	10.05

Table 83. Descriptive Statistics: Tanged Point Elongation Index (L/W)

SUB_CATEGORY	n_obs	min	max	mean	med	sd	var
Ahrensburgian Point	3	1.87	3.76	2.77	2.68	0.95	0.90
Bromme Point	6	2.68	3.77	3.21	3.13	0.39	0.15
Chwalibogowice Point	1	3.65	3.65	3.65	3.65	NA	NA
Swidry Point	1	3.98	3.98	3.98	3.98	NA	NA
Tanged Point (Unclassified)	13	2.44	3.98	3.15	3.08	0.52	0.27

Table 84. Descriptive Statistics: Tanged Point Elongation Index (L/W)

SUB_CATEGORY	n_obs	min	max	mean	med	sd	var
Ahrensburgian Point	3	1.65	3.12	2.37	2.34	0.74	0.54
Bromme Point	6	4.92	6.03	5.52	5.54	0.46	0.21
Chwalibogowice Point	1	3.45	3.45	3.45	3.45	NA	NA
Swidry Point	1	4.52	4.52	4.52	4.52	NA	NA
Tanged Point (Unclassified)	13	3.74	7.18	5.17	5.10	1.06	1.13

Table 85. Descriptive Statistics: Tip Cross-Sectional Area (TCSA)

SUB_CATEGORY	n_obs	min	max	mean	med	sd	var
Ahrensburgian Point	3	6.67	24.68	16.21	17.27	9.05	81.94
Bromme Point	6	34.69	59.95	48.27	49.97	9.01	81.21
Chwalibogowice Point	1	16.01	16.01	16.01	16.01	NA	NA
Swidry Point	1	29.81	29.81	29.81	29.81	NA	NA
Tanged Point (Unclassified)	13	25.47	57.83	42.45	41.31	9.53	90.83

Table 86. Descriptive Statistics: Tip Cross-Sectional Perimeter (TCSP)

SUB_CATEGORY	n_obs	min	max	mean	med	sd	var
Ahrensburgian Point	3	12.46	24.32	19.76	22.50	6.39	40.80
Bromme Point	6	22.70	32.34	27.74	27.44	3.59	12.92
Chwalibogowice Point	1	15.06	15.06	15.06	15.06	NA	NA
Swidry Point	1	21.19	21.19	21.19	21.19	NA	NA
Tanged Point (Unclassified)	13	18.80	35.37	26.53	26.93	4.28	18.29

Length (mm)
60
50
40
30
BRUM
HACK
SASS
SEGE
SKOV
Taxonomic Unit
Bromme
Federmesser

Width (mm)
20
16
12
8
BRUM
HACK
SASS
SEGE
SKOV
Taxonomic Unit
Bromme
Federmesser

4.0
3.5
3.0
2.5
2.0
Elongation (L/W)
BRUM
HACK
SASS
SEGE
SKOV
Taxonomic Unit
Bromme
Federmesser

6
4
2
Thickness (mm)
BRUM
HACK
SASS
SEGE
SKOV
Taxonomic Unit
Bromme
Federmesser

Tip Cross-Sectional Area (TCSA)
60
40
20
BRUM
HACK
SASS
SEGE
SKOV
Taxonomic Unit
Bromme
Federmesser

Tip Cross-Sectional Area (TCSP)
35
30
25
20
15
BRUM
HACK
SASS
SEGE
SKOV
Taxonomic Unit
Bromme
Federmesser

Weight (g)
20
15
10
5
0
Ahrensburgian Point
Bromme Point
Chwalibogowice Point
Swidry Point
Tanged Point (Unclassified)

Length (mm)
60
50
40
30
Ahrensburgian Point
Bromme Point
Chwalibogowice Point
Swidry Point
Tanged Point (Unclassified)

Width (mm)
20
16
12
8
Ahrensburgian Point
Bromme Point
Chwalibogowice Point
Swidry Point
Tanged Point (Unclassified)

Elongation (L/W)
4.0
3.5
3.0
2.5
2.0
Ahrensburgian Point
Bromme Point
Chwalibogowice Point
Swidry Point
Tanged Point (Unclassified)

Thickness (mm)
6
4
2
Ahrensburgian Point
Bromme Point
Chwalibogowice Point
Swidry Point
Tanged Point (Unclassified)

Tip Cross-Sectional Area (TCSA)
60
40
20
Ahrensburgian Point
Bromme Point
Chwalibogowice Point
Swidry Point
Tanged Point (Unclassified)

```
## Warning: Removed 15 row(s) containing missing values (geom_path).
```

40
30
20
10
0
TCSP (mm)
0
20
40
60
TCSA (mm²)
CLASSIFICATION
Bromme
Federmesser

40
30
20
10
0
TCSP (mm)
0
20
40
60
TCSA (mm²)
CODE
BRUM
HACK
SASS
SEGE
SKOV

40
30
20
10
0
TCSP (mm)
0
20
40
60
TCSA (mm²)
CODE
BRUM
HACK
SASS
SEGE
SKOV
SUB_CATEGORY
Ahrensburgian Point
Bromme Point
Chwalibogowice Point
Swidry Point
Tanged Point (Unclassified)

40
30
20
10
0
TCSP (mm)
0
20
40
60
TCSA (mm²)
CLASSIFICATION
Bromme
Federmesser
SUB_CATEGORY
Ahrensburgian Point
Bromme Point
Chwalibogowice Point
Swidry Point
Tanged Point (Unclassified)

80
60
40
20
0
Tanged Point Length (mm)
0
10
20
30
40
Tanged Point Width (mm)
CLASSIFICATION
Bromme
Federmesser

80
60
40
20
0
Tanged Point Length (mm)
0
10
20
30
40
Tanged Point Width (mm)
CODE
BRUM
HACK
SASS
SEGE
SKOV

80
60
40
20
0
Tanged Point Length (mm)
0
10
20
30
40
Tanged Point Width (mm)
CODE
BRUM
HACK
SASS
SEGE
SKOV
SUB_CATEGORY
Ahrensburgian Point
Bromme Point
Chwalibogowice Point
Swidry Point
Tanged Point (Unclassified)

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  tp_data_excb_clean$WEIGHT and tp_data_excb_clean$CODE
##
##      BRUM  HACK  SASS  SEGE
## HACK 0.570 -     -     -
## SASS 1.000 0.054 -     -
## SEGE 1.000 1.000 0.562 -
## SKOV 1.000 1.000 1.000 1.000
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  tp_data_excb_clean$LENGTH and tp_data_excb_clean$CODE
##
```

```
##      BRUM HACK SASS SEGE
## HACK 1.00 -    -    -
## SASS 1.00 1.00 -    -
## SEGE 1.00 0.47 1.00 -
## SKOV 1.00 1.00 1.00 1.00
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  tp_data_excb_clean$WIDTH and tp_data_excb_clean$CODE
##
##      BRUM HACK SASS SEGE
## HACK 1    -    -    -
## SASS 1    1    -    -
## SEGE 1    1    1    -
## SKOV 1    1    1    1
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  tp_data_excb_clean$ELONGATION and tp_data_excb_clean$CODE
##
##      BRUM HACK SASS SEGE
## HACK 0.57 -    -    -
## SASS 0.68 1.00 -    -
## SEGE 1.00 1.00 1.00 -
## SKOV 1.00 1.00 1.00 1.00
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  tp_data_excb_clean$THICKNESS and tp_data_excb_clean$CODE
##
##      BRUM  HACK  SASS  SEGE
## HACK 0.570 -     -     -
## SASS 1.000 0.084 -     -
## SEGE 1.000 0.107 1.000 -
## SKOV 1.000 1.000 1.000 1.000
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  tp_data_excb_clean$TCSA and tp_data_excb_clean$CODE
##
##      BRUM HACK SASS SEGE
## HACK 1.00 -    -    -
## SASS 1.00 0.88 -    -
## SEGE 1.00 0.47 1.00 -
```

```
## SKOV 1.00 1.00 1.00 1.00
##
## P value adjustment method: bonferroni
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  tp_data_excb_clean$TCSP and tp_data_excb_clean$CODE
##
##      BRUM HACK SASS SEGE
## HACK 1    -    -    -
## SASS 1    1    -    -
## SEGE 1    1    1    -
## SKOV 1    1    1    1
##
## P value adjustment method: bonferroni
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  tp_data_excb_clean$WEIGHT and tp_data_excb_clean$CLASSIFICATION
##
##             Bromme
## Federmesser 0.0052
##
## P value adjustment method: bonferroni
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  tp_data_excb_clean$LENGTH and tp_data_excb_clean$CLASSIFICATION
##
##             Bromme
## Federmesser 0.057
##
## P value adjustment method: bonferroni
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  tp_data_excb_clean$WIDTH and tp_data_excb_clean$CLASSIFICATION
##
##             Bromme
## Federmesser 0.53
##
## P value adjustment method: bonferroni
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  tp_data_excb_clean$ELONGATION and tp_data_excb_clean$CLASSIFICATION
##
##             Bromme
## Federmesser 0.16
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  tp_data_excb_clean$THICKNESS and tp_data_excb_clean$CLASSIFICATION
##
##             Bromme
## Federmesser 0.0011
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  tp_data_excb_clean$TCSA and tp_data_excb_clean$CLASSIFICATION
##
##             Bromme
## Federmesser 0.026
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  tp_data_excb_clean$TCSP and tp_data_excb_clean$CLASSIFICATION
##
##             Bromme
## Federmesser 0.37
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  tp_data_excb_clean$WEIGHT and tp_data_excb_clean$SUB_CATEGORY
##
##                             Ahrensburgian Point Bromme Point
## Bromme Point                0.28                -
## Chwalibogowice Point        1.00                1.00
## Swidry Point                1.00                1.00
## Tanged Point (Unclassified) 0.31                1.00
##                             Chwalibogowice Point Swidry Point
## Bromme Point                -                     -
## Chwalibogowice Point        -                     -
## Swidry Point                1.00                  -
## Tanged Point (Unclassified) 1.00                  1.00
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  tp_data_excb_clean$LENGTH and tp_data_excb_clean$SUB_CATEGORY
##
##                             Ahrensburgian Point Bromme Point
## Bromme Point                0.28                -
## Chwalibogowice Point        1.00                1.00
```

```
## Swidry Point                1.00                1.00
## Tanged Point (Unclassified) 0.15                1.00
##                             Chwalibogowice Point Swidry Point
## Bromme Point                -                     -
## Chwalibogowice Point        -                     -
## Swidry Point                1.00                  -
## Tanged Point (Unclassified) 1.00                  1.00
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  tp_data_excb_clean$WIDTH and tp_data_excb_clean$SUB_CATEGORY
##
##                             Ahrensburgian Point Bromme Point
## Bromme Point                0.93                -
## Chwalibogowice Point        1.00                1.00
## Swidry Point                1.00                1.00
## Tanged Point (Unclassified) 1.00                1.00
##                             Chwalibogowice Point Swidry Point
## Bromme Point                -                     -
## Chwalibogowice Point        -                     -
## Swidry Point                1.00                  -
## Tanged Point (Unclassified) 1.00                  1.00
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  tp_data_excb_clean$ELONGATION and tp_data_excb_clean$SUB_CATEGORY
##
##                             Ahrensburgian Point Bromme Point
## Bromme Point                1                   -
## Chwalibogowice Point        1                   1
## Swidry Point                1                   1
## Tanged Point (Unclassified) 1                   1
##                             Chwalibogowice Point Swidry Point
## Bromme Point                -                     -
## Chwalibogowice Point        -                     -
## Swidry Point                1                     -
## Tanged Point (Unclassified) 1                     1
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  tp_data_excb_clean$THICKNESS and tp_data_excb_clean$SUB_CATEGORY
##
##                             Ahrensburgian Point Bromme Point
## Bromme Point                0.28                -
## Chwalibogowice Point        1.00                1.00
## Swidry Point                1.00                1.00
```

```
## Tanged Point (Unclassified) 0.11                1.00
##                             Chwalibogowice Point Swidry Point
## Bromme Point                -                     -
## Chwalibogowice Point        -                     -
## Swidry Point                1.00                  -
## Tanged Point (Unclassified) 1.00                  1.00
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  tp_data_excb_clean$TCSA and tp_data_excb_clean$SUB_CATEGORY
##
##                             Ahrensburgian Point Bromme Point
## Bromme Point                0.28                -
## Chwalibogowice Point        1.00                1.00
## Swidry Point                1.00                1.00
## Tanged Point (Unclassified) 0.11                1.00
##                             Chwalibogowice Point Swidry Point
## Bromme Point                -                     -
## Chwalibogowice Point        -                     -
## Swidry Point                1.00                  -
## Tanged Point (Unclassified) 1.00                  1.00
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  tp_data_excb_clean$TCSP and tp_data_excb_clean$SUB_CATEGORY
##
##                             Ahrensburgian Point Bromme Point
## Bromme Point                0.53                -
## Chwalibogowice Point        1.00                1.00
## Swidry Point                1.00                1.00
## Tanged Point (Unclassified) 0.80                1.00
##                             Chwalibogowice Point Swidry Point
## Bromme Point                -                     -
## Chwalibogowice Point        -                     -
## Swidry Point                1.00                  -
## Tanged Point (Unclassified) 1.00                  1.00
##
## P value adjustment method: bonferroni
```

Tang Orientation
Count
0
2
4
6
BRUM
HACK
SASS
SEGE
SKOV
Type
DISTAL
LATERAL
PROXIMAL

Tang Orientation
Count
0.0
2.5
5.0
7.5
10.0
12.5
Bromme
Federmesser
Type
DISTAL
LATERAL
PROXIMAL

Principal Component Analysis (PCA)

```
## # A tibble: 7 x 4
##   rowname eigenvalue variance cumulative
##   <chr>        <dbl>    <dbl>      <dbl>
## 1 Dim.1     4.28     61.1           61.1
## 2 Dim.2     1.65     23.6           84.7
## 3 Dim.3     0.530     7.58          92.3
## 4 Dim.4     0.507     7.24          99.5
## 5 Dim.5     0.0218    0.312         99.8
## 6 Dim.6     0.0123    0.176        100.
## 7 Dim.7     0.000109  0.00156      100
```

Percentage of explained variances
50
40
30
20
10
0
1
2
3
4
5
6
7
Dimension

Contribution of Variables
Dimension 1
Dimension 2
Dimension 3
Dimension 4
Dimension 5
WIDTH
WEIGHT
THICKNESS
TCSP
TCSA
LENGTH
ELONGATION
Variable
0 20 40 60
Contribution (%)

PCA 1 vs. PCA 2 (Classification)
ELONGATION
THICKNESS
WEIGHT
LENGTH
TCSA
TCSP
WIDTH
Dimension 2 (23.62%)
Dimension 1 (61.07%)
4
2
0
-2
-4
-10
-5
0
5
Groups
Bromme
Federmesser

PCA 2 vs. PCA 3 (Classification)
WEIGHT
WIDTH
TCSP
LENGTH
ELONGATION
TCSA
THICKNESS
Dimension 3 (7.57%)
Dimension 2 (23.62%)
2
1
0
-1
-2
-4
-2
0
2
4
Groups
Bromme
Federmesser

PCA 1 vs. PCA 2 (Code)
ELONGATION
THICKNESS
WEIGHT
LENGTH
TCSA
TCSP
WIDTH
2.5
0.0
-2.5
-10
-5
0
5
Dimension 2 (23.62%)
Dimension 1 (61.07%)
Groups
BRUM
HACK
SASS
SEGE
SKOV

PCA 2 vs. PCA 3 (Code)
WEIGHT
WIDTH
TCSP
LENGTH
ELONGATION
TCSA
THICKNESS
2
0
-2
Dimension 3 (7.57%)
-2.5
0.0
2.5
Dimension 2 (23.62%)
Groups
BRUM
HACK
SASS
SEGE
SKOV

PCA 1 vs. PCA 2 (Tanged Point Variant)
ELONGATION
THICKNESS
WEIGHT
LENGTH
TCSA
TCSP
WIDTH
Dimension 2 (23.62%)
Dimension 1 (61.07%)
3
2
1
0
-1
-2
-3
-4
-2
0
2
Groups
Ahrensburgian Point
Bromme Point
Chwalibogowice Point
Swidry Point
Tanged Point (Unclassified)

PCA 2 vs. PCA 3 (Tanged Point Variant)
WEIGHT
WIDTH
TCSP
LENGTH
ELONGATION
TCSA
THICKNESS
Dimension 3 (7.57%)
Dimension 2 (23.62%)
1
0
-1
-3
-2
-1
0
1
2
Groups
Ahrensburgian Point
Bromme Point
Chwalibogowice Point
Swidry Point
Tanged Point (Unclassified)

PCA 1:5 (Classification)
Value
2
0
-2
-4
Dimension 1
Dimension 2
Dimension 3
Dimension 4
Dimension 5
Classification
Bromme
Federmesser

PCA 1:5 (Classification)
Value
2
0
-2
-4
Dimension 1
Dimension 2
Dimension 3
Dimension 4
Dimension 5
Classification
BRUM
HACK
SASS
SEGE
SKOV

Analysis: Tanged Points (inc. burinated pieces)

Visual and Descriptive Summaries of Data

Table 87. Descriptive Statistics: Tanged Point Weight (g)

CONTEXT	n_obs	min	max	mean	med	sd	var
Brümmerhof (FStNr. 16)	3	7.89	14.92	11.52	11.76	3.52	12.40
Häcklingen (FStNr. 19)	7	0.53	7.16	3.39	2.48	2.43	5.93
Sassenholz (FStNr. 78)	21	3.28	71.25	16.56	16.21	14.02	196.60
Sassenholz (FStNr. 82)	1	20.12	20.12	20.12	20.12	NA	NA
Segebro	4	2.81	7.31	5.03	5.00	2.34	5.48
Skovmosen	1	4.52	4.52	4.52	4.52	NA	NA

Table 88. Descriptive Statistics: Tanged Point Length (mm)

CONTEXT	n_obs	min	max	mean	med	sd	var
Brümmerhof (FStNr. 16)	3	39.95	56.56	47.76	47	8.35	69.70
Häcklingen (FStNr. 19)	7	30.44	56.06	42.98	40	10.36	107.35
Sassenholz (FStNr. 78)	21	29.54	88.12	51.37	50	13.97	195.12
Sassenholz (FStNr. 82)	1	57.28	57.28	57.28	57	NA	NA
Segebro	4	43.73	65.32	58.33	62	10.04	100.83
Skovmosen	1	53.28	53.28	53.28	53	NA	NA

Table 89. Descriptive Statistics: Tanged Point Width (mm)

CONTEXT	n_obs	min	max	mean	med	sd	var
Brümmerhof (FStNr. 16)	3	10.04	18.98	14.48	14.42	4.47	19.98
Häcklingen (FStNr. 19)	7	8.09	23.01	15.02	14.76	5.27	27.82
Sassenholz (FStNr. 78)	21	12.04	34.98	17.91	17.54	4.69	22.04
Sassenholz (FStNr. 82)	1	27.14	27.14	27.14	27.14	NA	NA
Segebro	4	15.42	19.21	17.24	17.16	1.58	2.50
Skovmosen	1	17.75	17.75	17.75	17.75	NA	NA

Table 90. Descriptive Statistics: Tanged Point Elongation Index (L/W)

CONTEXT	n_obs	min	max	mean	med	sd	var
Brümmerhof (FStNr. 16)	3	2.46	3.98	3.46	3.92	0.86	0.74
Häcklingen (FStNr. 19)	7	2.44	3.76	2.99	2.82	0.51	0.26
Sassenholz (FStNr. 78)	21	1.77	3.98	2.91	2.95	0.63	0.40
Sassenholz (FStNr. 82)	1	2.11	2.11	2.11	2.11	NA	NA
Segebro	4	2.84	3.85	3.37	3.40	0.41	0.17
Skovmosen	1	3.00	3.00	3.00	3.00	NA	NA

Table 91. Descriptive Statistics: Tanged Point Elongation Index (L/W)

CONTEXT	n_obs	min	max	mean	med	sd	var
Brümmerhof (FStNr. 16)	3	5.12	7.18	5.97	5.61	1.08	1.16
Häcklingen (FStNr. 19)	7	1.65	4.52	3.43	3.74	1.07	1.16
Sassenholz (FStNr. 78)	21	3.12	8.96	5.29	5.12	1.42	2.02
Sassenholz (FStNr. 82)	1	4.86	4.86	4.86	4.86	NA	NA
Segebro	4	4.81	6.28	5.76	5.96	0.68	0.46
Skovmosen	1	6.03	6.03	6.03	6.03	NA	NA

Table 92. Descriptive Statistics: Tip Cross-Sectional Area (TCSA)

CONTEXT	n_obs	min	max	mean	med	sd	var
Brümmerhof (FStNr. 16)	3	36.04	53.24	42.07	36.92	9.69	93.83
Häcklingen (FStNr. 19)	7	6.67	52.00	27.58	25.47	15.87	252.00
Sassenholz (FStNr. 78)	21	24.68	144.12	49.03	44.90	26.01	676.36
Sassenholz (FStNr. 82)	1	65.95	65.95	65.95	65.95	NA	NA
Segebro	4	46.20	54.46	49.27	48.20	3.59	12.91
Skovmosen	1	53.52	53.52	53.52	53.52	NA	NA

Table 93. Descriptive Statistics: Tip Cross-Sectional Perimeter (TCSP)

CONTEXT	n_obs	min	max	mean	med	sd	var
Brümmerhof (FStNr. 16)	3	18.80	30.00	24.02	23.26	5.64	31.79
Häcklingen (FStNr. 19)	7	12.46	35.37	23.31	22.50	7.99	63.90
Sassenholz (FStNr. 78)	21	19.53	54.31	28.36	27.70	7.15	51.11
Sassenholz (FStNr. 82)	1	41.55	41.55	41.55	41.55	NA	NA

Segebro	4	25.36	29.95	27.63	27.61	1.95	3.82
Skovmosen	1	28.48	28.48	28.48	28.48	NA	NA

Table 94. Descriptive Statistics: Tanged Point Weight (g)

CLASSIFICATION	n_obs	min	max	mean	med	sd	var
Bromme	30	2.81	71.25	14.23	11.43	12.56	157.82
Federmesser	7	0.53	7.16	3.39	2.48	2.43	5.93

Table 95. Descriptive Statistics: Tanged Point Length (mm)

CLASSIFICATION	n_obs	min	max	mean	med	sd	var
Bromme	30	29.54	88.12	52.20	53	12.59	158.46
Federmesser	7	30.44	56.06	42.98	40	10.36	107.35

Table 96. Descriptive Statistics: Tanged Point Width (mm)

CLASSIFICATION	n_obs	min	max	mean	med	sd	var
Bromme	30	10.04	34.98	17.78	17.54	4.59	21.03
Federmesser	7	8.09	23.01	15.02	14.76	5.27	27.82

Table 97. Descriptive Statistics: Tanged Point Elongation Index (L/W)

CLASSIFICATION	n_obs	min	max	mean	med	sd	var
Bromme	30	1.77	3.98	3.01	3.03	0.65	0.42
Federmesser	7	2.44	3.76	2.99	2.82	0.51	0.26

Table 98. Descriptive Statistics: Tanged Point Elongation Index (L/W)

CLASSIFICATION	n_obs	min	max	mean	med	sd	var
Bromme	30	3.12	8.96	5.43	5.12	1.27	1.60
Federmesser	7	1.65	4.52	3.43	3.74	1.07	1.16

Table 99. Descriptive Statistics: Tip Cross-Sectional Area (TCSA)

CLASSIFICATION	n_obs	min	max	mean	med	sd	var
Bromme	30	24.68	144.12	49.08	47.88	22.13	489.85
Federmesser	7	6.67	52.00	27.58	25.47	15.87	252.00

Table 100. Descriptive Statistics: Tip Cross-Sectional Perimeter (TCSP)

CLASSIFICATION	n_obs	min	max	mean	med	sd	var
Bromme	30	18.80	54.31	28.27	27.99	6.77	45.85

Federmesser	7	12.46	35.37	23.31	22.50	7.99	63.90

Table 101. Descriptive Statistics: Tanged Point Weight (g)

SUB_CATEGORY	n_obs	min	max	mean	med	sd	var
Ahrensburgian Point	3	0.53	4.21	2.25	2.01	1.85	3.43
Bromme Point	12	4.52	20.92	14.17	15.57	5.52	30.52
Chwalibogowice Point	1	1.39	1.39	1.39	1.39	NA	NA
Swidry Point	1	10.12	10.12	10.12	10.12	NA	NA
Tanged Point (Unclassified)	20	2.48	71.25	13.12	7.60	15.31	234.49

Table 81. Descriptive Statistics: Tanged Point Length (mm)

SUB_CATEGORY	n_obs	min	max	mean	med	sd	var
Ahrensburgian Point	3	29.54	39.59	33.19	30	5.56	30.92
Bromme Point	6	49.99	62.14	55.33	54	5.40	29.15
Chwalibogowice Point	1	33.84	33.84	33.84	34	NA	NA
Swidry Point	1	52.45	52.45	52.45	52	NA	NA
Tanged Point (Unclassified)	13	36.28	65.32	51.74	53	9.47	89.59

Table 102. Descriptive Statistics: Tanged Point Width (mm)

SUB_CATEGORY	n_obs	min	max	mean	med	sd	var
Ahrensburgian Point	3	8.09	15.82	12.89	14.76	4.19	17.56
Bromme Point	12	14.10	27.14	18.86	18.82	3.35	11.20
Chwalibogowice Point	1	9.28	9.28	9.28	9.28	NA	NA
Swidry Point	1	13.19	13.19	13.19	13.19	NA	NA
Tanged Point (Unclassified)	20	10.04	34.98	17.55	17.54	5.09	25.88

Table 103. Descriptive Statistics: Tanged Point Elongation Index (L/W)

SUB_CATEGORY	n_obs	min	max	mean	med	sd	var
Ahrensburgian Point	3	1.87	3.76	2.77	2.68	0.95	0.90
Bromme Point	12	1.77	3.87	2.87	2.84	0.66	0.43
Chwalibogowice Point	1	3.65	3.65	3.65	3.65	NA	NA
Swidry Point	1	3.98	3.98	3.98	3.98	NA	NA
Tanged Point (Unclassified)	20	2.01	3.98	3.04	2.95	0.53	0.28

Table 104. Descriptive Statistics: Tanged Point Elongation Index (L/W)

SUB_CATEGORY	n_obs	min	max	mean	med	sd	var
Ahrensburgian Point	3	1.65	3.12	2.37	2.34	0.74	0.54
Bromme Point	12	3.21	6.03	5.17	5.16	0.74	0.54
Chwalibogowice Point	1	3.45	3.45	3.45	3.45	NA	NA
Swidry Point	1	4.52	4.52	4.52	4.52	NA	NA
Tanged Point (Unclassified)	20	3.74	8.96	5.49	5.12	1.46	2.14

Table 105. Descriptive Statistics: Tip Cross-Sectional Area (TCSA)

SUB_CATEGORY	n_obs	min	max	mean	med	sd	var
Ahrensburgian Point	3	6.67	24.68	16.21	17.27	9.05	81.94
Bromme Point	12	34.03	65.95	48.44	48.50	9.48	89.80
Chwalibogowice Point	1	16.01	16.01	16.01	16.01	NA	NA
Swidry Point	1	29.81	29.81	29.81	29.81	NA	NA
Tanged Point (Unclassified)	20	24.99	144.12	49.48	45.55	26.25	688.82

Table 106. Descriptive Statistics: Tip Cross-Sectional Perimeter (TCSP)

SUB_CATEGORY	n_obs	min	max	mean	med	sd	var
Ahrensburgian Point	3	12.46	24.32	19.76	22.50	6.39	40.80
Bromme Point	12	22.70	41.55	29.67	29.65	4.76	22.68
Chwalibogowice Point	1	15.06	15.06	15.06	15.06	NA	NA
Swidry Point	1	21.19	21.19	21.19	21.19	NA	NA
Tanged Point (Unclassified)	20	18.80	54.31	27.99	27.74	7.56	57.22

90
80
70
60
50
40
30
Length (mm)
BRUM
HACK
SASS
SEGE
SKOV
Taxonomic Unit
Bromme
Federmesser

30
20
10
Width (mm)
BRUM
HACK
SASS
SEGE
SKOV
Taxonomic Unit
Bromme
Federmesser

Elongation (L/W)
4.0
3.5
3.0
2.5
2.0
BRUM
HACK
SASS
SEGE
SKOV
Taxonomic Unit
Bromme
Federmesser

Thickness (mm)
7.5
5.0
2.5
BRUM
HACK
SASS
SEGE
SKOV
Taxonomic Unit
Bromme
Federmesser

Tip Cross-Sectional Area (TCSA)
150
100
50
0
BRUM
HACK
SASS
SEGE
SKOV
Taxonomic Unit
Bromme
Federmesser

Tip Cross-Sectional Area (TCSP)
50
40
30
20
BRUM
HACK
SASS
SEGE
SKOV
Taxonomic Unit
Bromme
Federmesser

Weight (g)
0
20
40
60
Ahrensburgian Point
Bromme Point
Chwalibogowice Point
Swidry Point
Tanged Point (Unclassified)

Length (mm)
30
40
50
60
70
80
90
Ahrensburgian Point
Bromme Point
Chwalibogowice Point
Swidry Point
Tanged Point (Unclassified)

Width (mm)
30
20
10
Ahrensburgian Point
Bromme Point
Chwalibogowice Point
Swidry Point
Tanged Point (Unclassified)

Elongation (L/W)
4.0
3.5
3.0
2.5
2.0
Ahrensburgian Point
Bromme Point
Chwalibogowice Point
Swidry Point
Tanged Point (Unclassified)

Thickness (mm)
7.5
5.0
2.5
Ahrensburgian Point
Bromme Point
Chwalibogowice Point
Swidry Point
Tanged Point (Unclassified)

Tip Cross-Sectional Area (TCSA)
150
100
50
0
Ahrensburgian Point
Bromme Point
Chwalibogowice Point
Swidry Point
Tanged Point (Unclassified)

Tip Cross-Sectional Area (TCSP)
50
40
30
20
Ahrensburgian Point
Bromme Point
Chwalibogowice Point
Swidry Point
Tanged Point (Unclassified)

Tanged Point Length (mm)
75
50
25
0
0
10
20
30
40
Tanged Point Width (mm)
CLASSIFICATION
Bromme
Federmesser

Tanged Point Length (mm)
75
50
25
0
0
10
20
30
40
Tanged Point Width (mm)
CODE
BRUM
HACK
SASS
SEGE
SKOV

Tanged Point Length (mm)
75
50
25
0
0
10
20
30
40
Tanged Point Width (mm)
CODE
BRUM
HACK
SASS
SEGE
SKOV
SUB_CATEGORY
Ahrensburgian Point
Bromme Point
Chwalibogowice Point
Swidry Point
Tanged Point (Unclassified)

Tanged Point Length (mm)
75
50
25
0
0
10
20
30
40
Tanged Point Width (mm)
CLASSIFICATION
Bromme
Federmesser
SUB_CATEGORY
Ahrensburgian Point
Bromme Point
Chwalibogowice Point
Swidry Point
Tanged Point (Unclassified)

60
40
20
0
TCSP (mm)
0
50
100
150
TCSA (mm²)
CLASSIFICATION
Bromme
Federmesser

TCSP (mm)
60
40
20
0
0
50
100
150
TCSA (mm²)
CODE
BRUM
HACK
SASS
SEGE
SKOV

TCSP (mm)
60
40
20
0
0
50
100
150
TCSA (mm²)
CODE
BRUM
HACK
SASS
SEGE
SKOV
SUB_CATEGORY
Ahrensburgian Point
Bromme Point
Chwalibogowice Point
Swidry Point
Tanged Point (Unclassified)

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  tp_data_incb_clean$WEIGHT and tp_data_incb_clean$CODE
##
##      BRUM   HACK   SASS   SEGE
## HACK 0.2265 -      -      -
## SASS 1.0000 0.0058 -      -
## SEGE 0.5183 1.0000 0.1164 -
## SKOV 1.0000 1.0000 1.0000 1.0000
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  tp_data_incb_clean$LENGTH and tp_data_incb_clean$CODE
##
```

```
##      BRUM HACK SASS SEGE
## HACK 1.00 -    -    -
## SASS 1.00 1.00 -    -
## SEGE 1.00 0.47 1.00 -
## SKOV 1.00 1.00 1.00 1.00
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  tp_data_incb_clean$WIDTH and tp_data_incb_clean$CODE
##
##      BRUM HACK SASS SEGE
## HACK 1    -    -    -
## SASS 1    1    -    -
## SEGE 1    1    1    -
## SKOV 1    1    1    1
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  tp_data_incb_clean$ELONGATION and tp_data_incb_clean$CODE
##
##      BRUM HACK SASS SEGE
## HACK 1    -    -    -
## SASS 1    1    -    -
## SEGE 1    1    1    -
## SKOV 1    1    1    1
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  tp_data_incb_clean$THICKNESS and tp_data_incb_clean$CODE
##
##      BRUM  HACK  SASS  SEGE
## HACK 0.227 -     -     -
## SASS 1.000 0.026 -     -
## SEGE 1.000 0.107 1.000 -
## SKOV 1.000 1.000 1.000 1.000
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  tp_data_incb_clean$TCSA and tp_data_incb_clean$CODE
##
##      BRUM HACK SASS SEGE
## HACK 1.00 -    -    -
## SASS 1.00 0.23 -    -
## SEGE 1.00 0.47 1.00 -
```

```
## SKOV 1.00 1.00 1.00 1.00
##
## P value adjustment method: bonferroni
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  tp_data_incb_clean$TCSP and tp_data_incb_clean$CODE
##
##      BRUM HACK SASS SEGE
## HACK 1    -    -    -
## SASS 1    1    -    -
## SEGE 1    1    1    -
## SKOV 1    1    1    1
##
## P value adjustment method: bonferroni
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  tp_data_incb_clean$WEIGHT and tp_data_incb_clean$CLASSIFICATION
##
##             Bromme
## Federmesser 8e-04
##
## P value adjustment method: bonferroni
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  tp_data_incb_clean$LENGTH and tp_data_incb_clean$CLASSIFICATION
##
##             Bromme
## Federmesser 0.06
##
## P value adjustment method: bonferroni
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  tp_data_incb_clean$WIDTH and tp_data_incb_clean$CLASSIFICATION
##
##             Bromme
## Federmesser 0.22
##
## P value adjustment method: bonferroni
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  tp_data_incb_clean$ELONGATION and tp_data_incb_clean$CLASSIFICATION
##
##             Bromme
## Federmesser 0.74
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  tp_data_incb_clean$THICKNESS and tp_data_incb_clean$CLASSIFICATION
##
##             Bromme
## Federmesser 0.00073
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  tp_data_incb_clean$TCSA and tp_data_incb_clean$CLASSIFICATION
##
##             Bromme
## Federmesser 0.011
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  tp_data_incb_clean$TCSP and tp_data_incb_clean$CLASSIFICATION
##
##             Bromme
## Federmesser 0.16
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  tp_data_incb_clean$WEIGHT and tp_data_incb_clean$SUB_CATEGORY
##
##                             Ahrensburgian Point Bromme Point
## Bromme Point                0.12                -
## Chwalibogowice Point        1.00                1.00
## Swidry Point                1.00                1.00
## Tanged Point (Unclassified) 0.20                1.00
##                             Chwalibogowice Point Swidry Point
## Bromme Point                -                     -
## Chwalibogowice Point        -                     -
## Swidry Point                1.00                  -
## Tanged Point (Unclassified) 1.00                  1.00
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  tp_data_incb_clean$LENGTH and tp_data_incb_clean$SUB_CATEGORY
##
##                             Ahrensburgian Point Bromme Point
## Bromme Point                0.17                -
## Chwalibogowice Point        1.00                1.00
```

```
## Swidry Point                1.00                1.00
## Tanged Point (Unclassified) 0.16                1.00
##                             Chwalibogowice Point Swidry Point
## Bromme Point                -                     -
## Chwalibogowice Point        -                     -
## Swidry Point                1.00                  -
## Tanged Point (Unclassified) 1.00                  1.00
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  tp_data_incb_clean$WIDTH and tp_data_incb_clean$SUB_CATEGORY
##
##                             Ahrensburgian Point Bromme Point
## Bromme Point                0.25                -
## Chwalibogowice Point        1.00                1.00
## Swidry Point                1.00                1.00
## Tanged Point (Unclassified) 1.00                1.00
##                             Chwalibogowice Point Swidry Point
## Bromme Point                -                     -
## Chwalibogowice Point        -                     -
## Swidry Point                1.00                  -
## Tanged Point (Unclassified) 1.00                  1.00
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  tp_data_incb_clean$ELONGATION and tp_data_incb_clean$SUB_CATEGORY
##
##                             Ahrensburgian Point Bromme Point
## Bromme Point                1                   -
## Chwalibogowice Point        1                   1
## Swidry Point                1                   1
## Tanged Point (Unclassified) 1                   1
##                             Chwalibogowice Point Swidry Point
## Bromme Point                -                     -
## Chwalibogowice Point        -                     -
## Swidry Point                1                     -
## Tanged Point (Unclassified) 1                     1
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  tp_data_incb_clean$THICKNESS and tp_data_incb_clean$SUB_CATEGORY
##
##                             Ahrensburgian Point Bromme Point
## Bromme Point                0.11                -
## Chwalibogowice Point        1.00                1.00
## Swidry Point                1.00                1.00
```

```
## Tanged Point (Unclassified) 0.07                1.00
##                             Chwalibogowice Point Swidry Point
## Bromme Point                -                     -
## Chwalibogowice Point        -                     -
## Swidry Point                1.00                  -
## Tanged Point (Unclassified) 1.00                  1.00
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  tp_data_incb_clean$TCSA and tp_data_incb_clean$SUB_CATEGORY
##
##                             Ahrensburgian Point Bromme Point
## Bromme Point                0.115               -
## Chwalibogowice Point        1.000               1.000
## Swidry Point                1.000               1.000
## Tanged Point (Unclassified) 0.071               1.000
##                             Chwalibogowice Point Swidry Point
## Bromme Point                -                     -
## Chwalibogowice Point        -                     -
## Swidry Point                1.000                 -
## Tanged Point (Unclassified) 1.000                 1.000
##
## P value adjustment method: bonferroni
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data:  tp_data_incb_clean$TCSP and tp_data_incb_clean$SUB_CATEGORY
##
##                             Ahrensburgian Point Bromme Point
## Bromme Point                0.17                -
## Chwalibogowice Point        1.00                1.00
## Swidry Point                1.00                1.00
## Tanged Point (Unclassified) 0.75                1.00
##                             Chwalibogowice Point Swidry Point
## Bromme Point                -                     -
## Chwalibogowice Point        -                     -
## Swidry Point                1.00                  -
## Tanged Point (Unclassified) 1.00                  1.00
##
## P value adjustment method: bonferroni
```

Tang Orientation
Count
15
10
5
0
BRUM
HACK
SASS
SEGE
SKOV
Type
DISTAL
LATERAL
PROXIMAL

Tang Orientation
Count
20
15
10
5
0
Bromme
Federmesser
Type
DISTAL
LATERAL
PROXIMAL

Principal Component Analysis (PCA)

```
## # A tibble: 7 x 4
##   rowname eigenvalue variance cumulative
##   <chr>        <dbl>    <dbl>      <dbl>
## 1 Dim.1    4.68      66.8           66.8
## 2 Dim.2    1.36      19.4           86.2
## 3 Dim.3    0.666      9.51          95.7
## 4 Dim.4    0.260      3.71          99.4
## 5 Dim.5    0.0242     0.346         99.8
## 6 Dim.6    0.0150     0.214        100.
## 7 Dim.7    0.0000778  0.00111      100
```

Percentage of explained variances
50
40
30
20
10
0
1
2
3
4
5
6
7
Dimension

Contribution of Variables
Dimension 1
Dimension 2
Dimension 3
Dimension 4
Dimension 5
WIDTH
WEIGHT
THICKNESS
TCSP
TCSA
LENGTH
ELONGATION
Variable
0 20 40 60
Contribution (%)

PCA 1 vs. PCA 2 (Classification)
ELONGATION
LENGTH
THICKNESS
WEIGHT
TCSA
TCSP
WIDTH
2
0
-2
-5
0
5
10
Dimension 2 (19.42%)
Dimension 1 (66.79%)
Groups
Bromme
Federmesser

PCA 2 vs. PCA 3 (Classification)
LENGTH
WIDTH
TCSP
ELONGATION
WEIGHT
TCSA
THICKNESS
2
1
0
-1
-2
-3
-2
0
2
Dimension 3 (9.50%)
Dimension 2 (19.42%)
Groups
Bromme
Federmesser

PCA 1 vs. PCA 2 (Code)
ELONGATION
LENGTH
THICKNESS
WEIGHT
TCSA
TCSP
WIDTH
Dimension 2 (19.42%)
Dimension 1 (66.79%)
4
2
0
-2
-5
0
5
10
Groups
BRUM
HACK
SASS
SEGE
SKOV

PCA 2 vs. PCA 3 (Code)
Dimension 3 (9.50%)
Dimension 2 (19.42%)
4
2
0
-2
-4
-2
0
2
4
LENGTH
WIDTH
TCSP
ELONGATION
WEIGHT
TCSA
THICKNESS
Groups
BRUM
HACK
SASS
SEGE
SKOV

PCA 1 vs. PCA 2 (Tanged Point Variant)
ELONGATION
LENGTH
THICKNESS
WEIGHT
TCSA
TCSP
WIDTH
Dimension 2 (19.42%)
Dimension 1 (66.79%)
3
2
1
0
-1
-2
-3
-5
0
5
Groups
Ahrensburgian Point
Bromme Point
Chwalibogowice Point
Swidry Point
Tanged Point (Unclassified)

PCA 2 vs. PCA 3 (Tanged Point Variant)
LENGTH
WIDTH
TCSP
ELONGAT
WEIGHT
TCSA
THICKNESS
Dimension 3 (9.50%)
Dimension 2 (19.42%)
1
0
-1
-2
-3
-3
-2
-1
0
1
2
3
Groups
Ahrensburgian Point
Bromme Point
Chwalibogowice Point
Swidry Point
Tanged Point (Unclassified)

PCA 1:5 (Classification)
Value
5
0
-5
Dimension 1
Dimension 2
Dimension 3
Dimension 4
Dimension 5
Classification
Bromme
Federmesser

PCA 1:5 (Classification)
Value
5
0
-5
Dimension 1
Dimension 2
Dimension 3
Dimension 4
Dimension 5
Classification
BRUM
HACK
SASS
SEGE
SKOV

PCA 1:5 (Classification)
Value
5
0
-5
Dimension 1
Dimension 2
Dimension 3
Dimension 4
Dimension 5
Classification
Ahrensburgian Point
Bromme Point
Chwalibogowice Point
Swidry Point
Tanged Point (Unclassified)