

# Understanding Typologically Awkward Final Palaeolithic Assemblages

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## Introduction

The Late Glacial, defined as occurring from the first pronounced warming after the Last Glacial Maximum (LGM) to the beginning of the Holocene period (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 Creswellian and 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 robust archaeological taxonomic units are a fundamental precondition; 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; Ivanovaite and Riede, 2018; Reynolds and Riede, 2019). Otte and Keeley (1990) note that many of the taxonomic units for the Final Palaeolithic, and subsequently *fossiles directeurs* for ethno-geographic variability, are usually based on early antiquarian excavations but of a few key sites (reflected in the practice of naming them after *loci classici*), while Sauer and Riede (2019) highlight 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 and colleagues, who argued 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 these communities, stone tool variants remain the premier proxies for inferring population structure.

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

sue, specifically that of ‘typologically awkward’ assemblages, i.e. archaeological contexts which do not reflect strictly one cultural unit. A variety of perceived Federmesser and Bromme contexts, some with previously catalogued artefact types from other cultural units, are here investigated, through extensive technological and morphological analyses, in order to understand their true degree of variation of these liminal lithic assemblages.

All data and supporting material used throughout this exercise is stored on a GitHub open-access repository: <https://github.com/CSHoggard/-tech-data>.

Only complete examples are examined here, and total 599 artefacts. See Table 1 and Table 2 for more information.

## Materials and Methods

For this analysis, 10 archaeological contexts, constituting 15 unique horizons, are examined:

Previously classified Federmesser material

- 1) **Bienenbüttel (FStNr. 15)** (Lower Saxony, Germany):
- 2) **Häcklingen (FStNr. 19)** (Lower Saxony, Germany):
- 3) **Rietberg (1/2/5/Other/Spoil)** (North Rhine-Westphalia, Germany):
- 4) **Rothenkirchen** (Hesse, Germany):

Previously classified Bromme material

- 5) **Brüggerhof (FStNr. 16)** (Lower Saxony, Germany): ADD CONTEXT HERE
- 6) **Højgård** (Zealand, Denmark): ADD CONTEXT HERE
- 7) **Sassenholz (FStNr. 78/82)** (Lower Saxony, Germany): ADD CONTEXT 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 CONTEXT HERE
- 10) **Segebro** (Malmö, Sweden): ADD CONTEXT HERE

Table 1. Artefact Breakdown  
Context

Context	Backed Point	Blade	Core	Tanged Point
Bienenbüttel (FStNr. 15)	5	15	1	NA
Brüggerhof (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)	37	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

Sassenholz makes up the greatest proportion of the database featuring 219 artefacts, followed by the Rietberg complex (111), Søvind (93) and Häcklingen (67).

Table 2. Artefact Breakdown  
Technology

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

In total 383 originate from a presupposed Bromme context, representing 63.83% of all material. The Federmesser is here represented by 217 artefacts, representing 36.17% of all material.

## Technological attributes

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.

The following attributes are recorded for all artefacts:

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

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

Attribute	Variable(s)
<i>WEIGHT</i>	Weight (g)
<i>WIDTH</i>	Width (mm)
<i>THICKNESS</i>	Thickness (mm)

Attribute	Variable(s)
<i>PLAT_DEPTH</i>	Platform Depth (mm)
<i>DORS_BLADE_PROF</i>	Dorsal blade characterisation - 1: <b>Full Cortical Dorsal Face (FC)</b> ; 2: <b>Two Dorsal Faces - One Cortex (TDOC)</b> ; 3: <b>Three Dorsal Faces - One Cortex (THDOC)</b> ; 4: <b>Two Dorsal Faces - No Cortex (TDNC)</b> ; 5: <b>Three Dorsal Faces - No Cortex (THDNC)</b> ; 6: <b>Multiple Dorsal Faces (MDF)</b> ; 7: <b>Bilateral Crested Blade (BCB)</b> ; 8: <b>Crested Blade - One Flaked And One Uncortical (CBOU)</b> ; 9: <b>Crested Blade - Three Flaked Faces (CBTHF)</b> ; 10: <b>Crested Blade - One Flaked And One Cortical (CBOFOC)</b> ; 11: <b>Crested Blade - Flaked And Trimmed (CBFT)</b>
<i>BLADE_DET</i>	Blade determination - 1: <b>Ideal (ID)</b> ; 2: <b>Feathered (FE)</b> ; 3: <b>Plunged (PL)</b> ; 4: <b>Hinged (HI)</b>
<i>BLADE_CURV</i>	Blade curvature - 1: <b>Straight (ST)</b> ; 2: <b>Distal (DI)</b> ; 3: <b>Even (EV)</b> ; 4: <b>Ventral 'Belly' (VB)</b>
<i>DORSAL_PATTERN</i>	Dorsal scar pattern - 1: <b>Centripetal (CE)</b> ; 2: <b>3-Way Centripetal (TWC)</b> ; 3: <b>Bidirectional (BI)</b> ; 4: <b>Convergent (CON)</b> ; 5: <b>Convergent And Bidirectional (CONBI)</b> ; 6: <b>Convergent And Perpendicular (CONPE)</b> ; 7: <b>Double Perpendicular (DP)</b> ; 8: <b>Straight And Perpendicular (SAP)</b> ; 9: <b>Unidirectional (UNI)</b> ; 10: <b>Undetermined (UND)</b>
<i>BULB_MORPH</i>	Bulb and lip characteristics - 1: <b>Bulb Formation (BF)</b> ; 2: <b>Pronounced Bulb Formation (PBF)</b> ; 3: <b>Bulb And Lip Formation (BLF)</b> ; 4: <b>Lip Formation (LF)</b> ; 5: <b>Pronounced Lip Formation (PLF)</b> ; 6: <b>Diffused Bulb (DB)</b> ; 7: <b>No Bulb Or Lip (NBOL)</b>
<i>CONUS_FORM</i>	Cone Formation - 1: <b>No Formation (NFO)</b> ; 2: <b>Ring Crack On Butt (RCB)</b> ; 3: <b>Ring Crack And Ventral Fissures (RCVF)</b> ; 4: <b>Detached Bulb (DB)</b>
<i>BUTT_MORPH</i>	Butt morphology - 1: <b>Large And Thick Butt (LTB)</b> ; 2: <b>Large Oval Butt (LOB)</b> ; 3: <b>Thin Oval Butt (TOB)</b> ; 4: <b>Small Thick Butt (STB)</b> ; 5: <b>Small Butt (SB)</b> ; 6: <b>Punctiform Butt (PUNB)</b> ; 7: <b>Broken/Absent Butt (BAB)</b>
<i>BUTT_PREP_1</i>	Butt preparation #1 - 1: <b>Plain (PLA)</b> ; 2: <b>Facetted With Two Scars (FTS)</b> ; 3: <b>Facetted With Greater Than Two Scars (FGTTS)</b> ; 4: <b>Broken (B)</b>
<i>BUTT_PREP_2</i>	Butt preparation #2 - 1: <b>Cortical Unprepared (CU)</b> ; 2: <b>Non-Cortical Unprepared (NCU)</b> ; 3: <b>Dorsal Trimming (DT)</b> ; 4: <b>Dorsal Abrasion (DA)</b> ; 5: <b>Dorsal Abrasion And Grinding (DAG)</b> ; 6: <b>Dorsal Abrasion And Trimming (DATR)</b> ; 7: <b>Dorsal Abrasion, Trimming And Grinding (DATG)</b> ; 8: <b>Broken (B)</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)
<i>WEIGHT</i>	Weight (g)
<i>CORE_LENGTH</i>	Core length (mm) as oriented on morphological axis (max length) and flaking surface (most blade removals)
<i>CORE_WIDTH</i>	Core width (mm) as oriented on morphological axis (max length) and flaking surface (most blade removals)

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

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)
<i>WEIGHT</i>	Weight (g)
<i>LENGTH</i>	Length (mm)
<i>WIDTH</i>	Width (mm)
<i>THICKNESS</i>	Thickness (mm)
<i>ELONGATION</i>	Elongation Index (Length/Width)
<i>TANG_ORIENTATION</i>	Orientation of tang or base - 1) <b>Proximal</b> ; 2) <b>Distal</b> ; 3) <b>Lateral</b>
<i>TCSA</i>	Maximum tip cross-sectional area ( $\text{mm}^2$ ) <i>sensu</i> Shea (2006)
<i>TCSP</i>	Maximum tip cross-sectional perimeter (mm) <i>sensu</i> Shea (2006)
<i>BURINATION</i>	Presence of burination – 1) <b>Yes (Y)</b> ; 2) <b>No (N)</b>

## Methodology

A variety of technological and morphological analyses are performed here:

- 1) 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).
- 2) A **Gini-Simpson** index is 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).
- 3) **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.
- 4) **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.

## 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

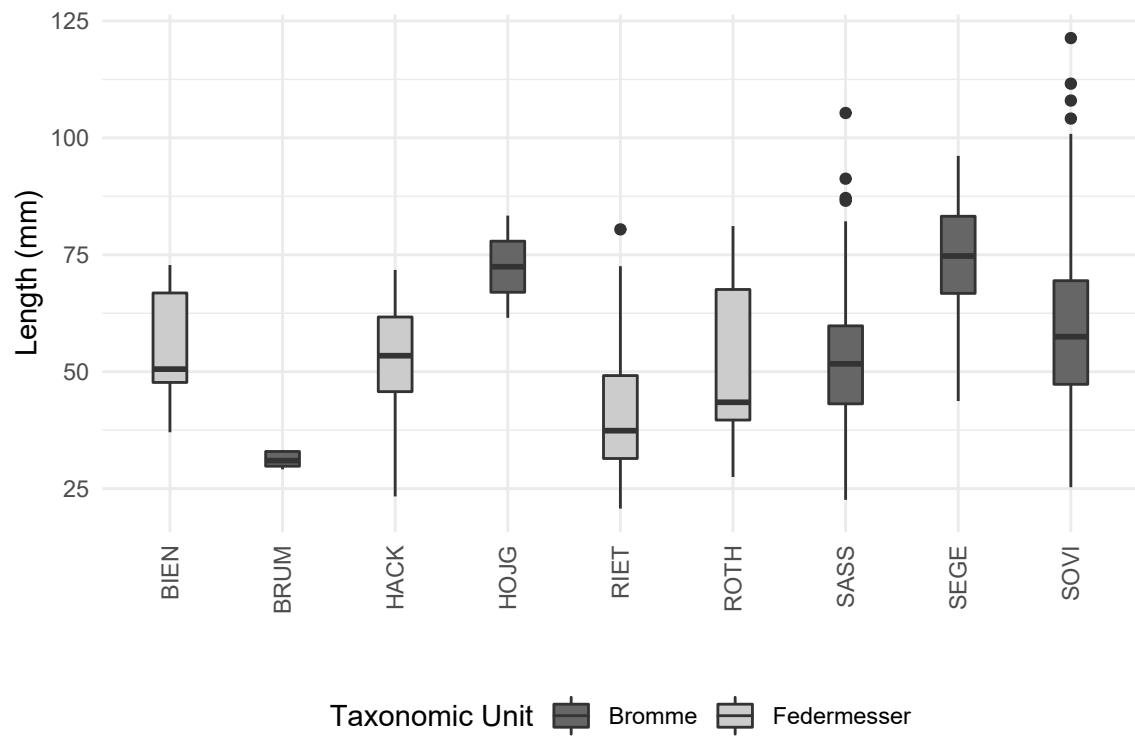
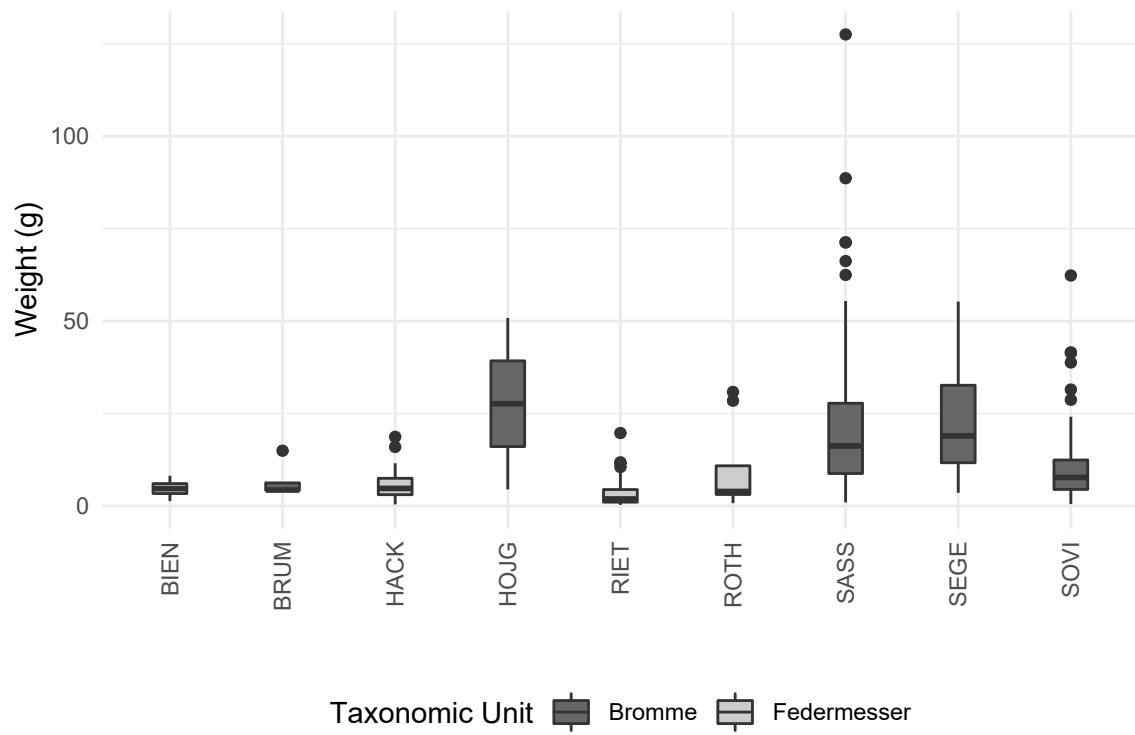
9.69

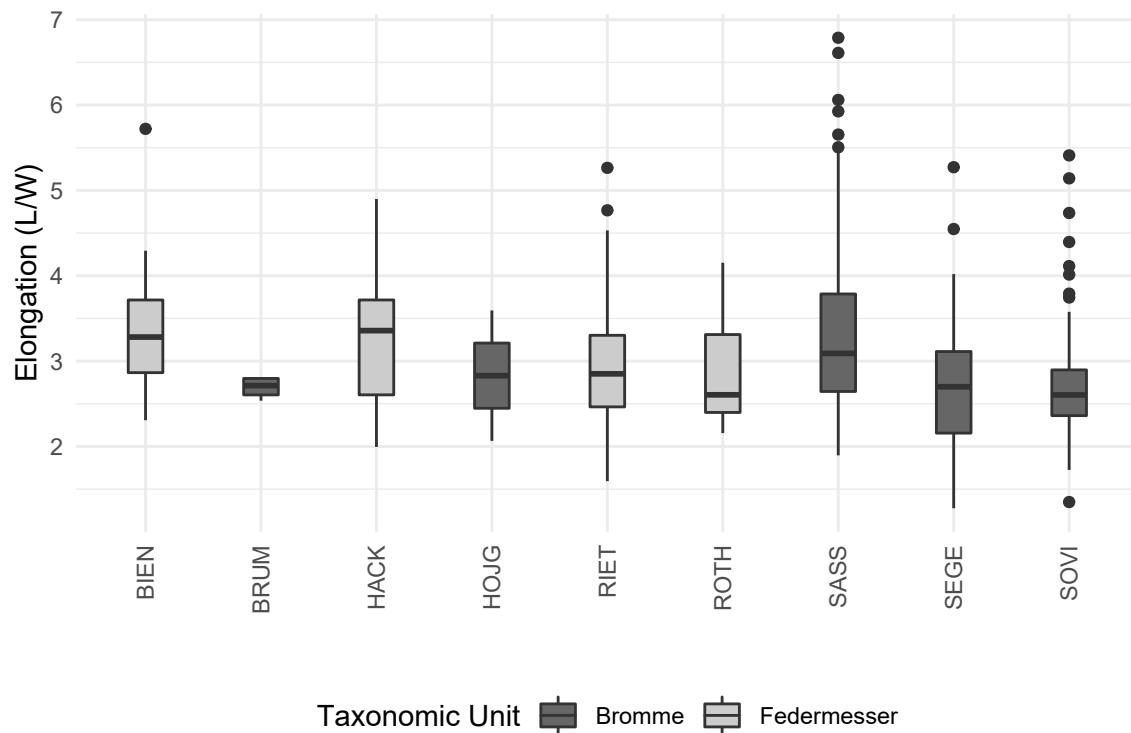
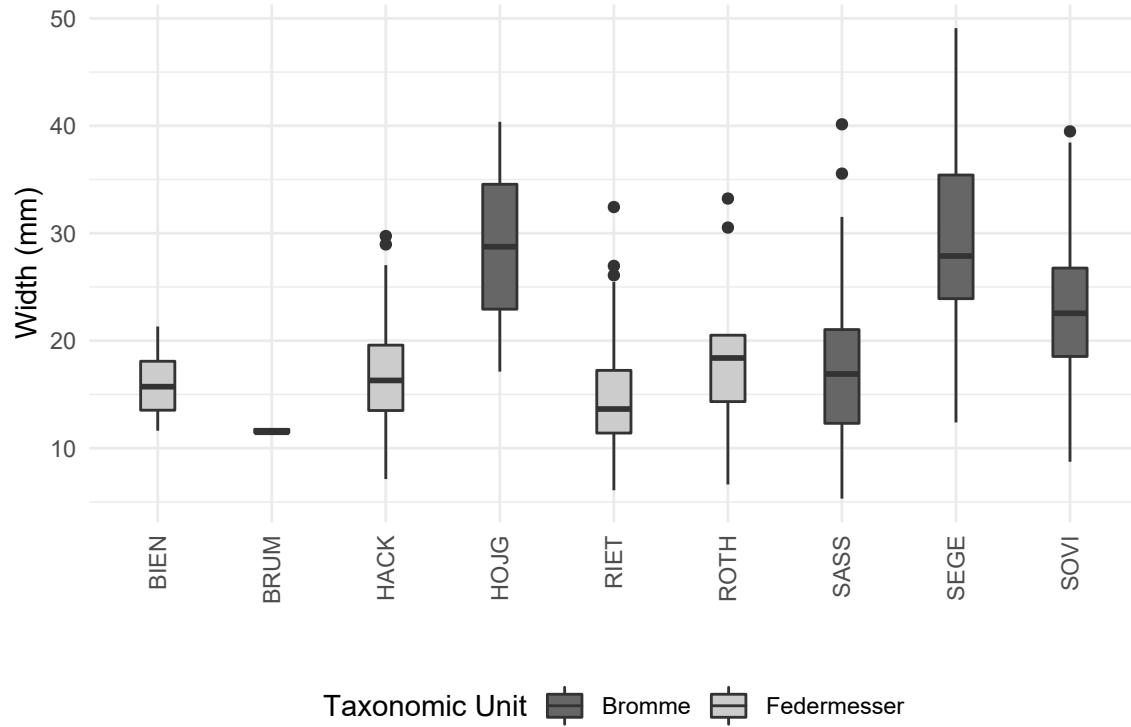
2.97

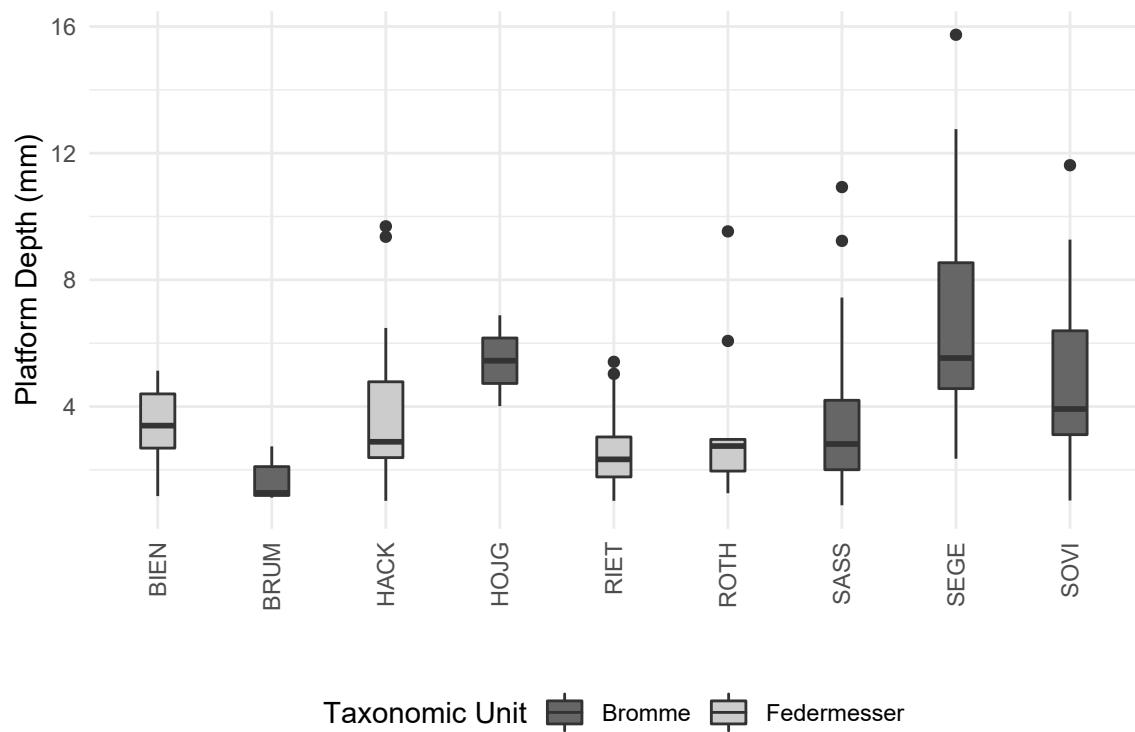
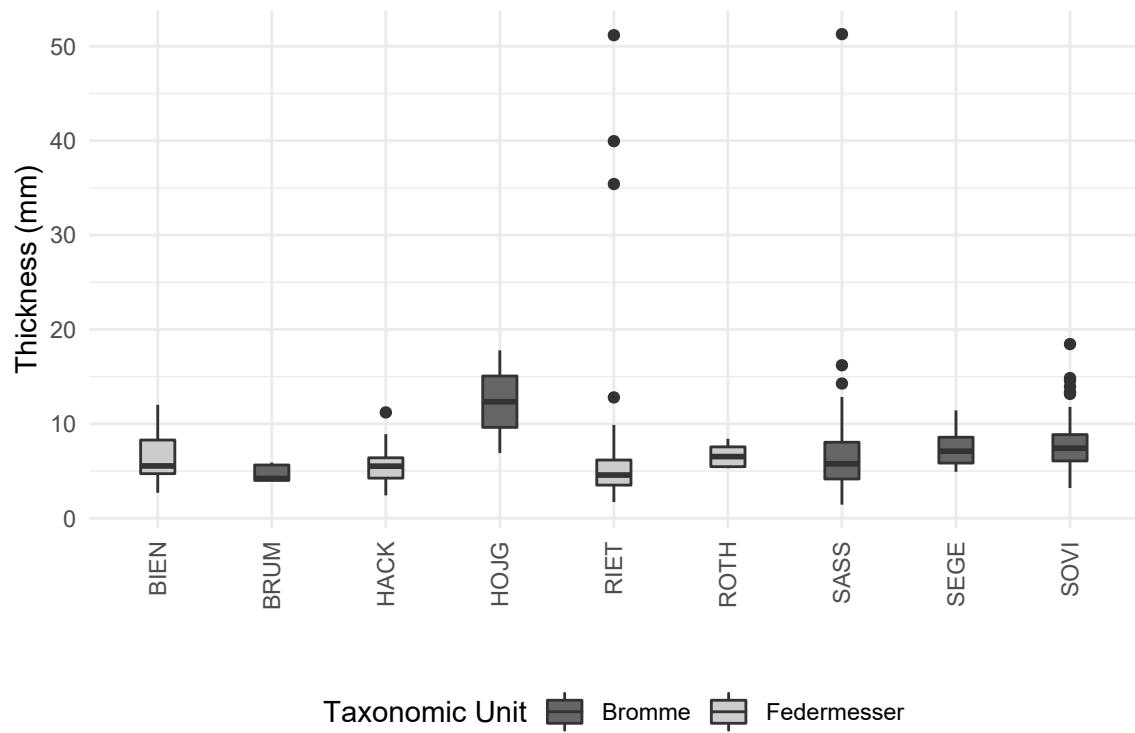
2.71

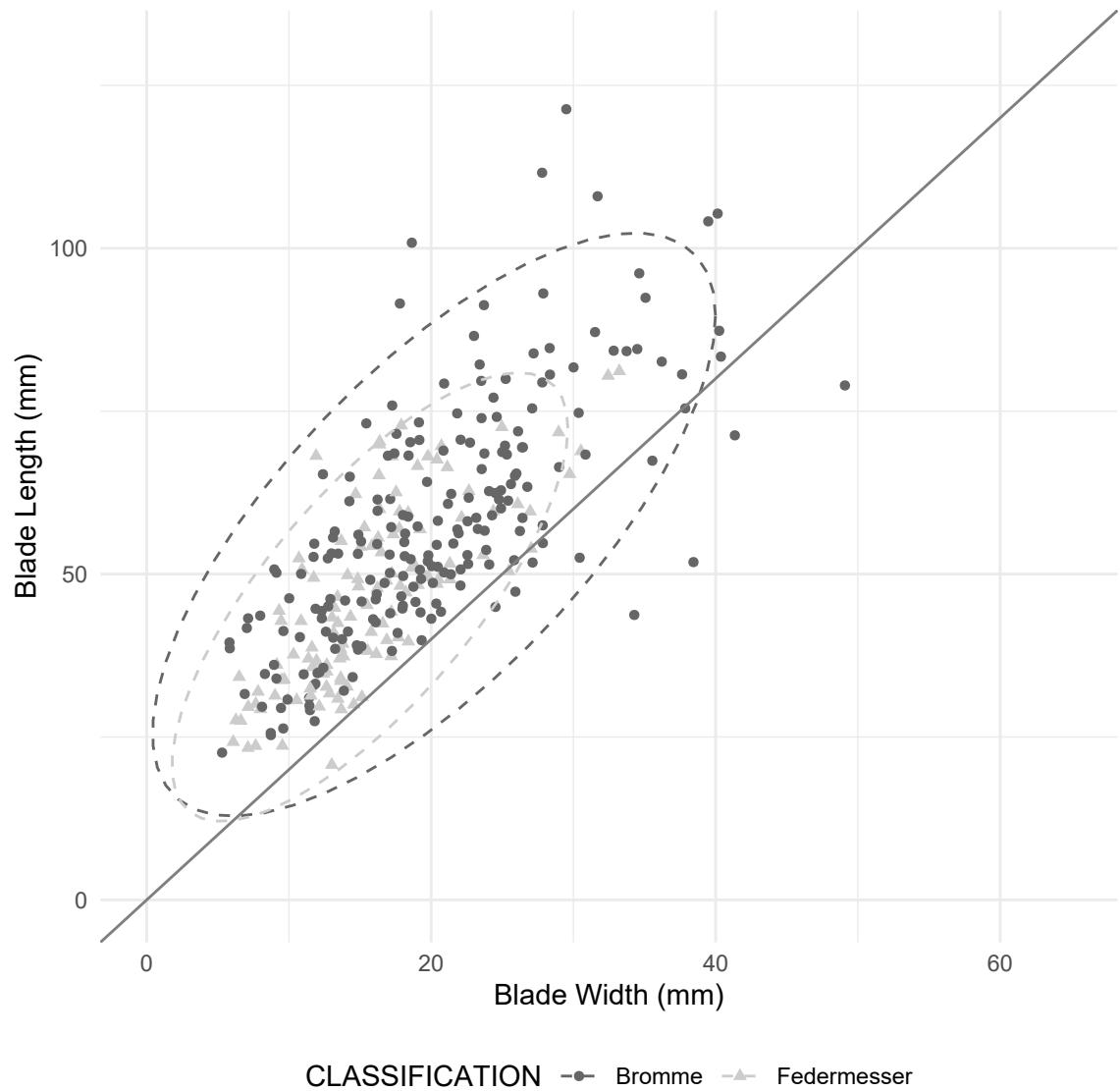
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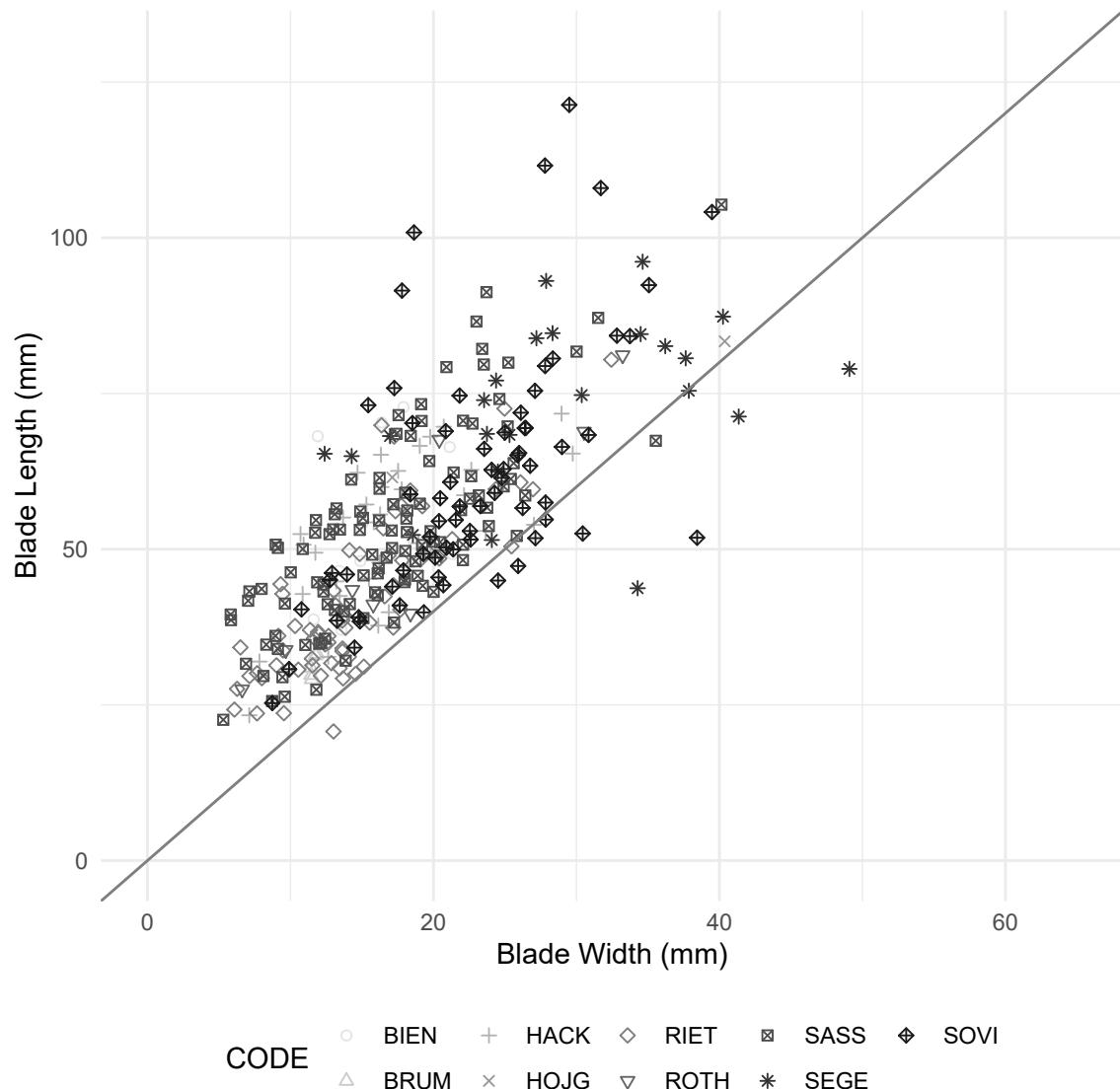
2.74











```
##
## 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
##

```

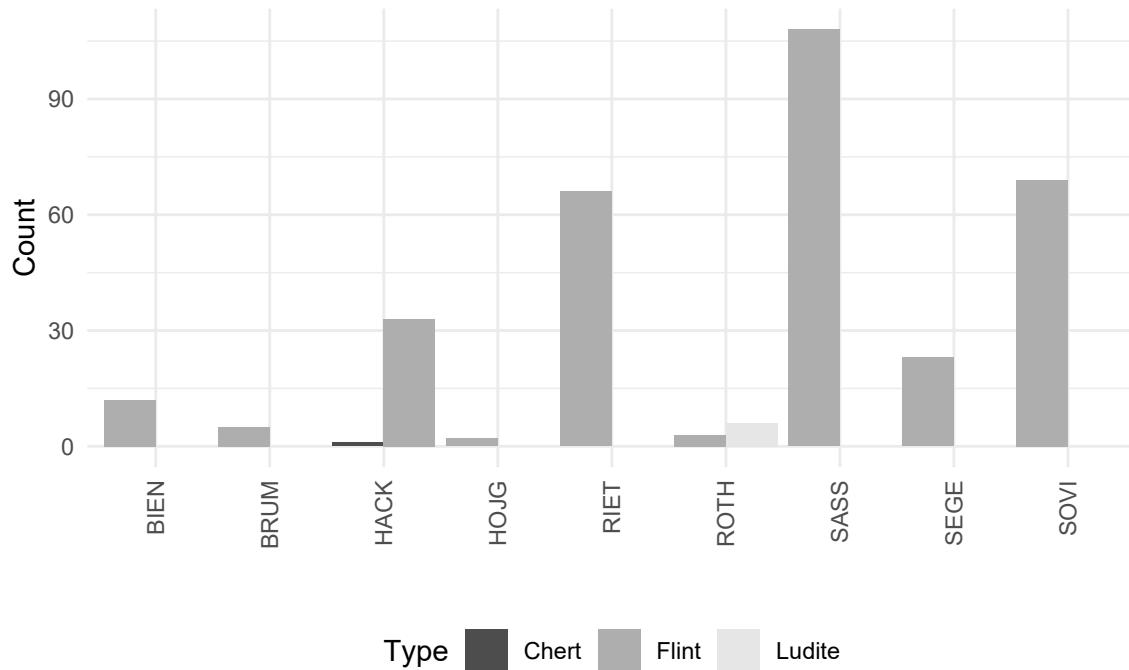
```

##      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

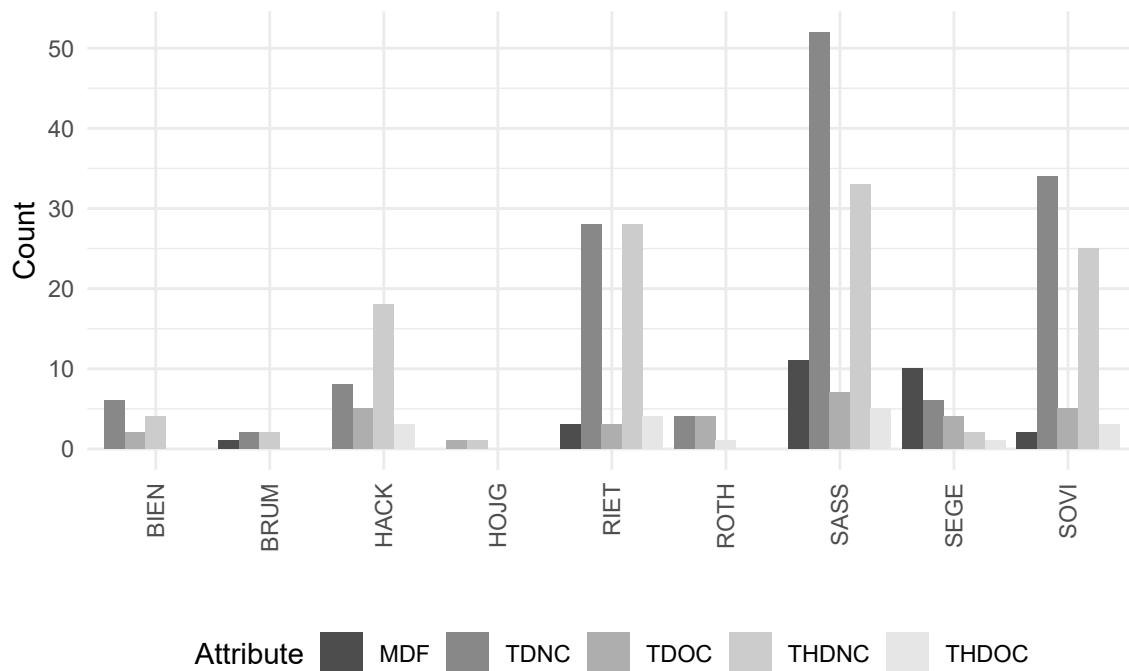
```

```
##  
## 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
```

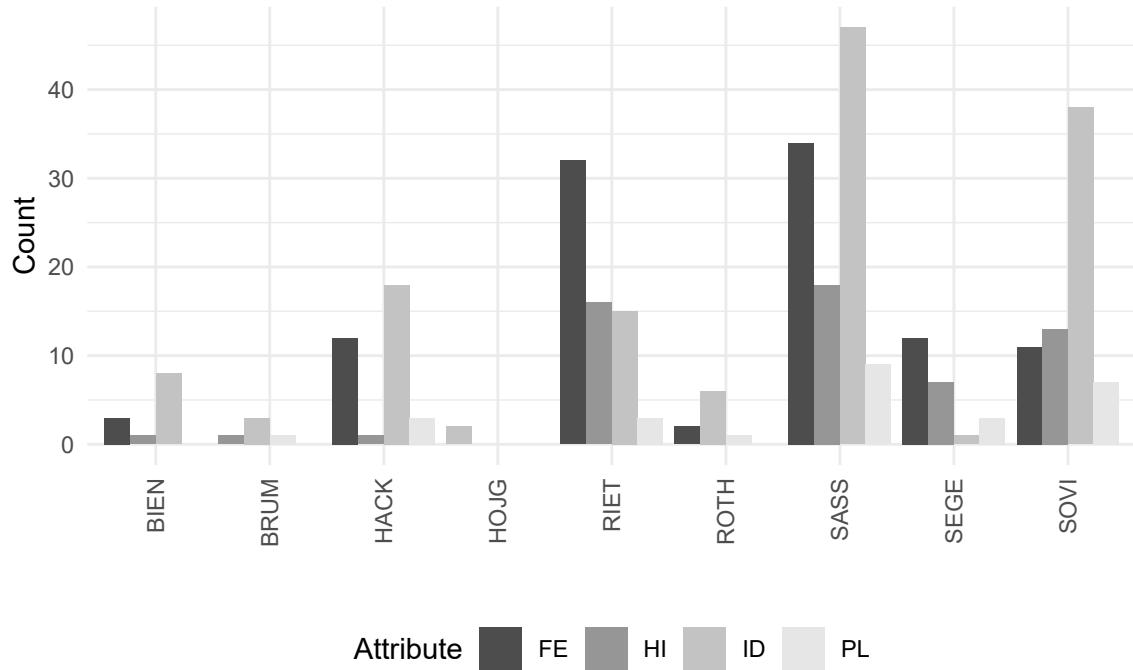
## Raw Material



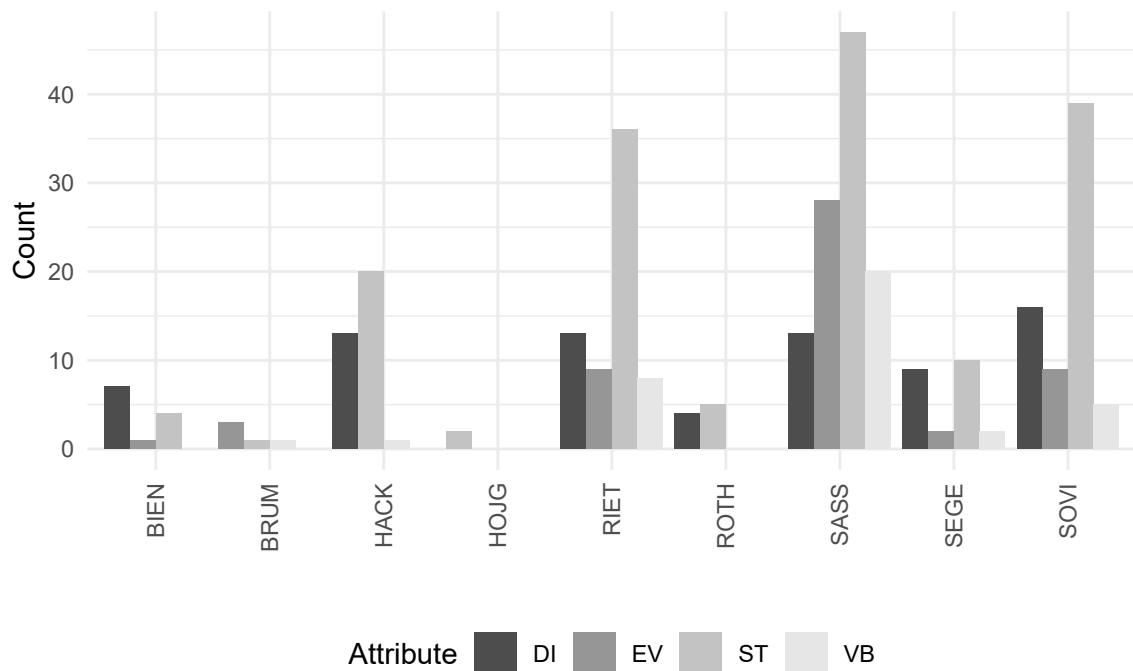
## Dorsal Blade Profile



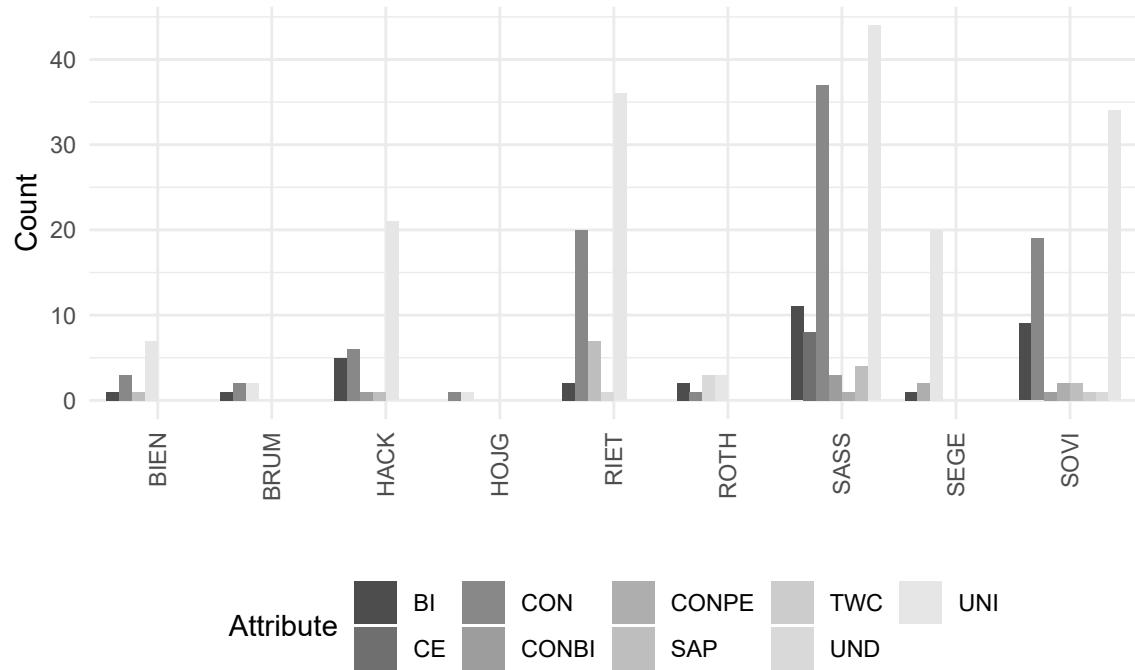
## Blade Determination Profile



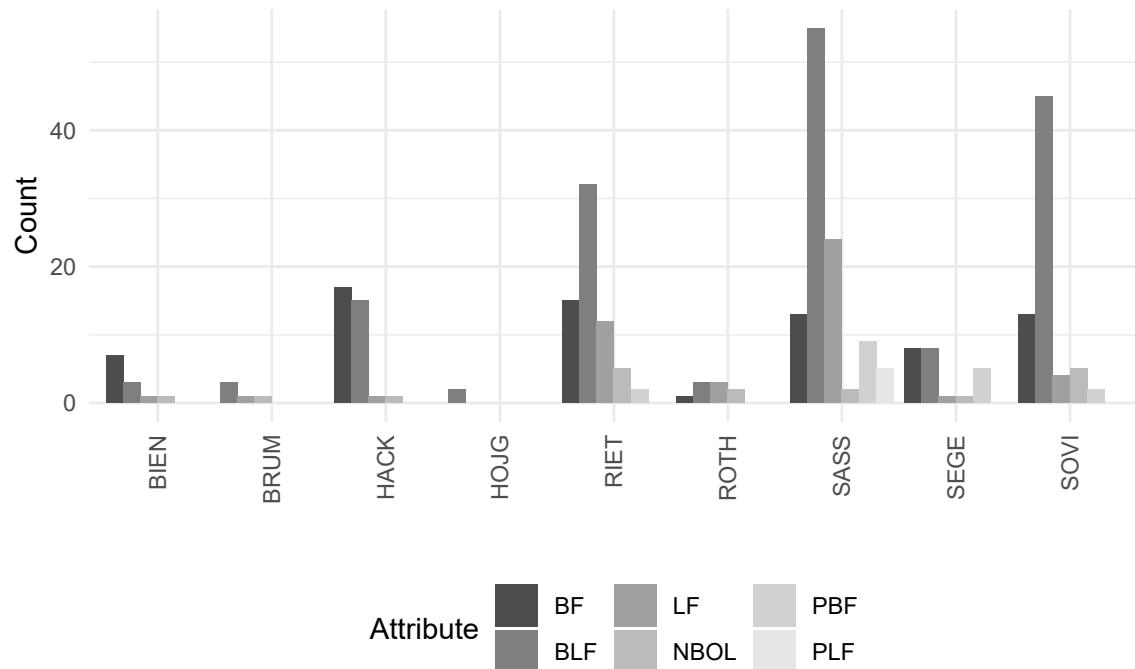
## Blade Curvature



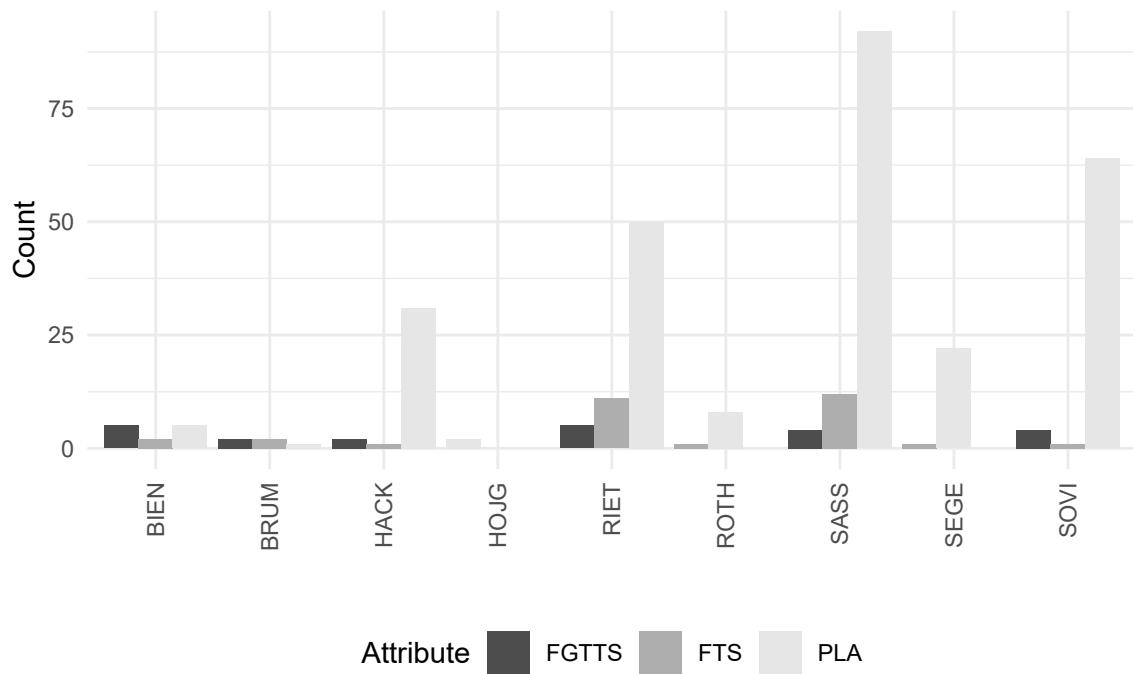
## Dorsal Pattern Profile



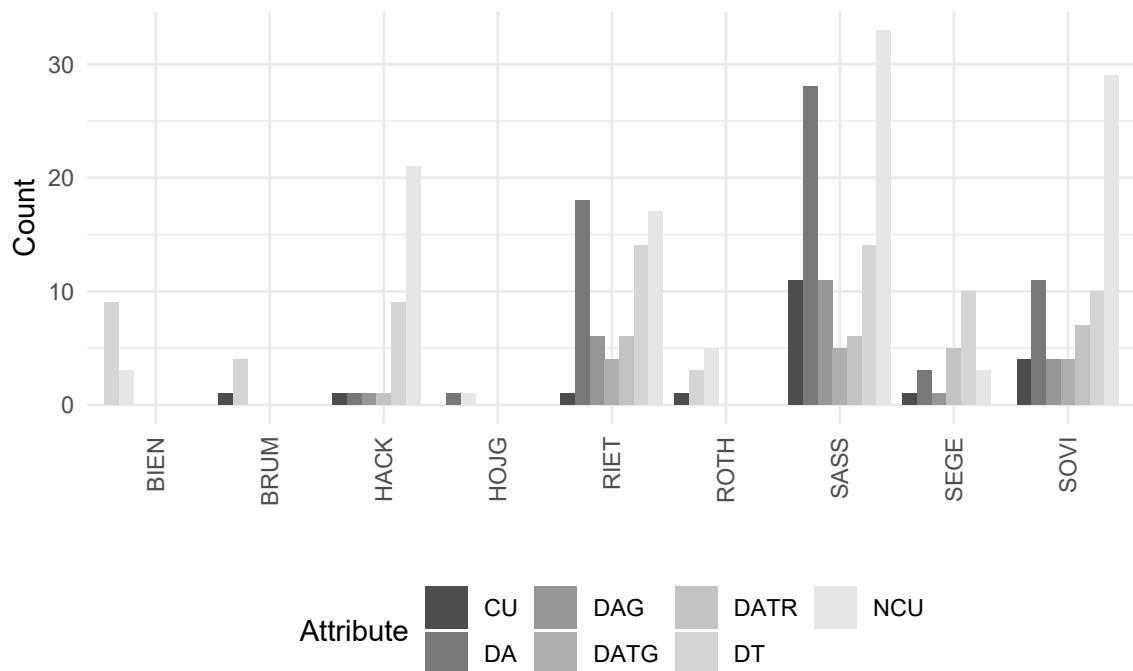
## Bulb Morphology



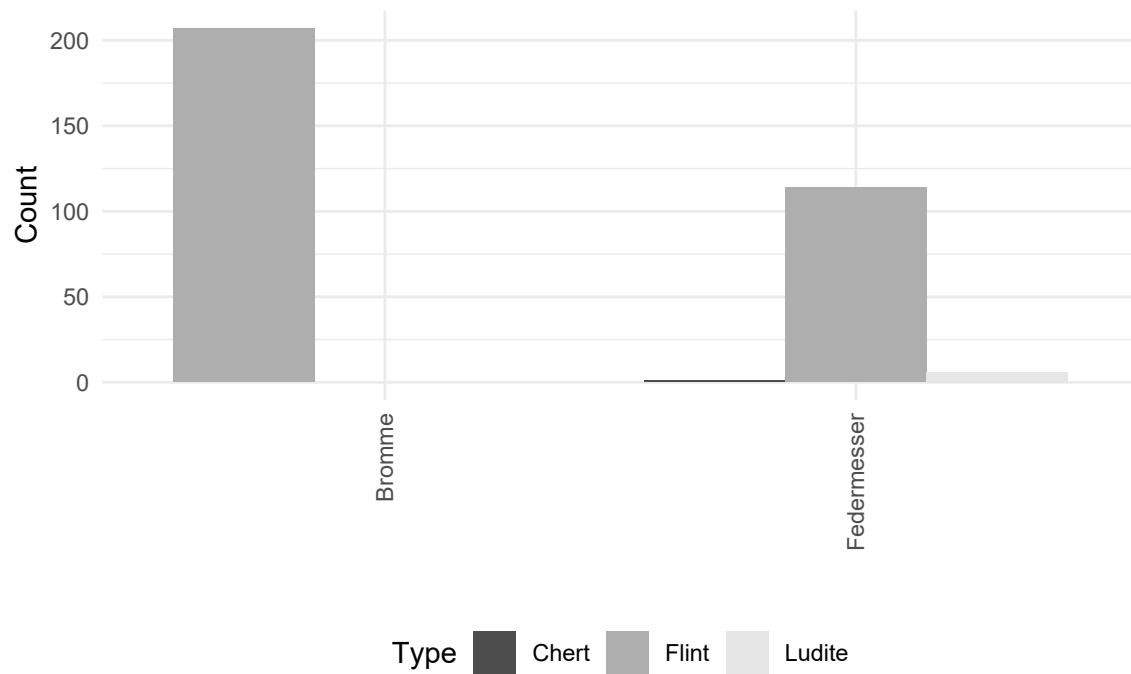
## Butt Preparation Method #1



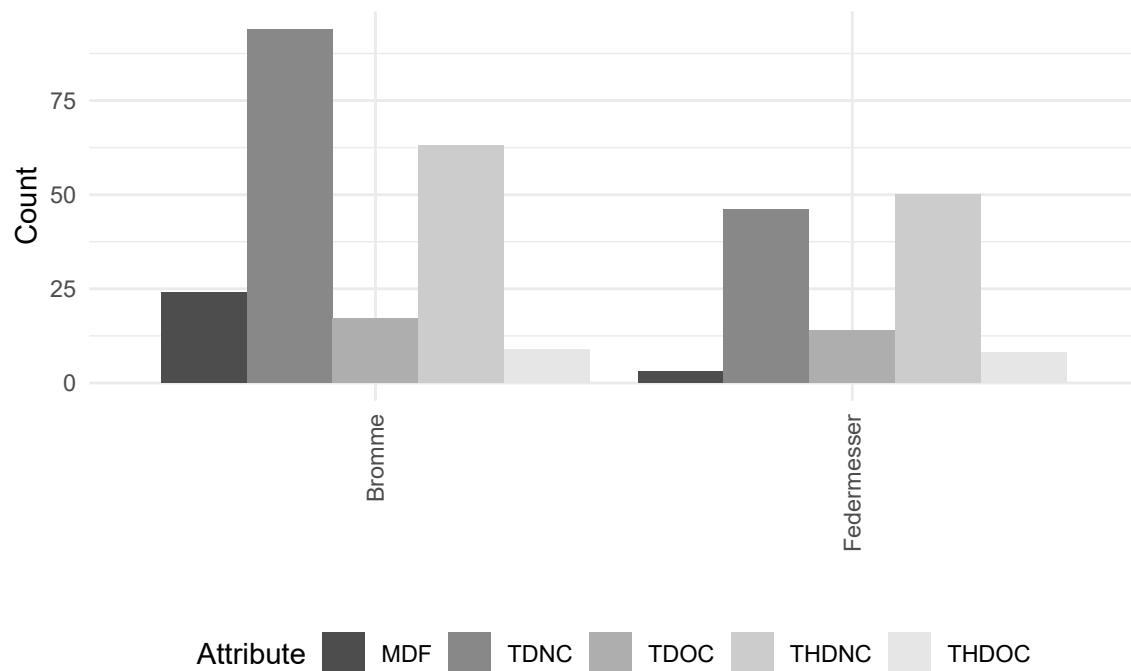
## Butt Preparation Method #2



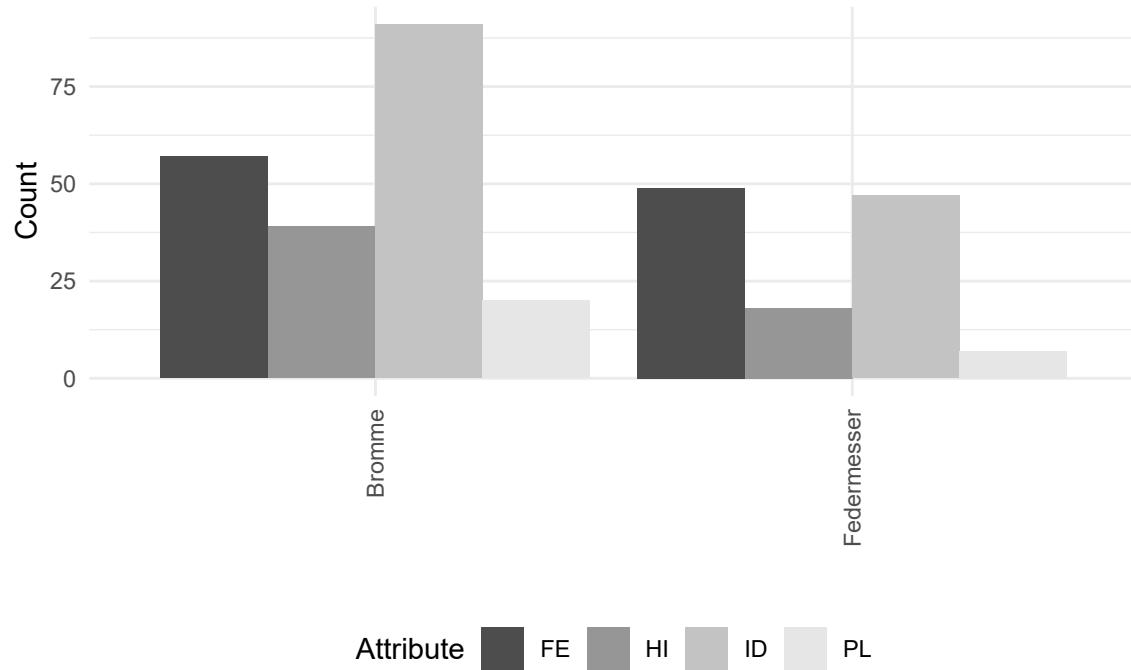
## Raw Material



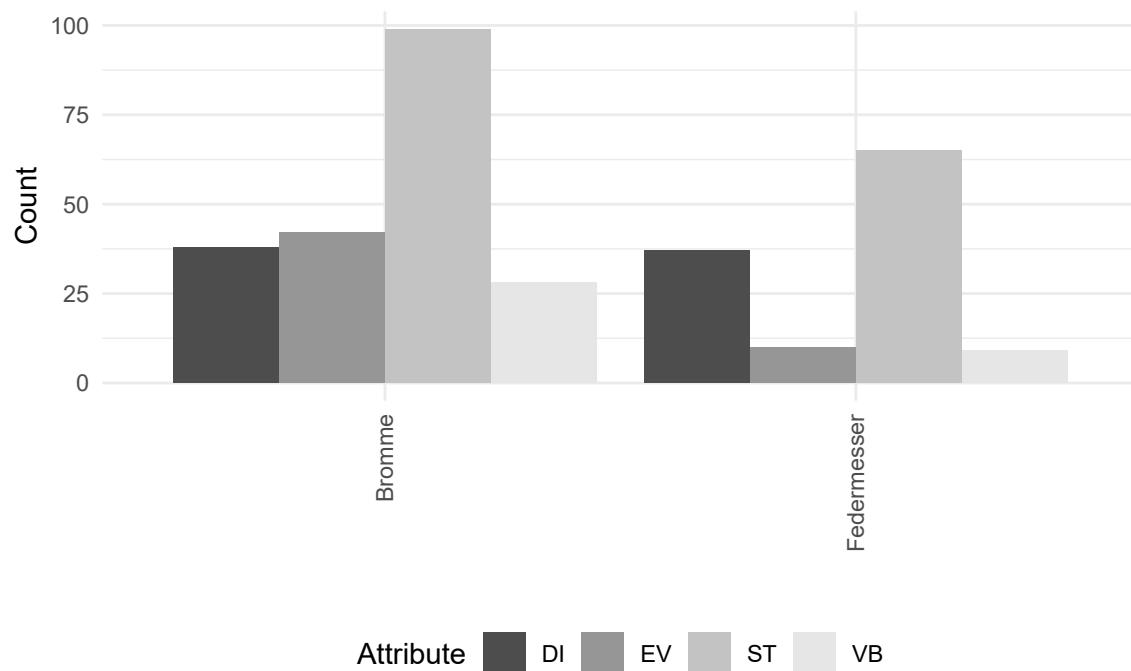
## Dorsal Blade Profile



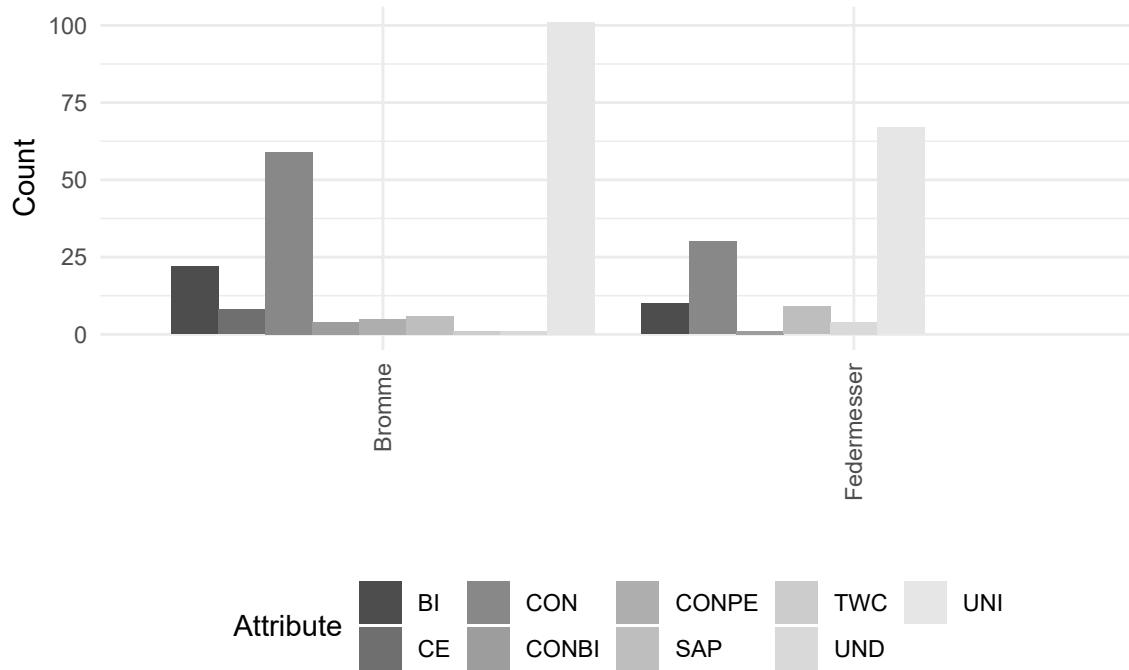
## Blade Determination Profile



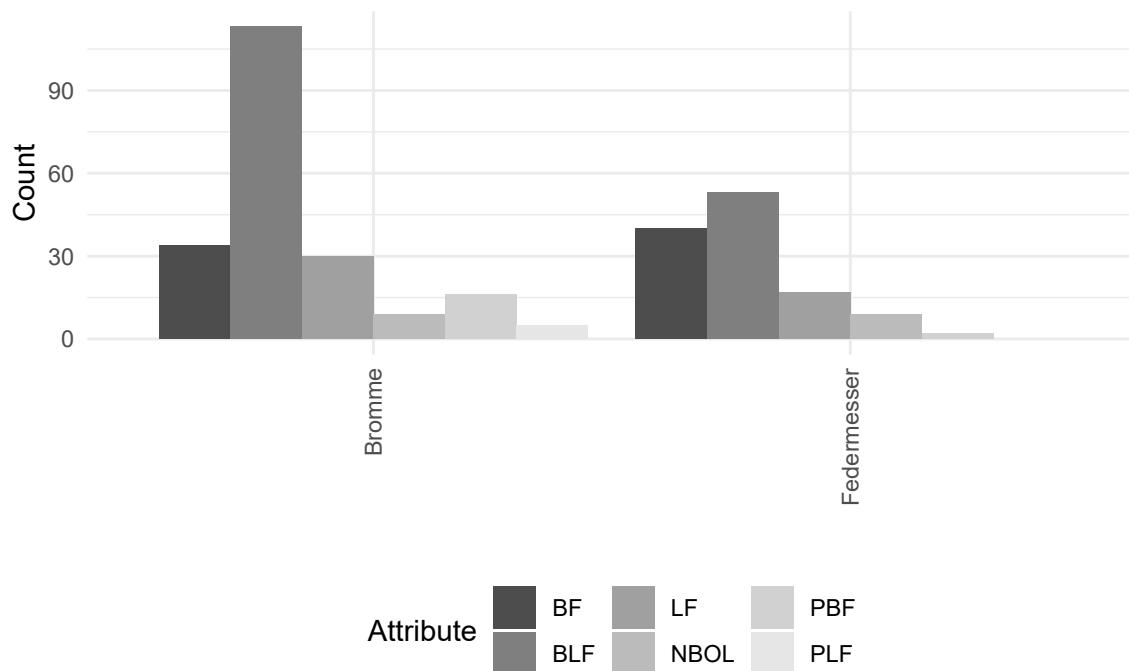
## Blade Curvature



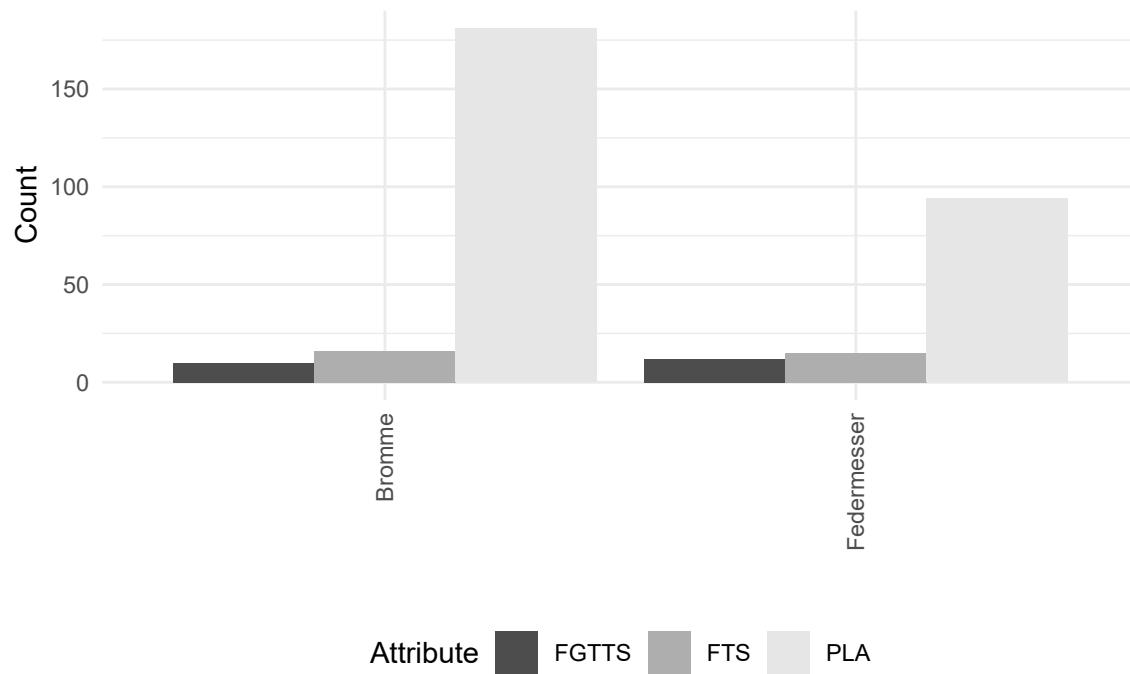
## Dorsal Pattern Profile



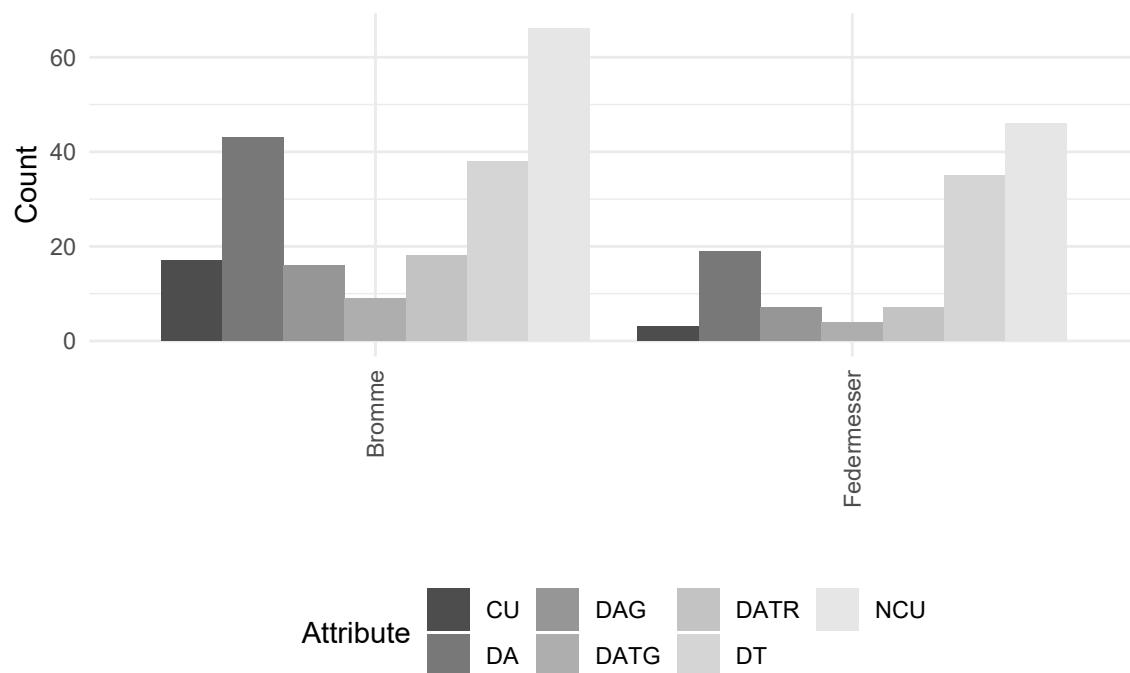
## Bulb Morphology



## Butt Preparation Method #1

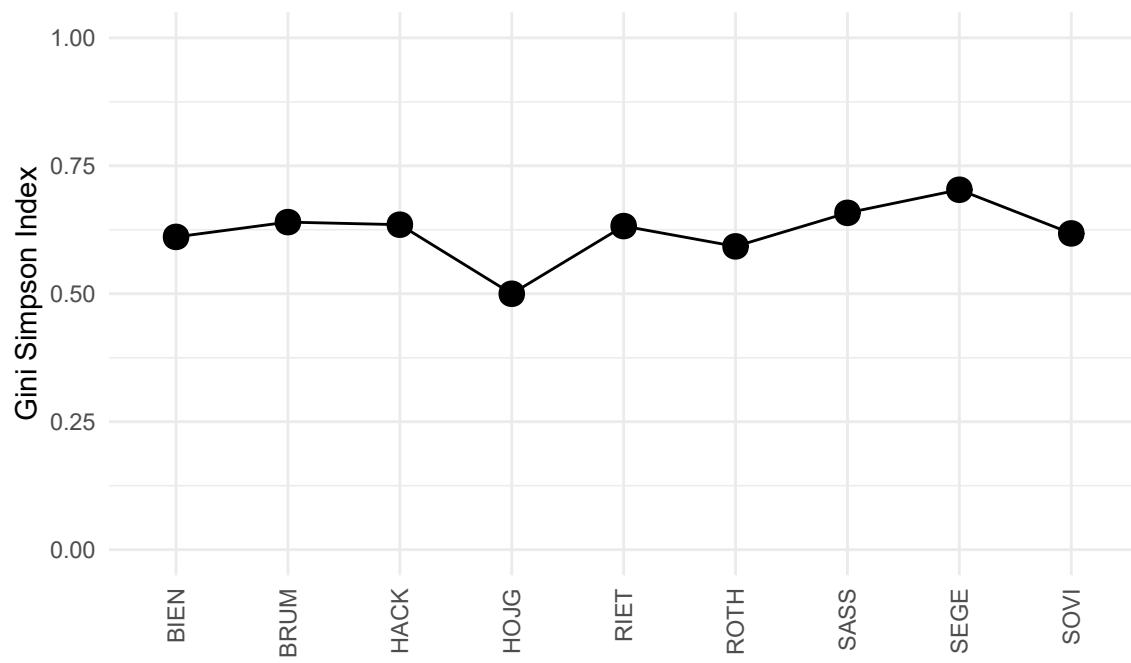


## Butt Preparation Method #2

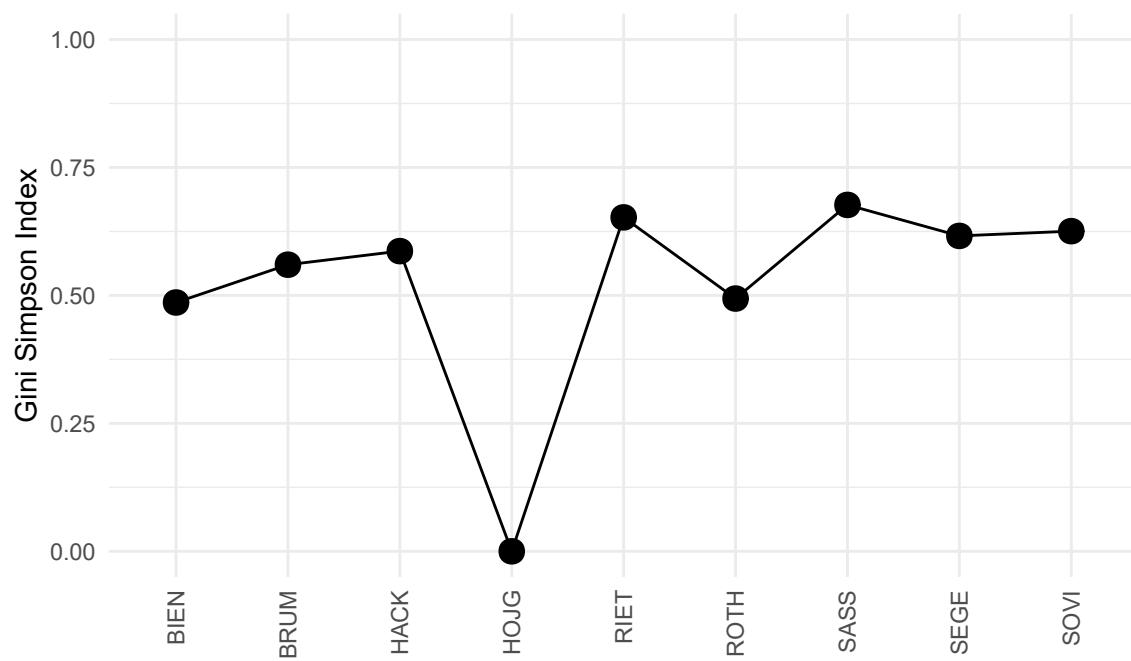


## Gini-Simpson and Morisita-Horn diversity indices

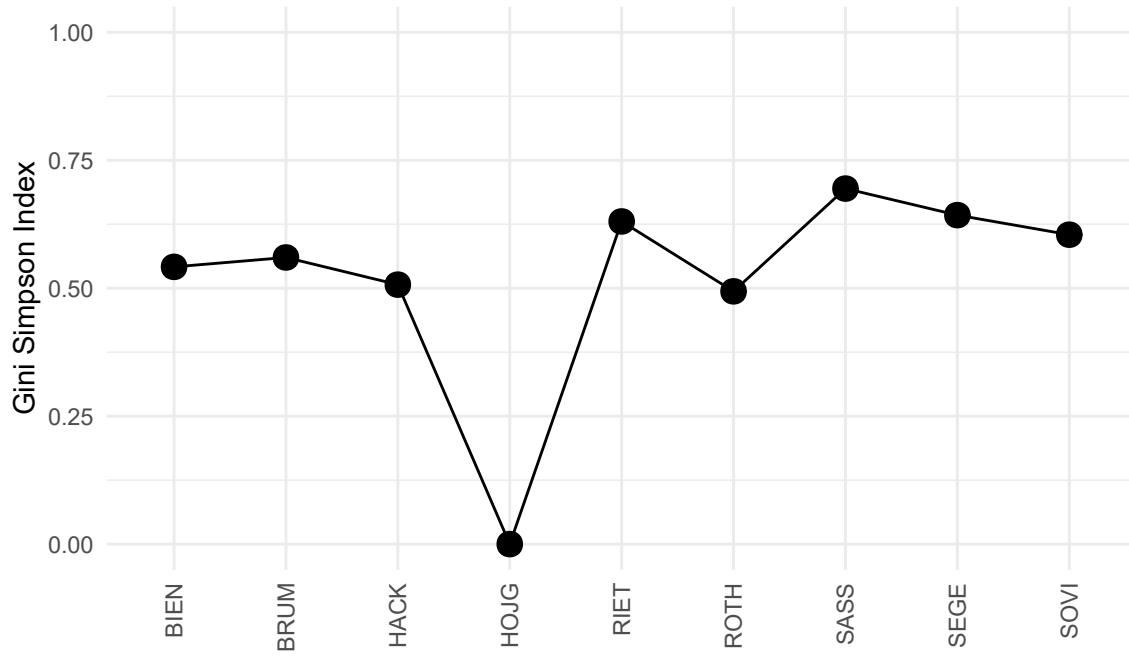
### Dorsal Profile



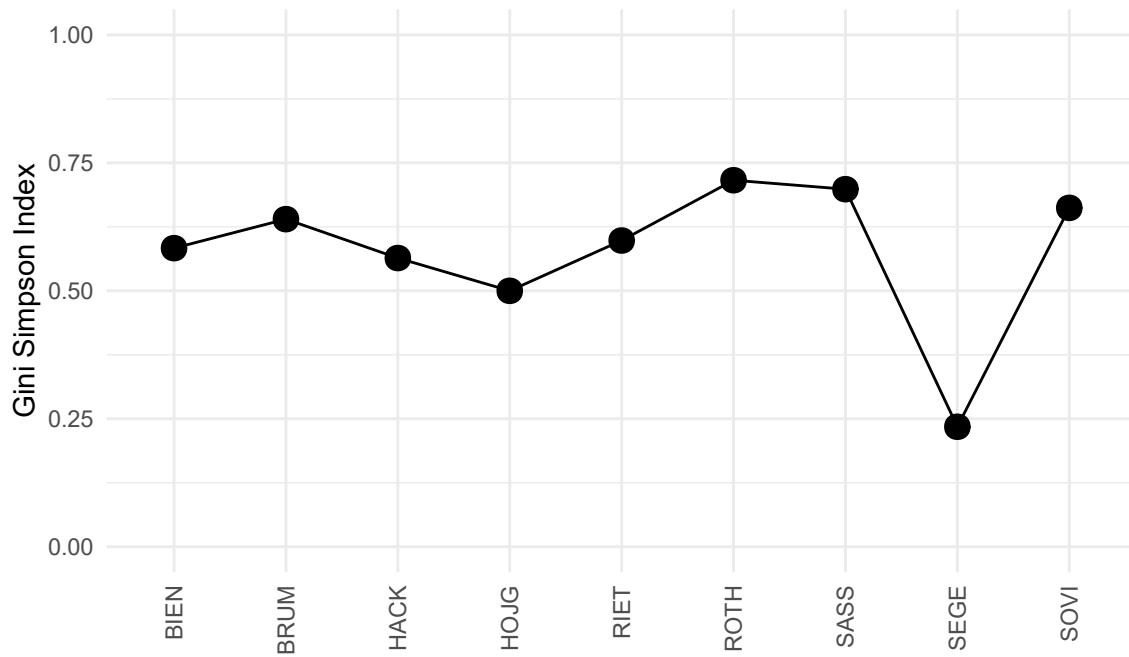
### Blade Determination Profile



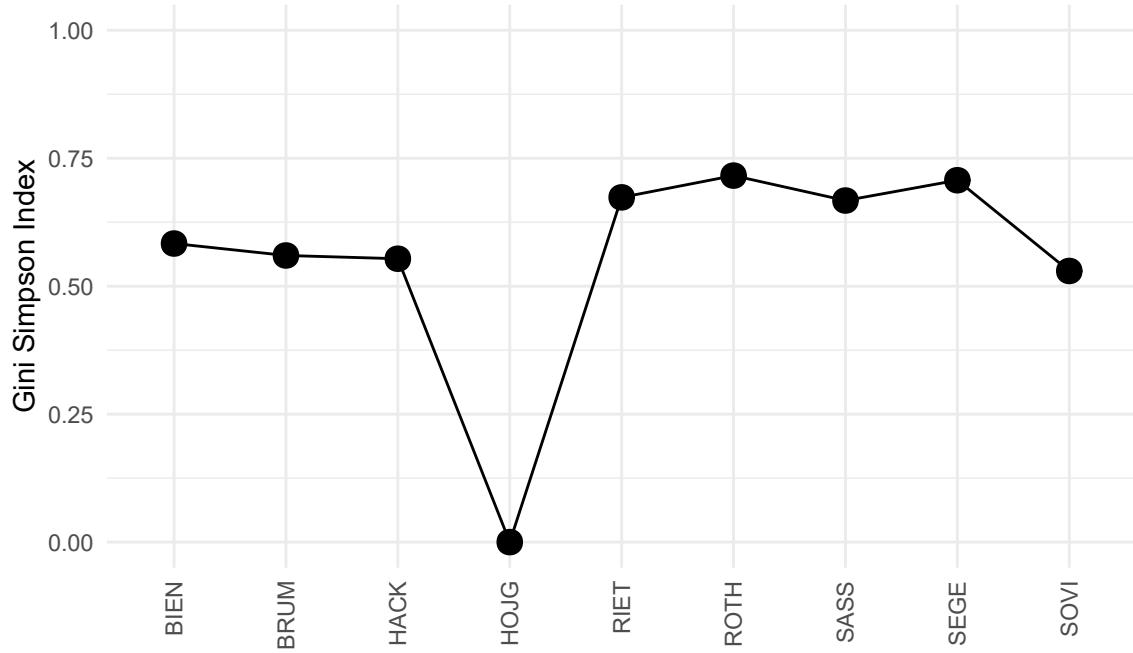
### Blade Curvature



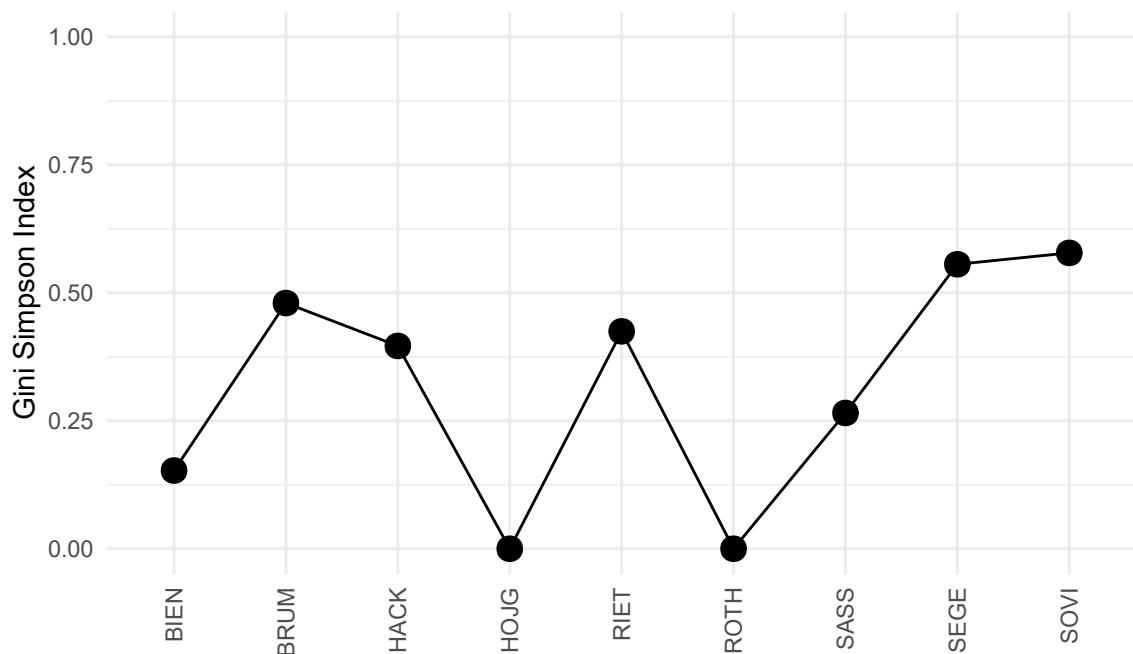
### Dorsal Pattern



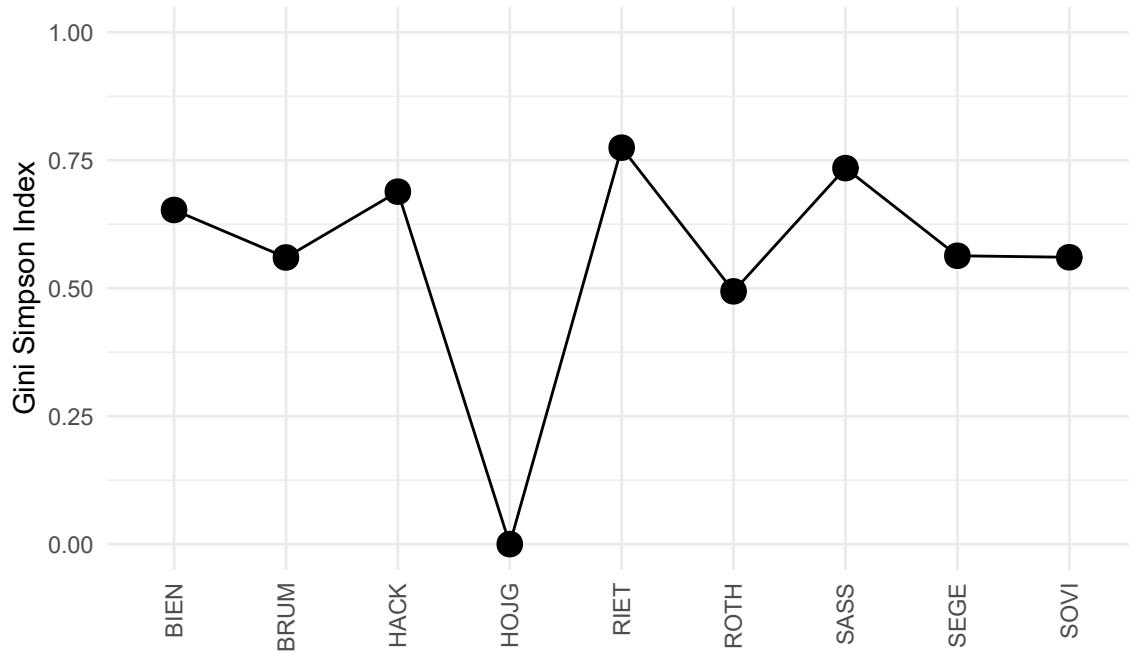
## Bulb Morphology



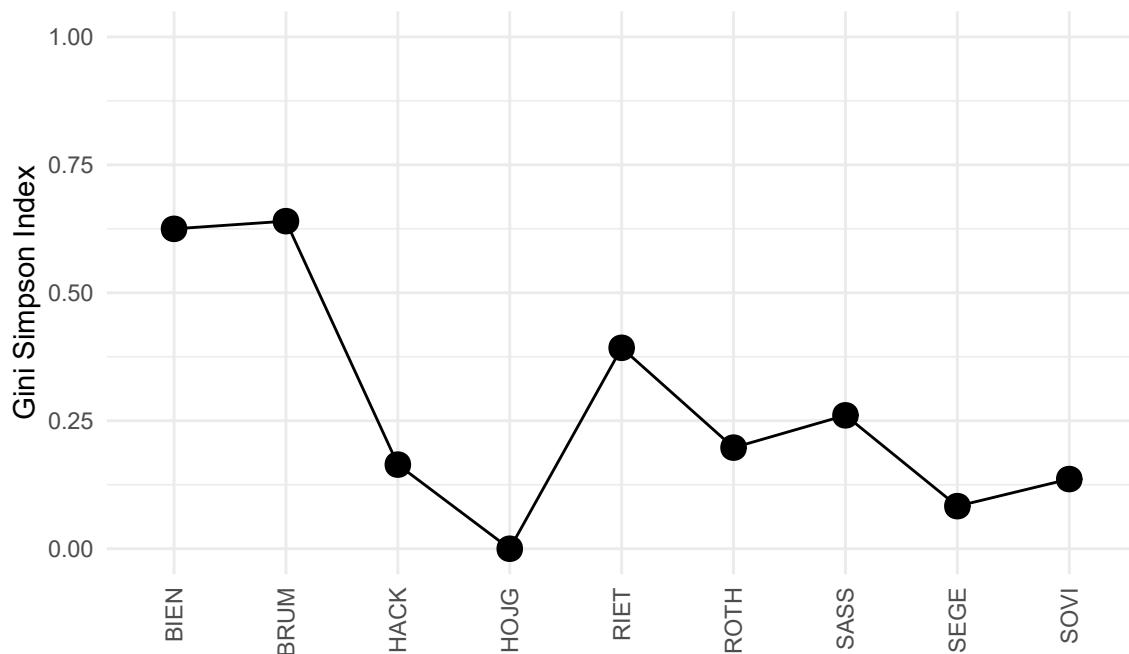
## Conus Formation



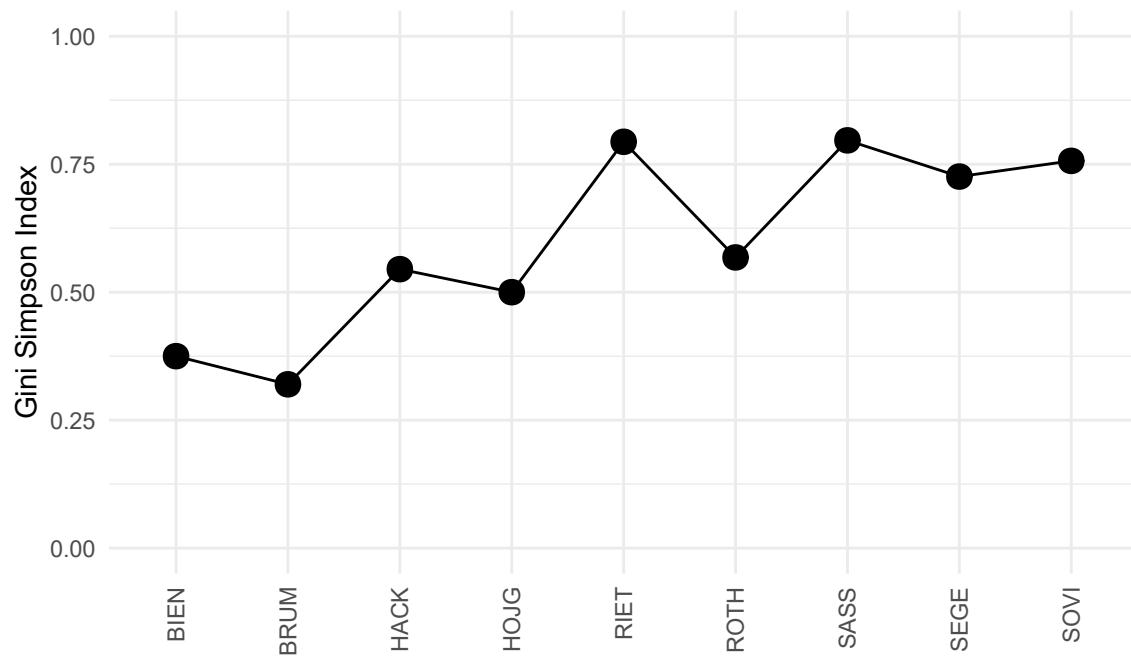
## Butt Morphology



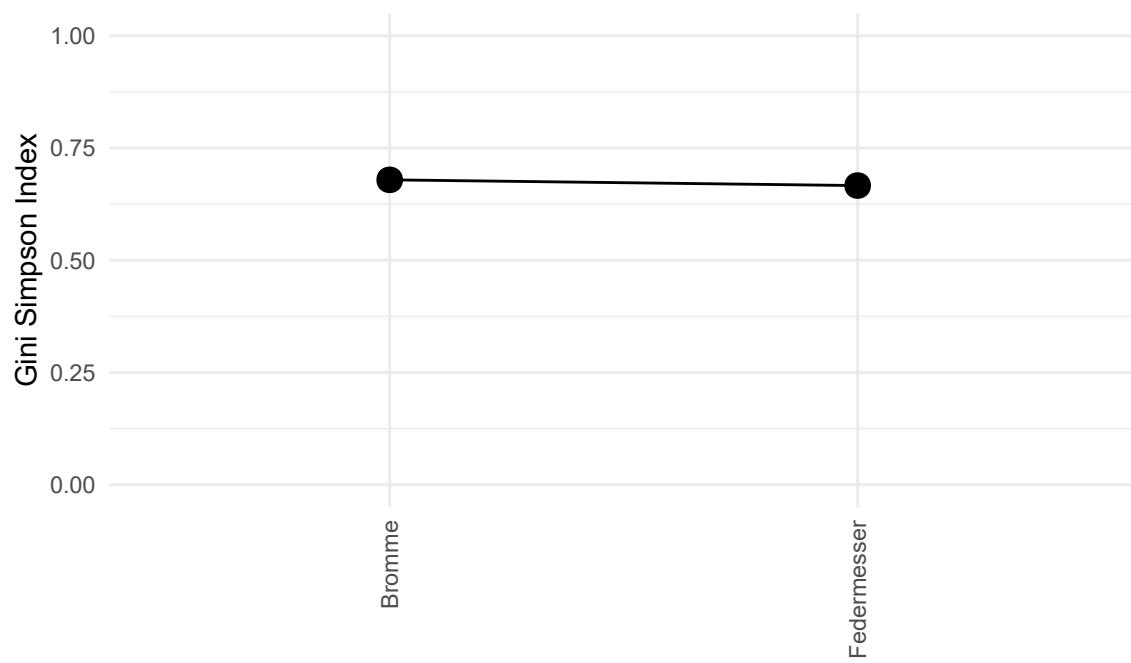
## Butt Preparation #1



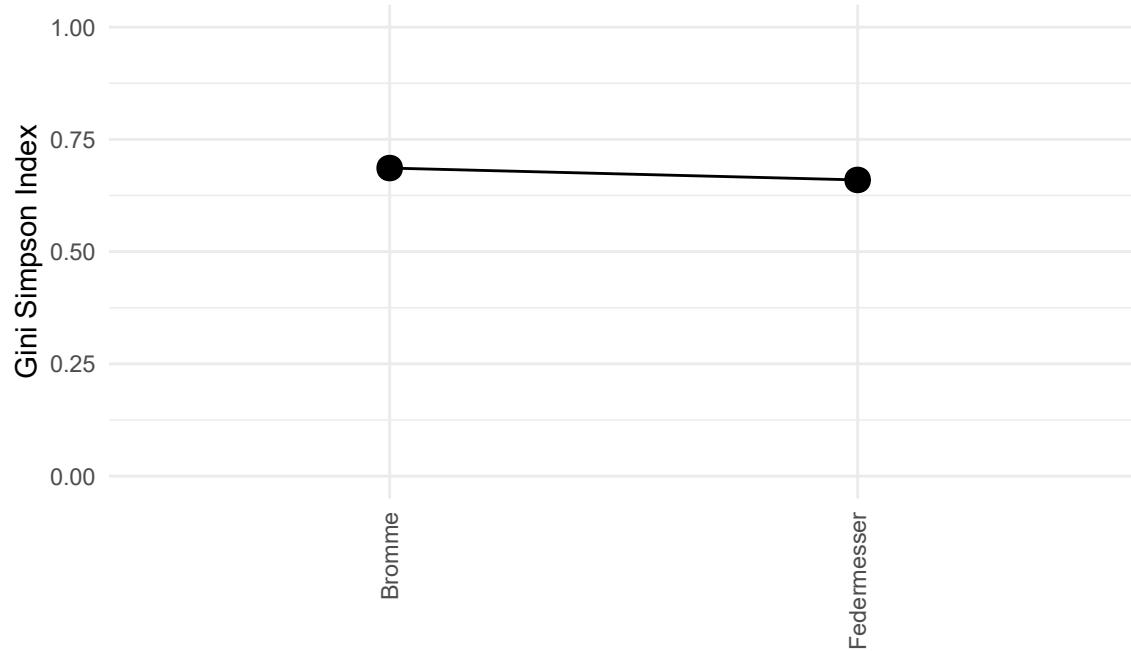
## Butt Preparation #2



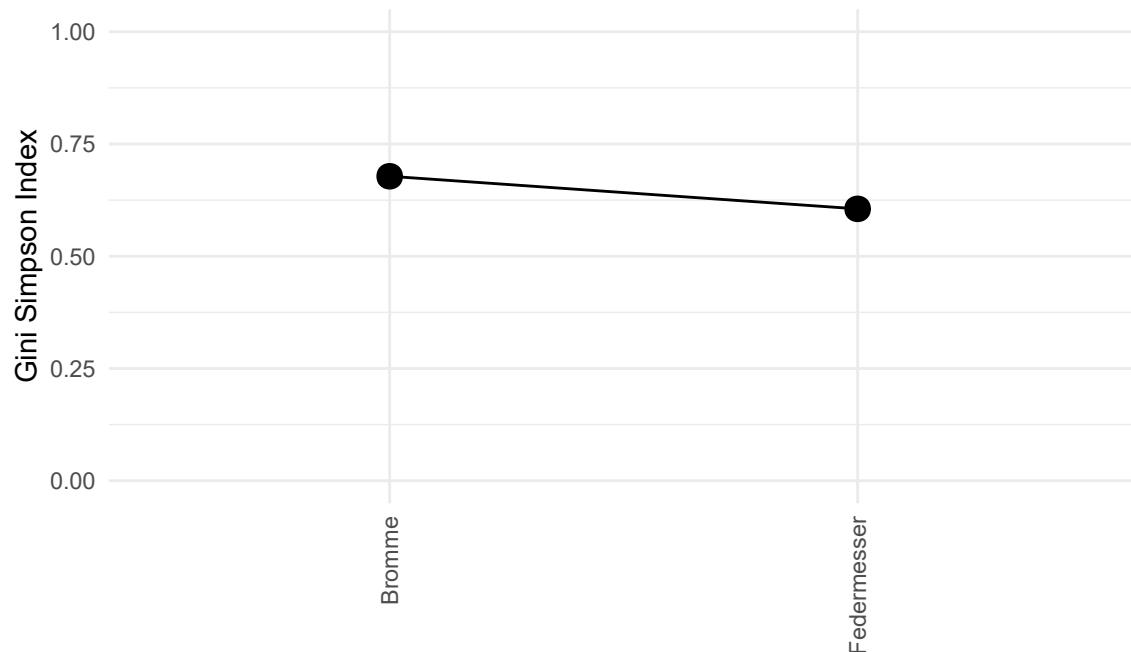
## Dorsal Profile



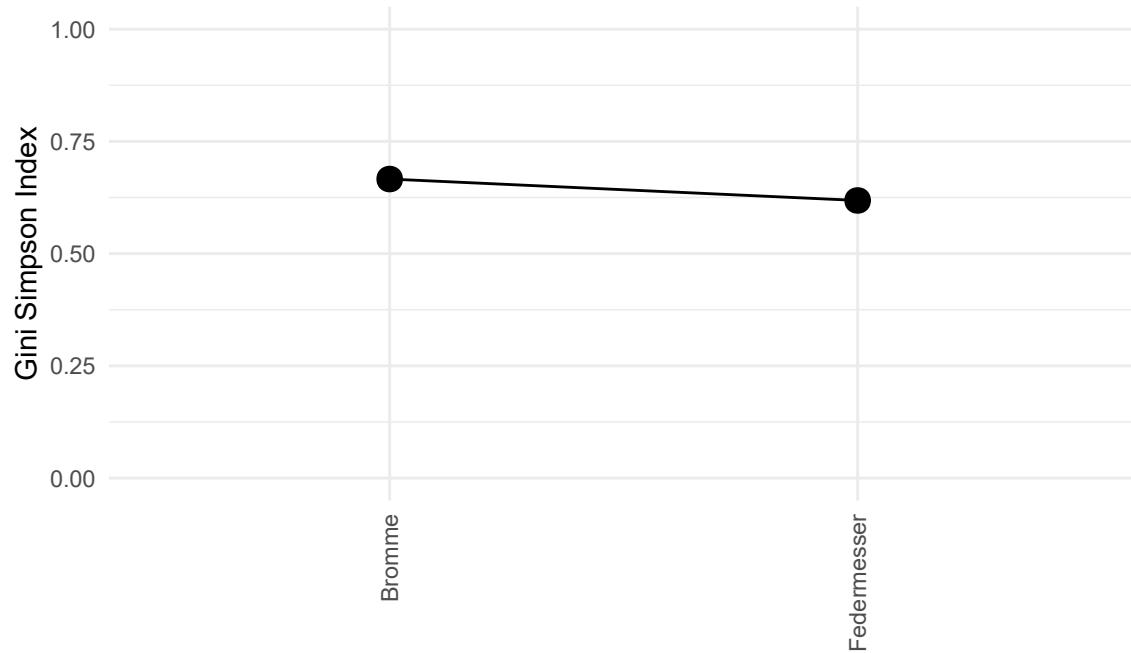
## Blade Determination Profile



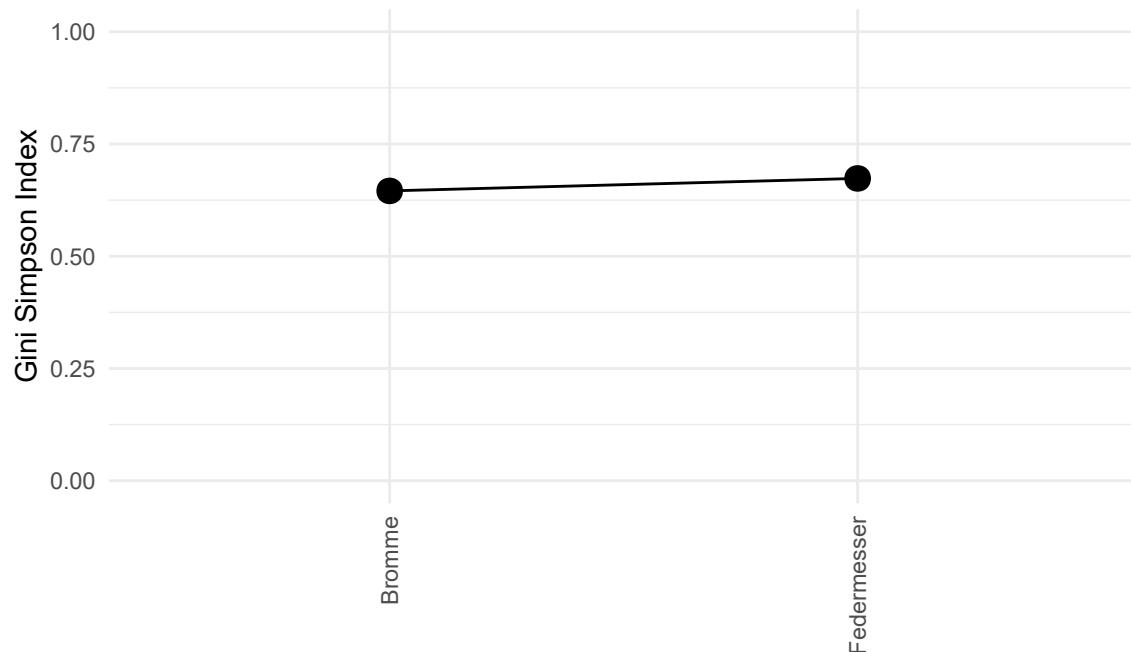
## Blade Curvature



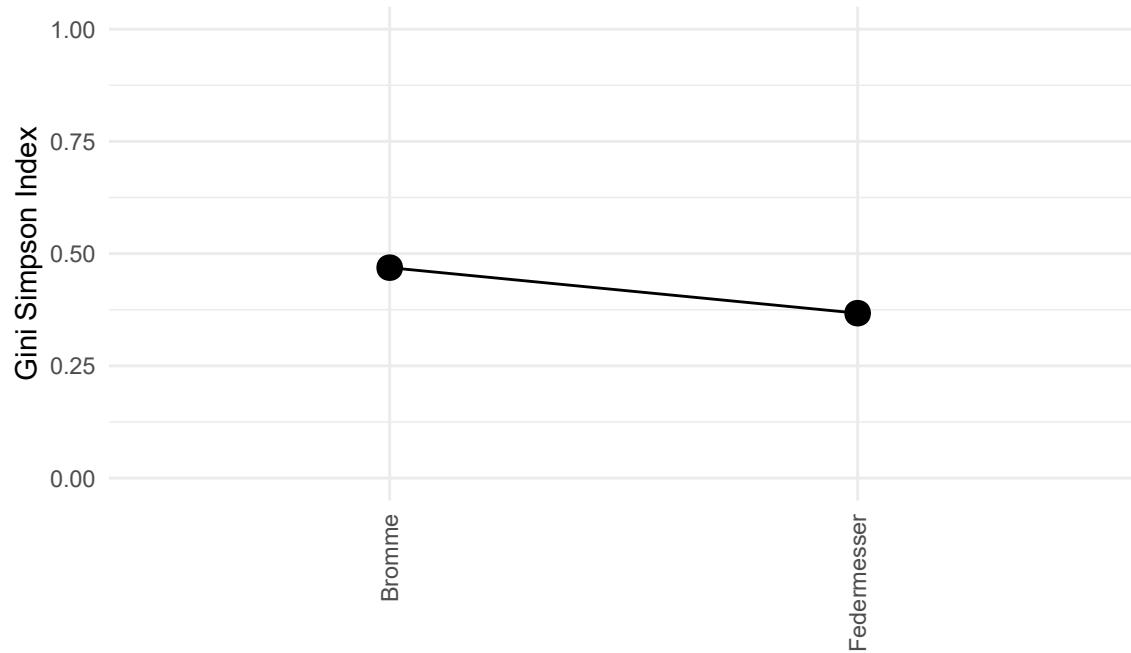
## Dorsal Pattern



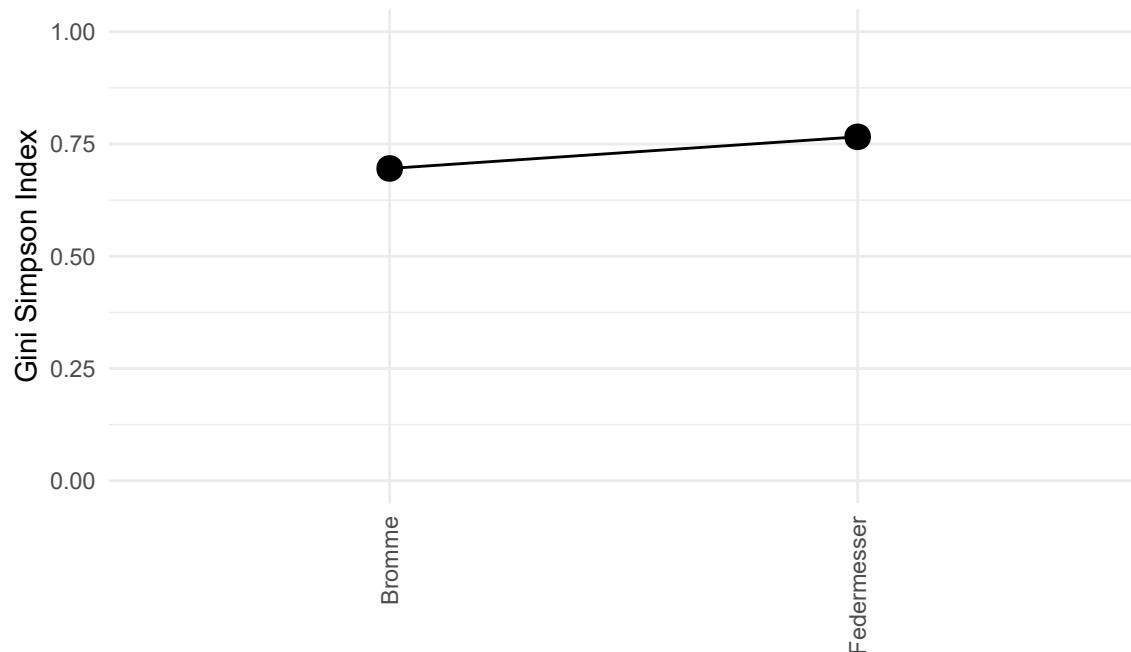
## Bulb Morphology



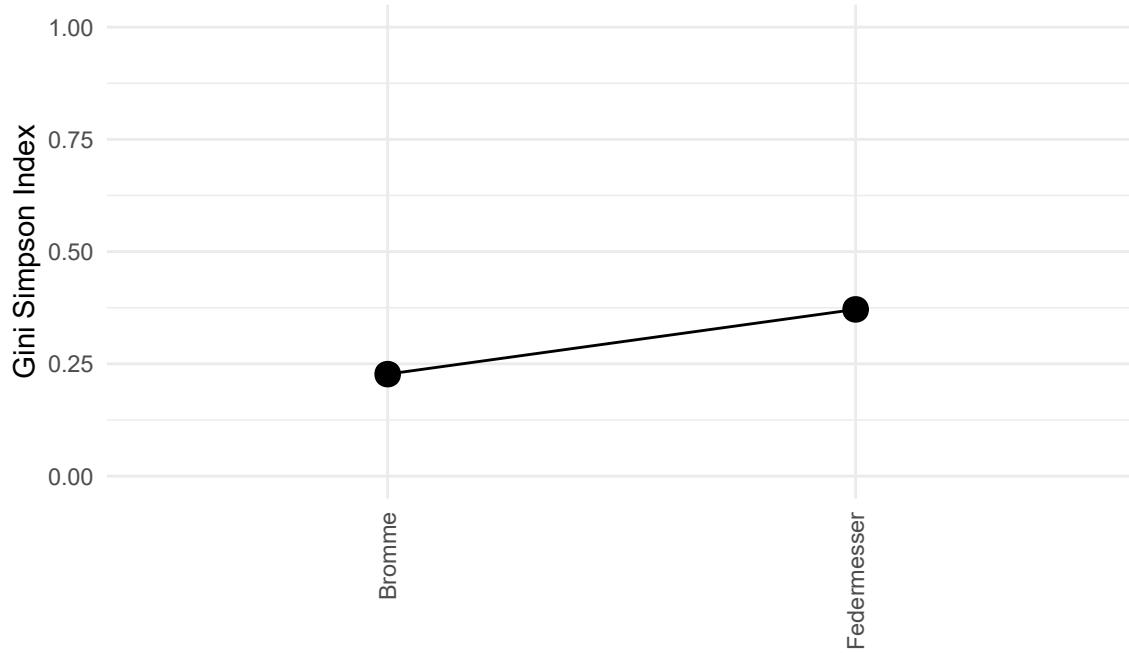
## Conus Formation



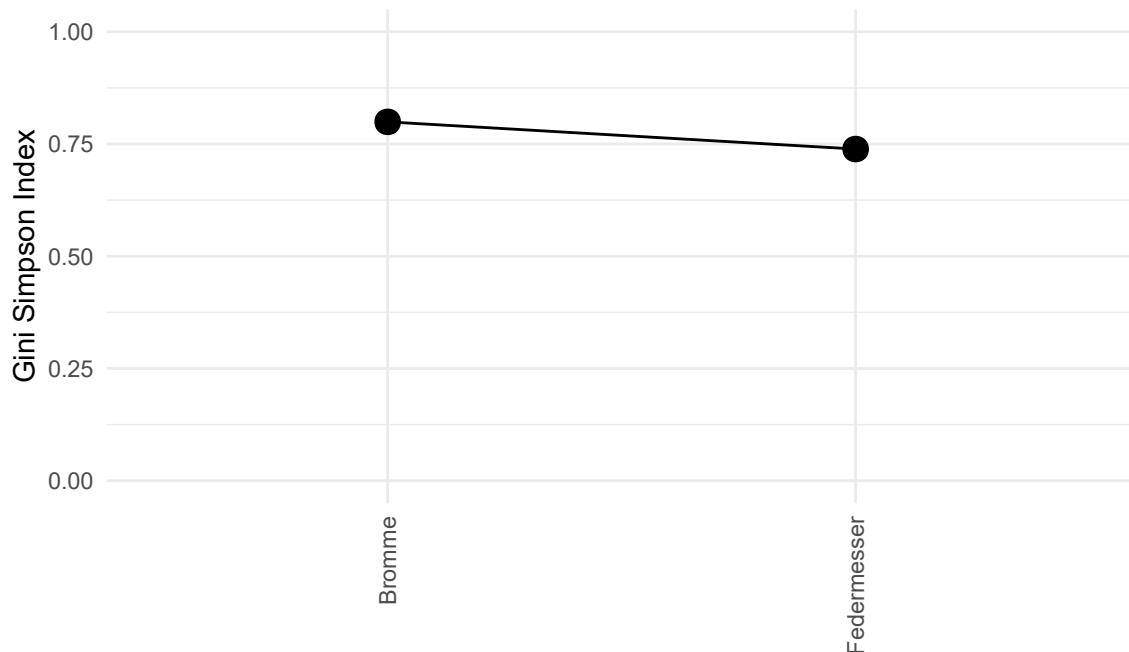
## Butt Morphology



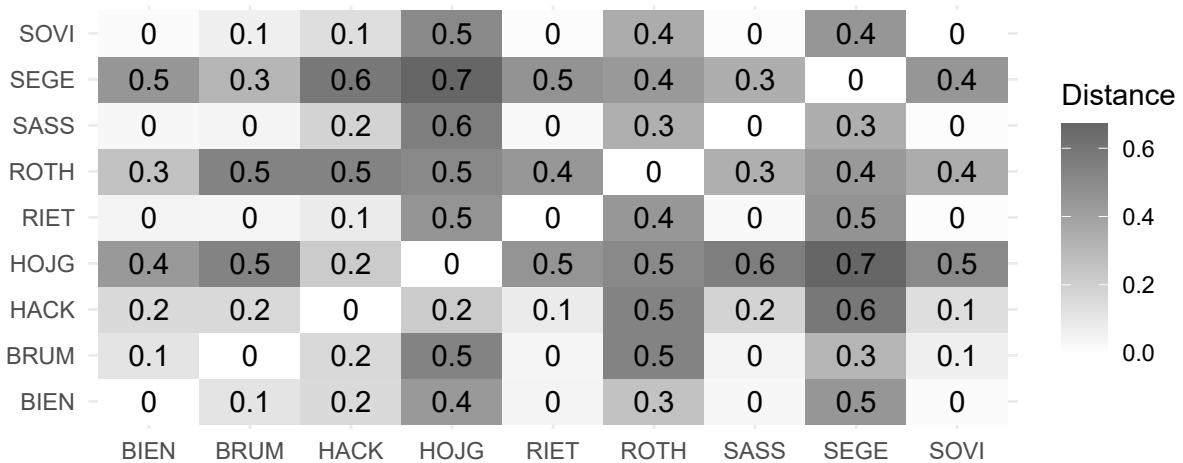
## Butt Preparation #1



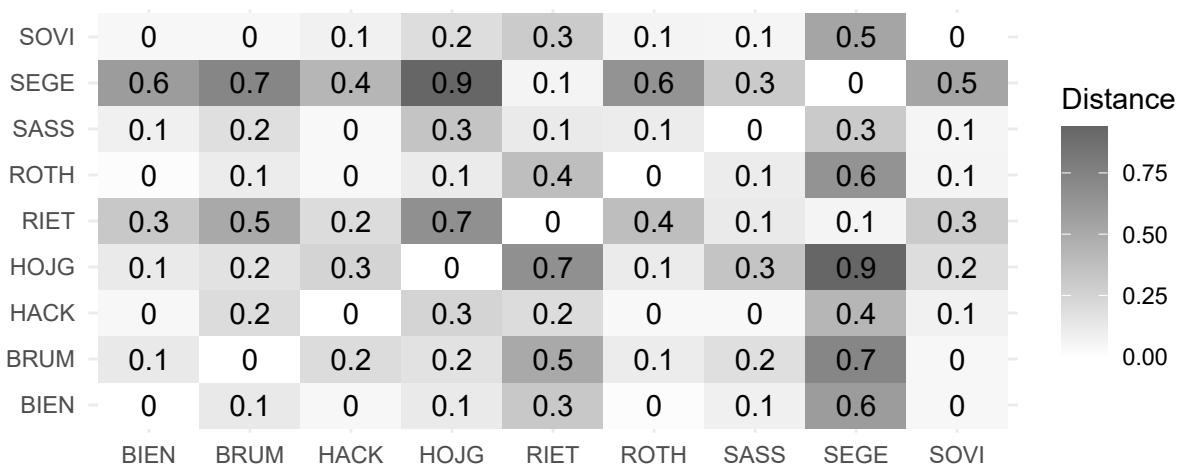
## Butt Preparation #2



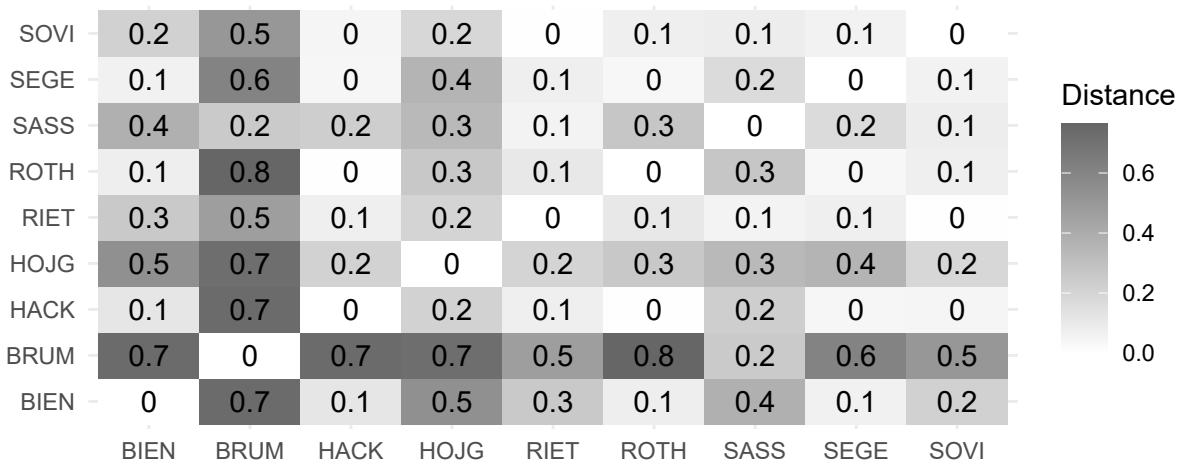
### Dorsal Profile: Morisita-Horn Index



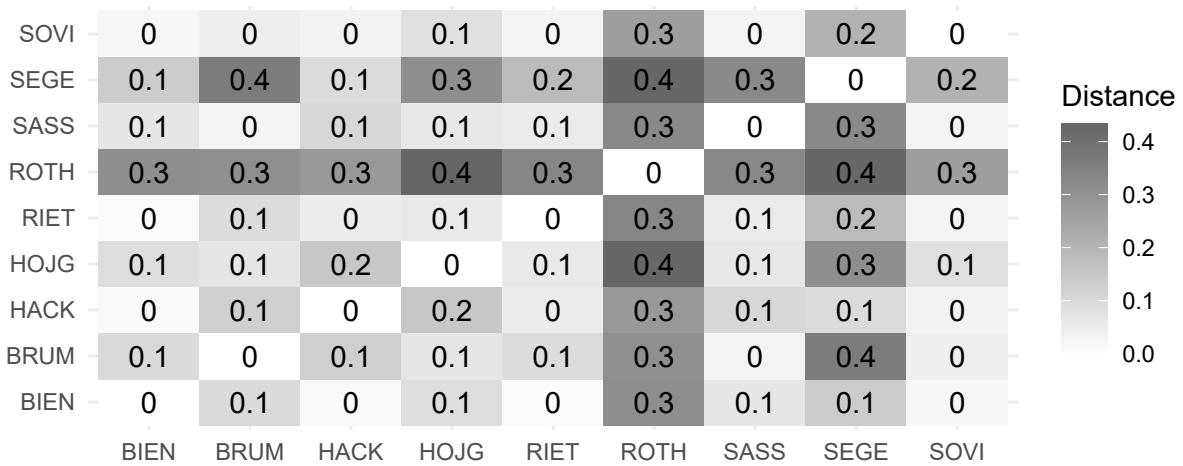
### Blade Determination Profile: Morisita-Horn Index



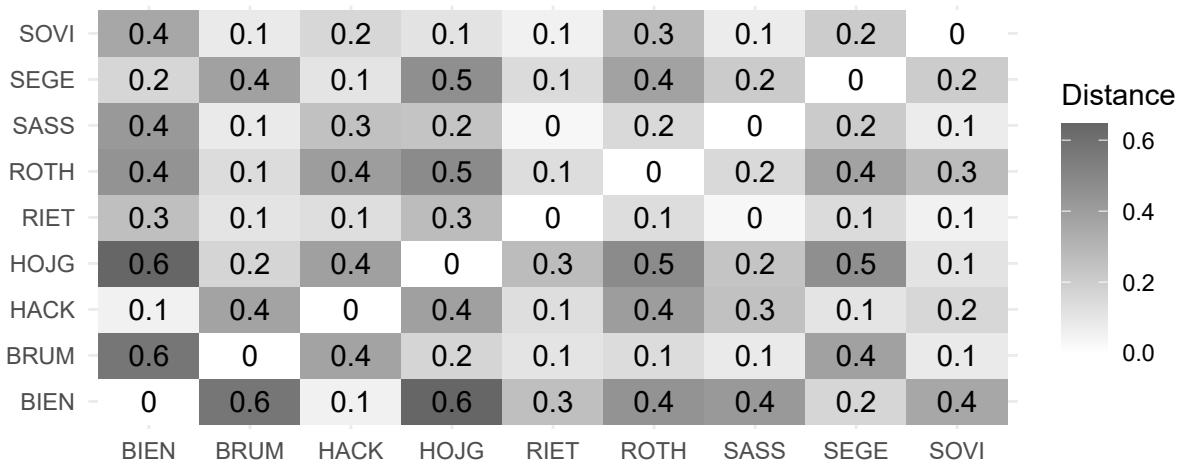
### Blade Curvature: Morisita-Horn Index



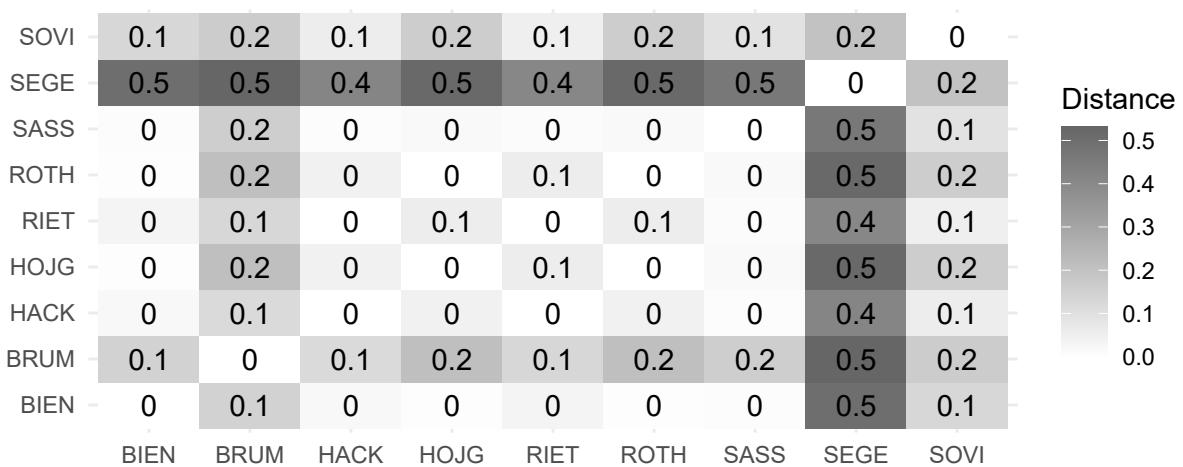
### Dorsal Pattern: Morisita-Horn Index



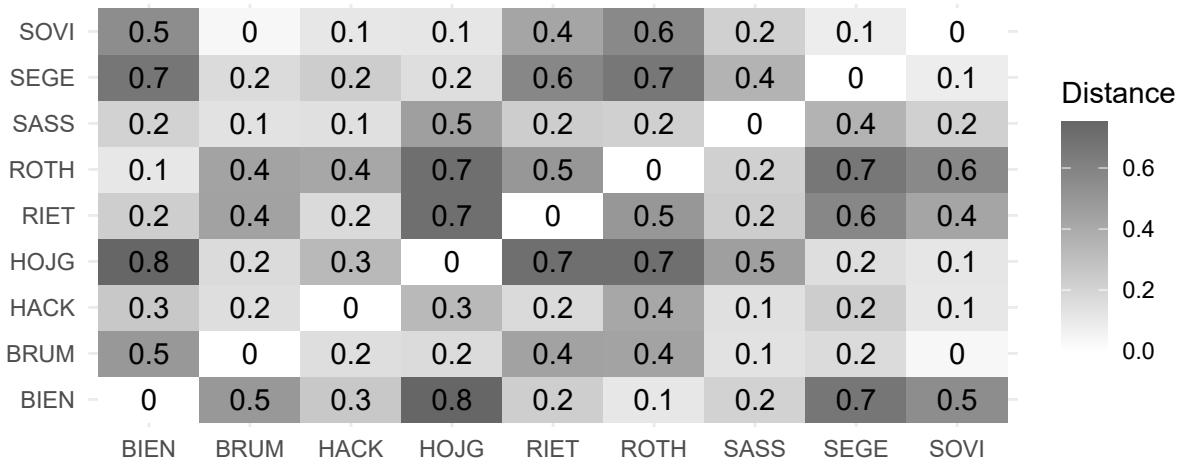
### Bulb Morphology: Morisita-Horn Index



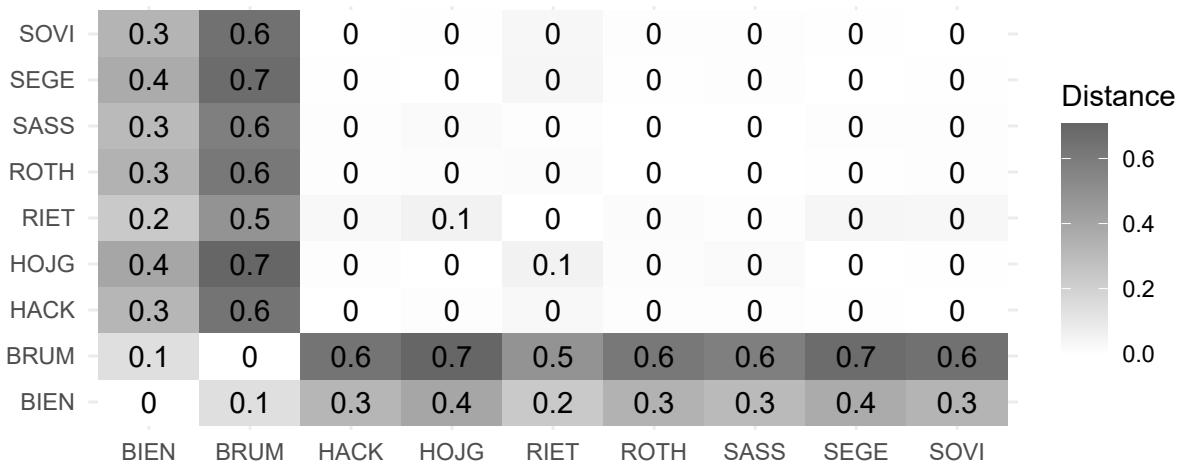
### Conus Formation: Morisita-Horn Index



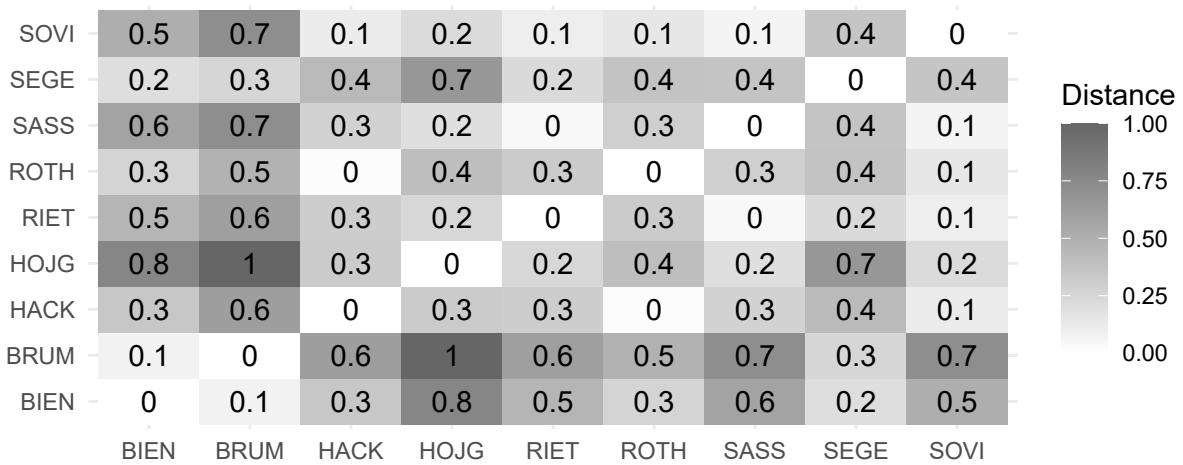
### Butt Morphology: Morisita-Horn Index



### Butt Preparation #1: Morisita-Horn Index



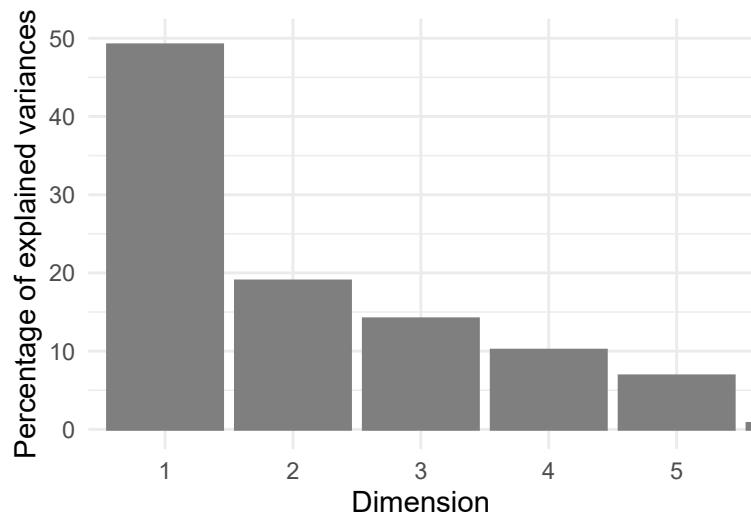
## Butt Preparation #2: Morisita-Horn Index



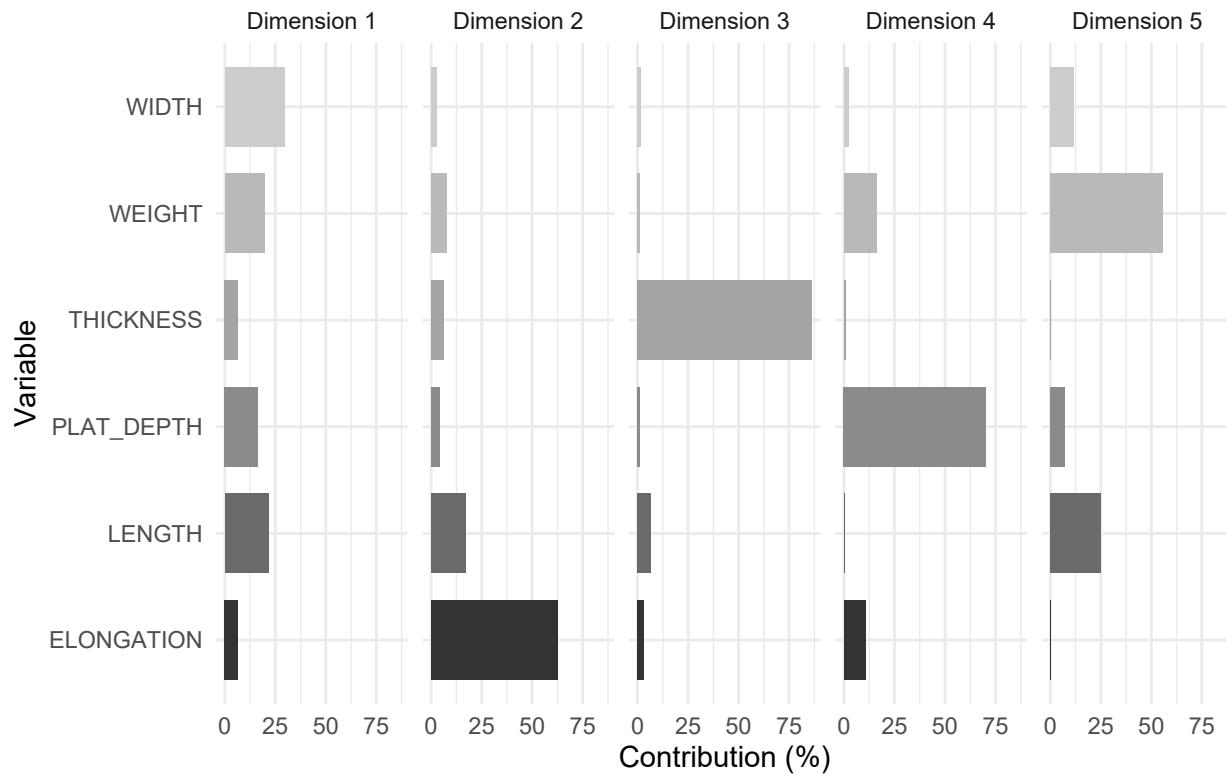
## Principal Component Analysis (PCA)

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

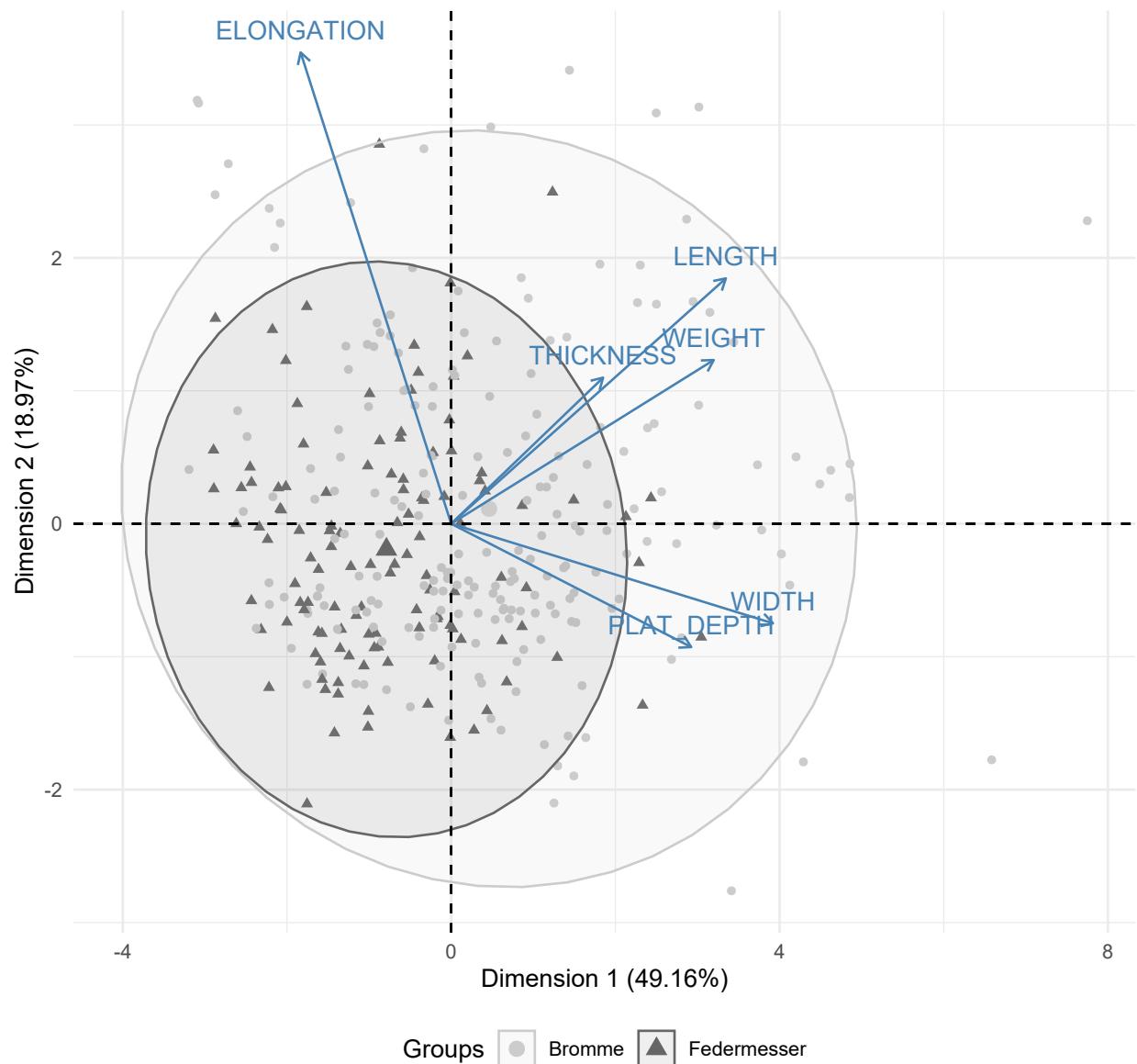
```
## # A tibble: 6 x 4
##   rowname eigenvalue variance cumulative
##   <chr>     <dbl>    <dbl>      <dbl>
## 1 Dim.1     2.95     49.2      49.2
## 2 Dim.2     1.14     19.0      68.1
## 3 Dim.3     0.848    14.1      82.3
## 4 Dim.4     0.608    10.1      92.4
## 5 Dim.5     0.411     6.84     99.2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



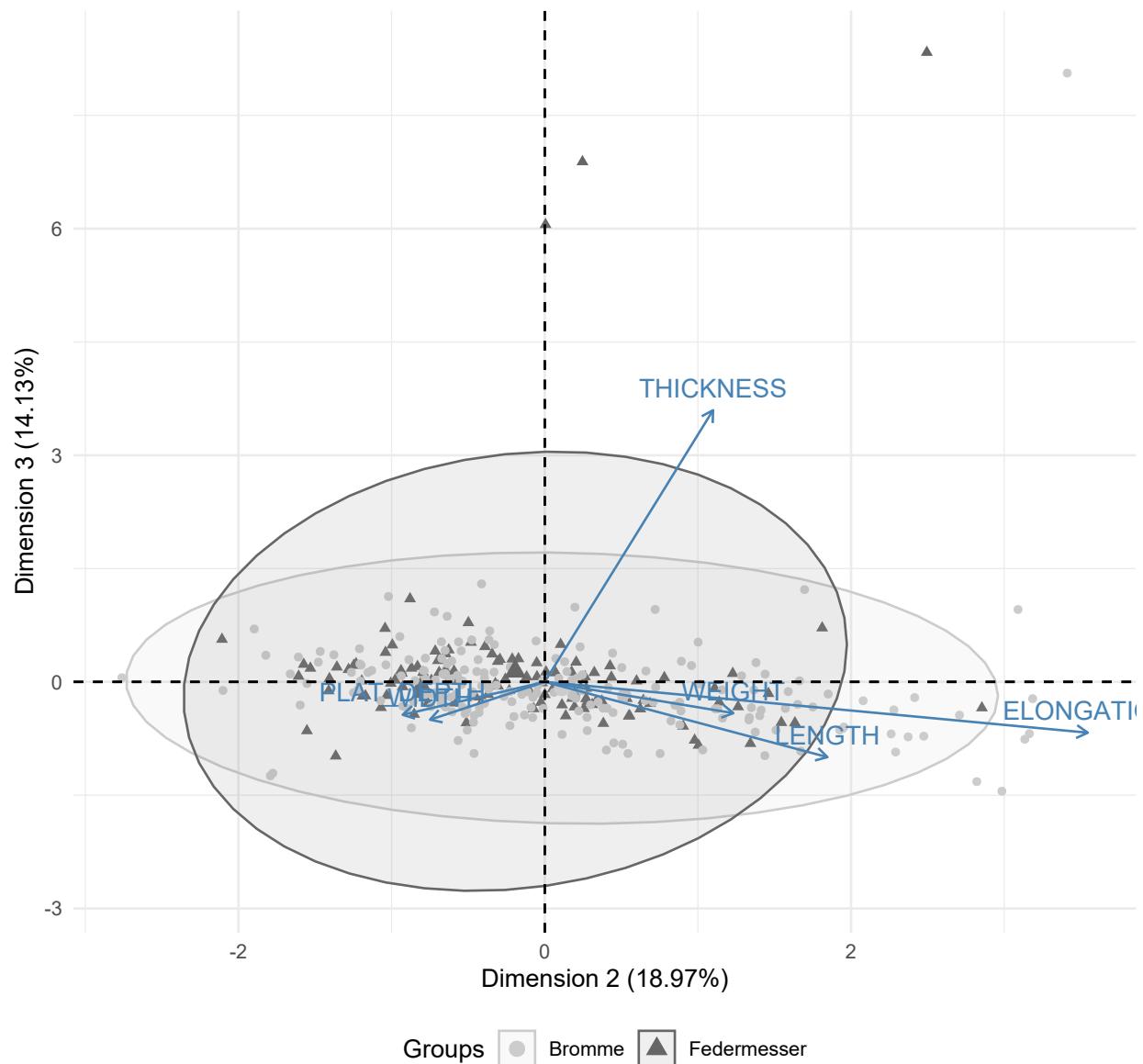
## Contribution of Variables



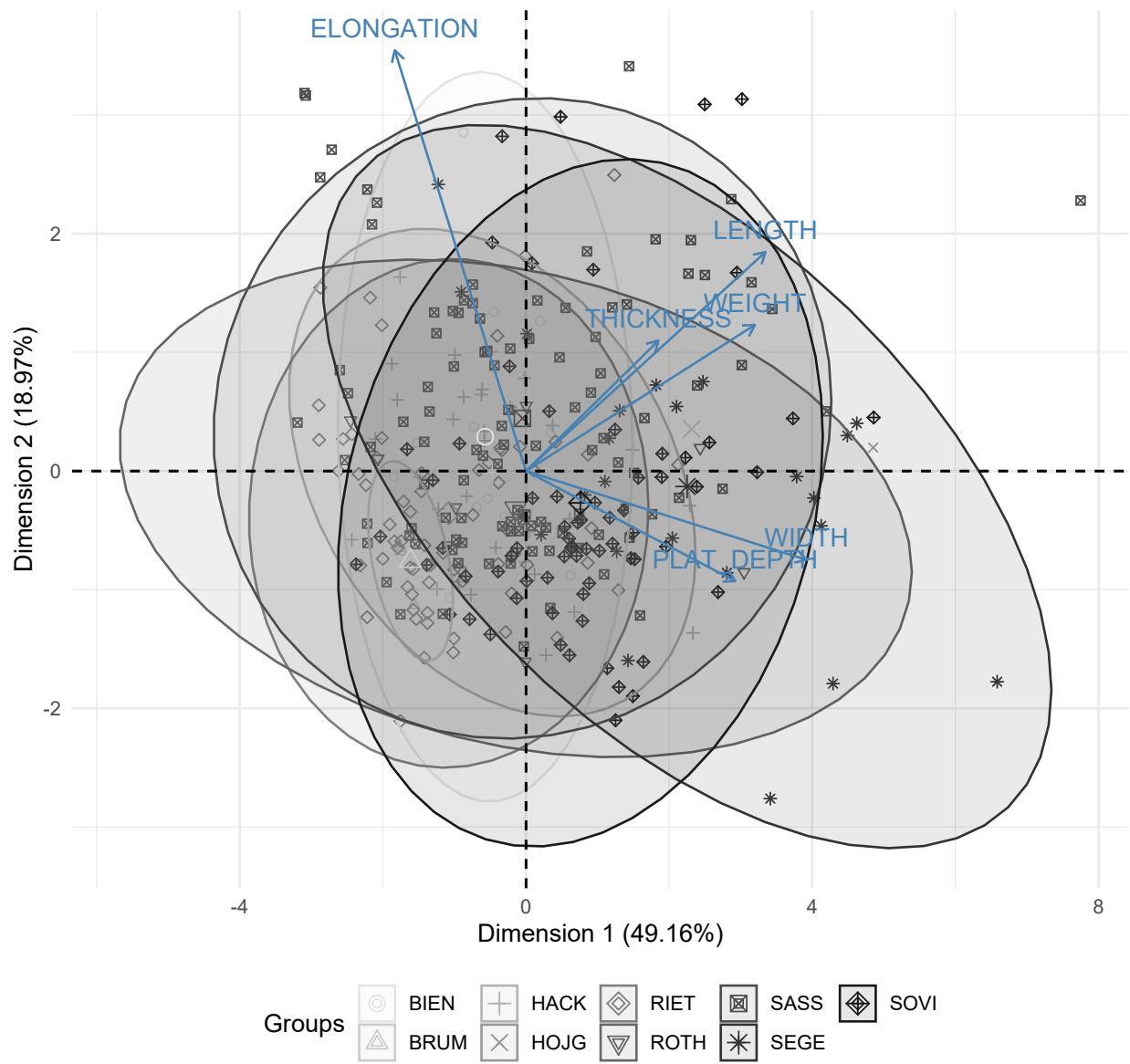
## PCA 1 vs. PCA 2 (Classification)



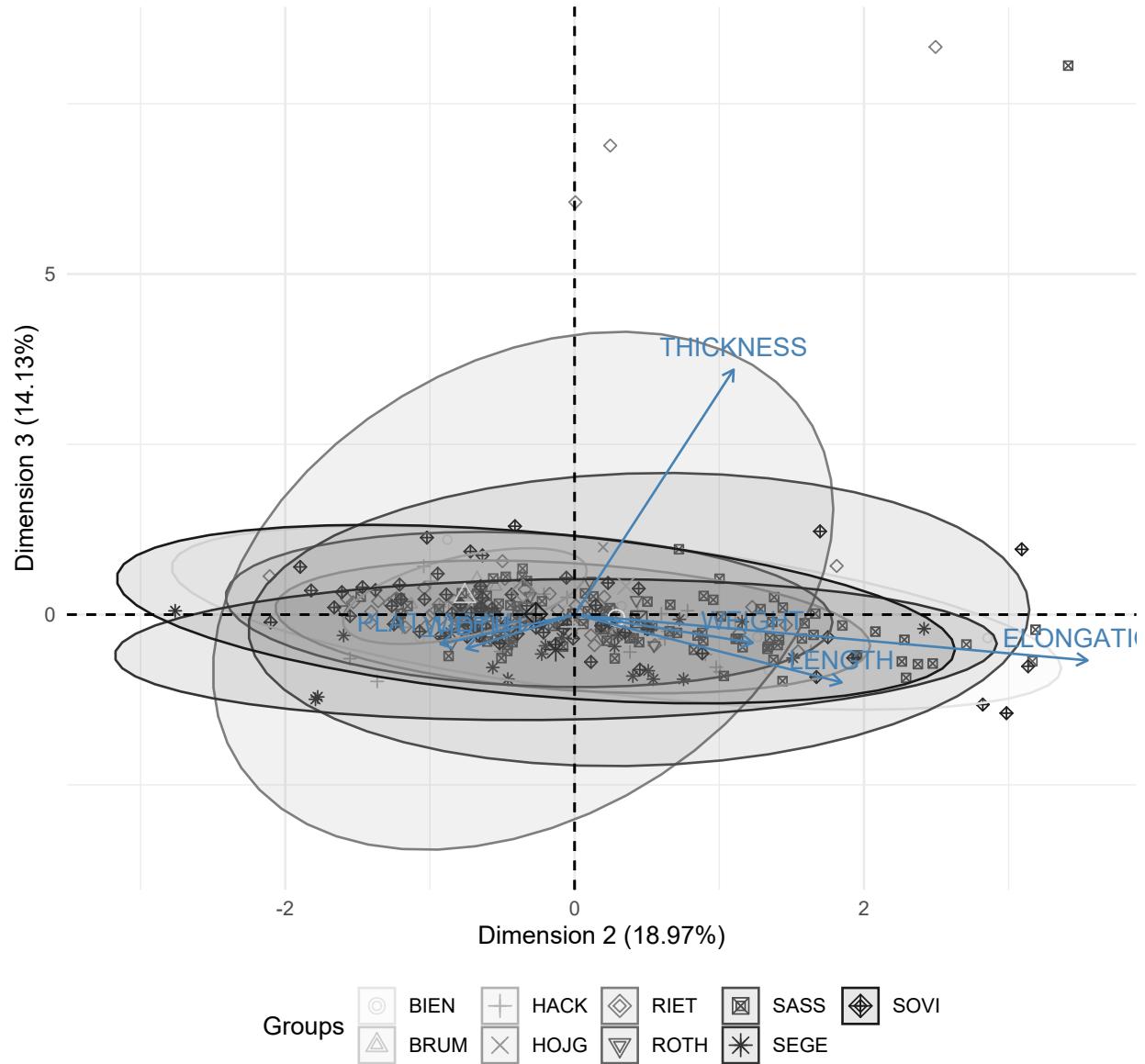
## PCA 2 vs. PCA 3 (Classification)



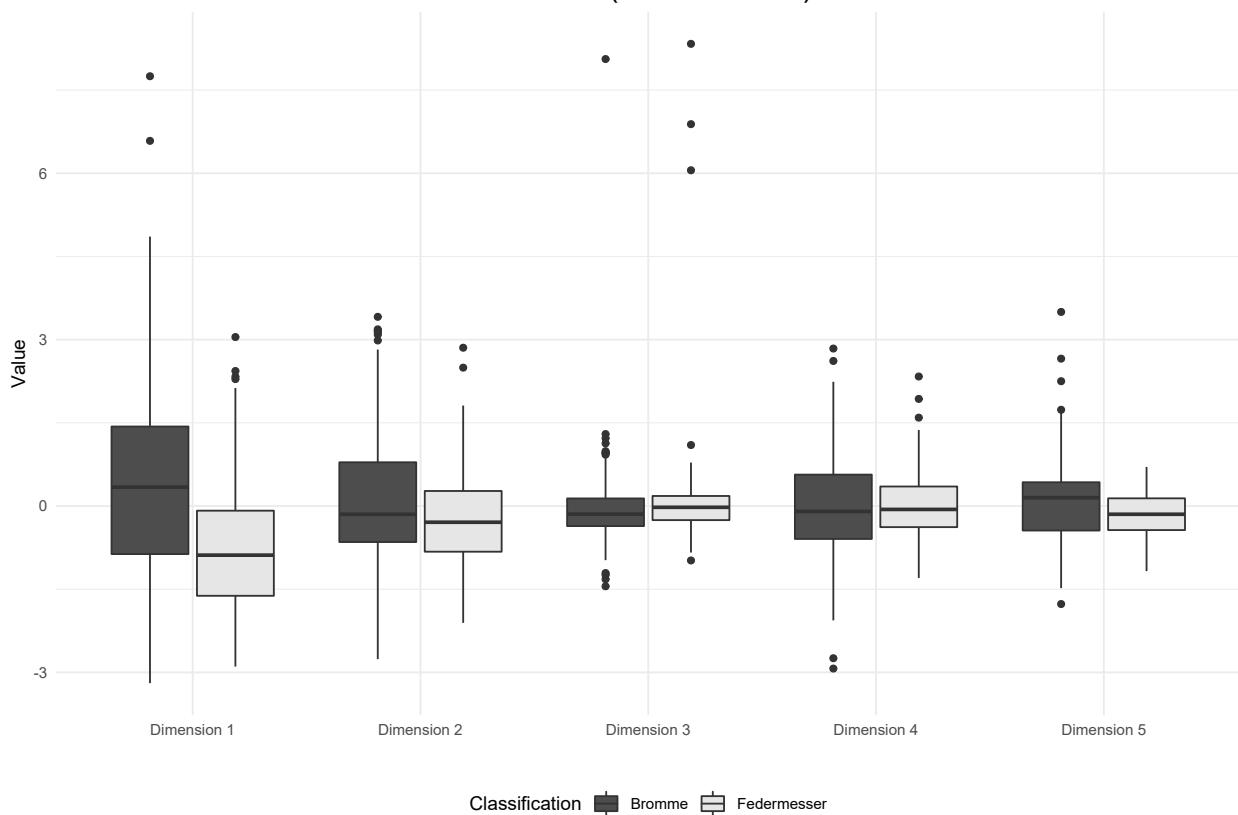
## PCA 1 vs. PCA 2 (Context)



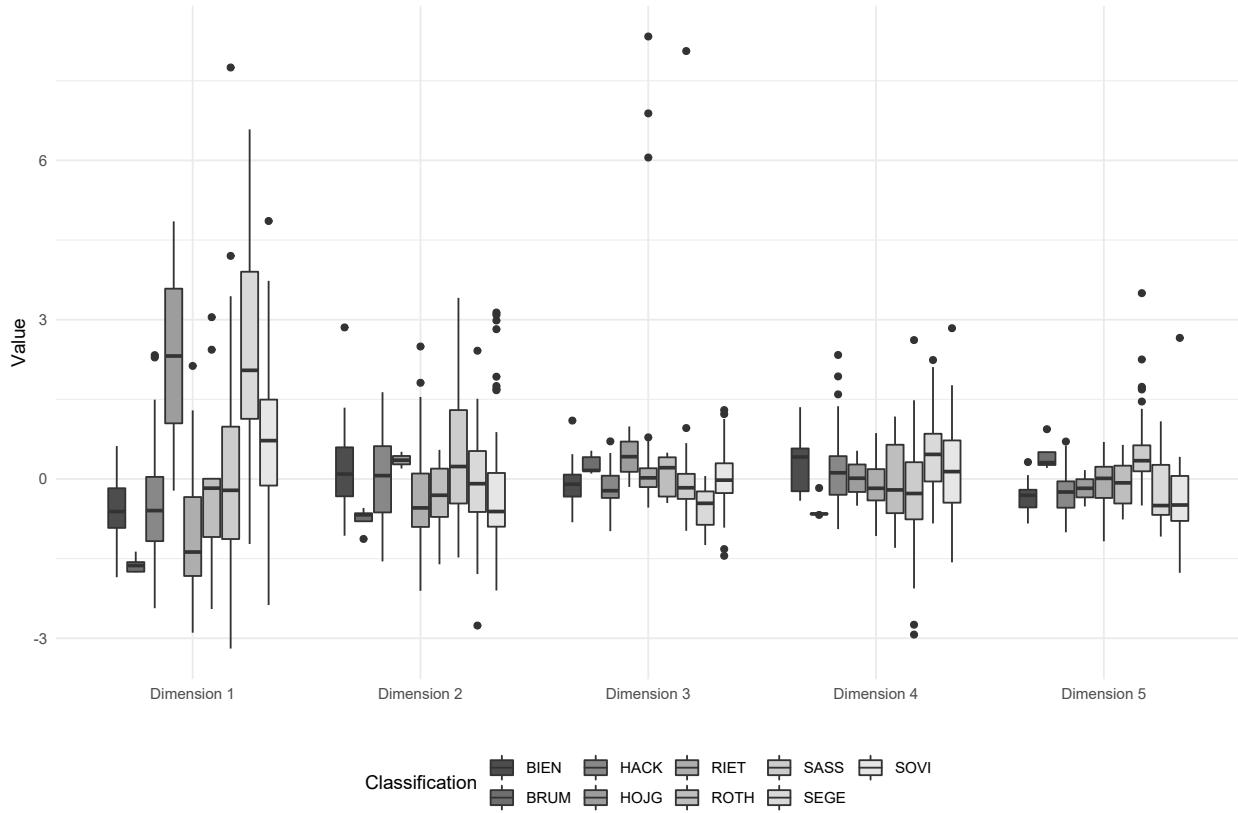
## PCA 2 vs. PCA 3 (Classification)



### PCA 1:5 (Classification)



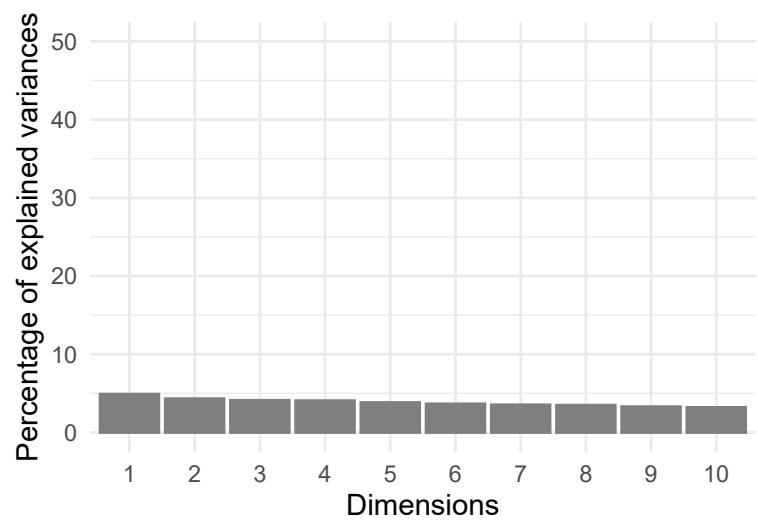
### PCA 1:5 (Classification)



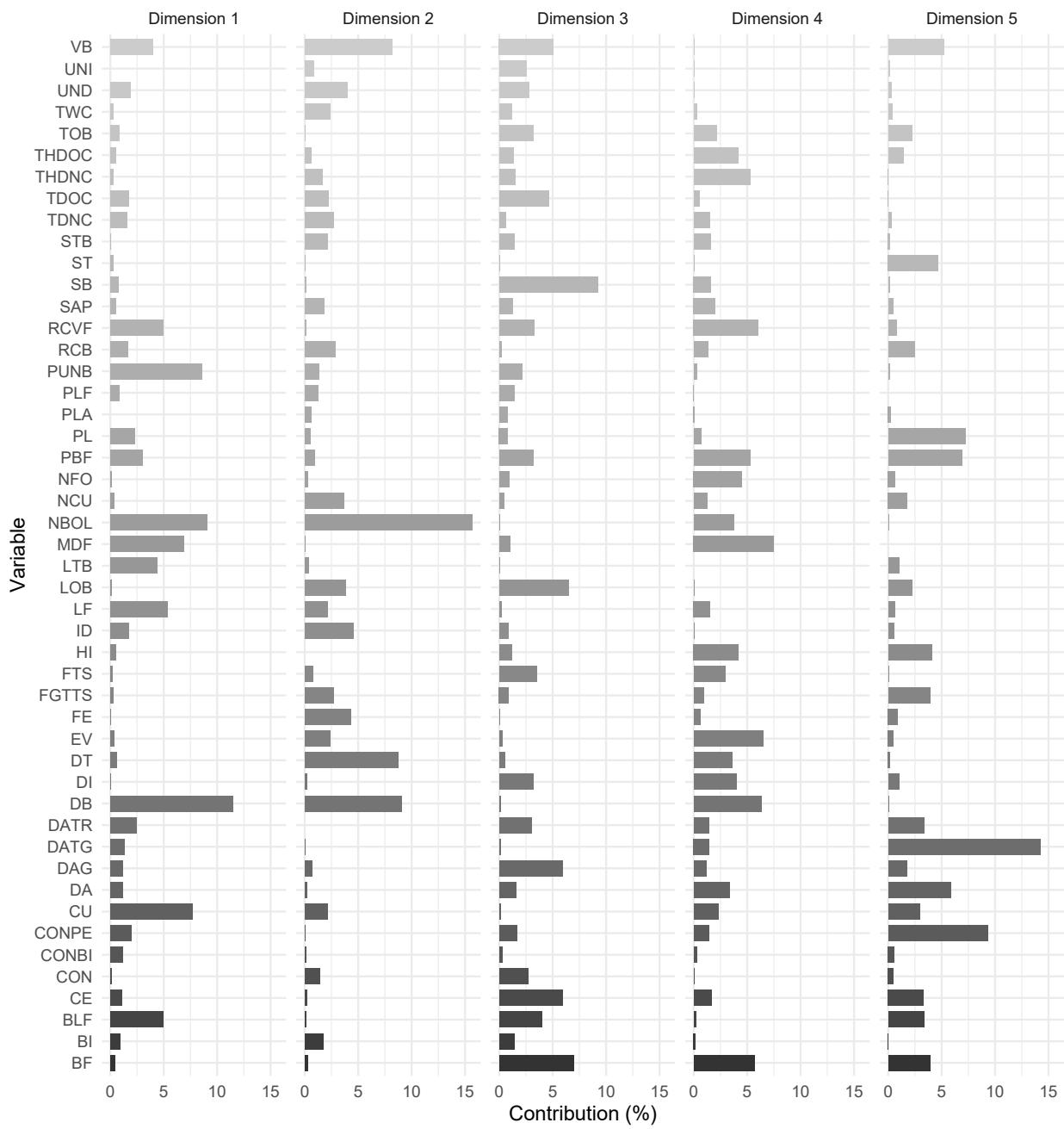
### Multiple Correspondence Analysis (MCA)

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
```



## Contribution of Variables



Refer to the attribute catalogue for specific terminology

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**)

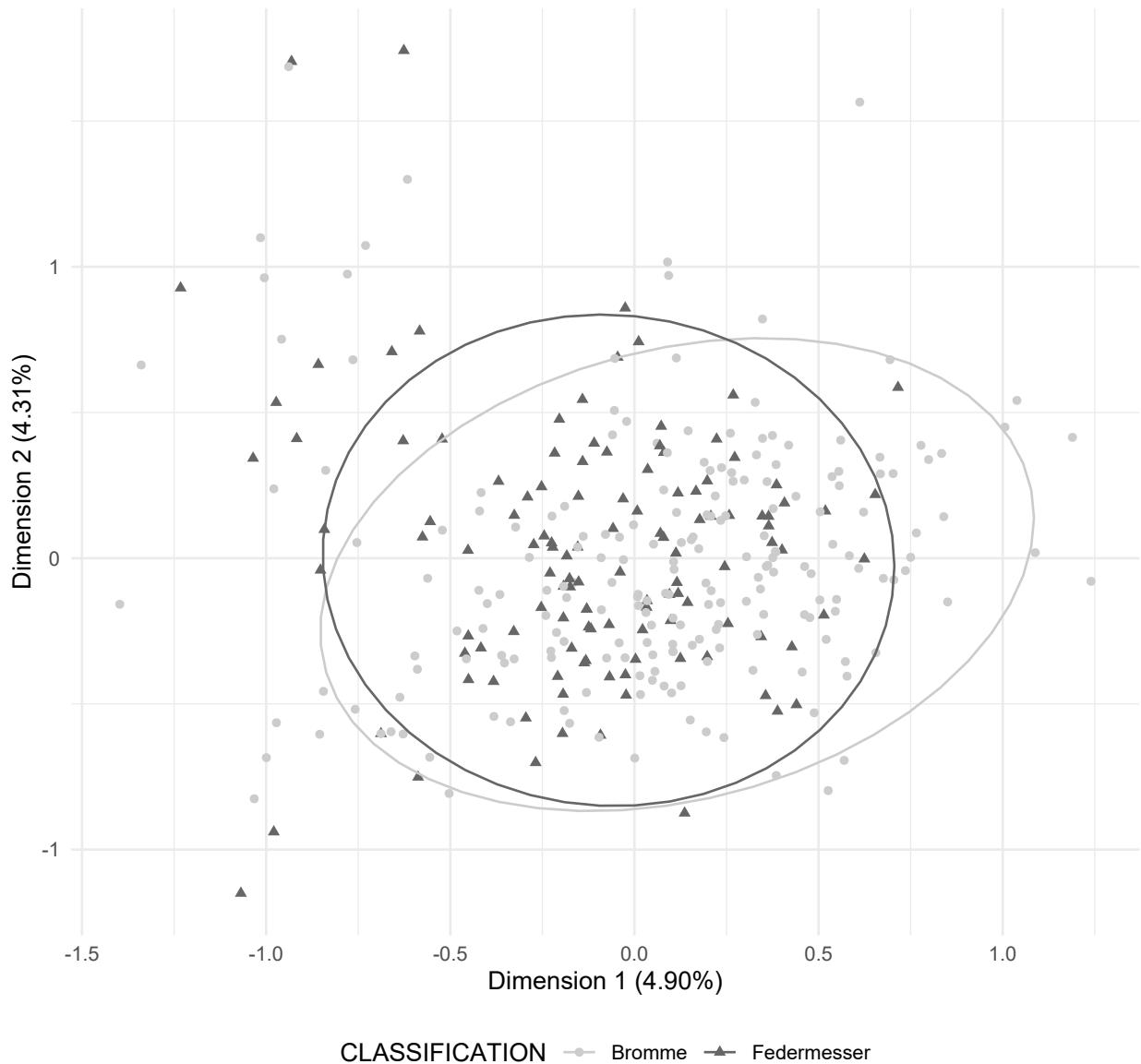
**MDF:** Multiple dorsal faces (**Dorsal Blade Prof**)

Key acronyms for responses in *Axis 2*:

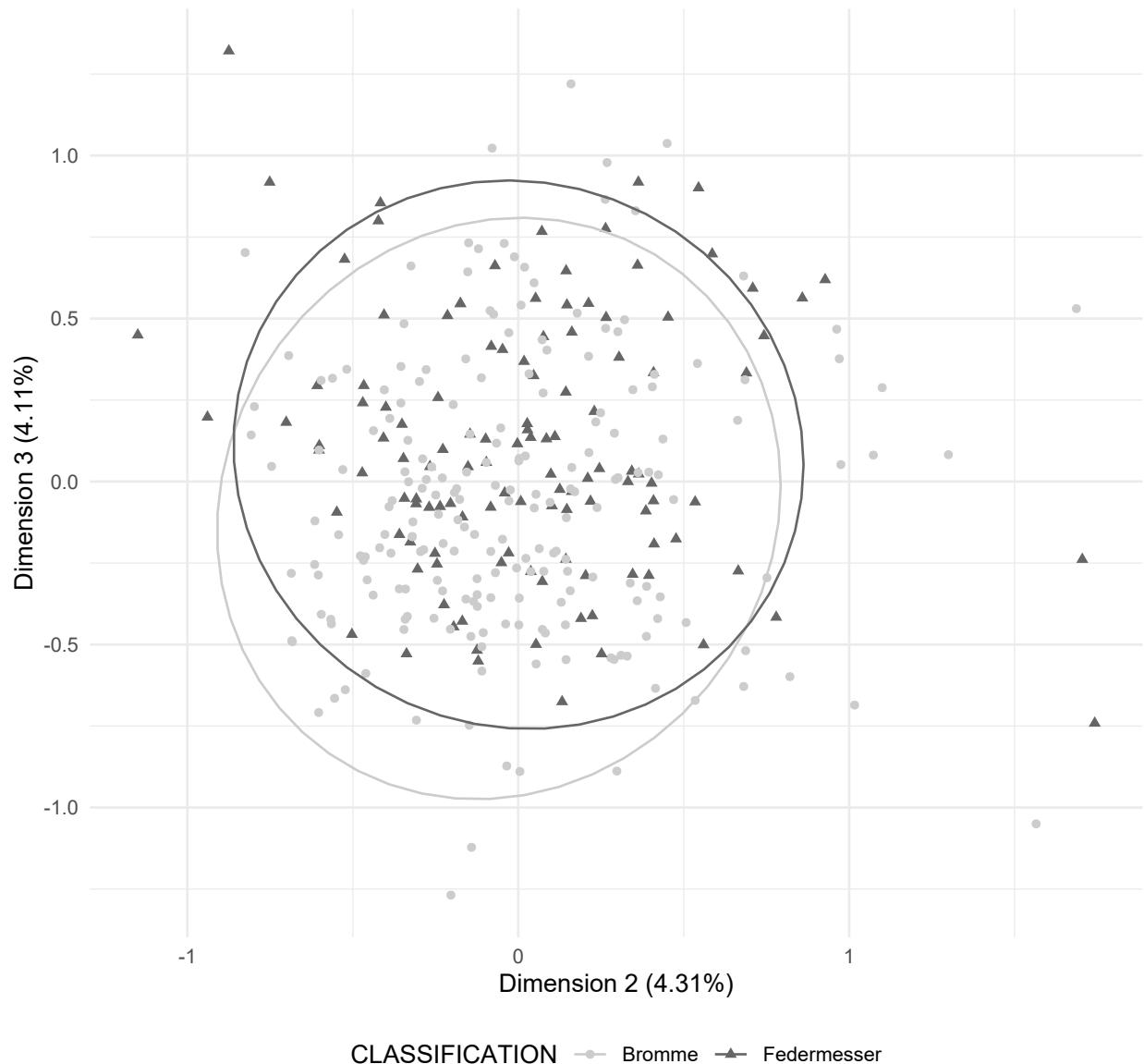
**NBOL:** No bulb or lip (**Bulb Morph**)

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

### MCA 1 vs. MCA 2 (Classification)

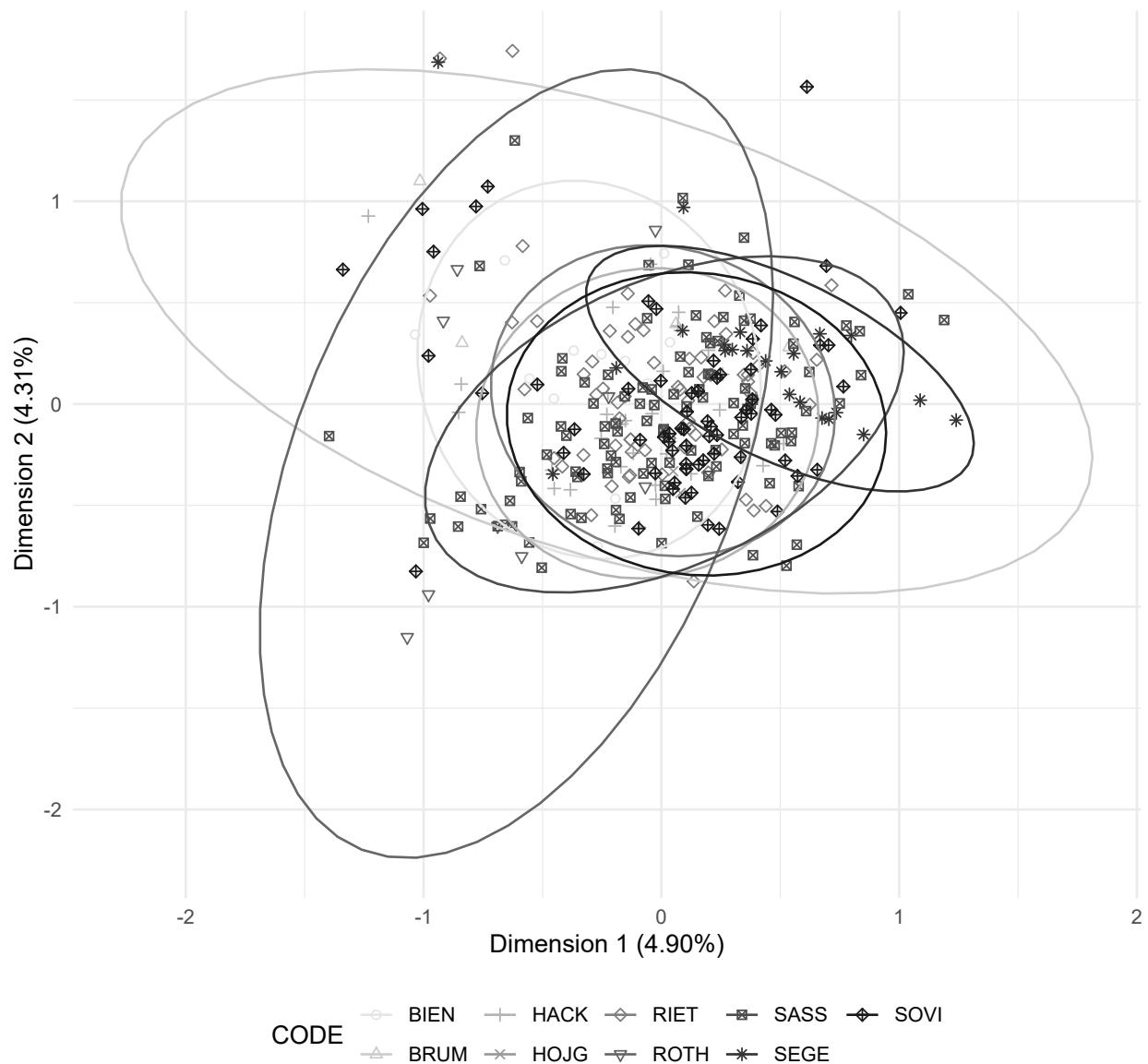


## MCA 2 vs. MCA 3 (Classification)



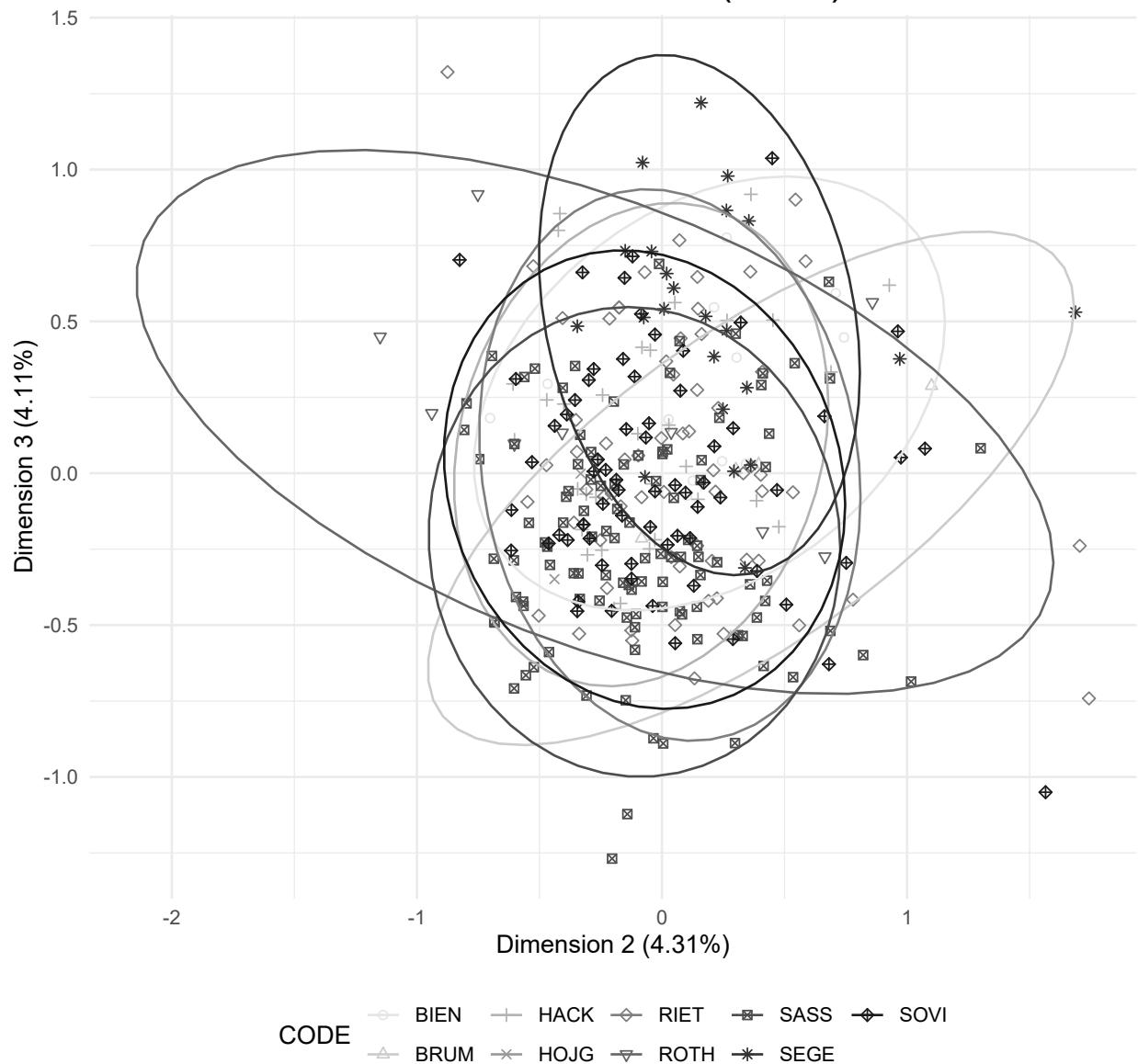
## Warning: Removed 1 row(s) containing missing values (geom\_path).

## MCA 1 vs. MCA 2 (Code)

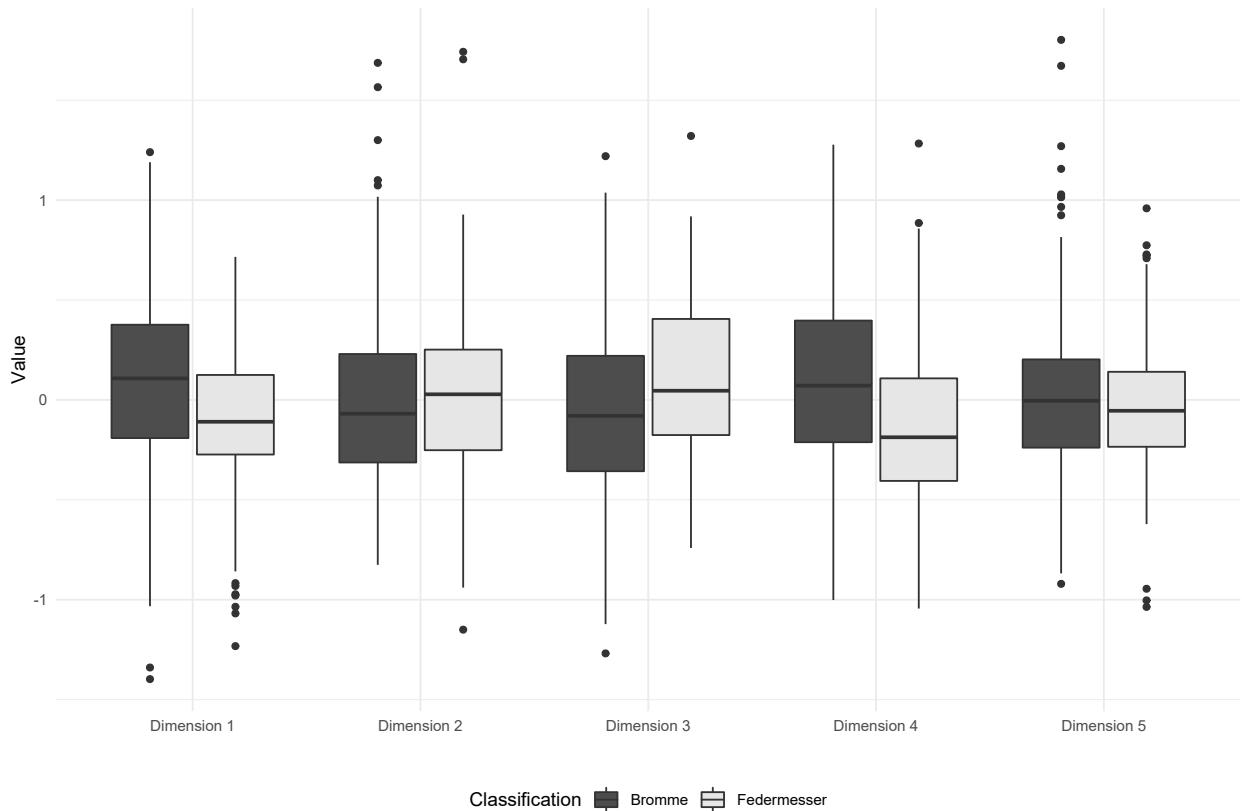


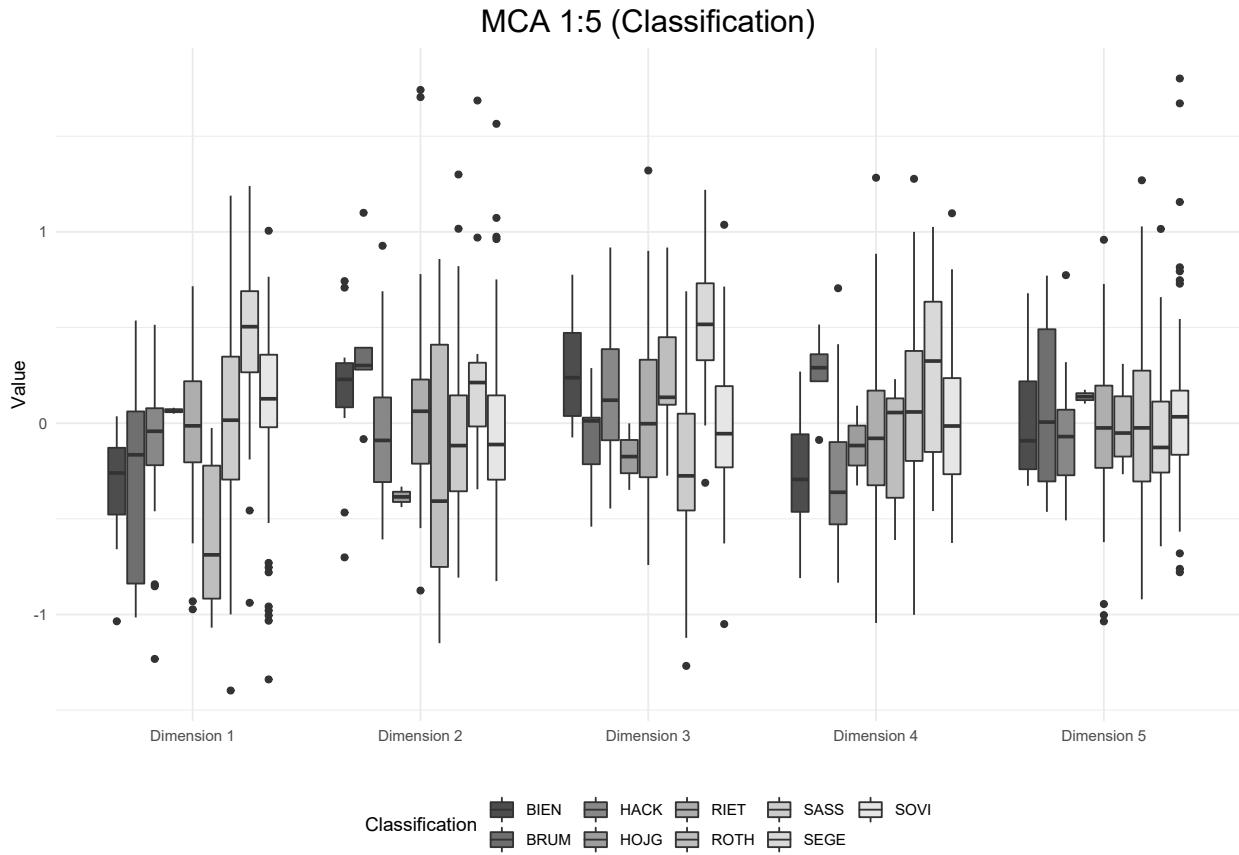
```
## Warning: Removed 1 row(s) containing missing values (geom_path).
```

## MCA 2 vs. MCA 3 (Code)



### MCA 1:5 (Classification)





## 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)

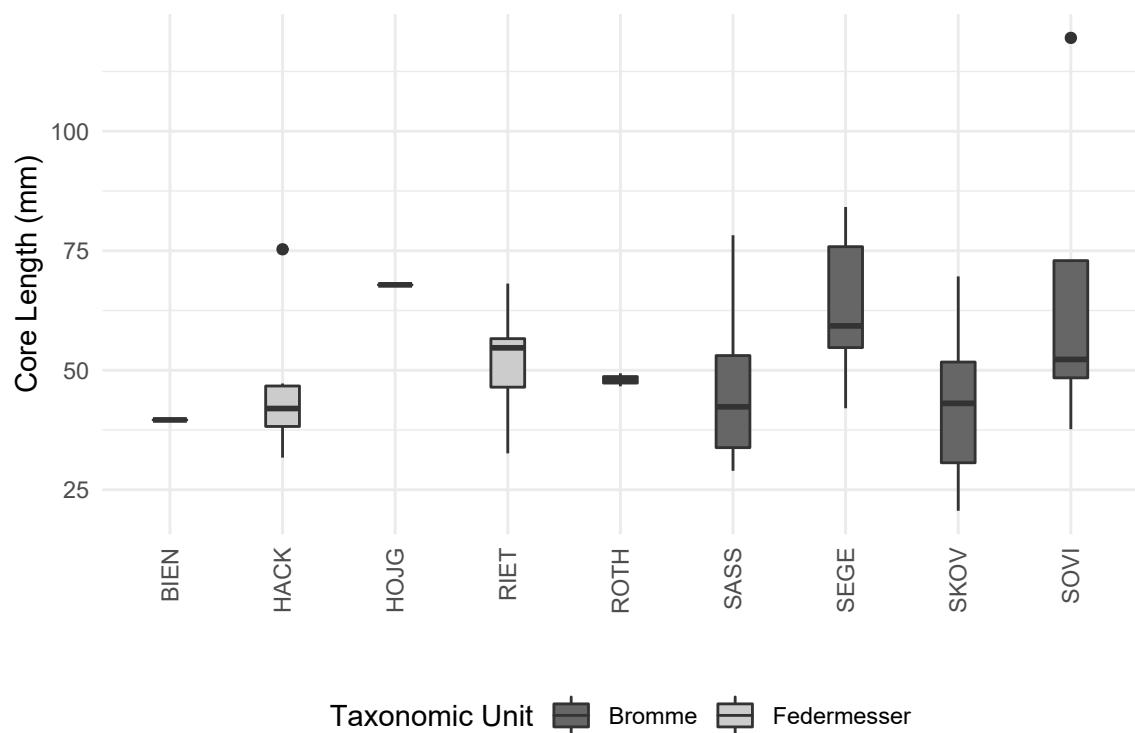
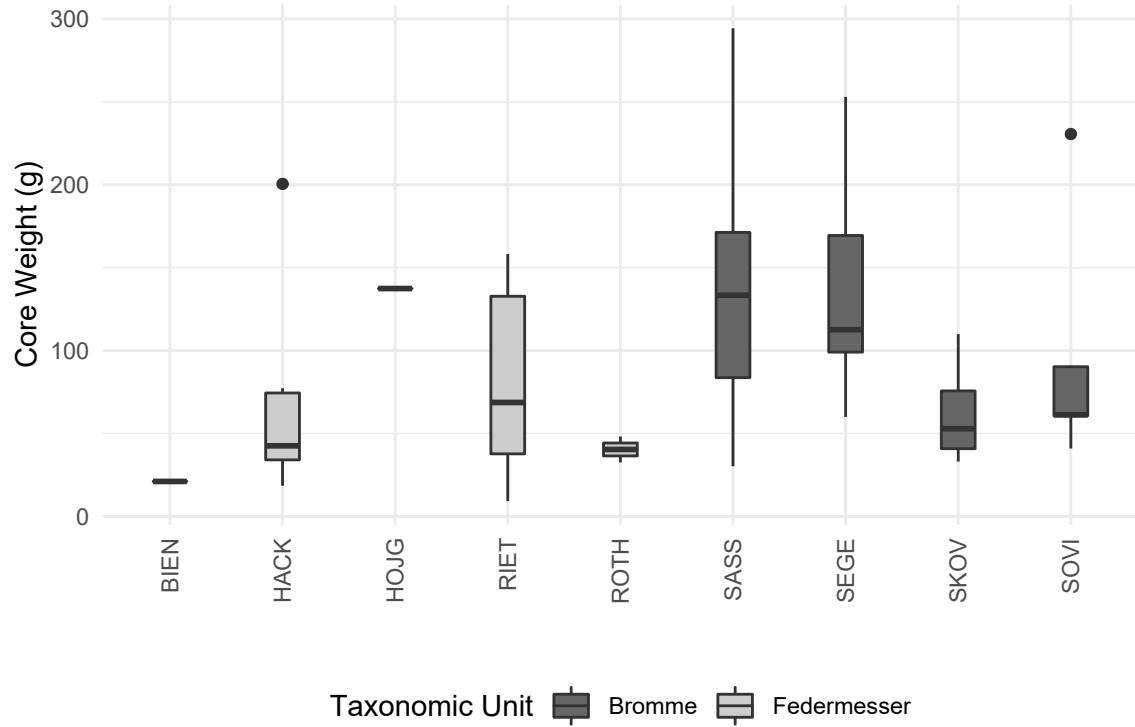
CLASSIFICATION	n_obs	min	max	mean	med	sd	var
Bromme	50	13.10	74.32	34.85	32.42	15.64	244.46
Federmesser	20	14.53	55.26	27.26	25.29	10.39	108.02

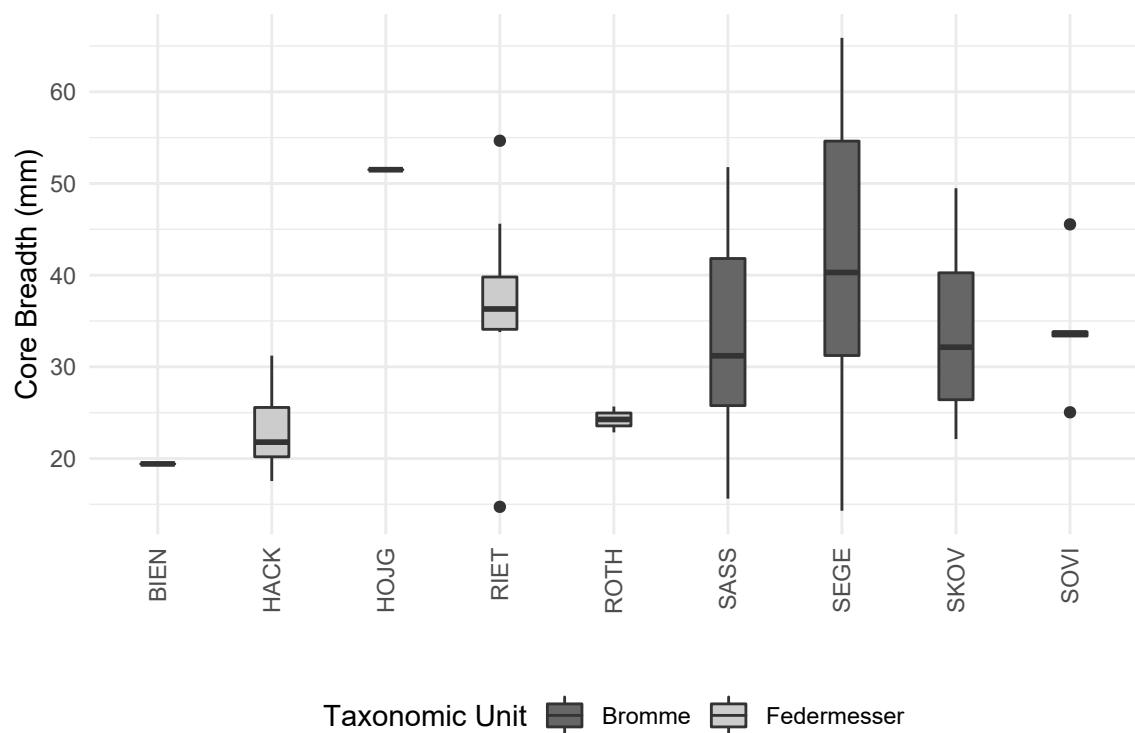
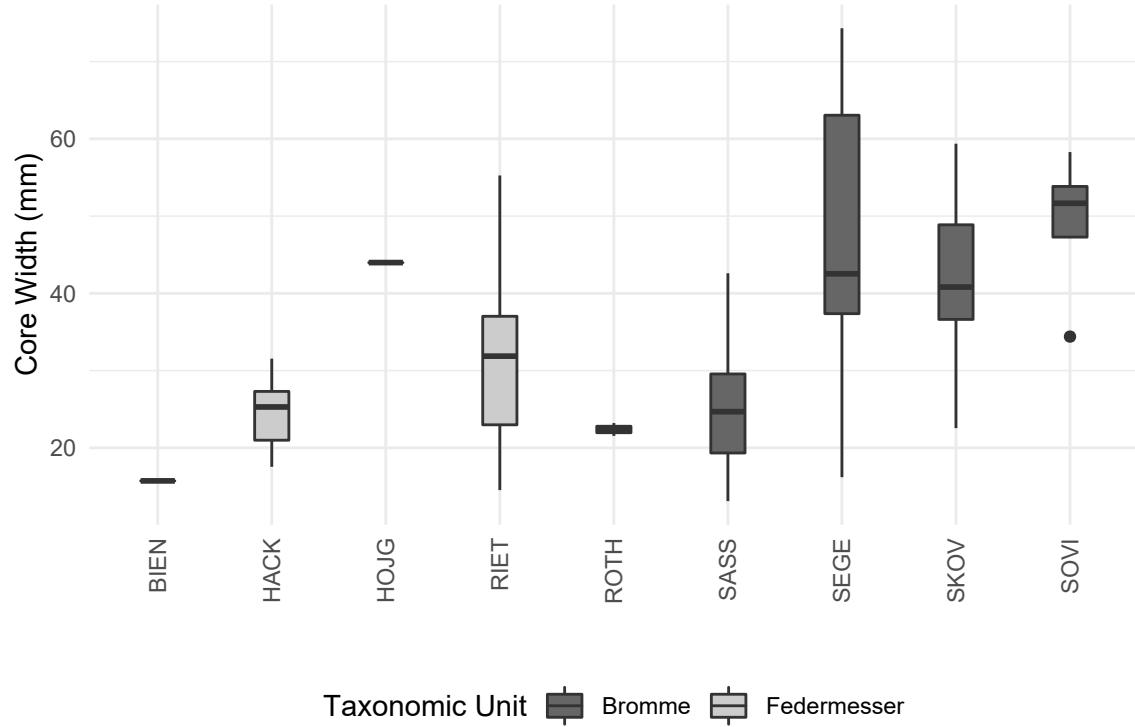
Table 23. Descriptive Statistics: Blade Core Breadth (mm)

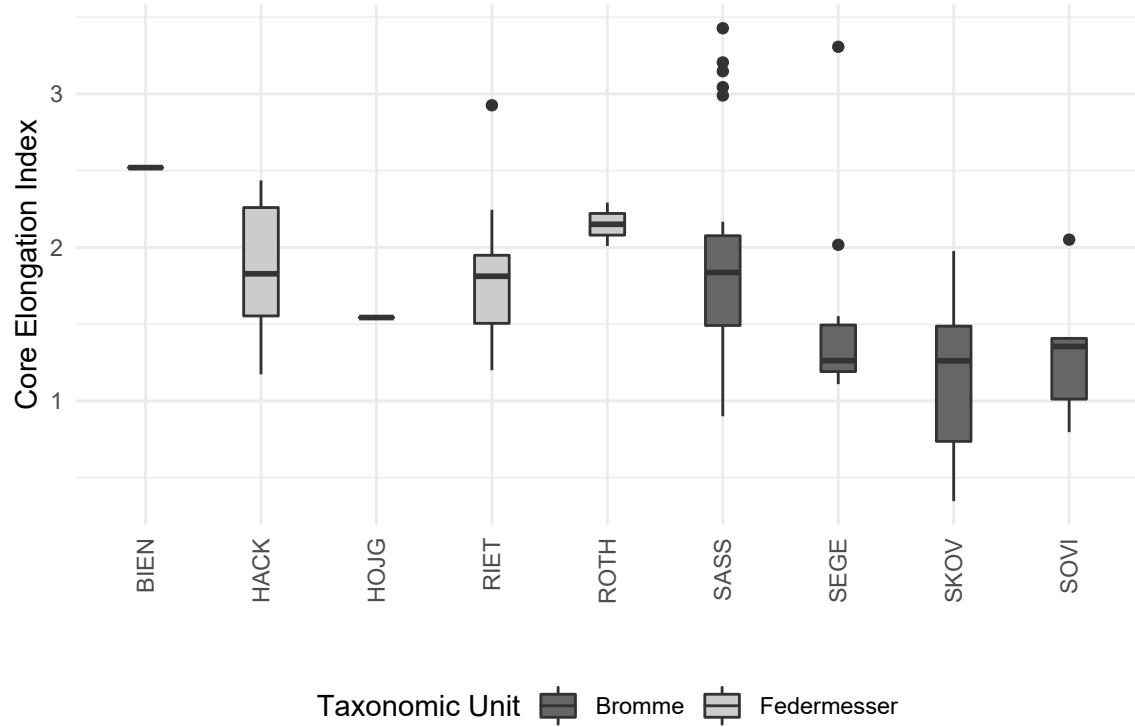
CLASSIFICATION	n_obs	min	max	mean	med	sd	var
Bromme	50	14.30	65.88	35.40	33.24	11.98	143.47
Federmesser	20	14.73	54.66	29.19	27.20	10.27	105.56

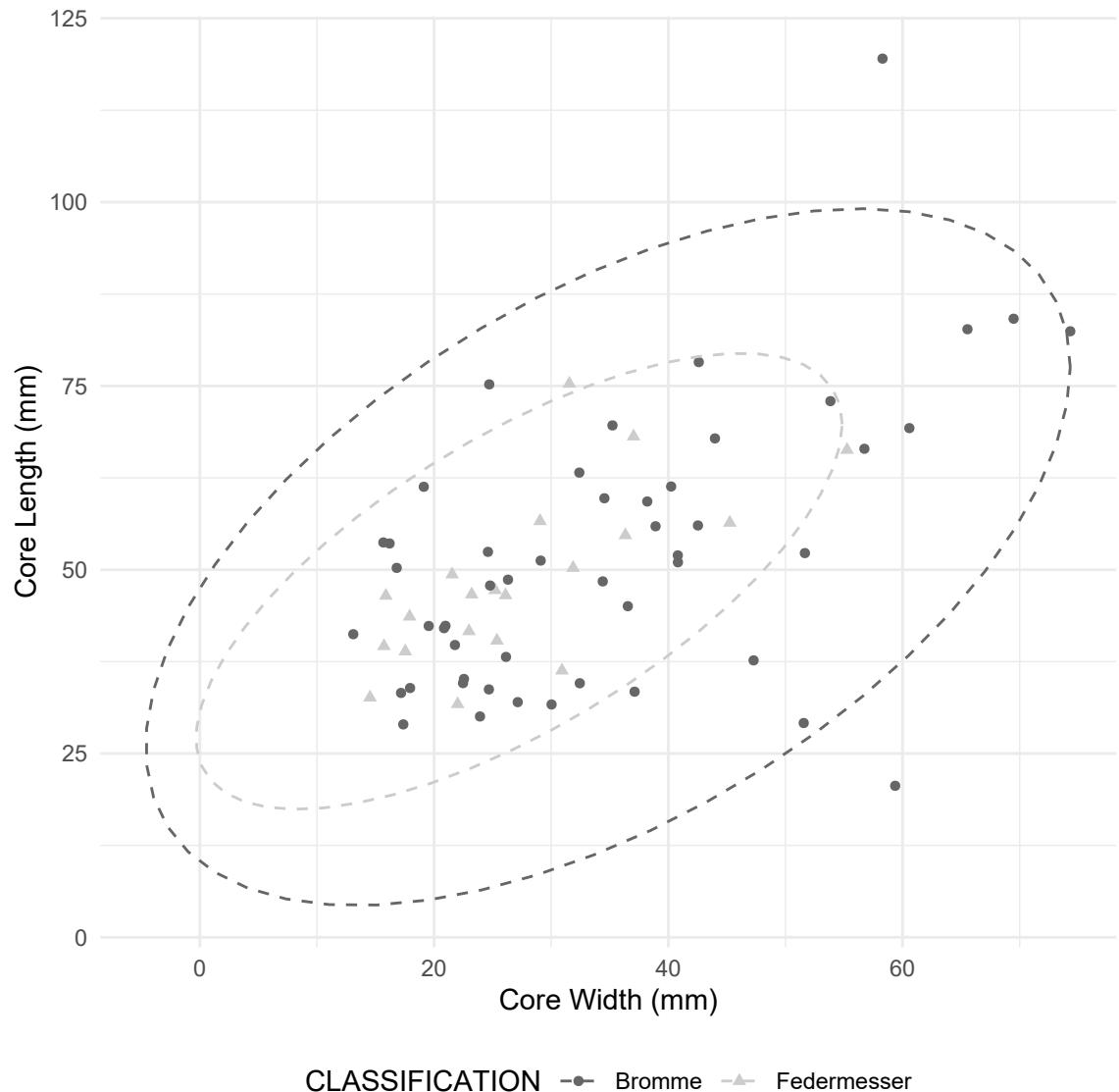
Table 24. Descriptive Statistics: Blade Core Elongation (L/W)

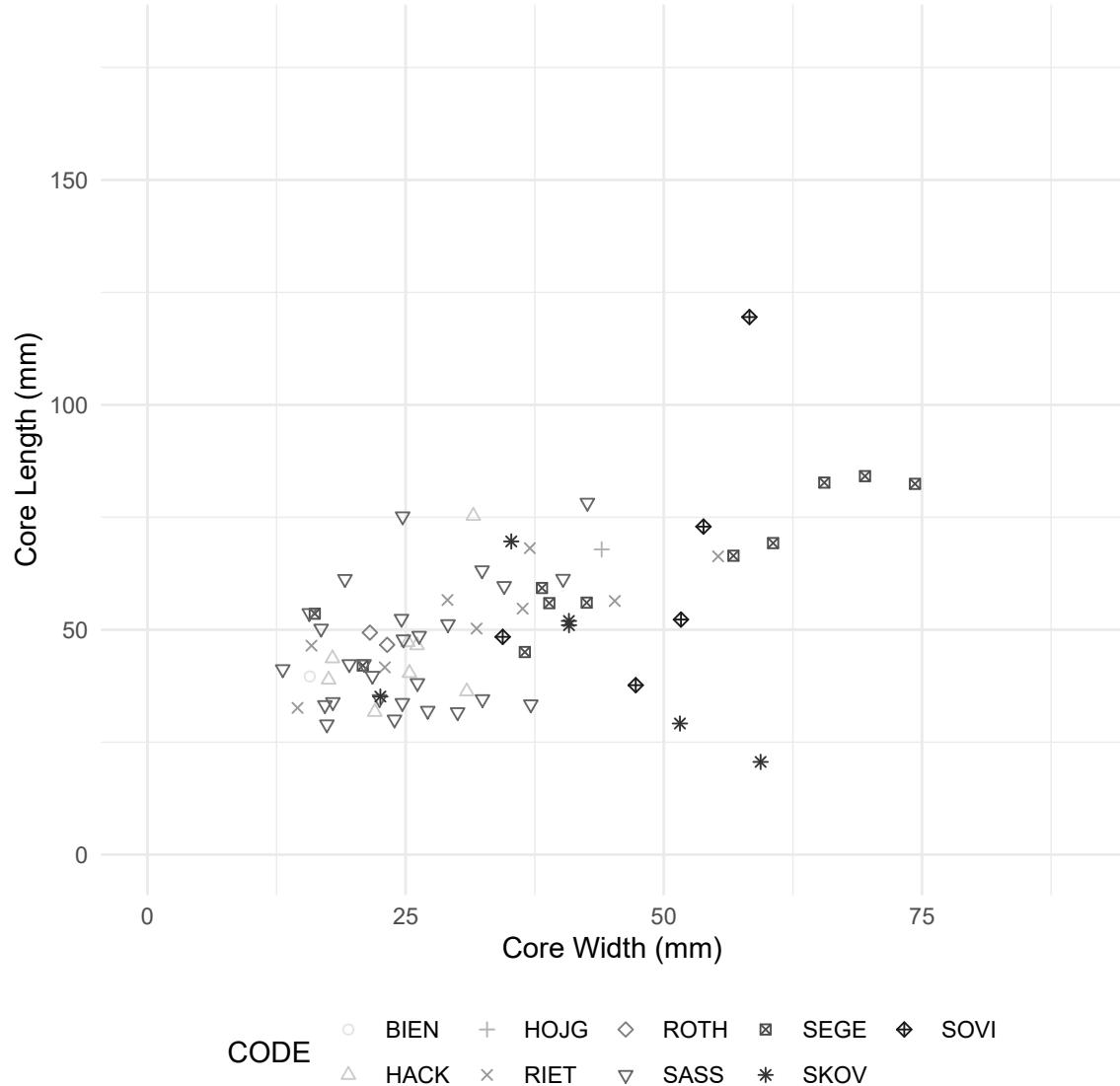
CLASSIFICATION	n_obs	min	max	mean	med	sd	var
Bromme	50	0.35	3.43	1.67	1.54	0.69	0.48
Federmesser	20	1.17	2.93	1.90	1.86	0.48	0.23











```
##
## 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
##

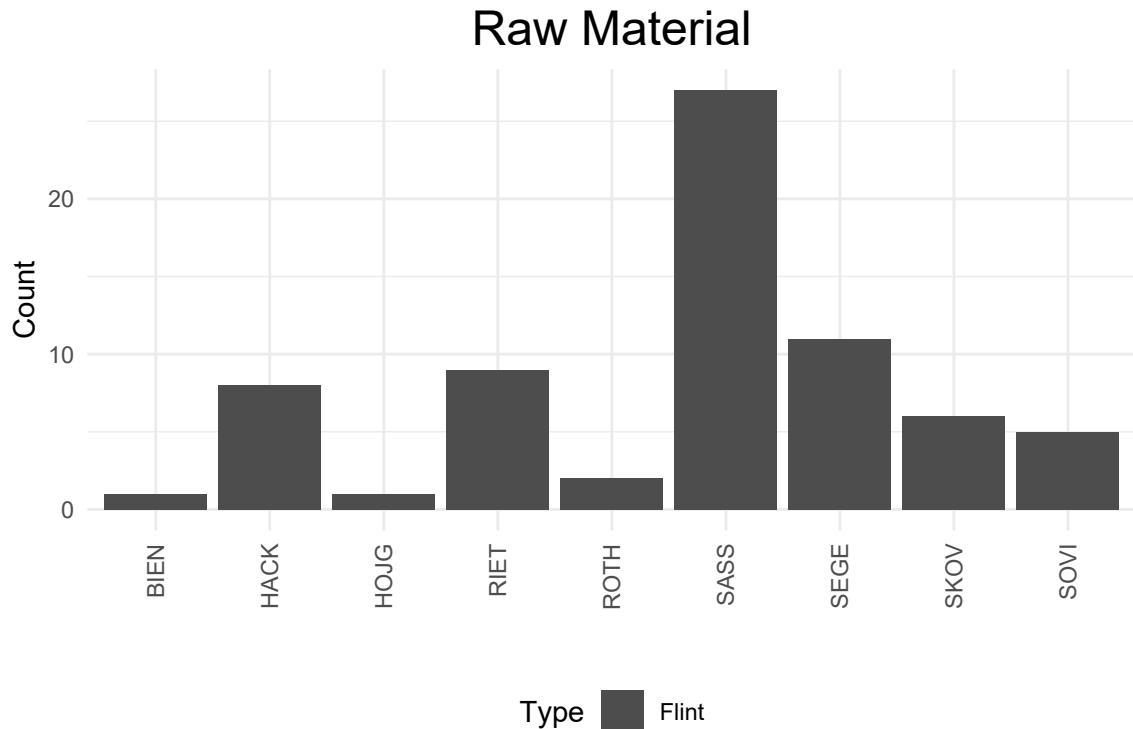
```

```

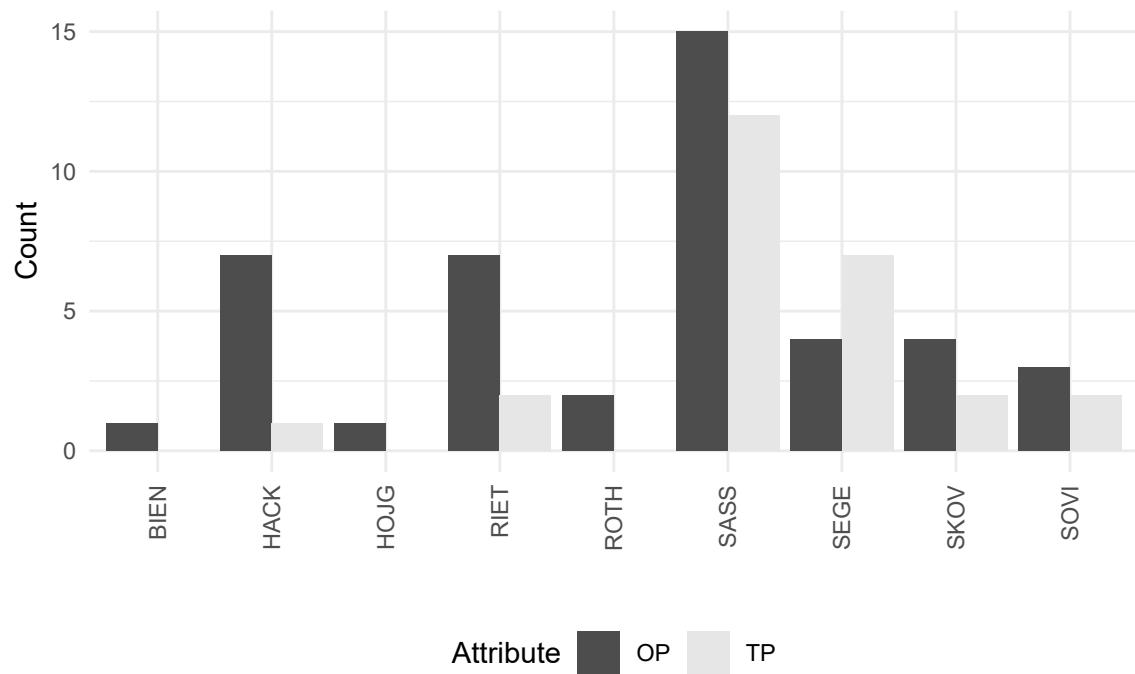
##      BIEN HACK HOJG RIET ROTH SASS SEGE SKOV
## HACK 1   -   -   -   -   -   -   -
## HOJG 1   1   -   -   -   -   -   -
## RIET 1   1   1   -   -   -   -   -
## ROTH 1   1   1   1   -   -   -   -
## SASS 1   1   1   1   1   -   -   -
## SEGE 1   1   1   1   1   1   -   -
## SKOV 1   1   1   1   1   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

```

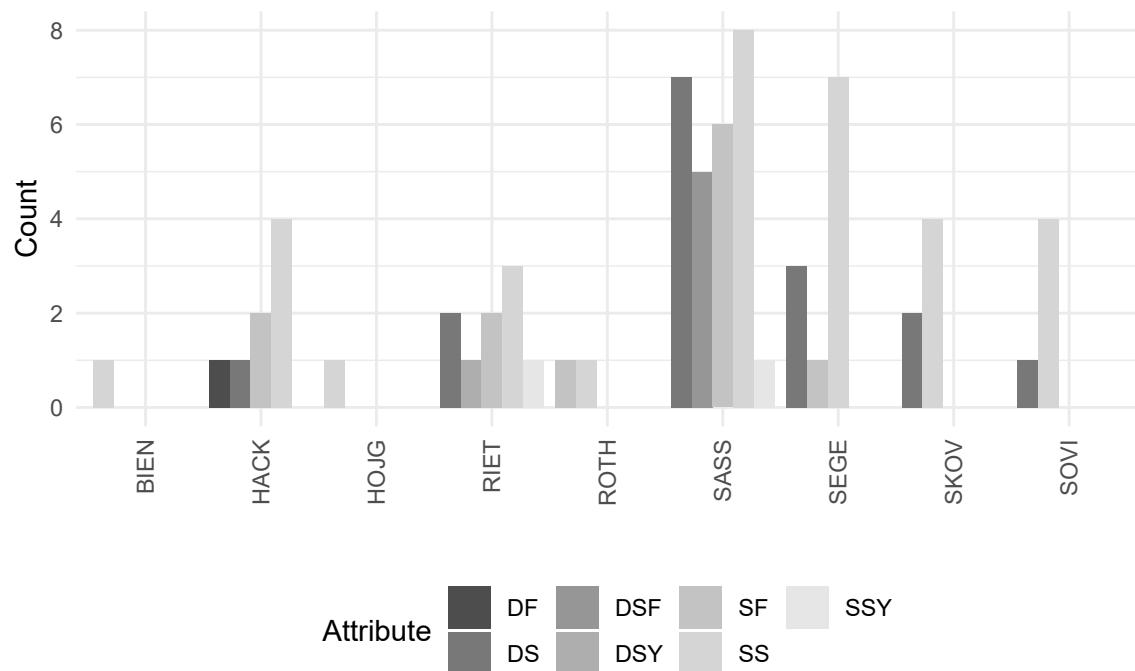
```
##  
##          Bromme  
## Federmesser 0.055  
##  
## P value adjustment method: bonferroni
```



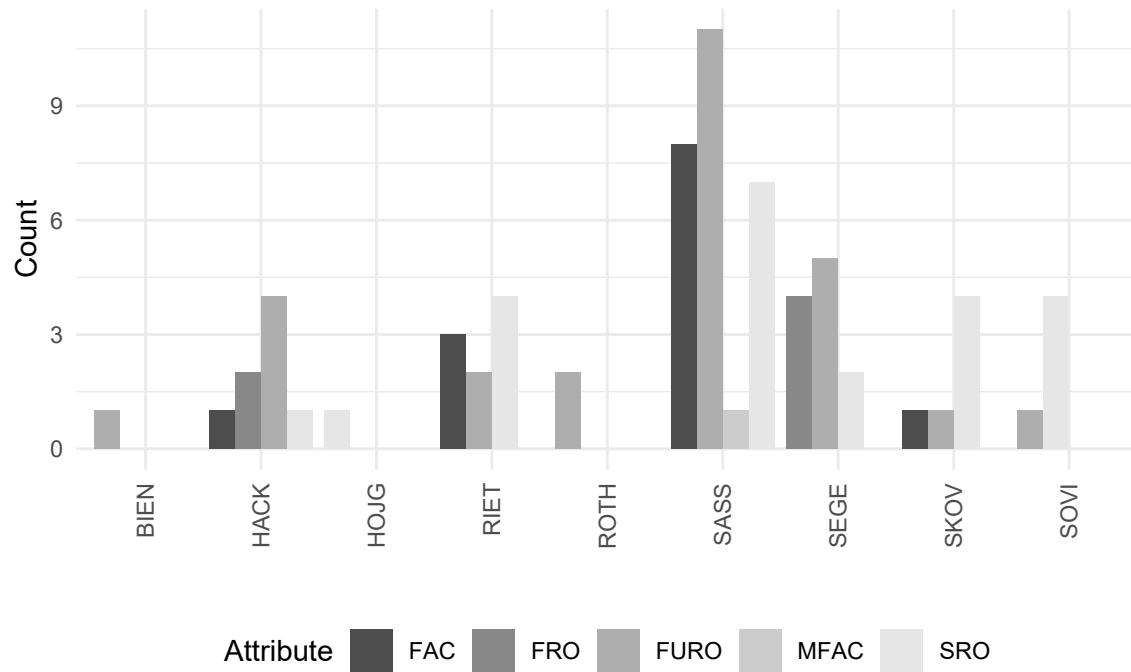
## Core Morphology



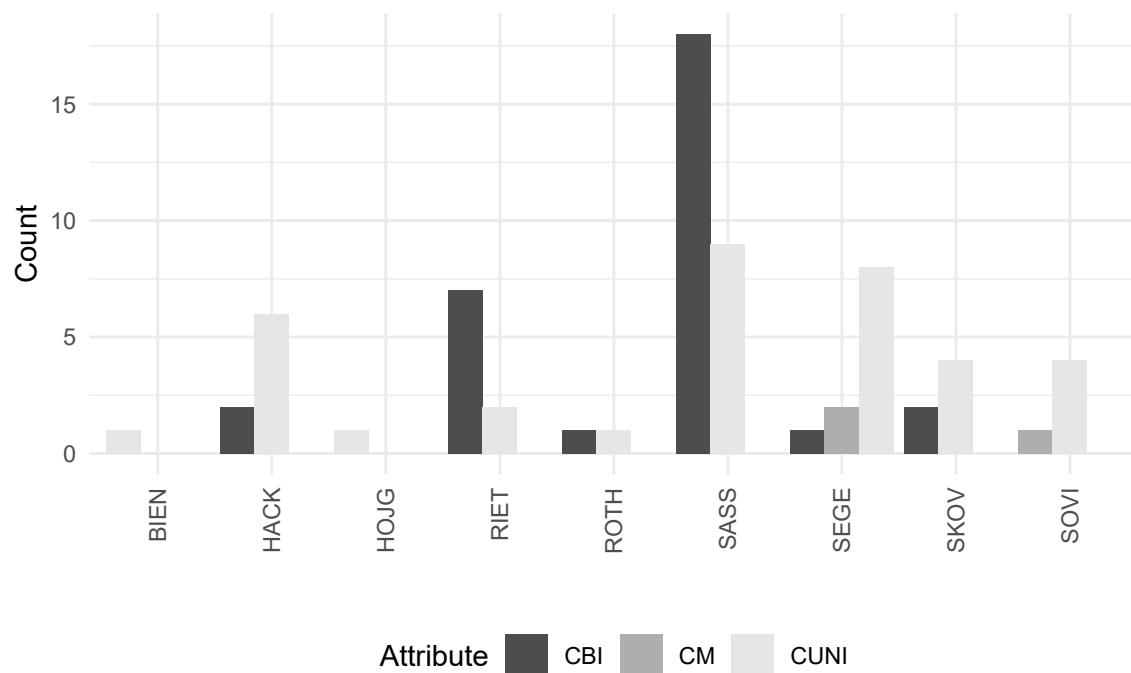
## Platform Profile



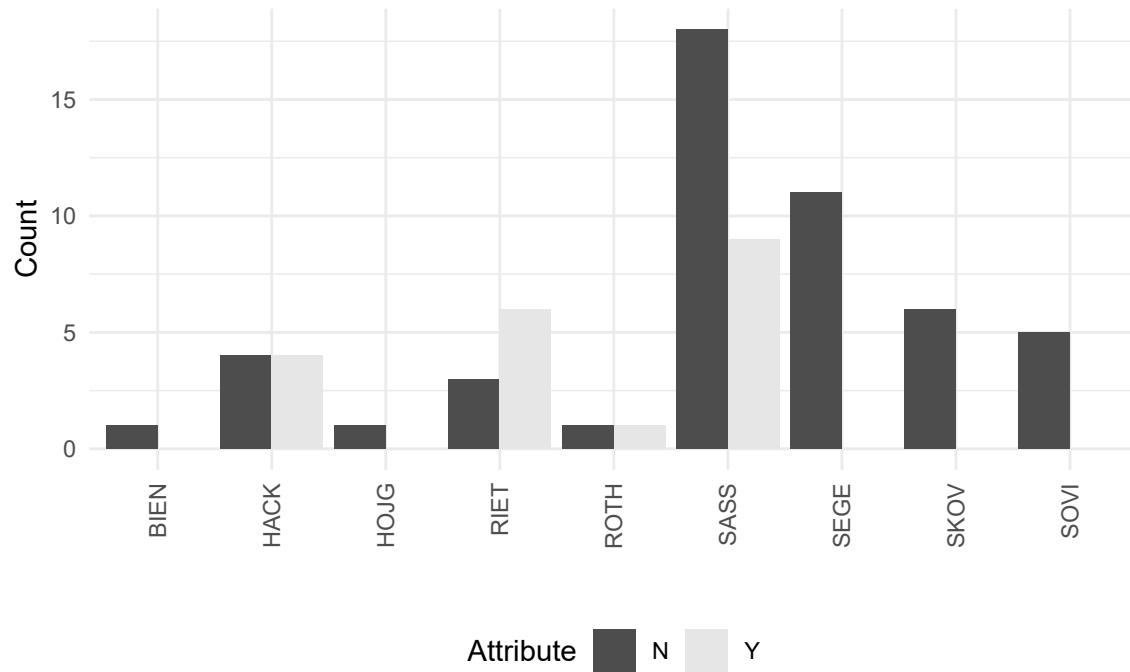
## Core Reduction Strategy



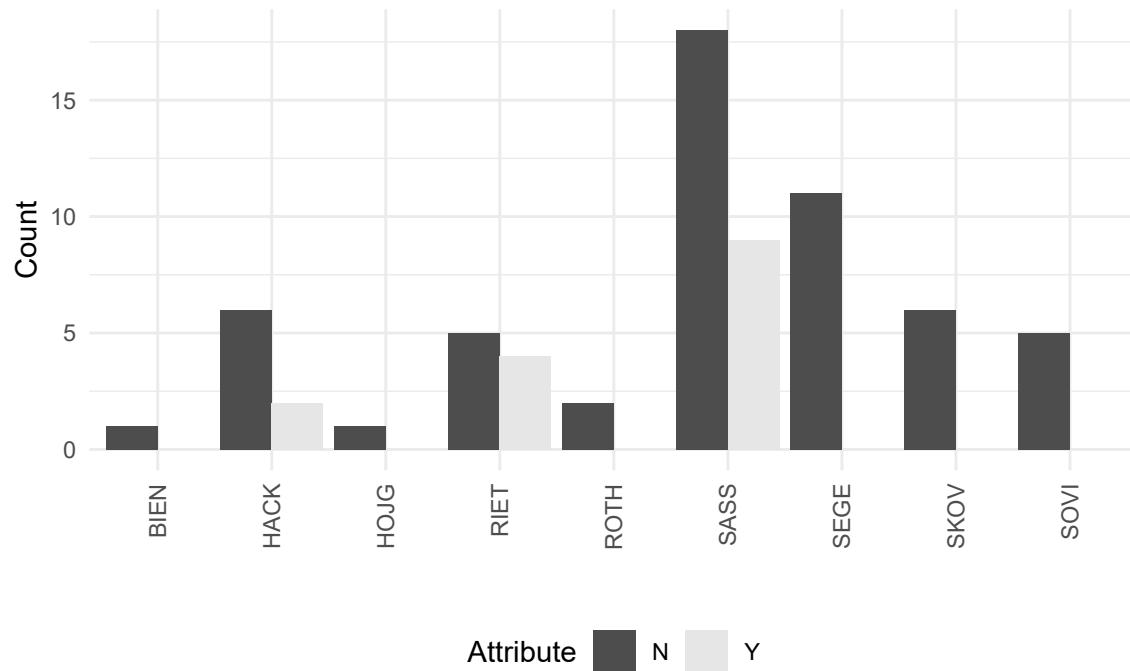
## Core Directionality



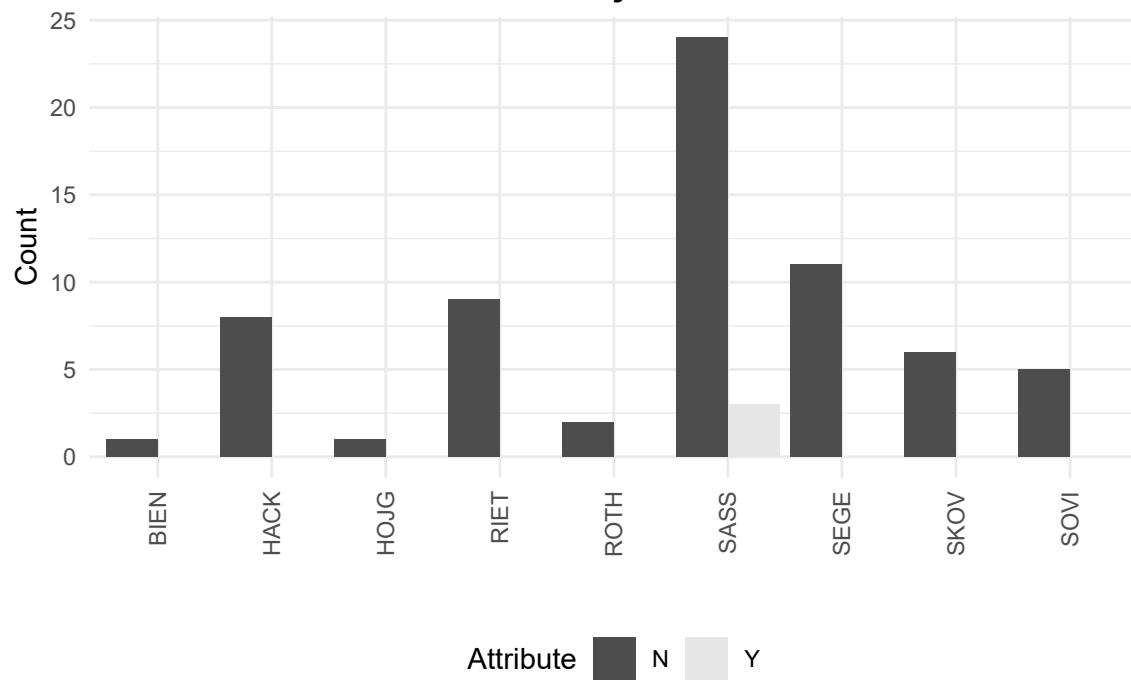
## Core Tablet Rejuvenation



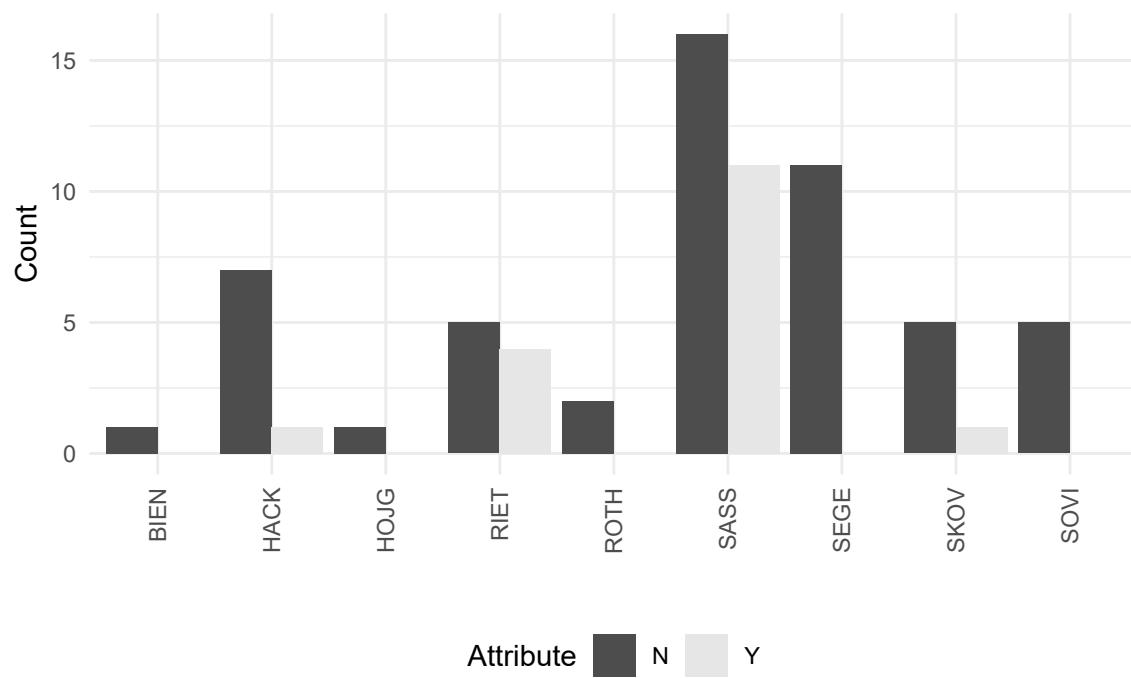
## Preparatory Flake Rejuvenation



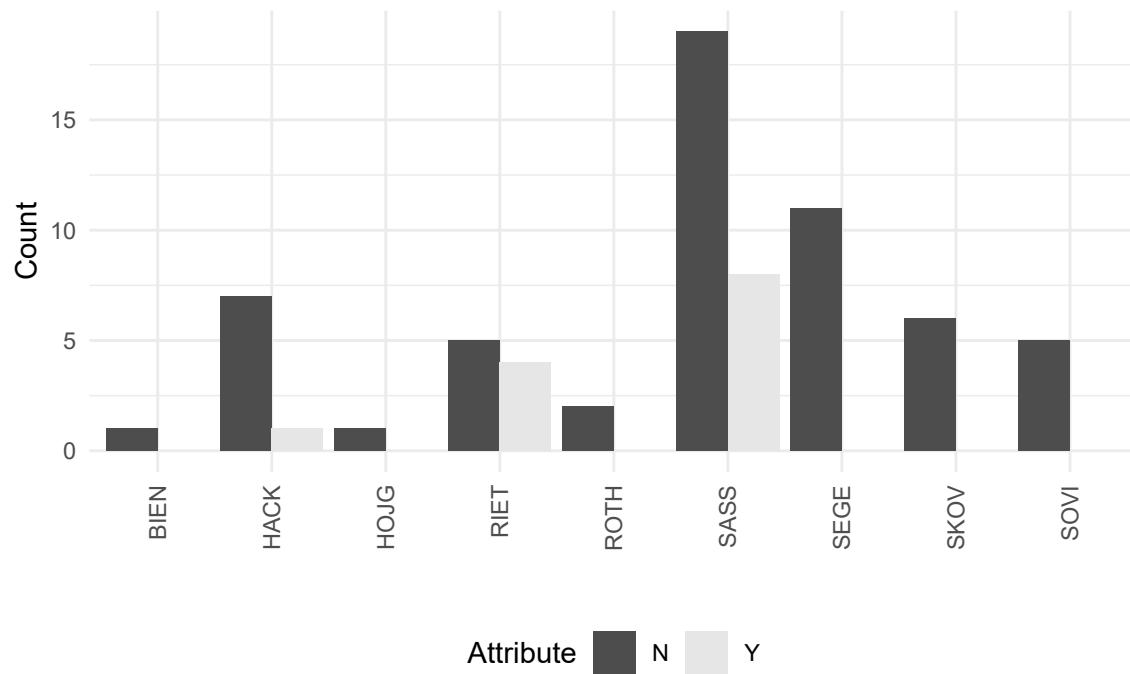
## Frontal Rejuvenation



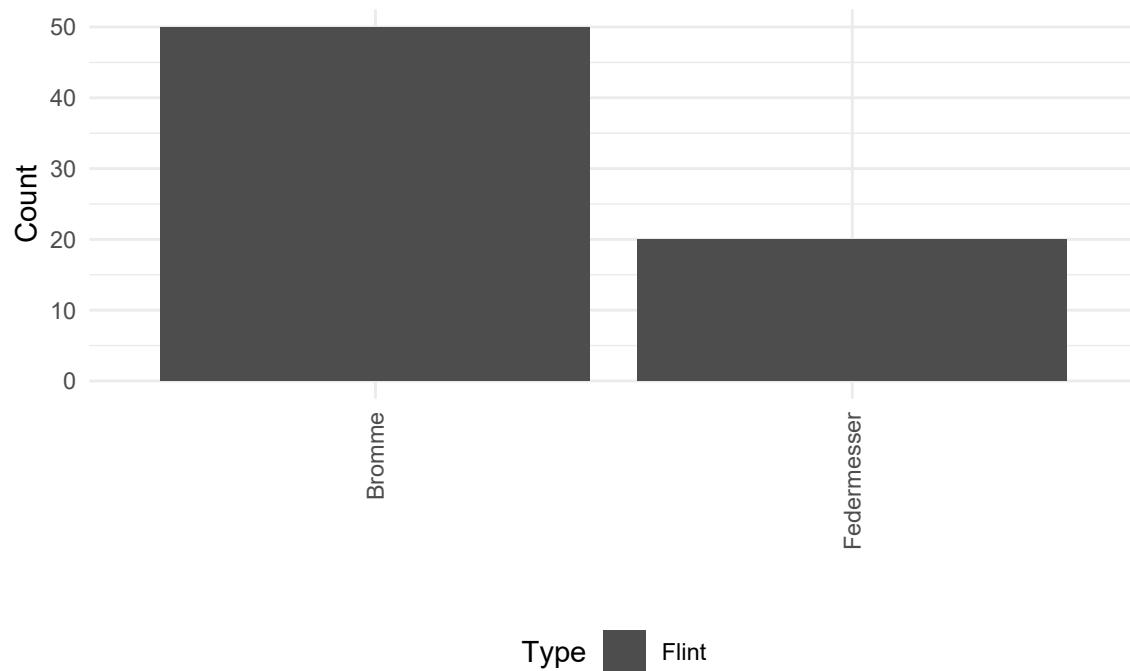
## Distal Rejuvenation



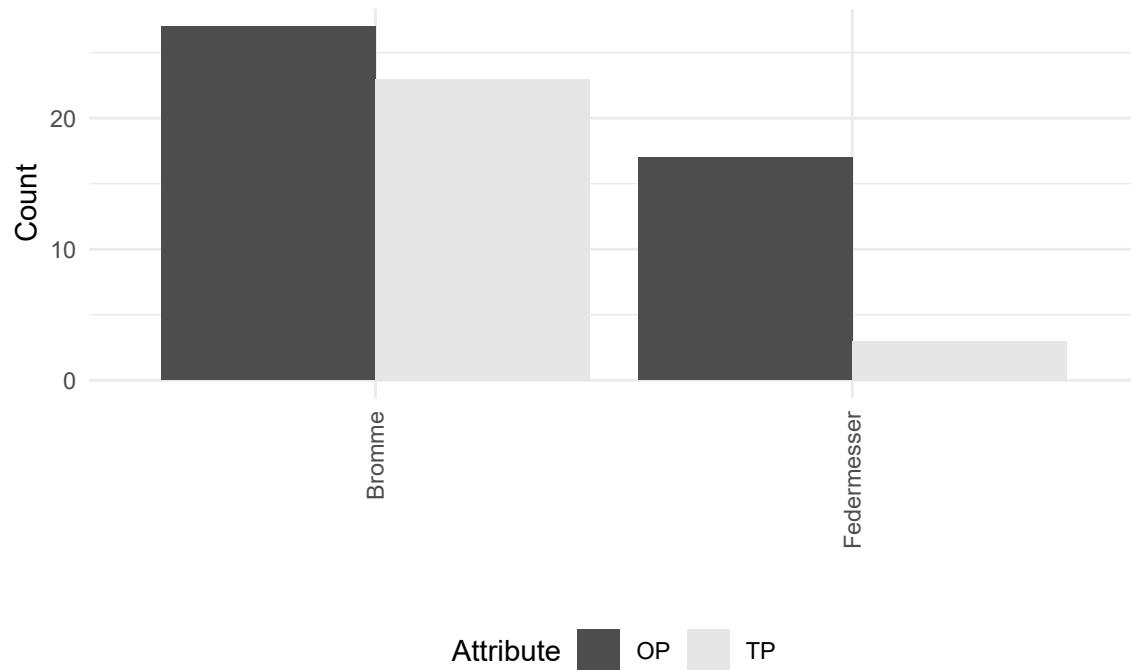
## Lateral Rejuvenation



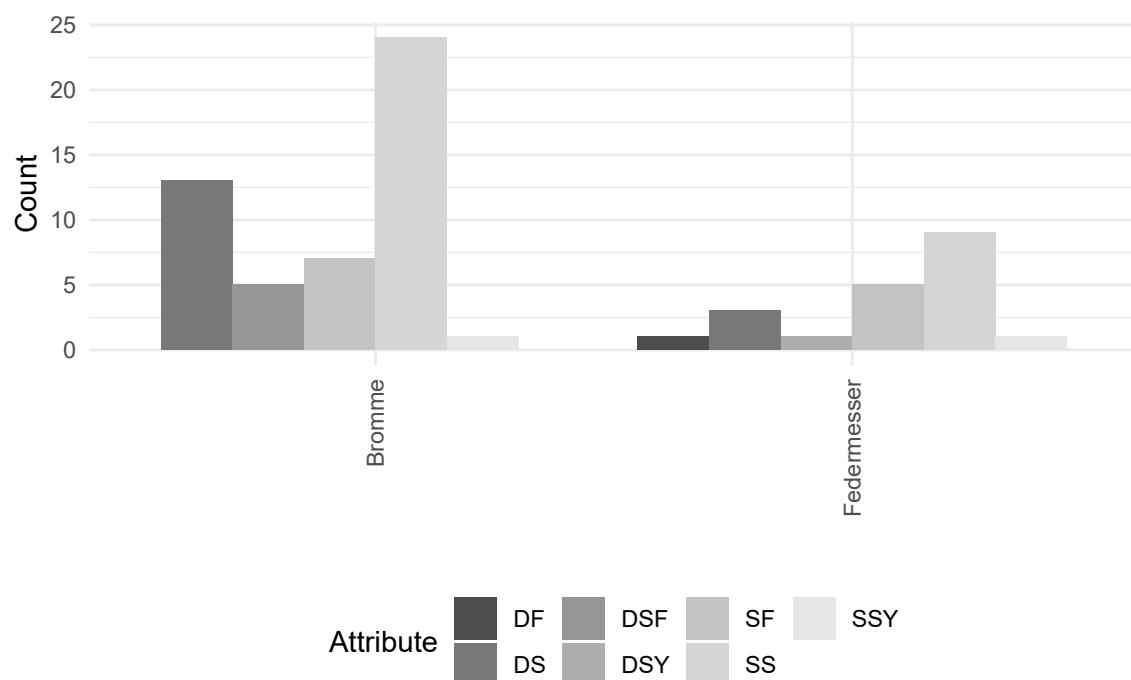
## Raw Material



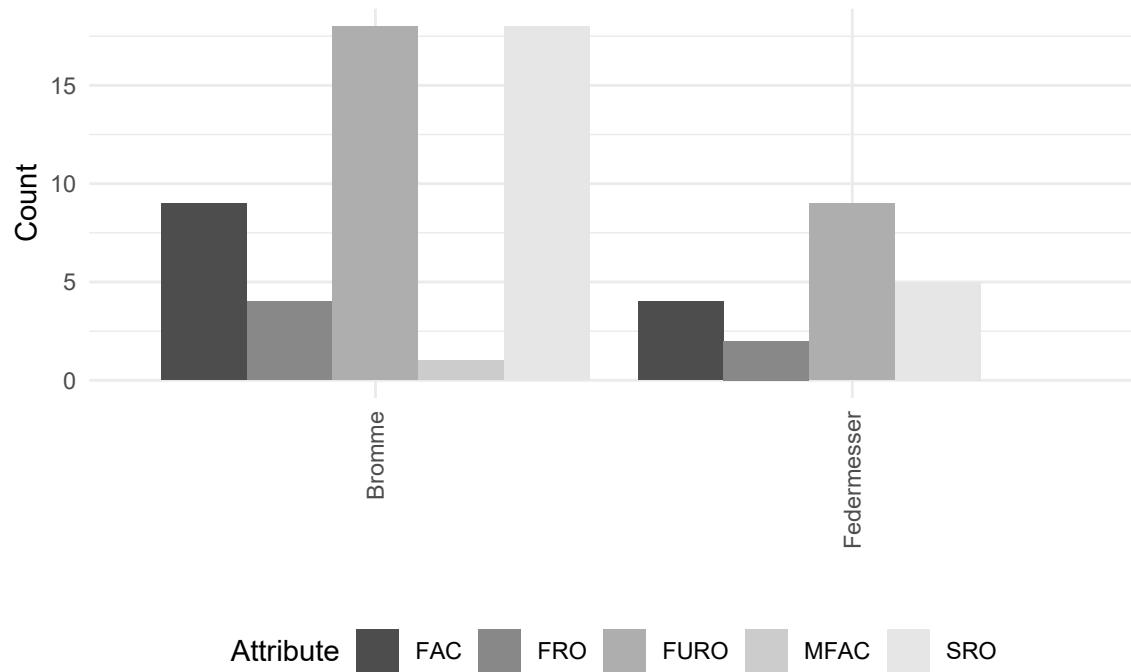
## Core Morphology



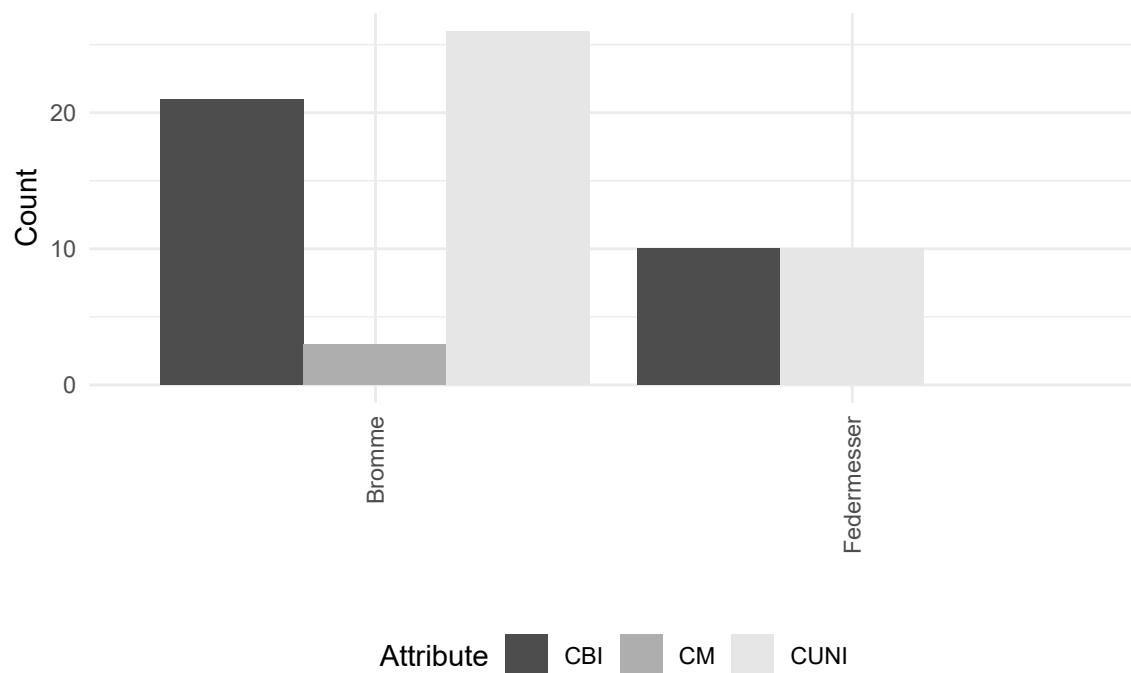
## Core Platform Profile



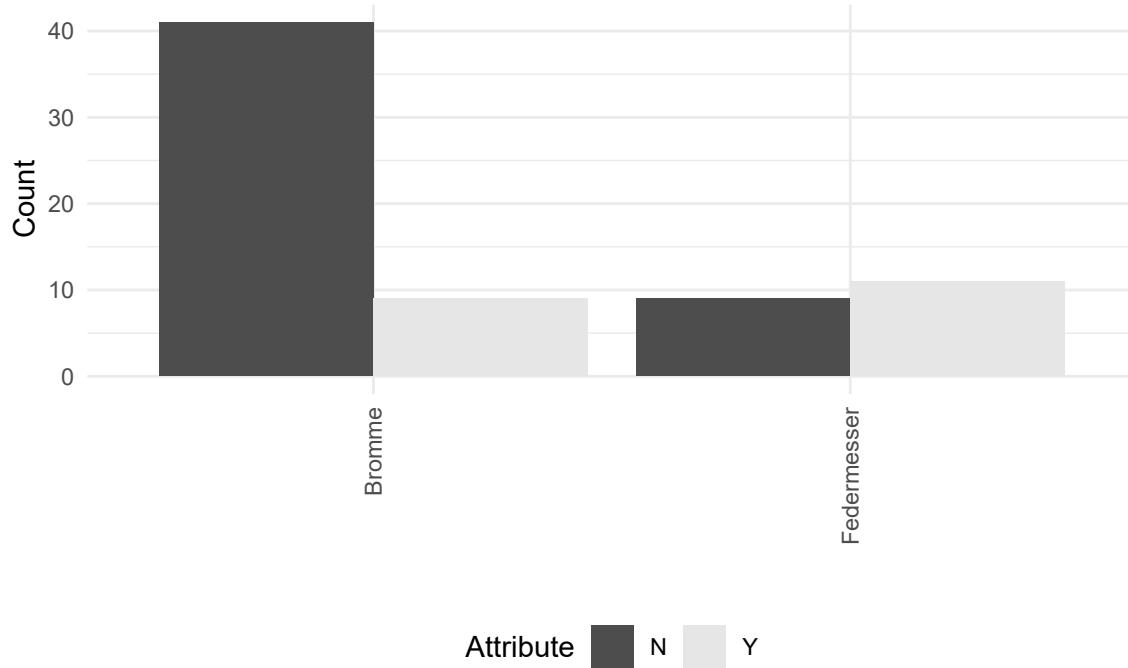
## Core Reduction Strategy



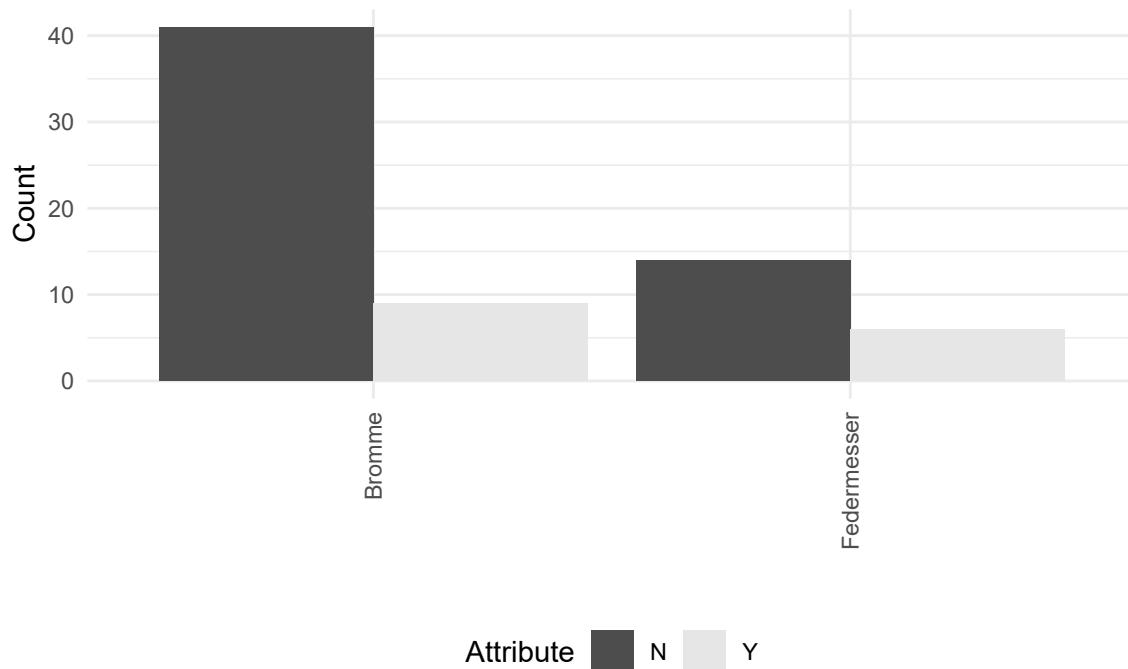
## Core Directionality



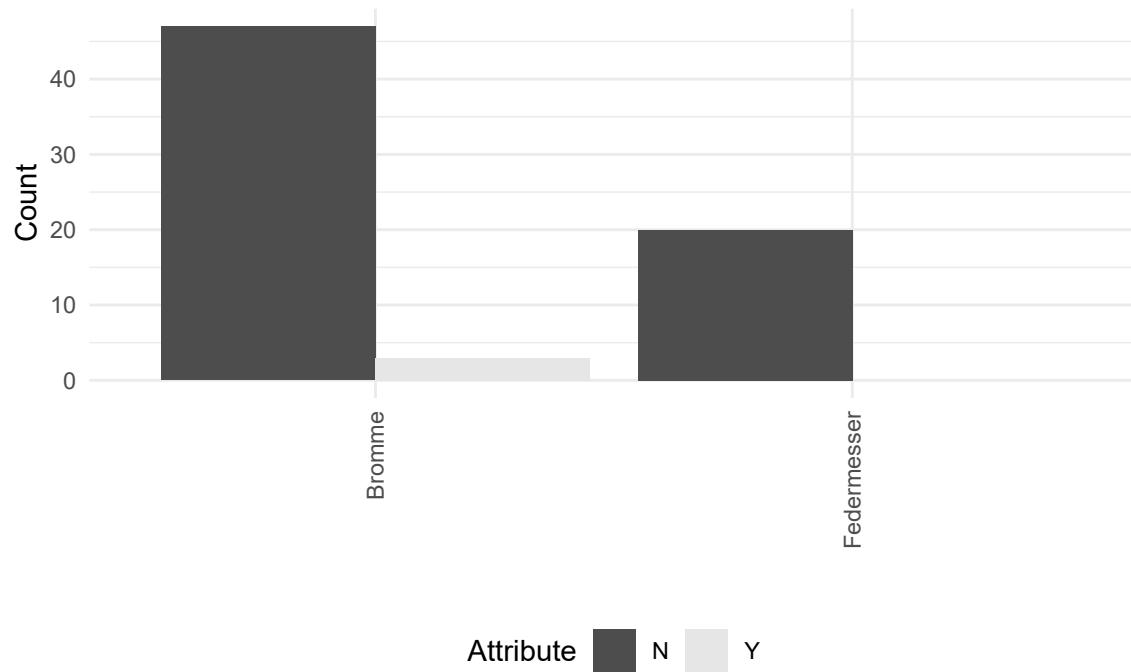
## Core Tablet Rejuvenation



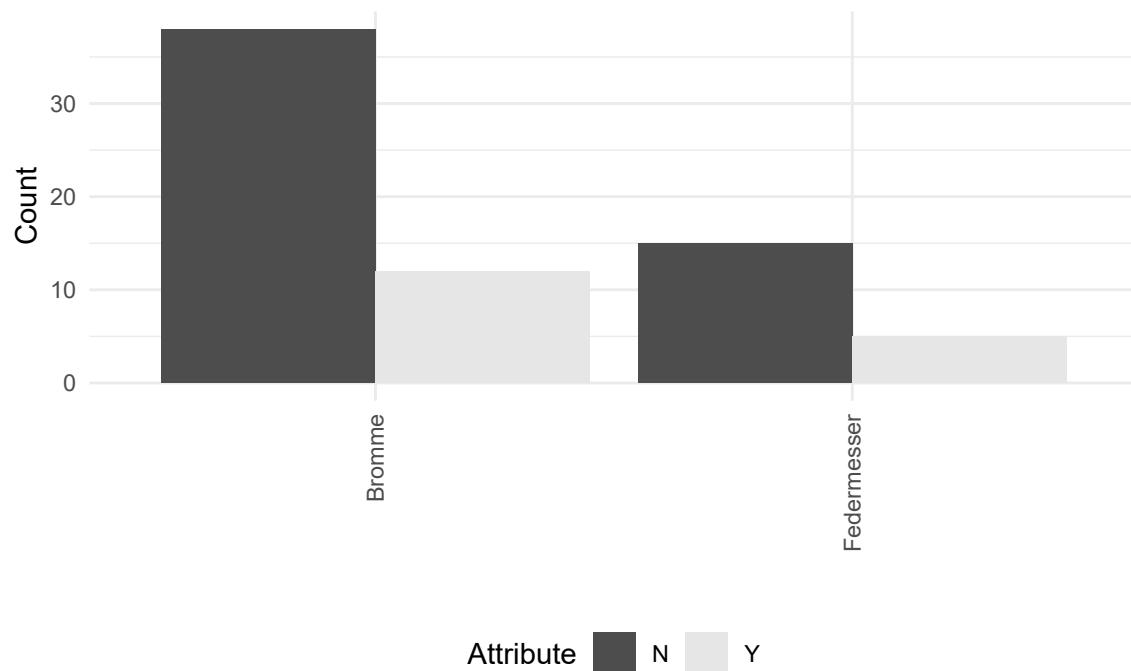
## Preparatory Flake Rejuvenation



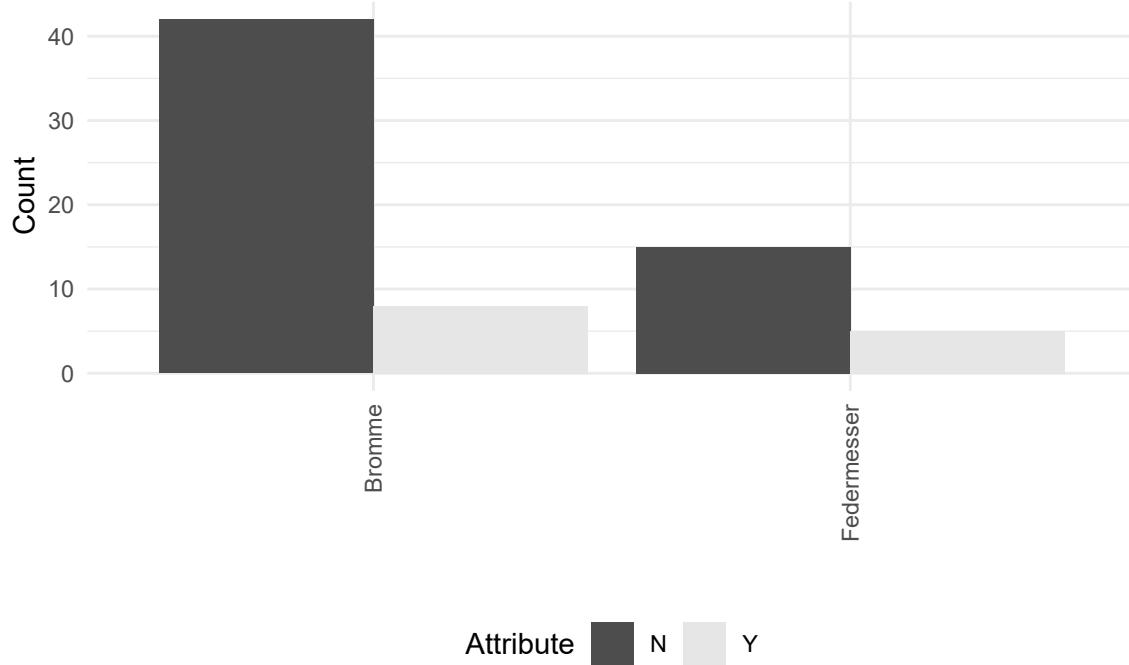
## Frontal Rejuvenation



## Core Distal Rejuvenation

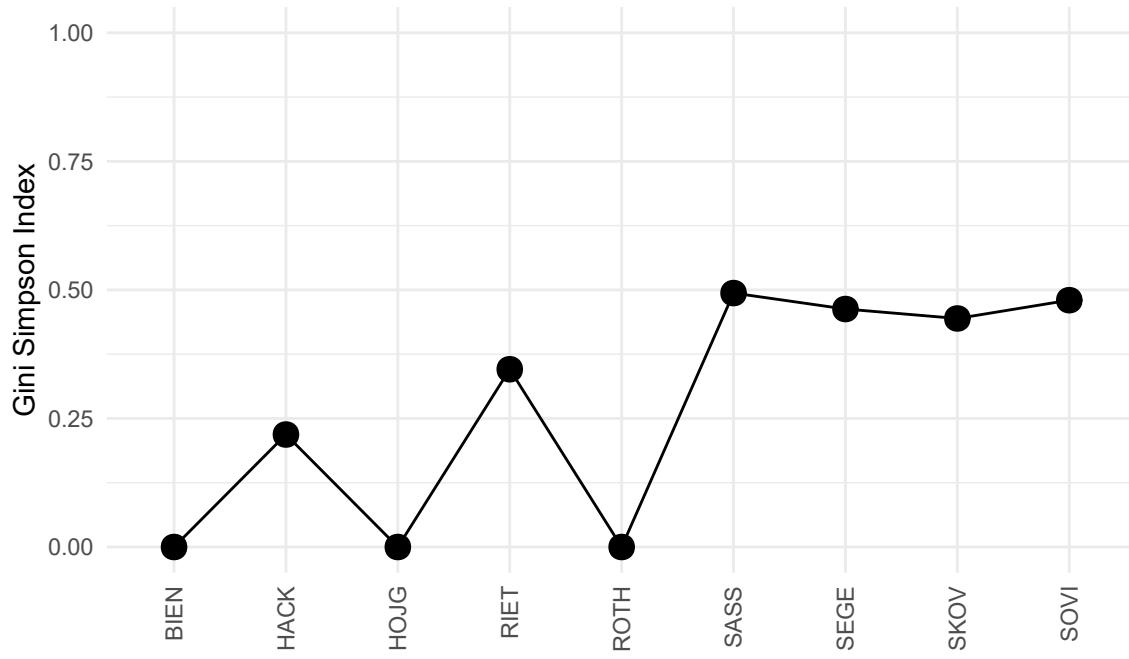


## Core Lateral Rejuvenation

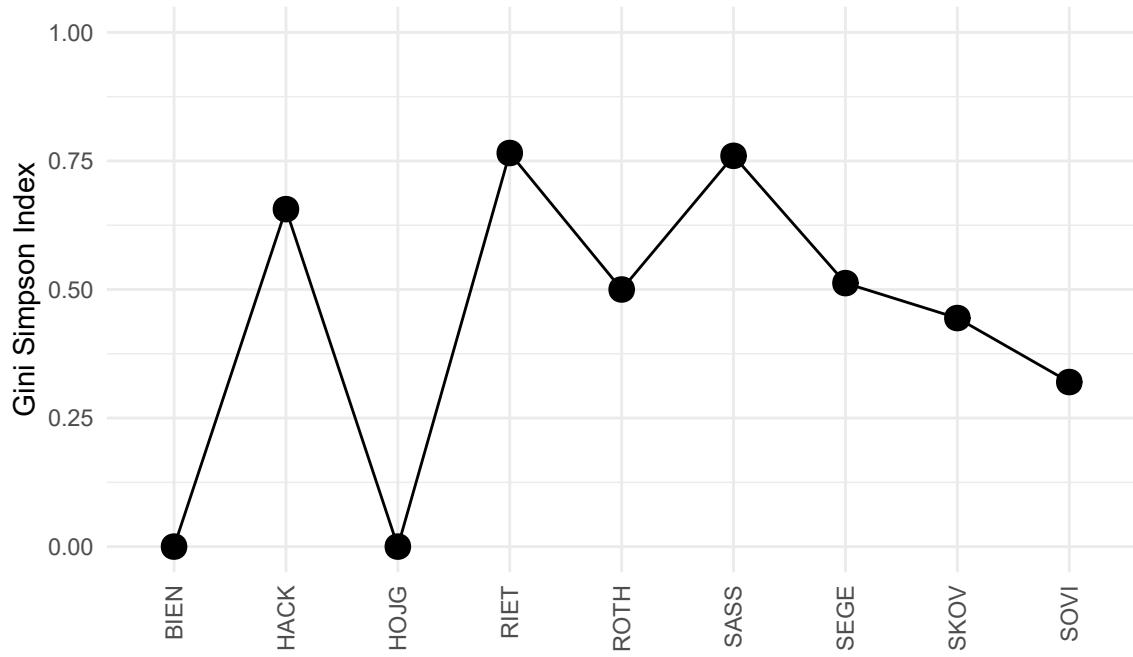


## Gini-Simpson and Morisita-Horn diversity indices

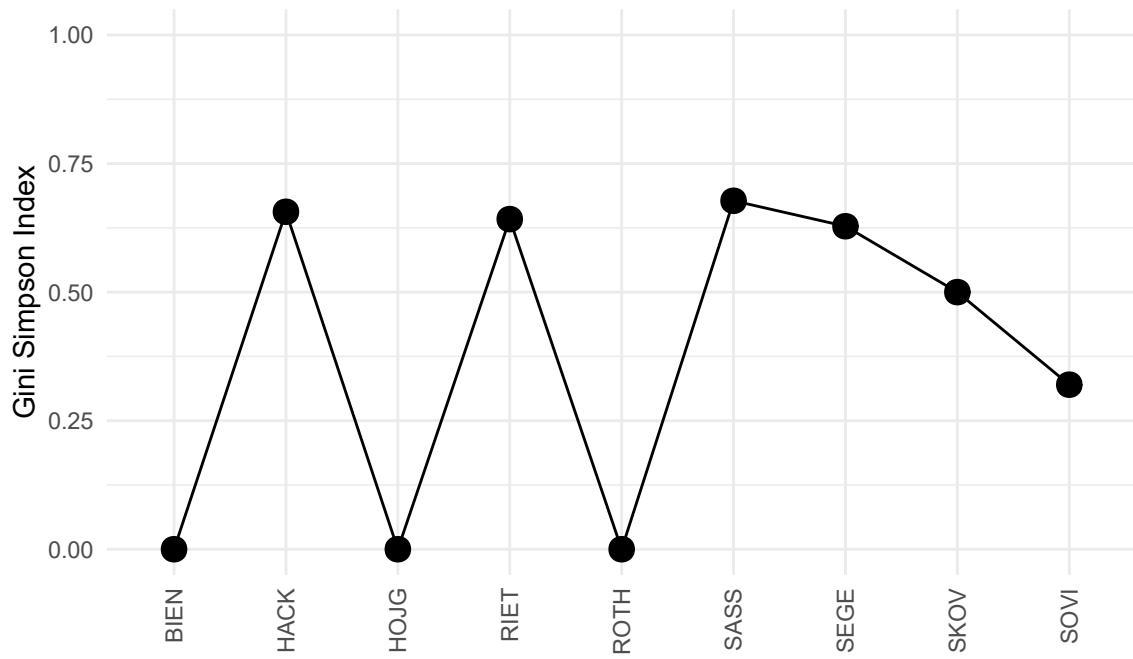
### Core Morphology



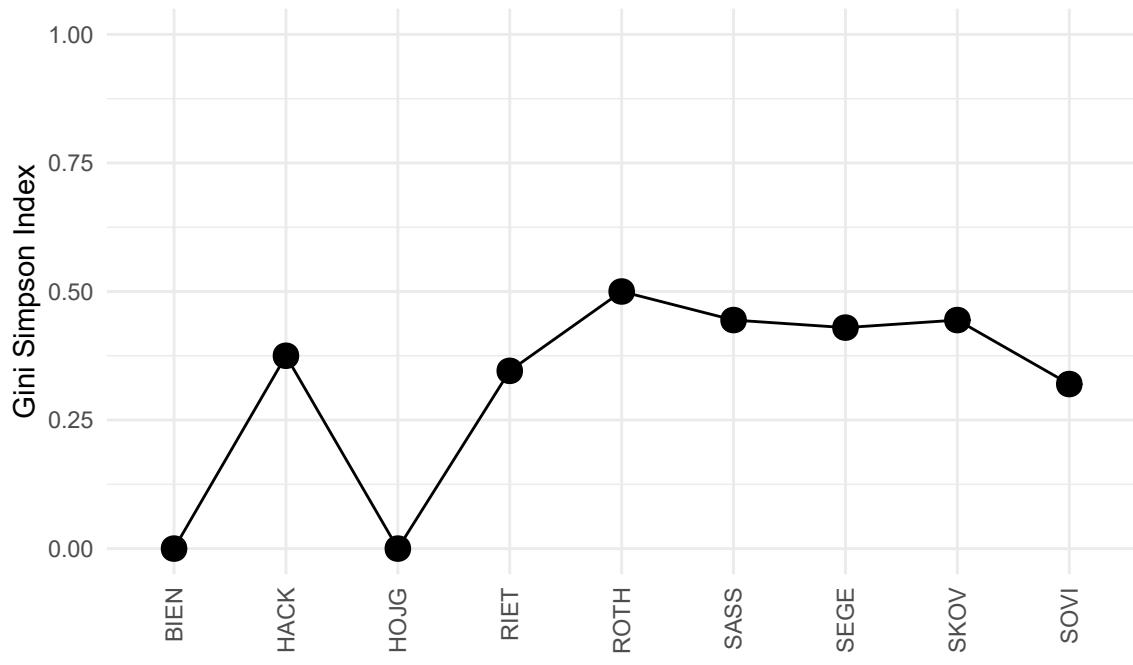
## Core Platform Profile



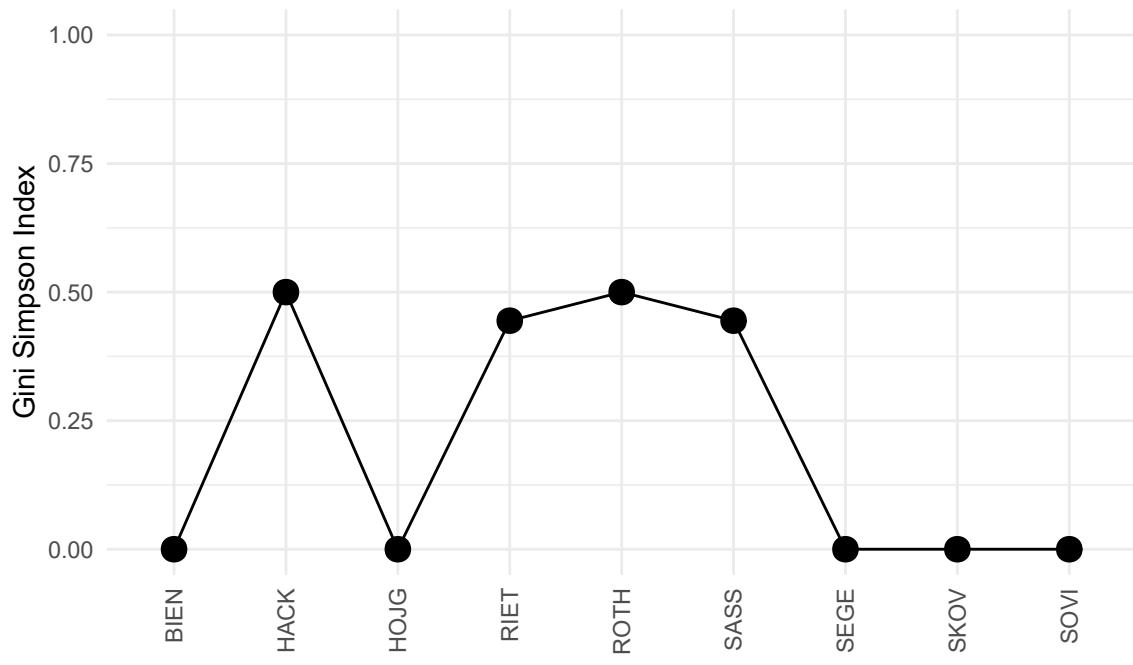
## Core Reduction Strategy



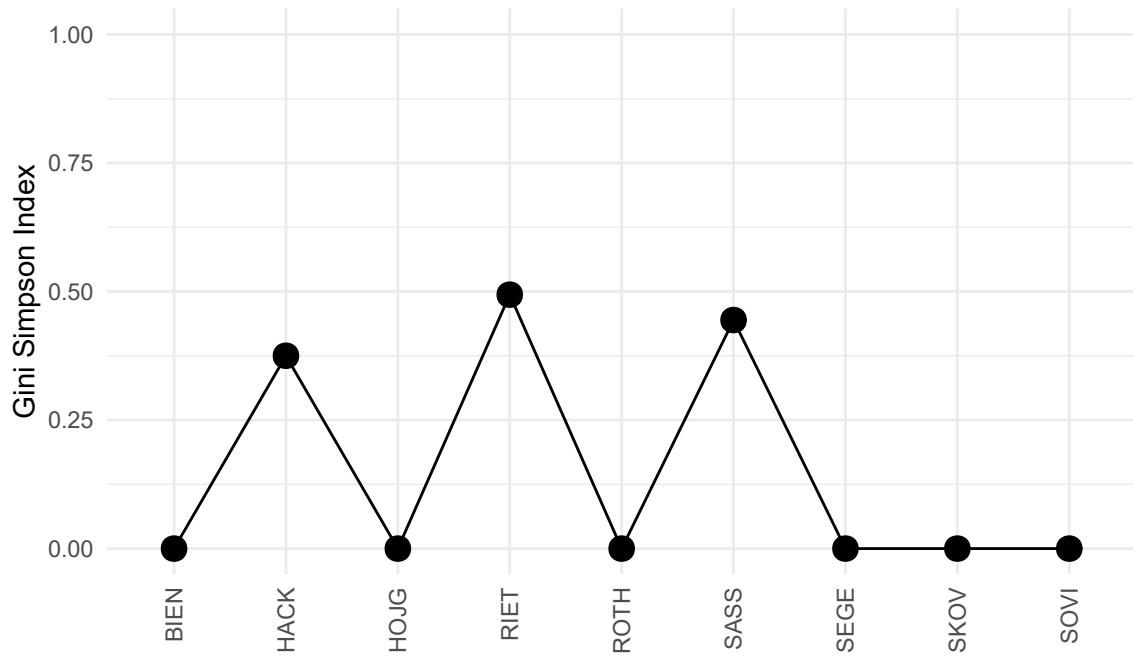
### Core Directionality



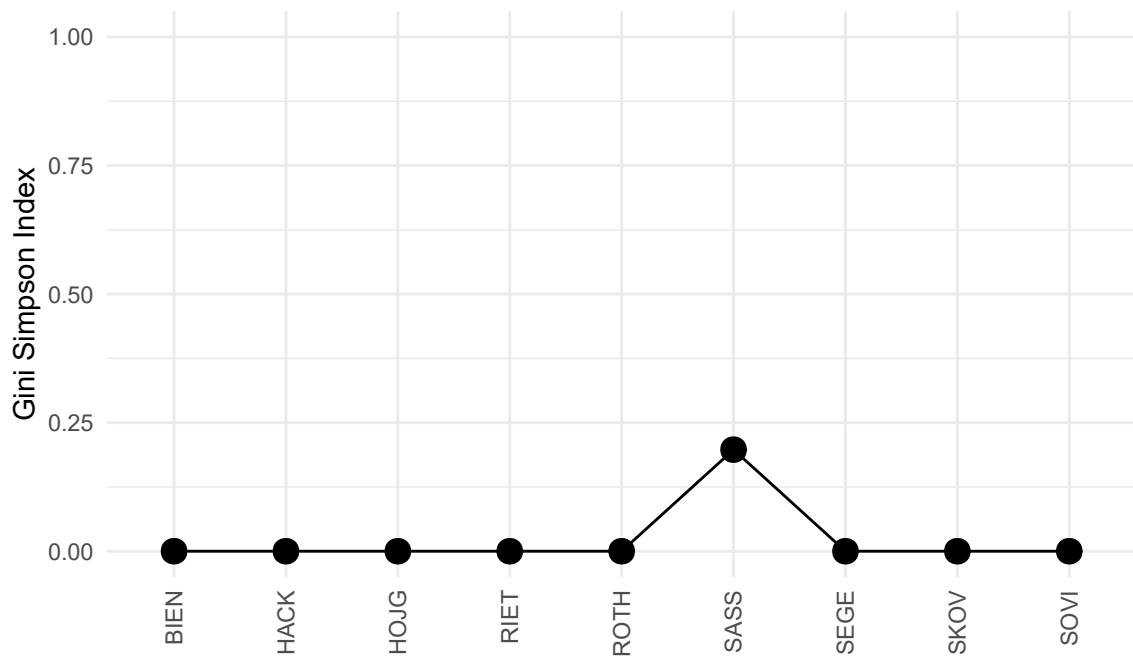
### Core Tablet Rejuvenation



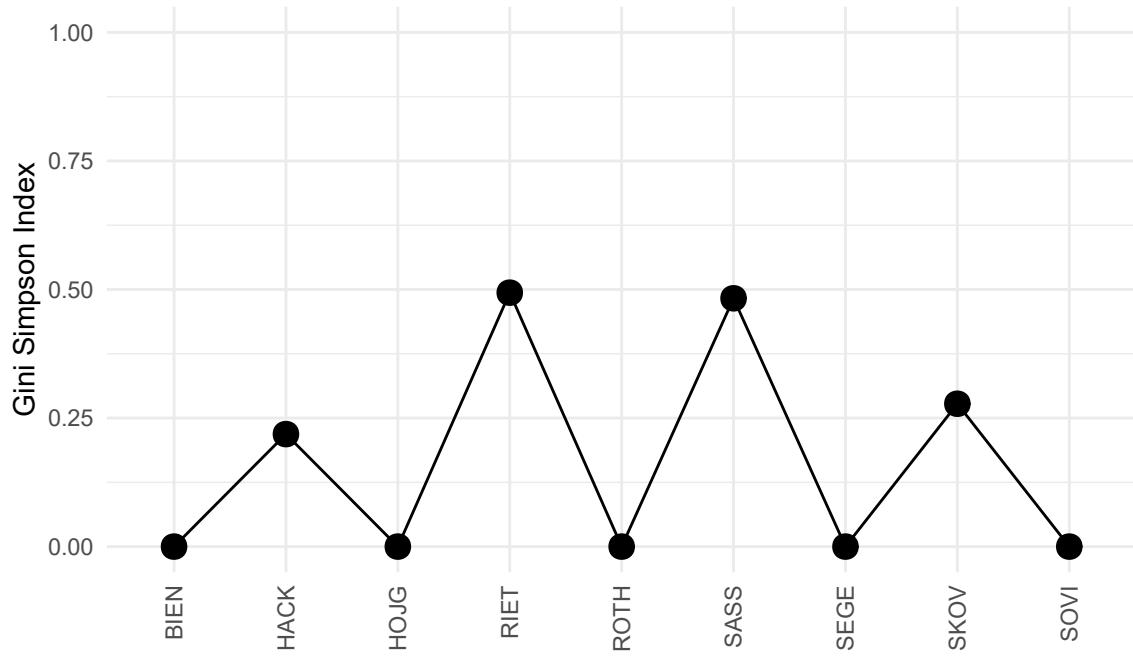
## Preparatory Flake Rejuvenation



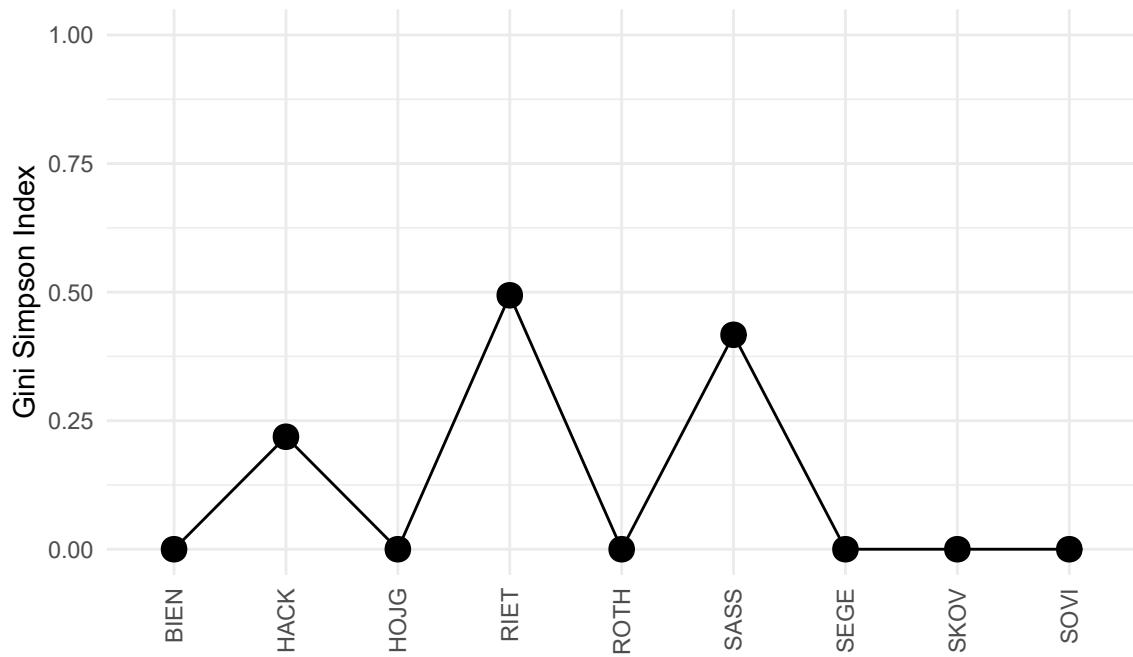
## Frontal Rejuvenation



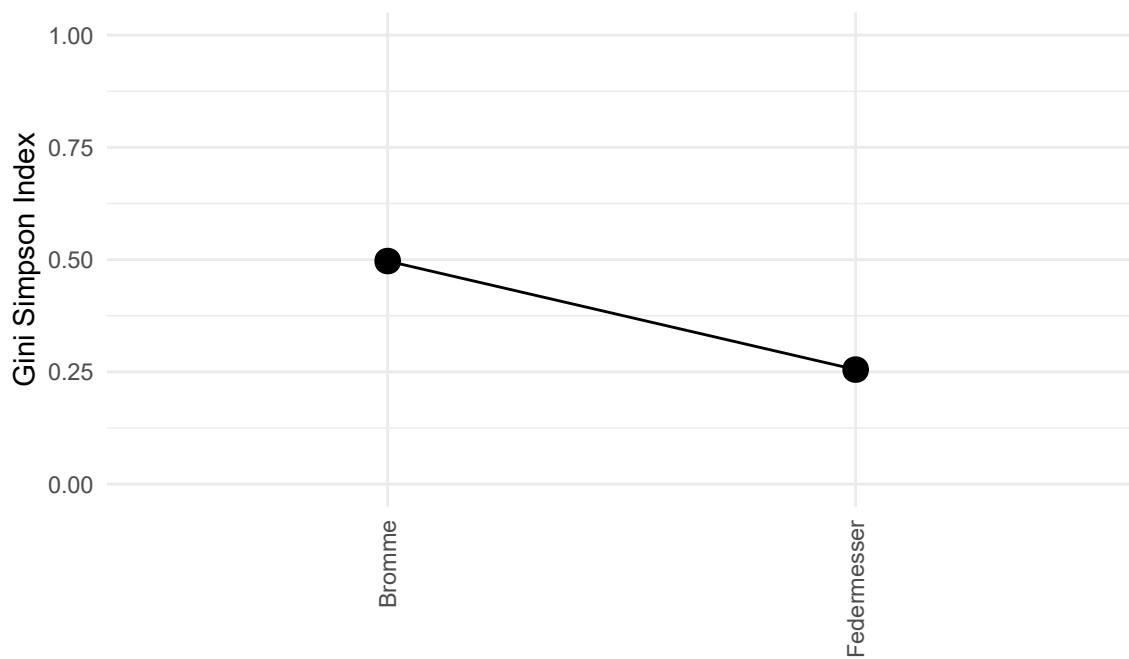
## Core Distal Rejuvenation



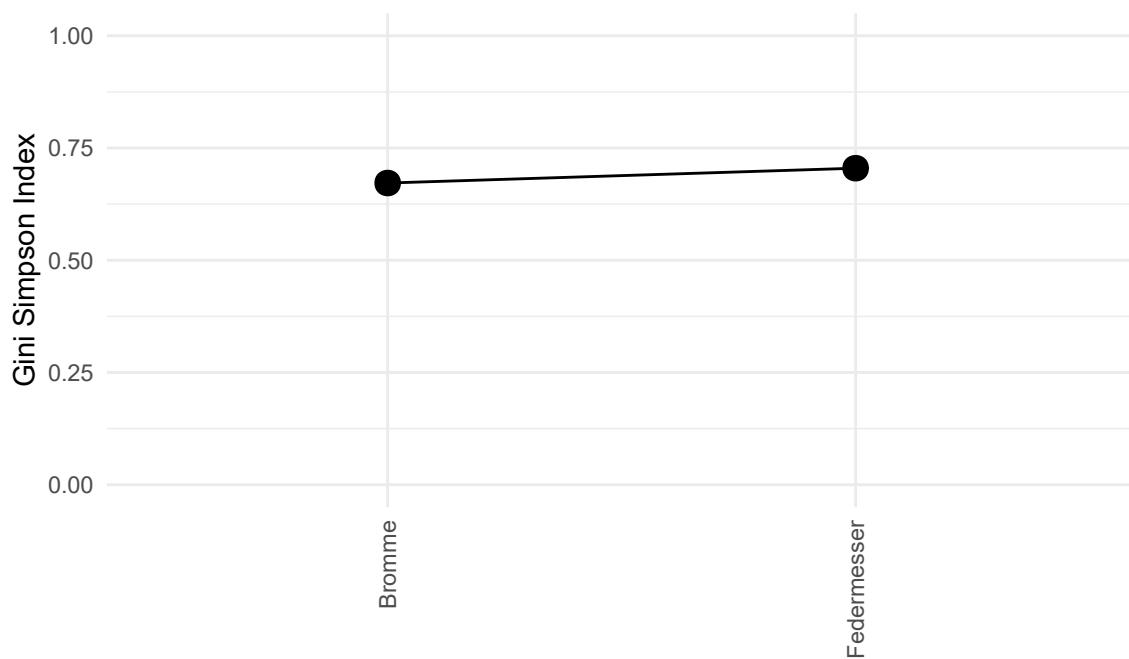
## Core Lateral Rejuvenation



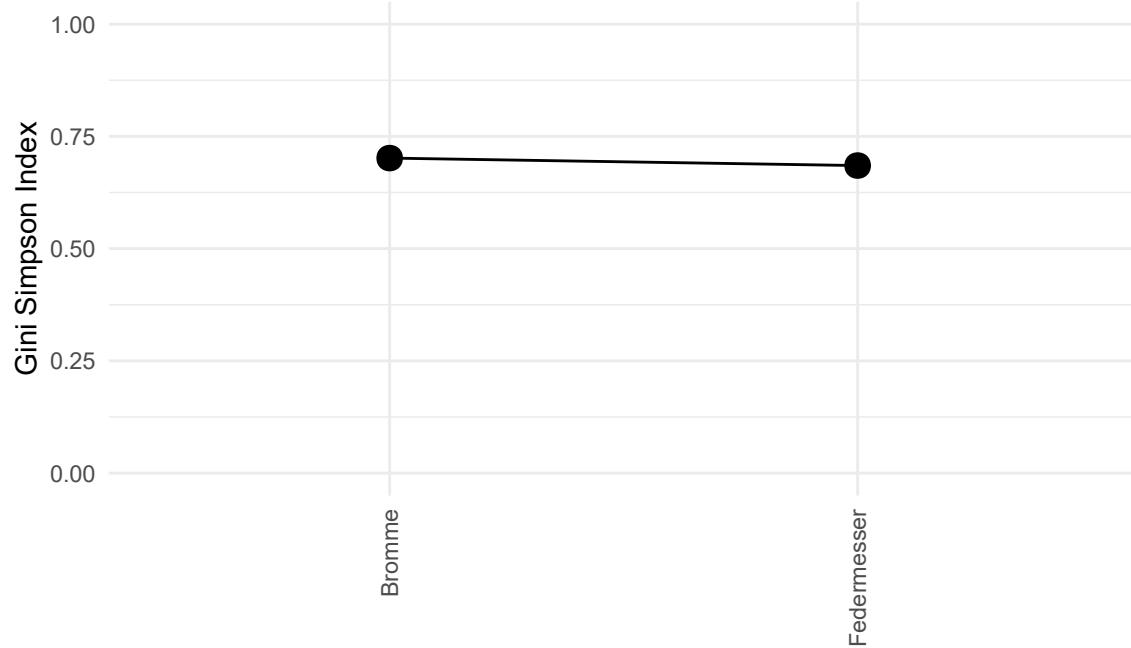
## Core Morphology



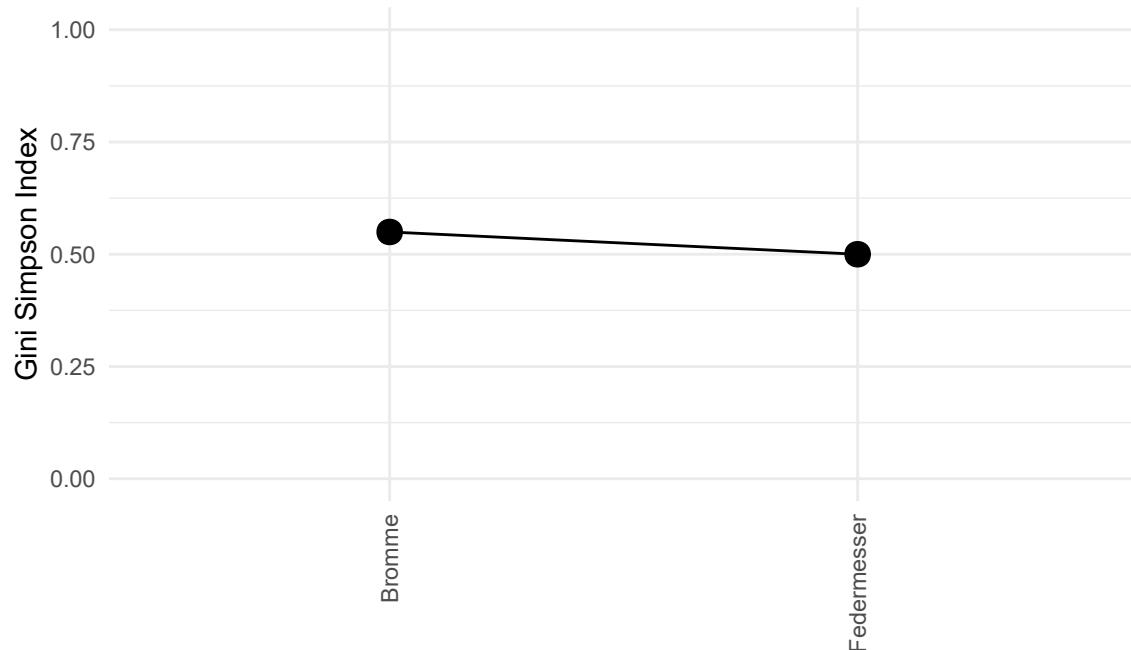
## Core Platform Profile



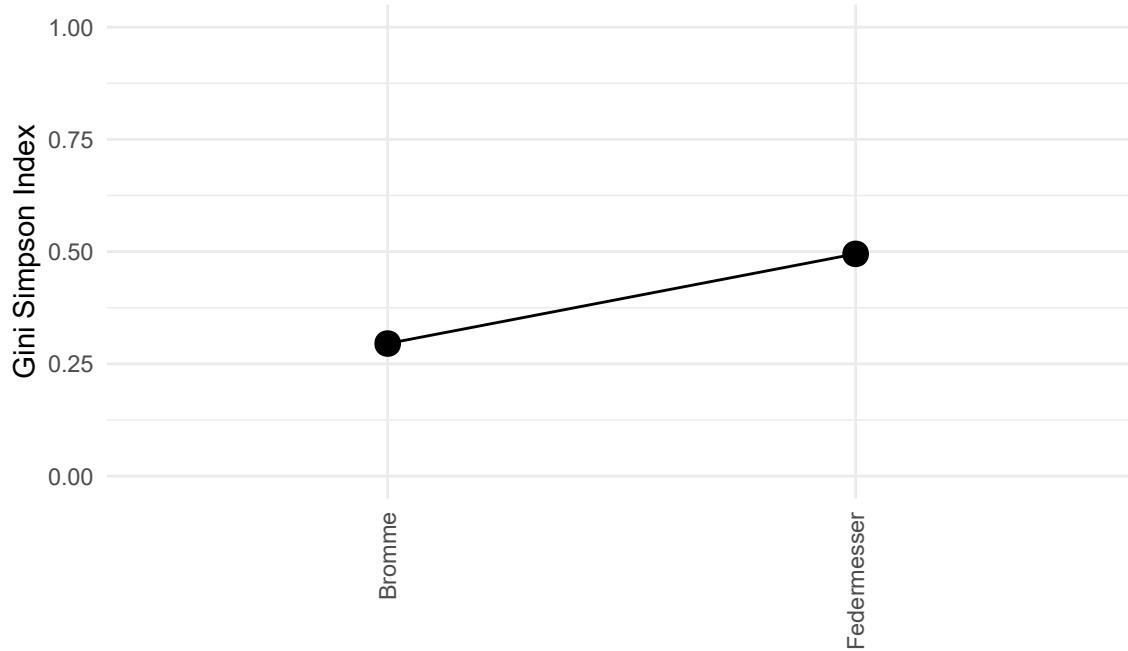
## Core Reduction Strategy



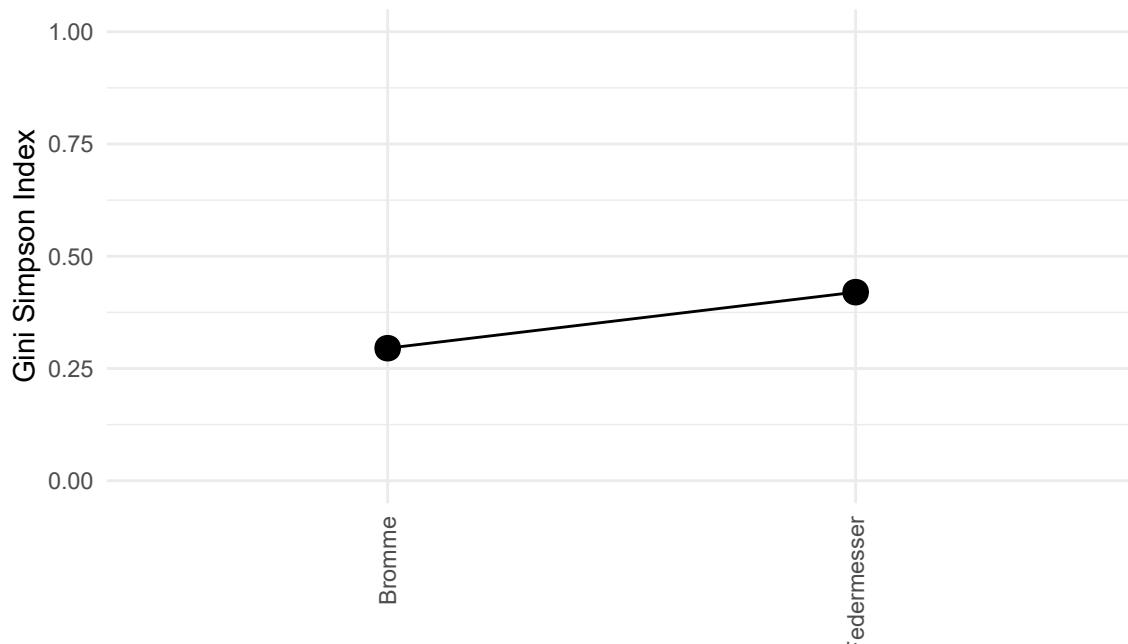
## Core Directionality



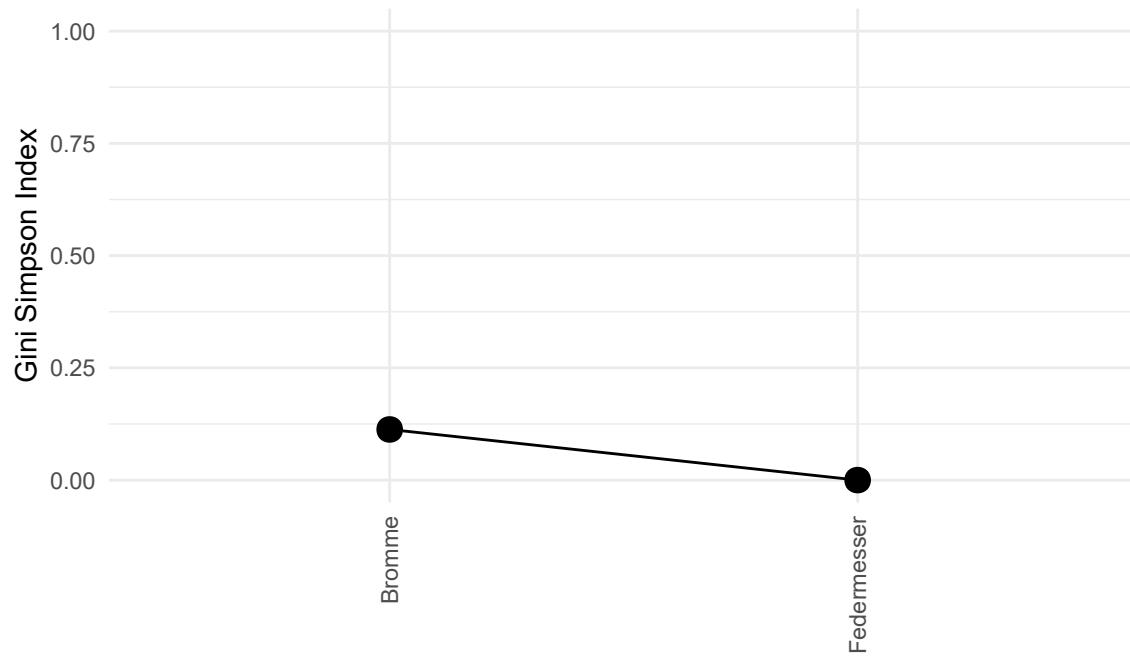
## Core Tablet Rejuvenation



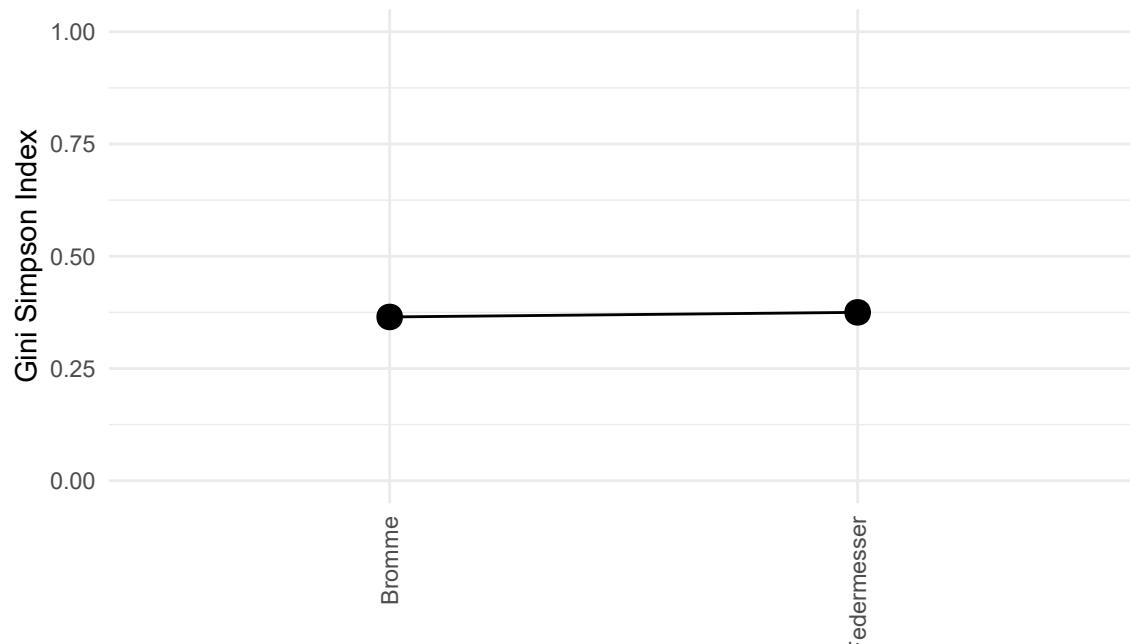
## Preparatory Rejuvenation



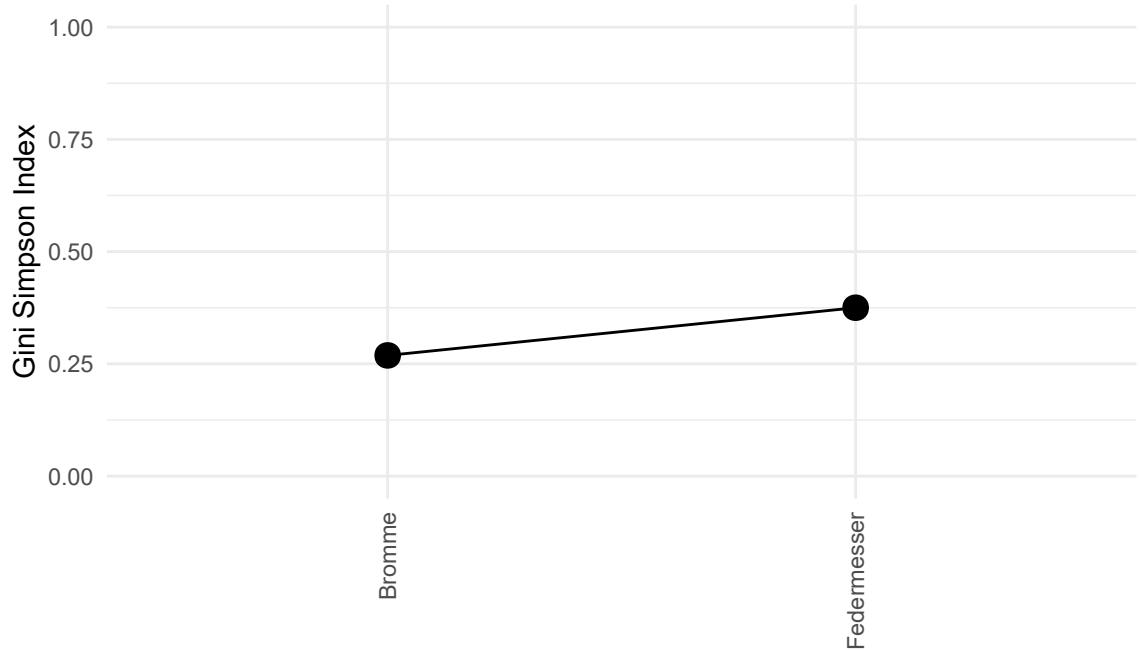
## Frontal Rejuvenation



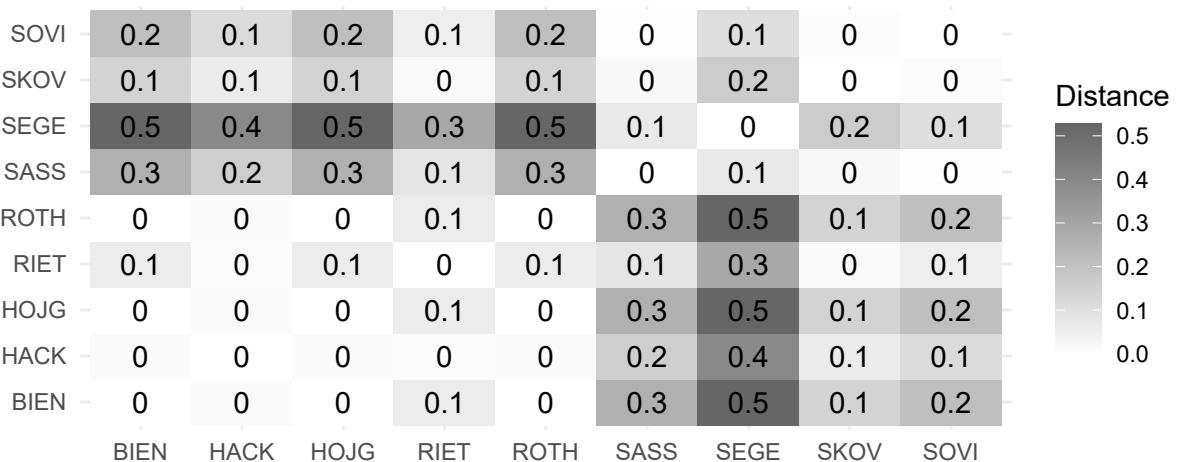
## Core Distal Rejuvenation



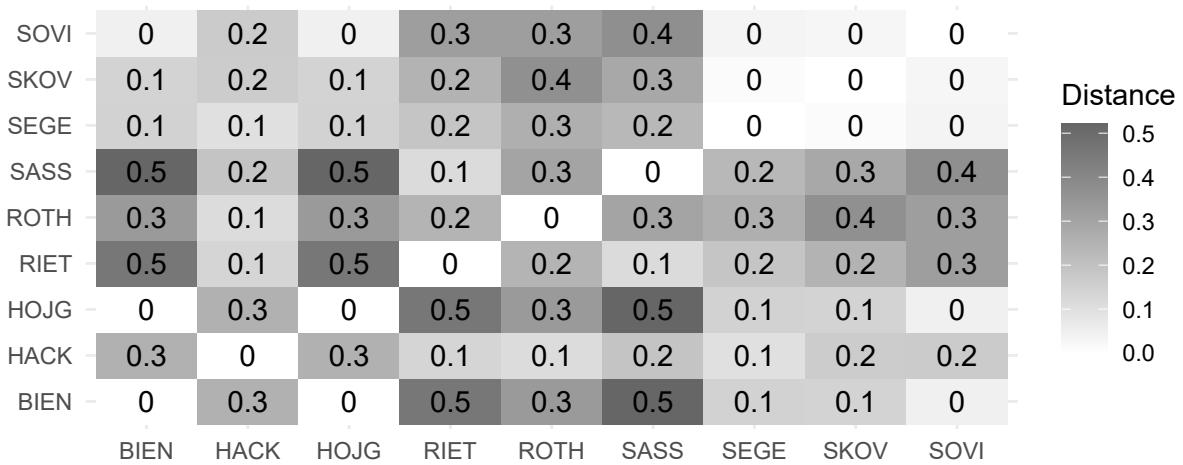
## Core Lateral Rejuvenation



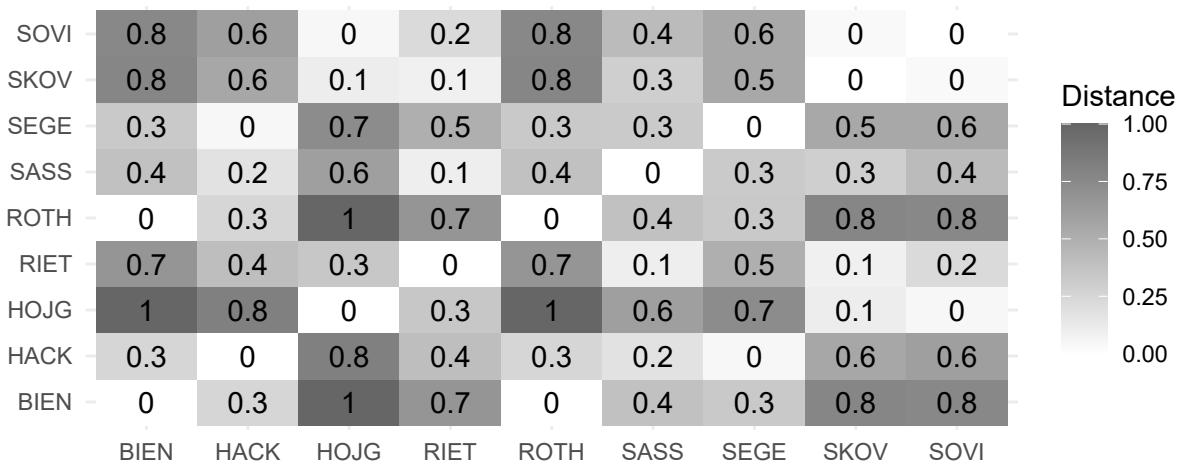
## Core Morphology: Morisita-Horn Index



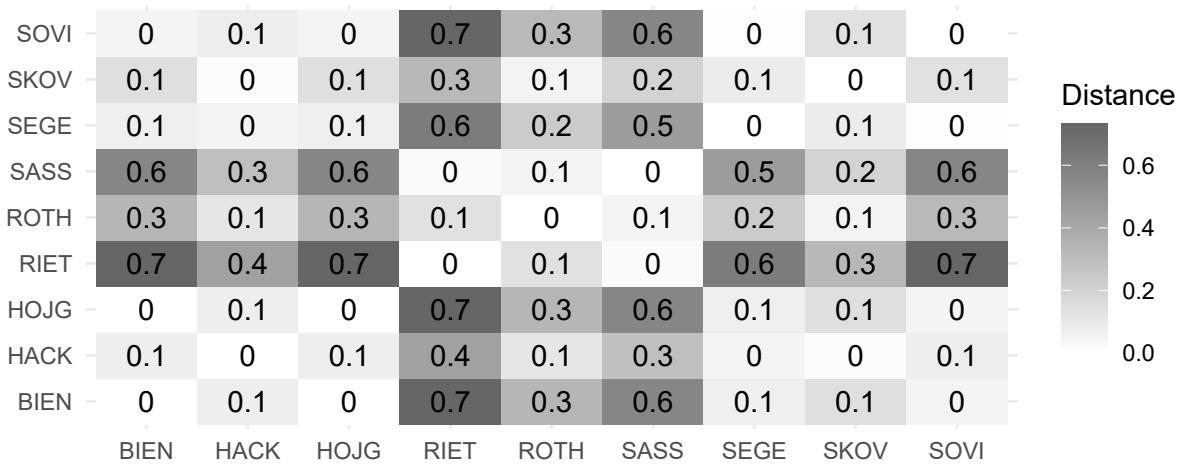
### Core Platform Profile: Morisita-Horn Index



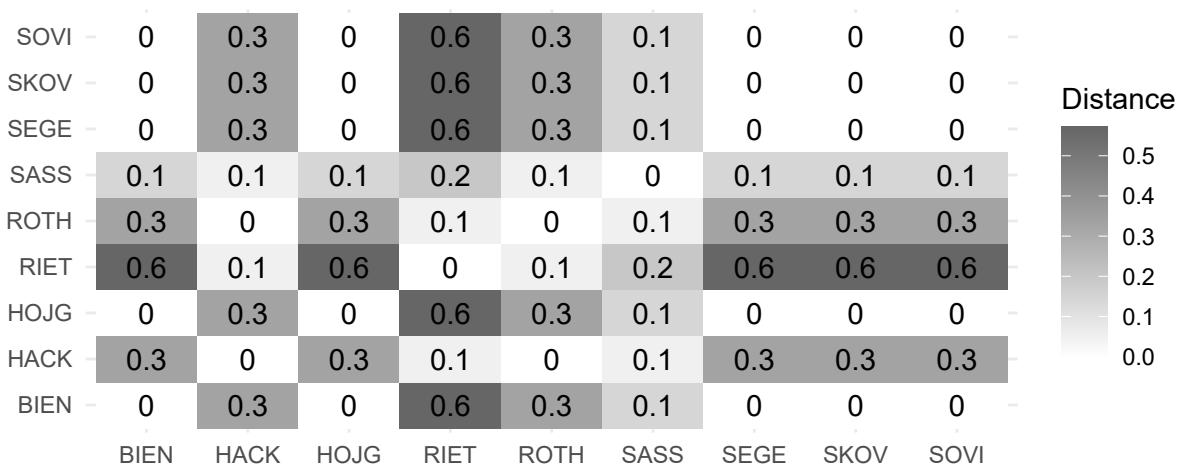
### Core Reduction Strategy: Morisita-Horn Index



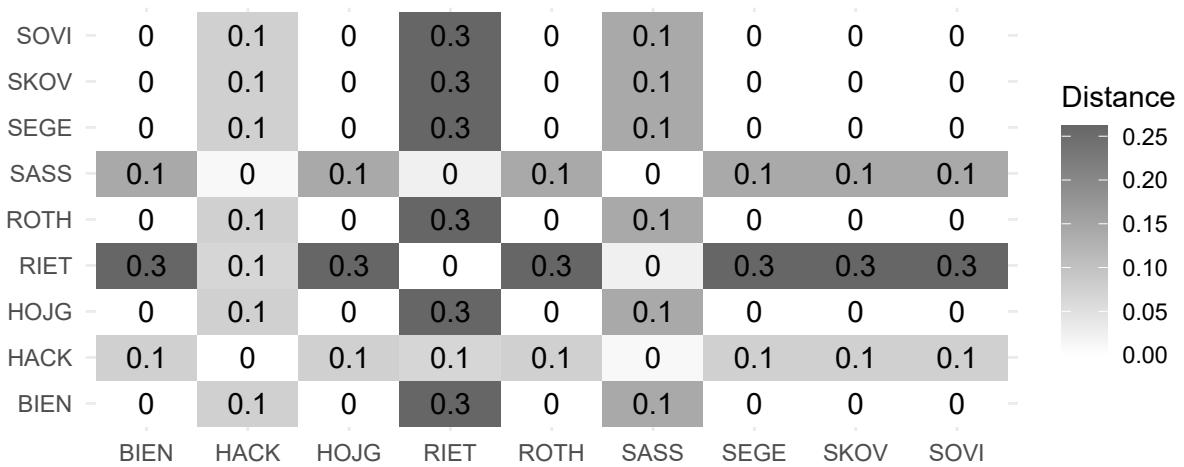
### Core Directionality: Morisita-Horn Index



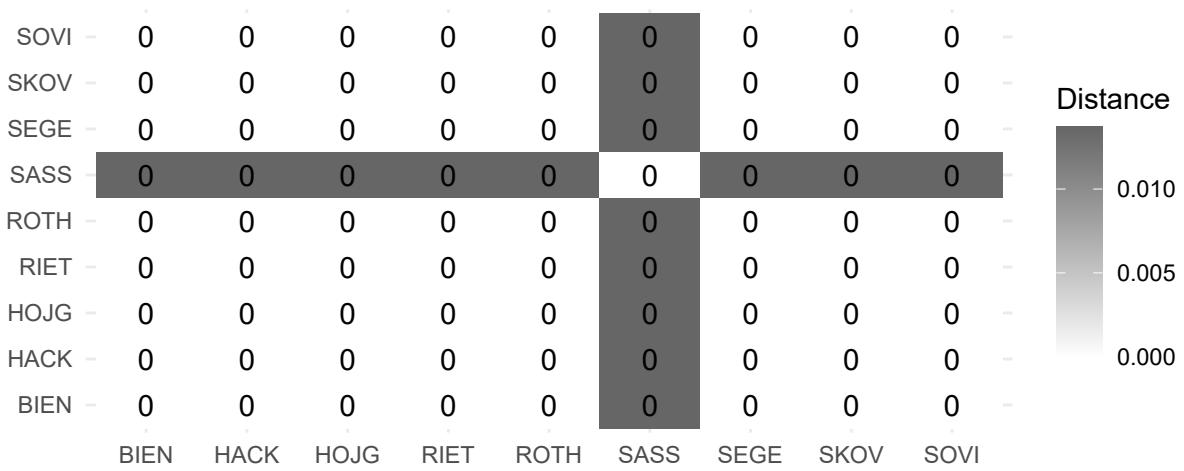
### Core Tablet Rejuvenation: Morisita-Horn Index



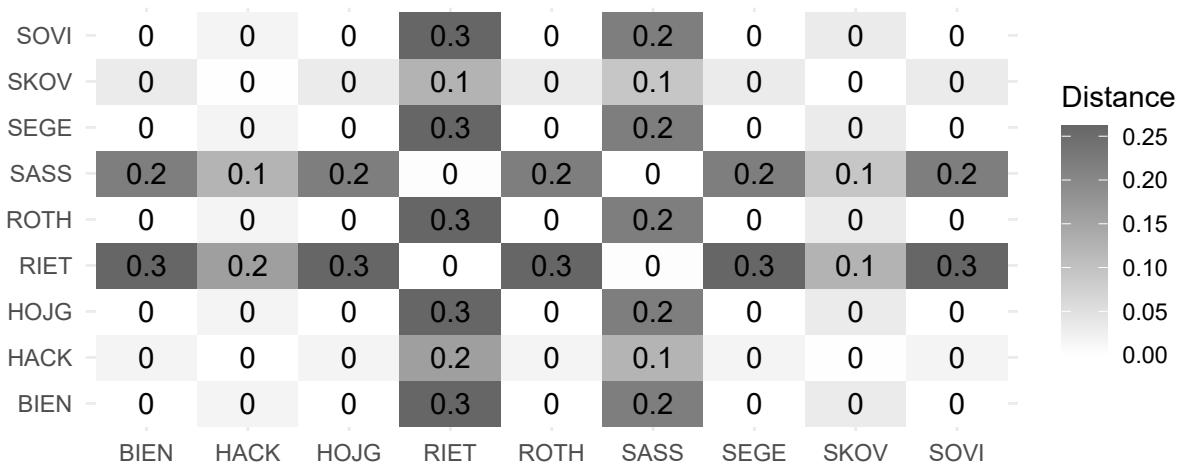
### Preparatory Flake Rejuvenation: Morisita-Horn Index



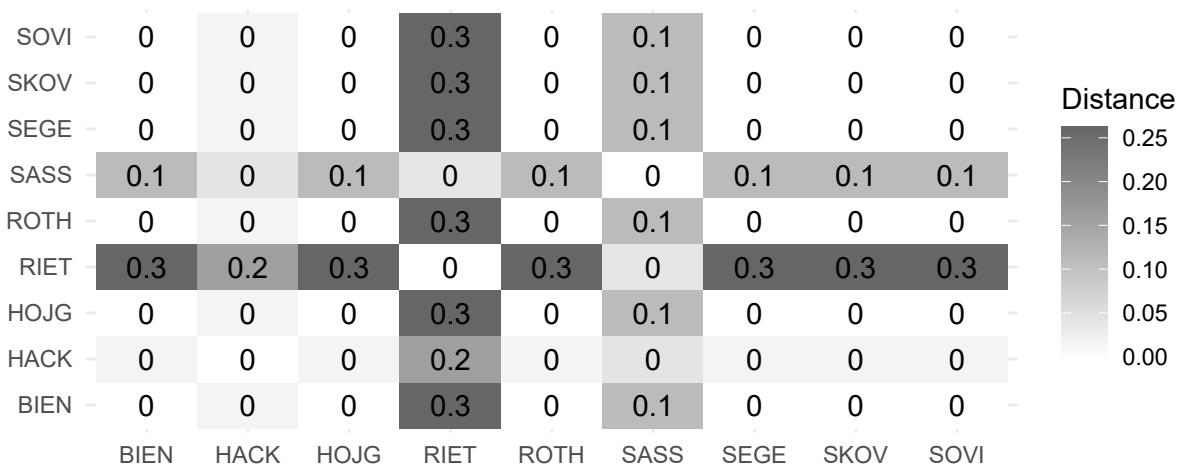
### Frontal Rejuvenation: Morisita-Horn Index



## Core Distal Rejuvenation: Morisita-Horn Index

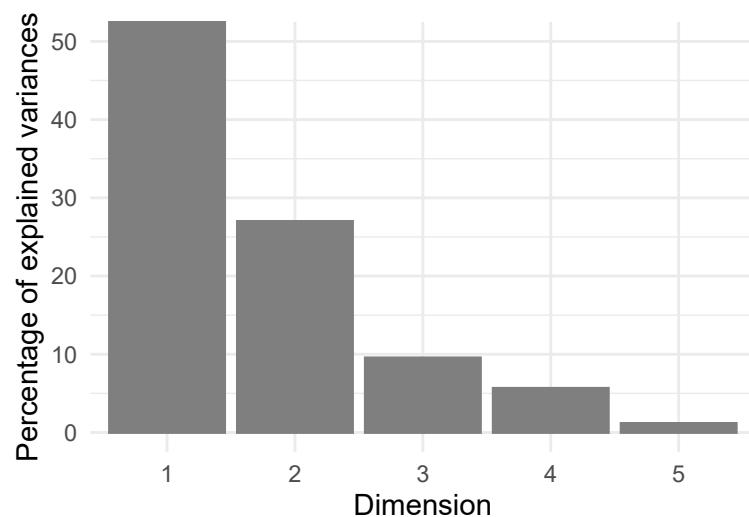


## Core Lateral Rejuvenation: Morisita-Horn Index

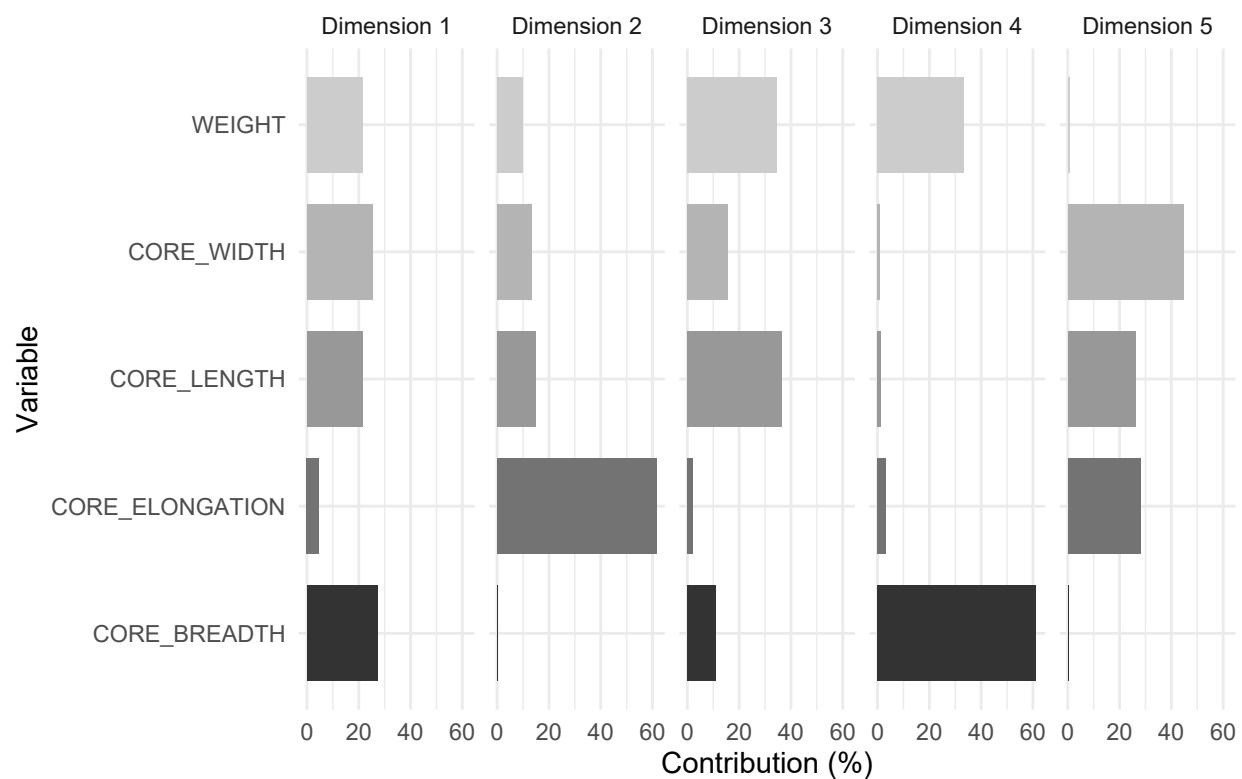


## Principal Component Analysis (PCA)

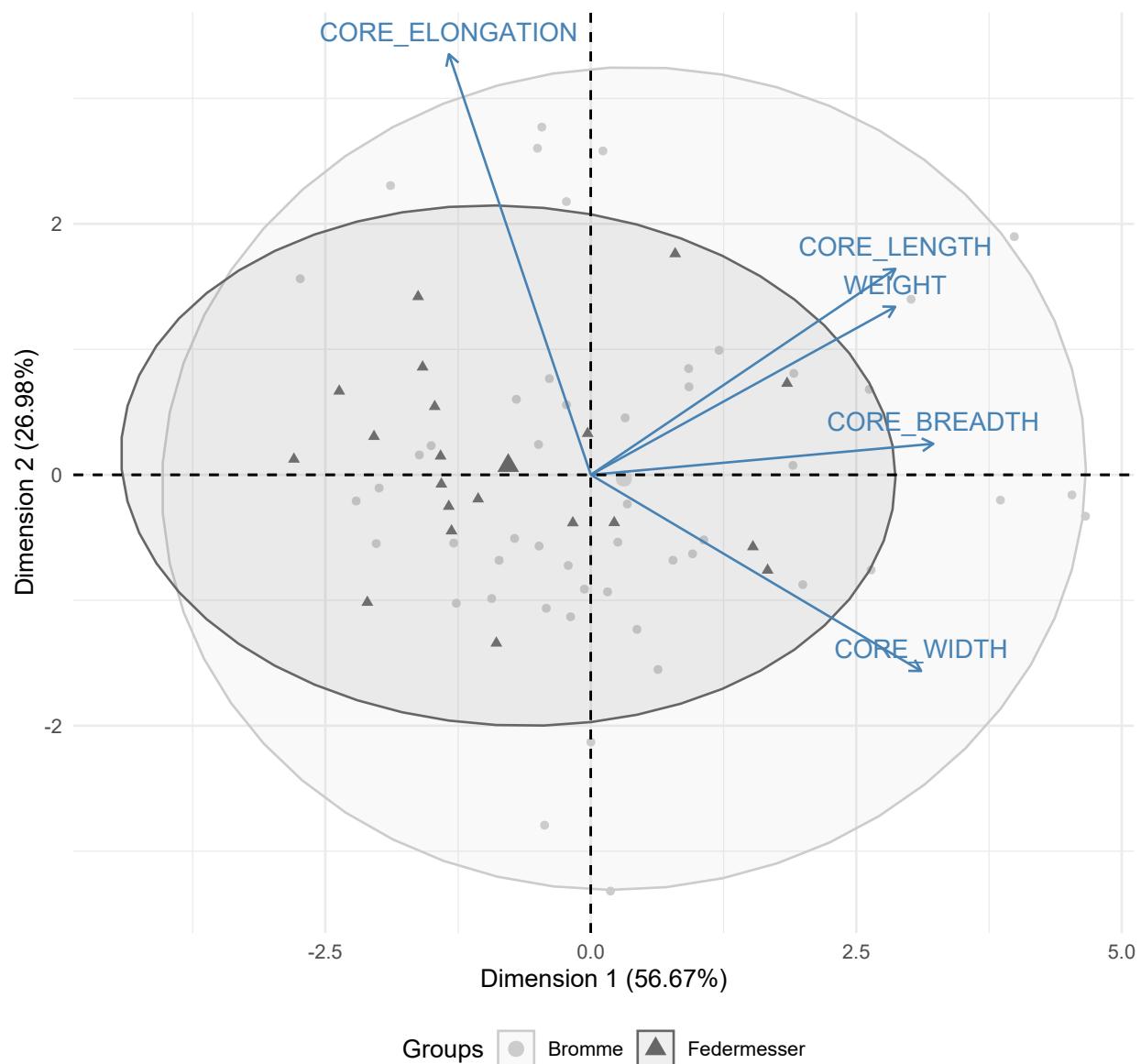
```
## # A tibble: 5 x 4
##   rowname eigenvalue variance cumulative
##   <chr>      <dbl>    <dbl>     <dbl>
## 1 Dim.1      2.83     56.7     56.7
## 2 Dim.2      1.35     27.0     83.7
## 3 Dim.3      0.477    9.54    93.2
## 4 Dim.4      0.282    5.65    98.8
## 5 Dim.5      0.0579   1.16    100.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



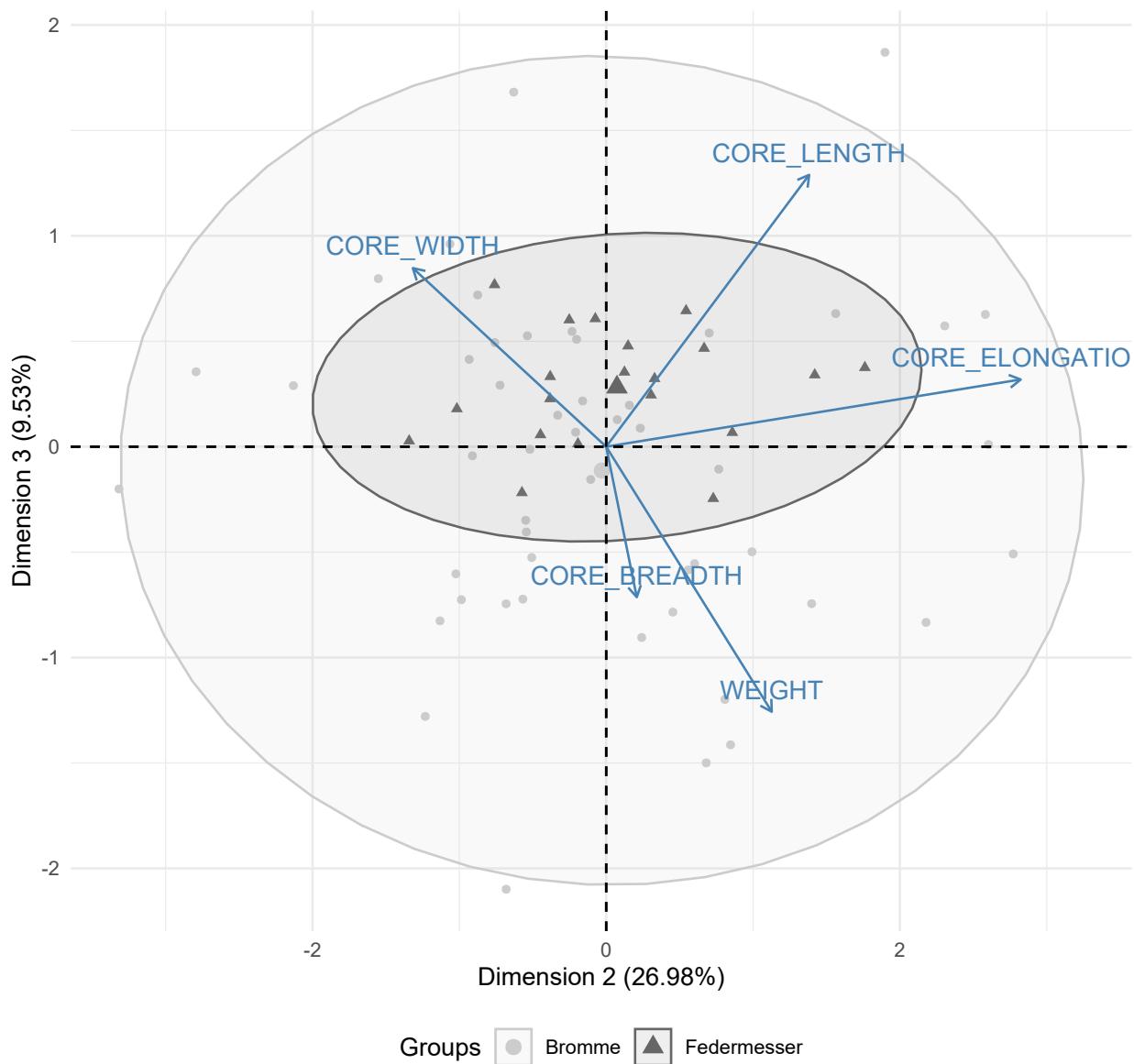
## Contribution of Variables



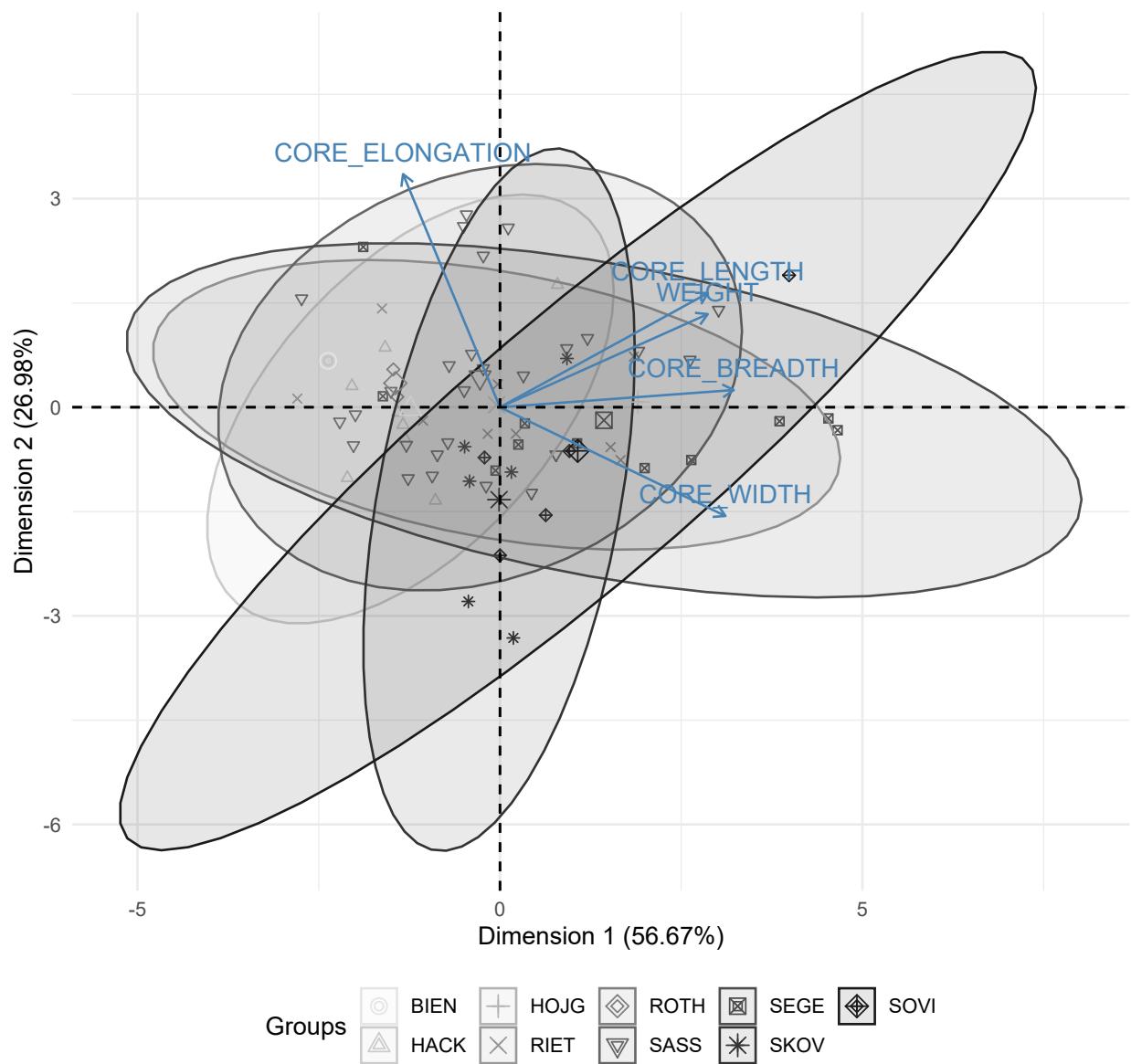
## PCA 1 vs. PCA 2 (Classification)



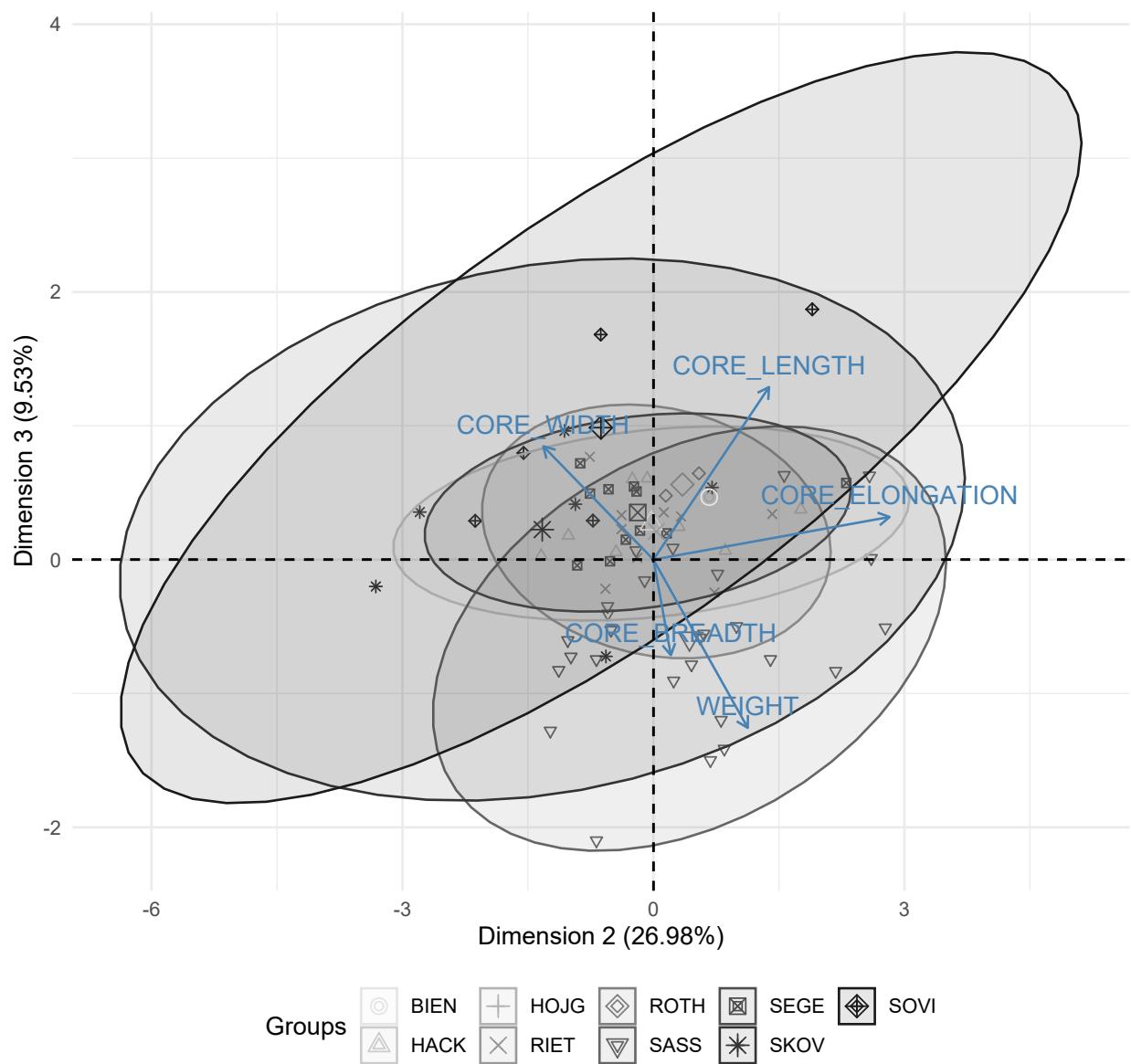
## PCA 2 vs. PCA 3 (Classification)



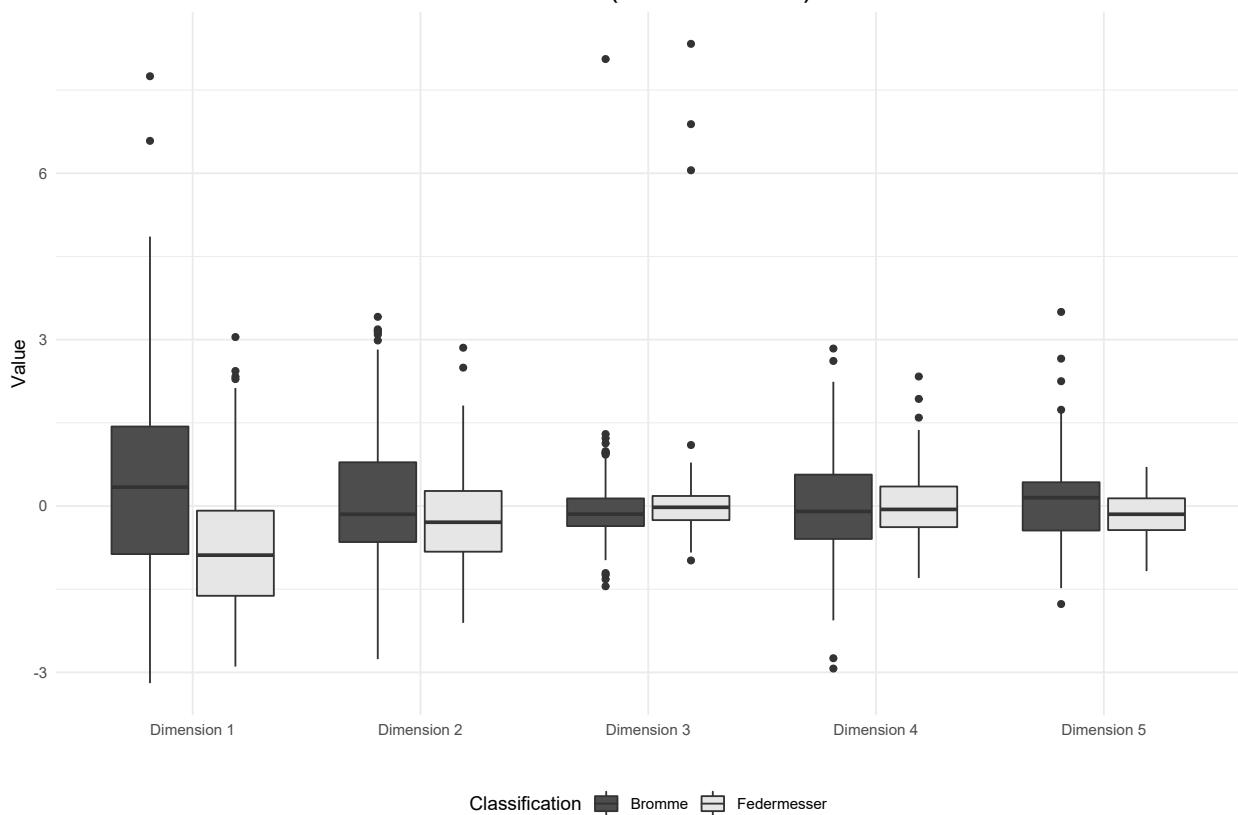
## PCA 1 vs. PCA 2 (Context)



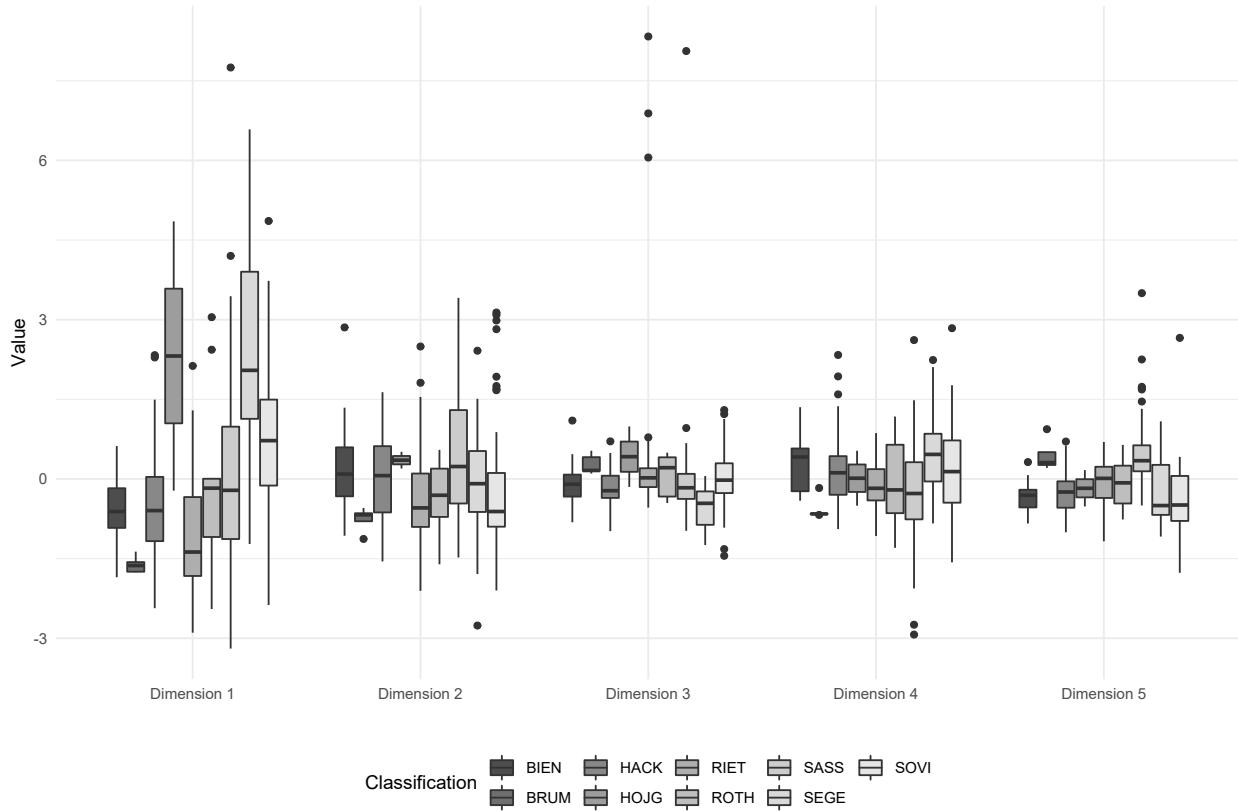
## PCA 2 vs. PCA 3 (Context)



### PCA 1:5 (Classification)

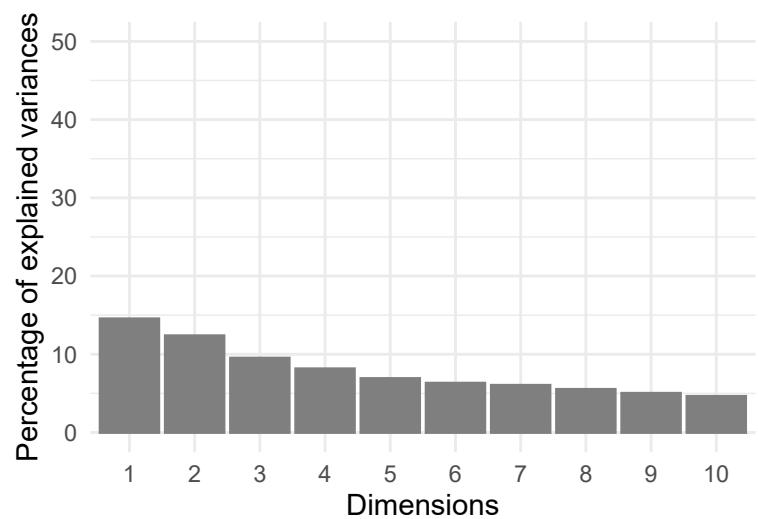


### PCA 1:5 (Classification)

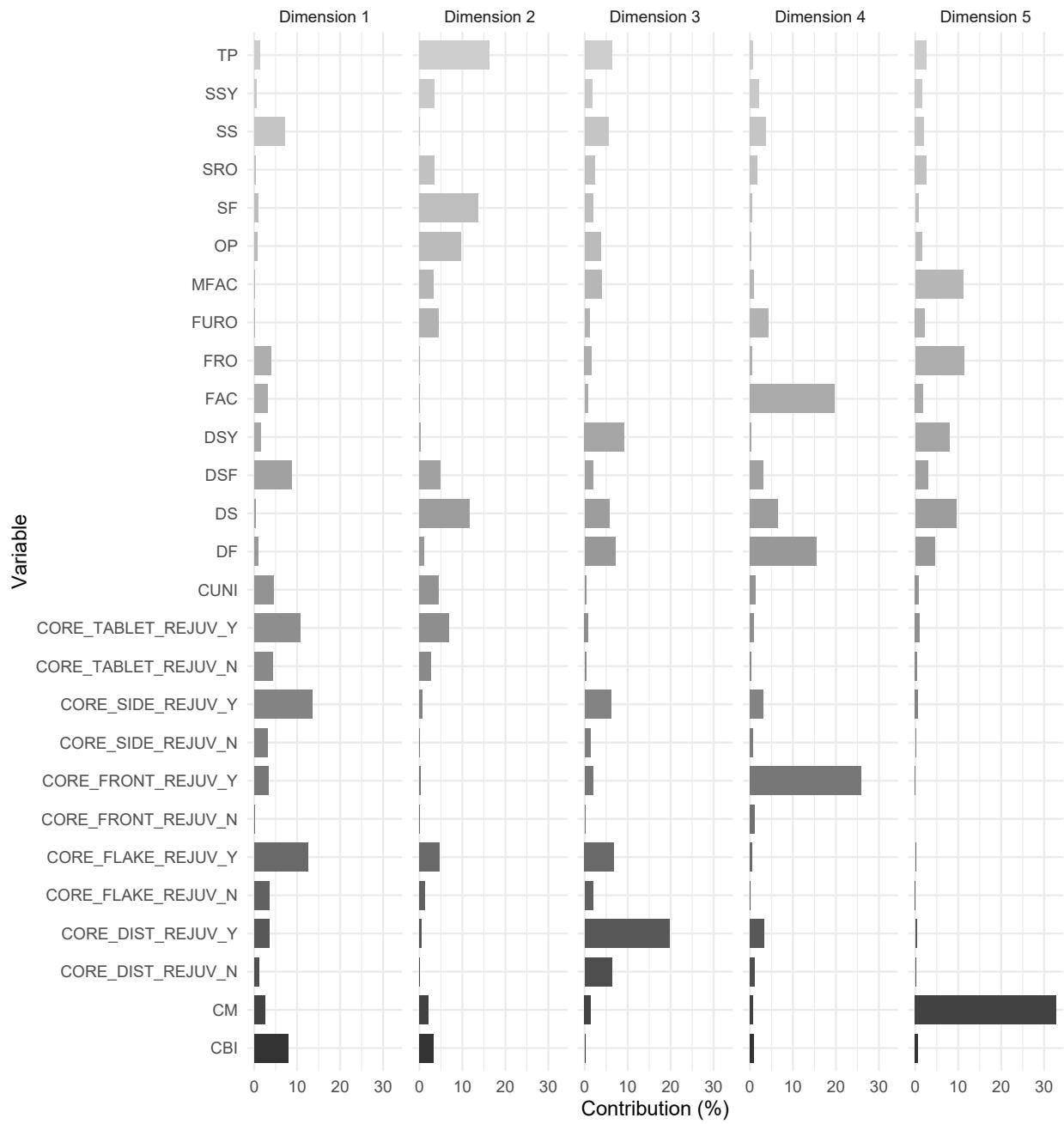


### Multiple Correspondence Analysis (MCA)

```
## # 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
```



## Contribution of Variables



Refer to the attribute catalogue for specific terminology

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 faceted core platforms (**Plat Rejuv**)

**CBI:** Bidirectional blade scars (**Core Directionality**)

Key acronyms for responses in *Axis 2*:

**TP:** Two platforms (**Core Morph**)

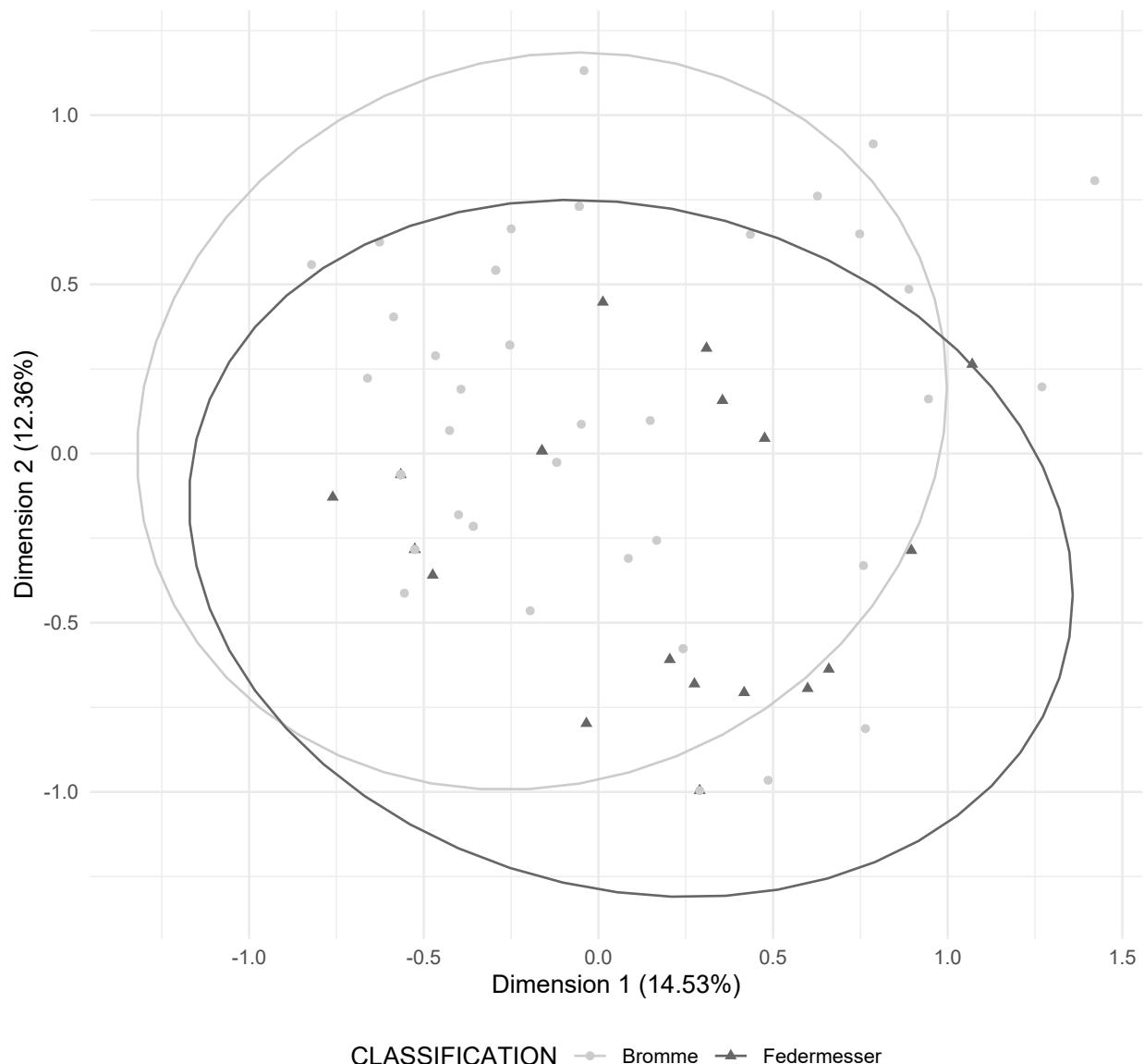
*SF*: Single faceted and/or flaked platforms (**Plat Rejuv**)

*DS*: Double smooth platforms (**Plat Rejuv**)

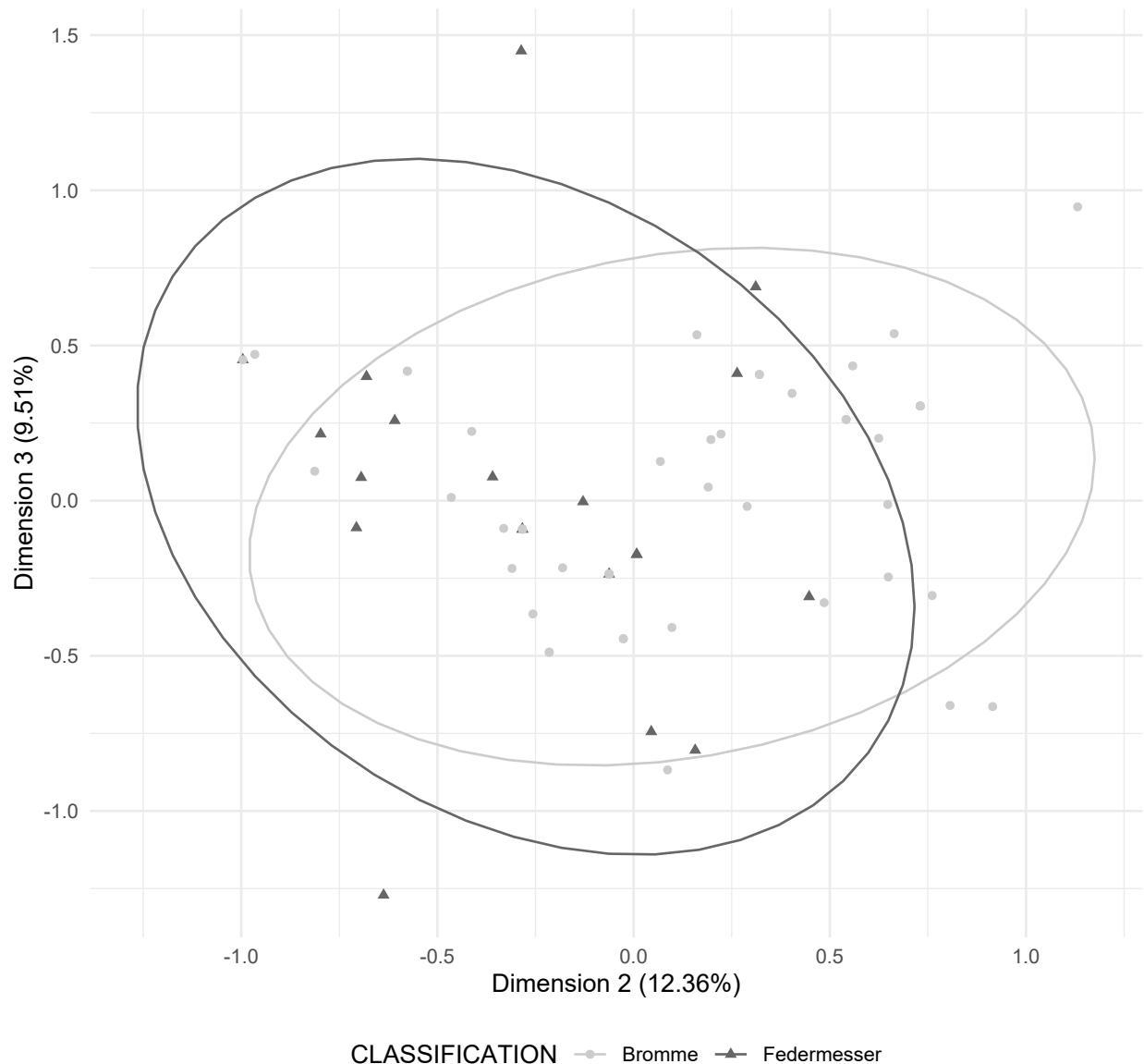
*OP*: One platform (**Core Morph**)

*CORE\_TABLET\_REJUV\_Y*: Core tabletting: positive response(**Core Tablet Rejuv**)

## MCA 1 vs. MCA 2 (Classification)

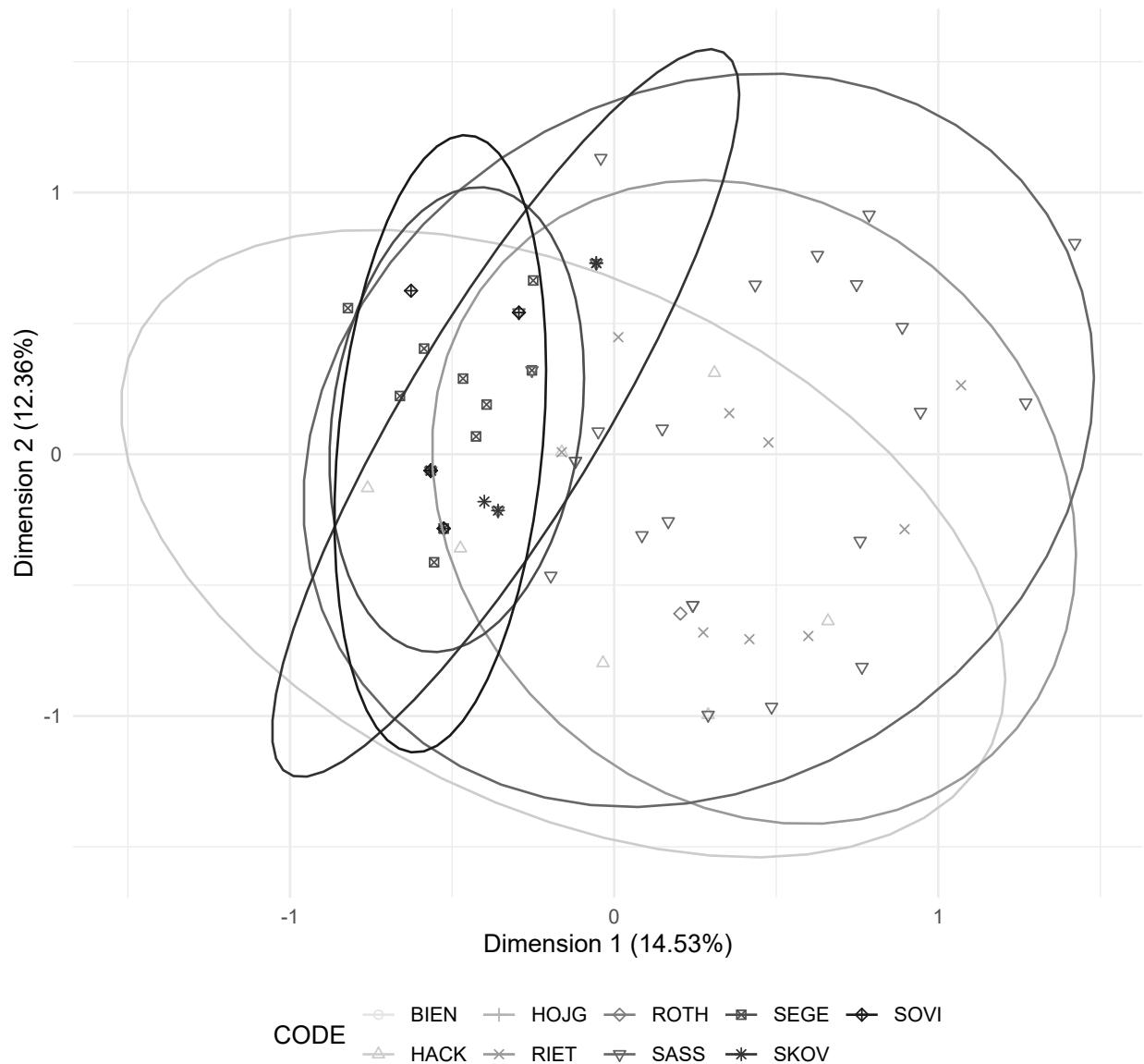


## MCA 2 vs. MCA 3 (Classification)

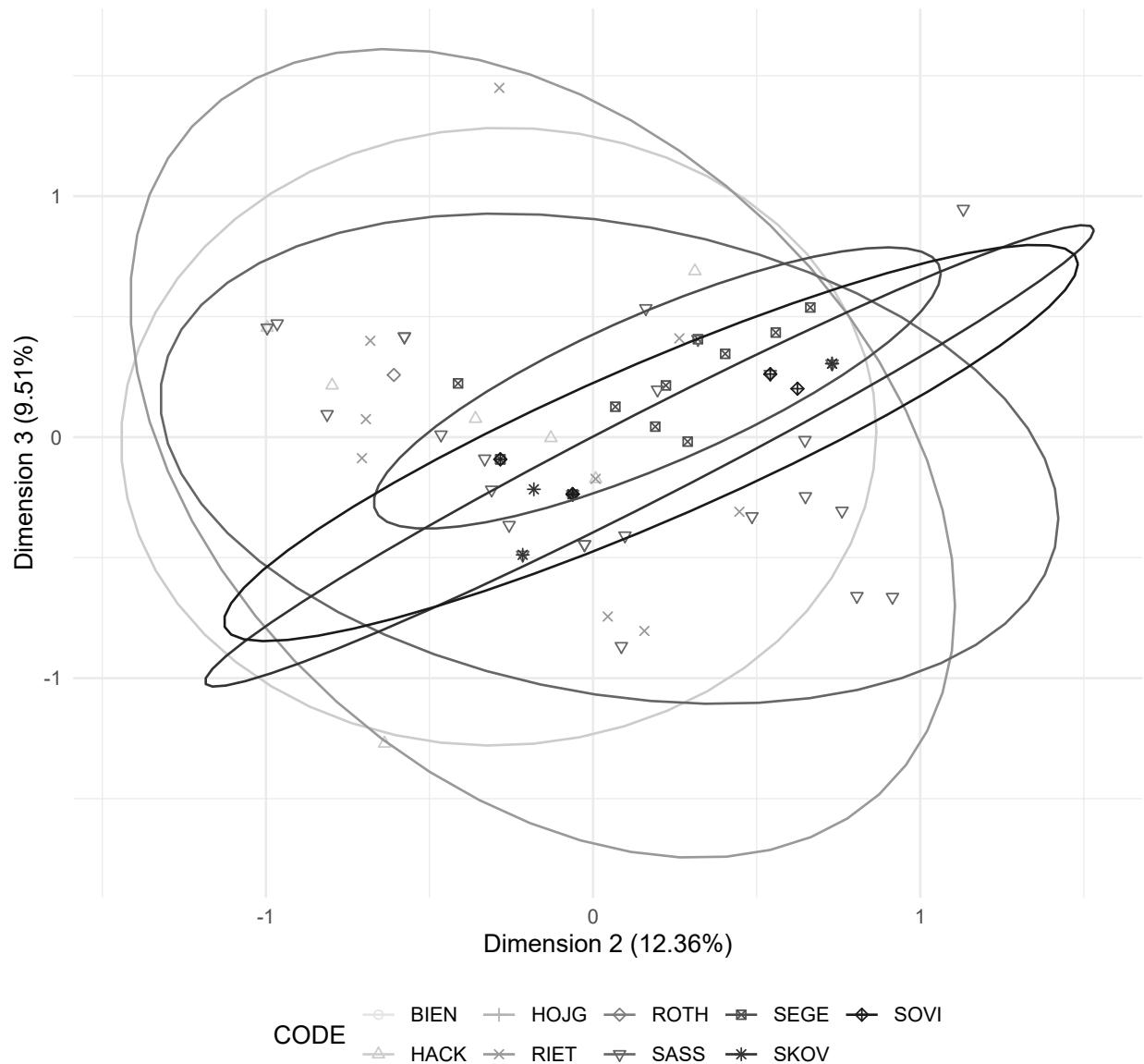


## Warning: Removed 3 row(s) containing missing values (geom\_path).

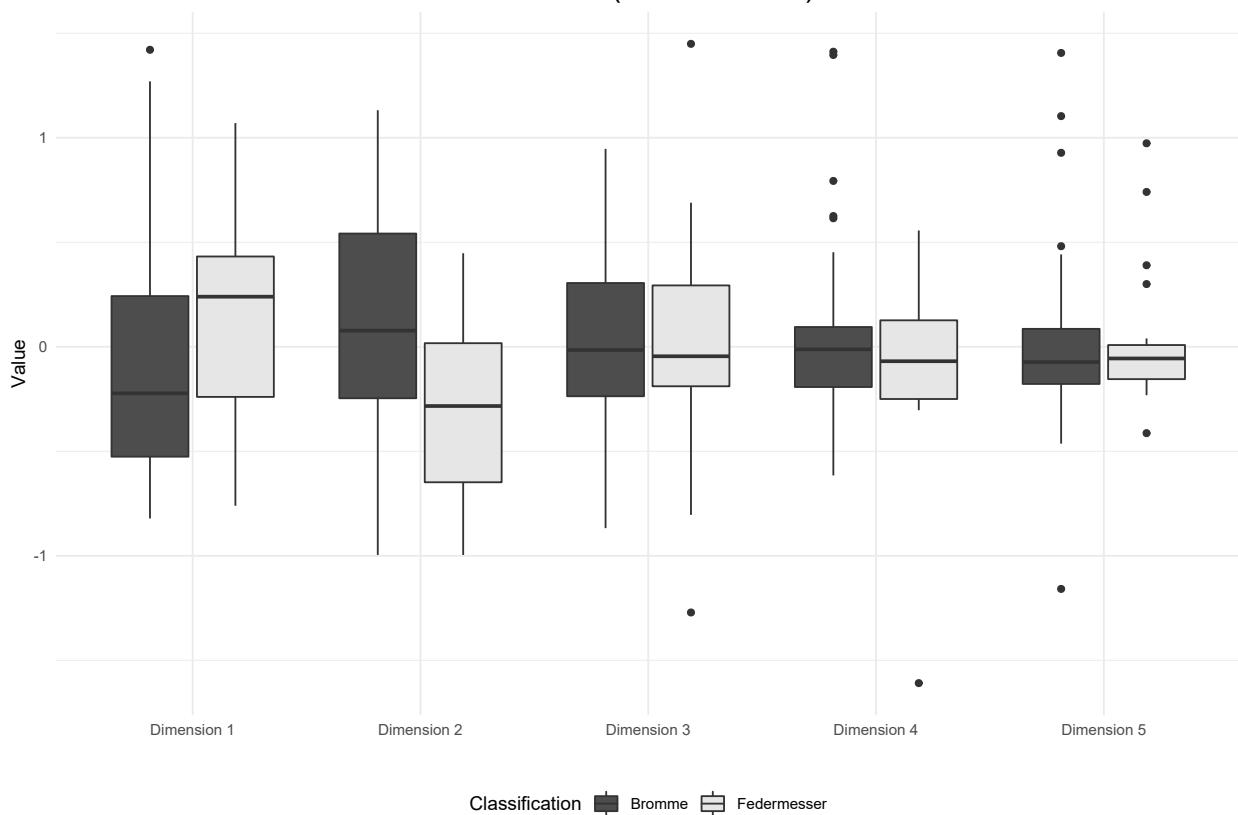
## MCA 1 vs. MCA 2 (Code)



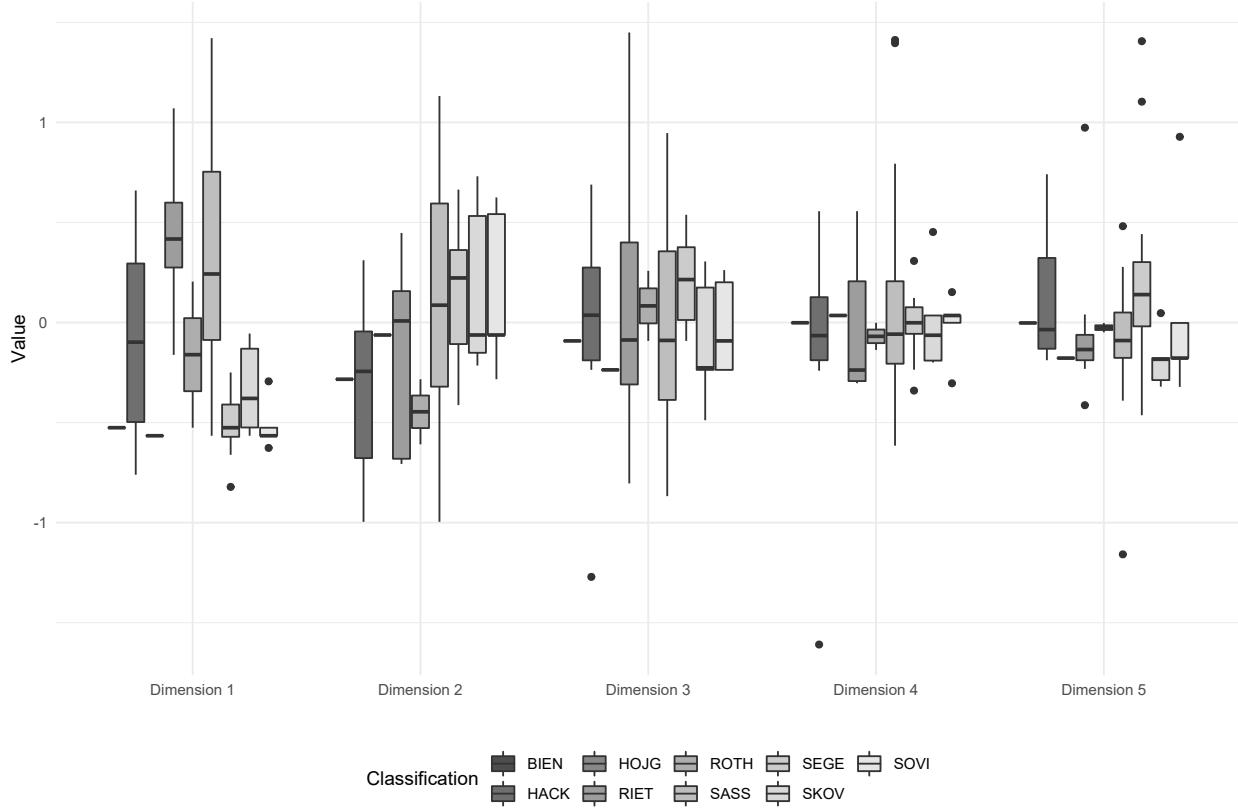
## MCA 2 vs. MCA 3 (Code)



### MCA 1:5 (Classification)



### MCA 1:5 (Classification)



### 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
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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)

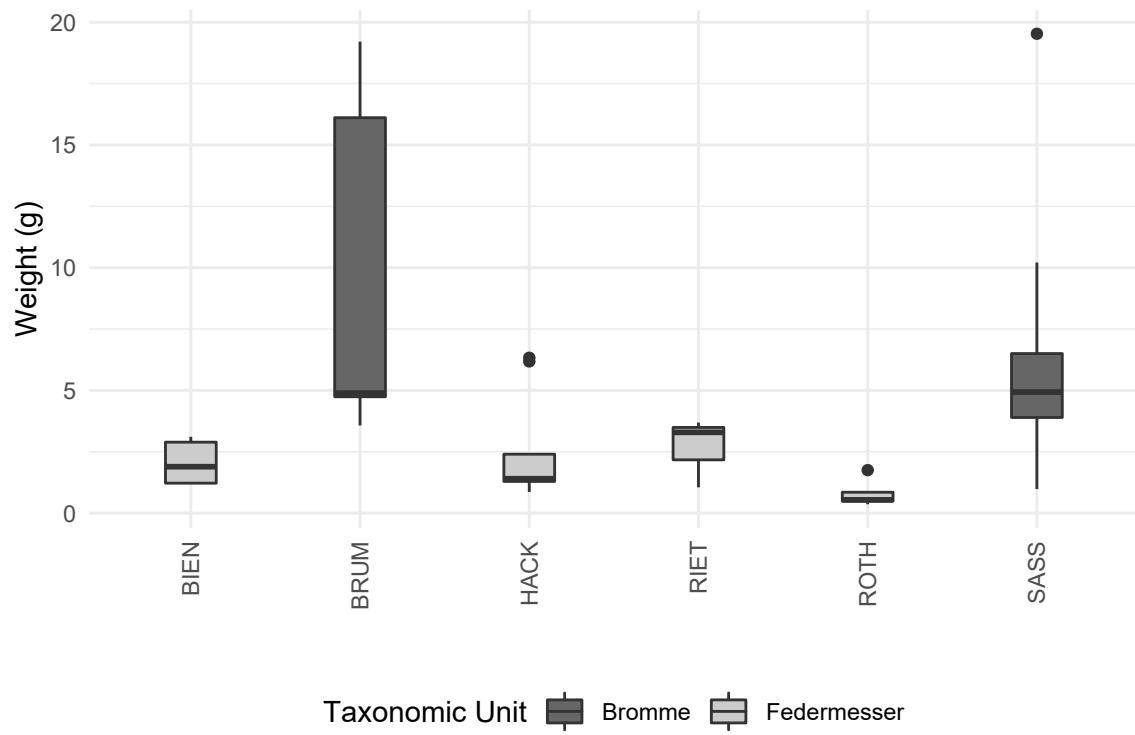
SUB_CATEGORY	n_obs	min	max	mean	med	sd	var
Backed Point (Reclassified)	7	2.44	6.10	3.95	3.56	1.46	2.13
Backed Point (Unclassified)	42	1.54	7.45	4.55	4.61	1.34	1.79
Creswellian Point	5	1.84	4.01	2.47	2.01	0.90	0.82
Federmesser Point	2	2.41	4.77	3.59	3.59	1.67	2.78

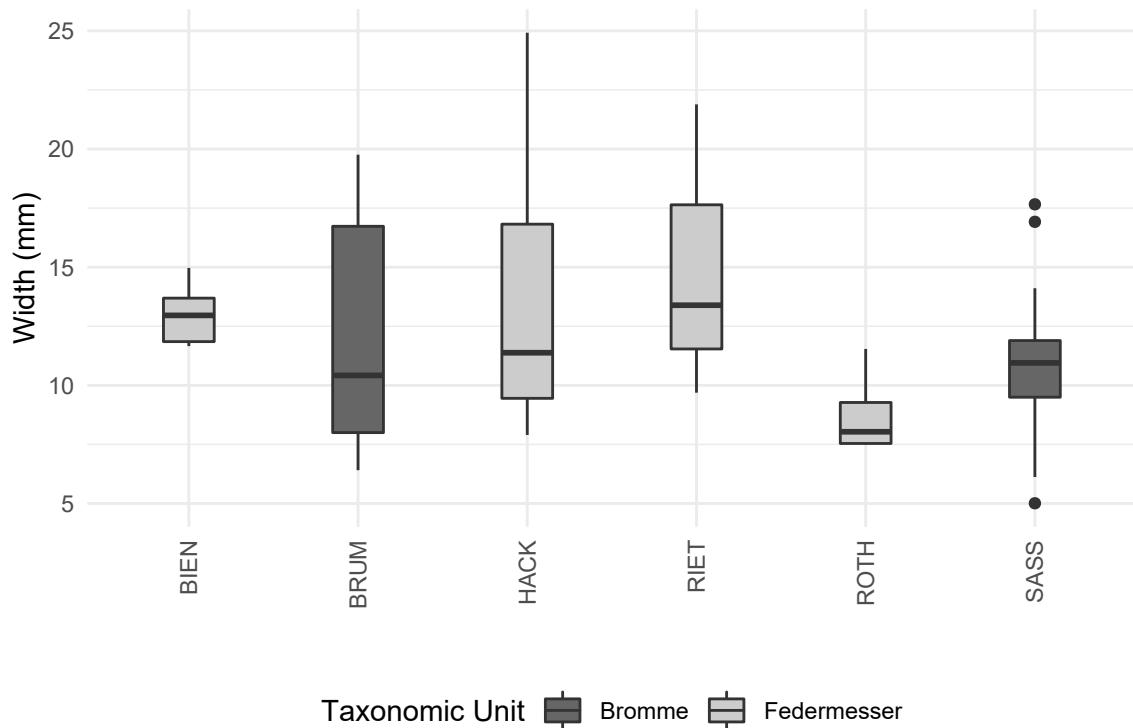
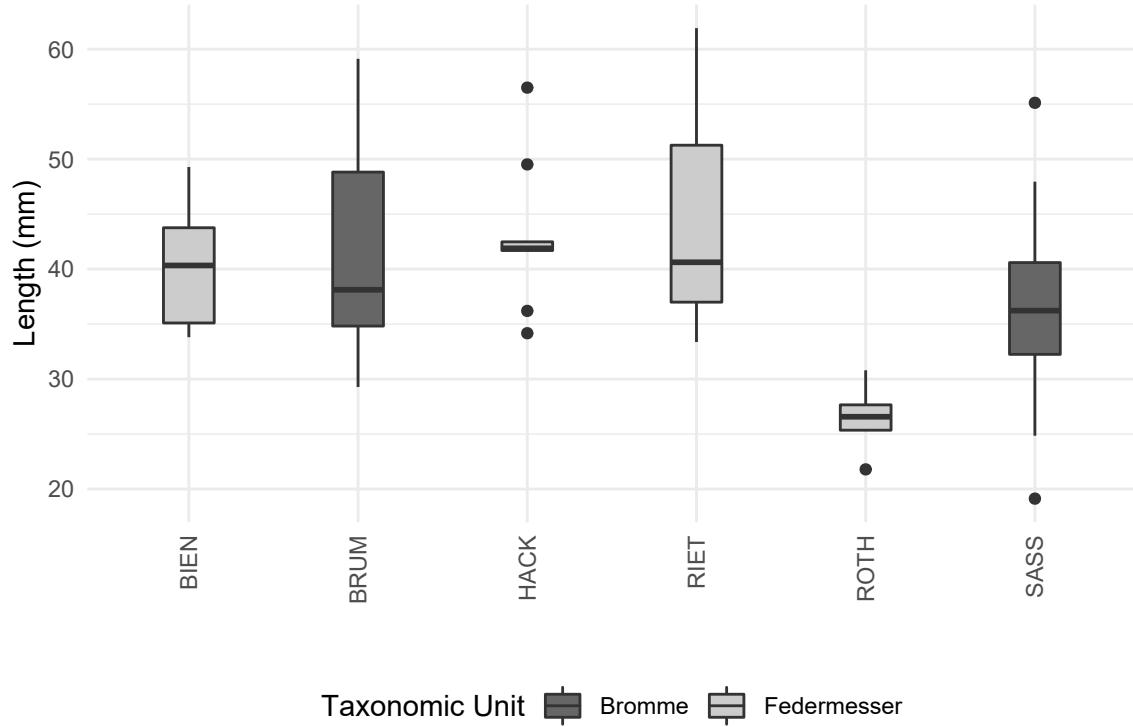
Table 44. Descriptive Statistics: Tip Cross-Sectional Area (TCSA)

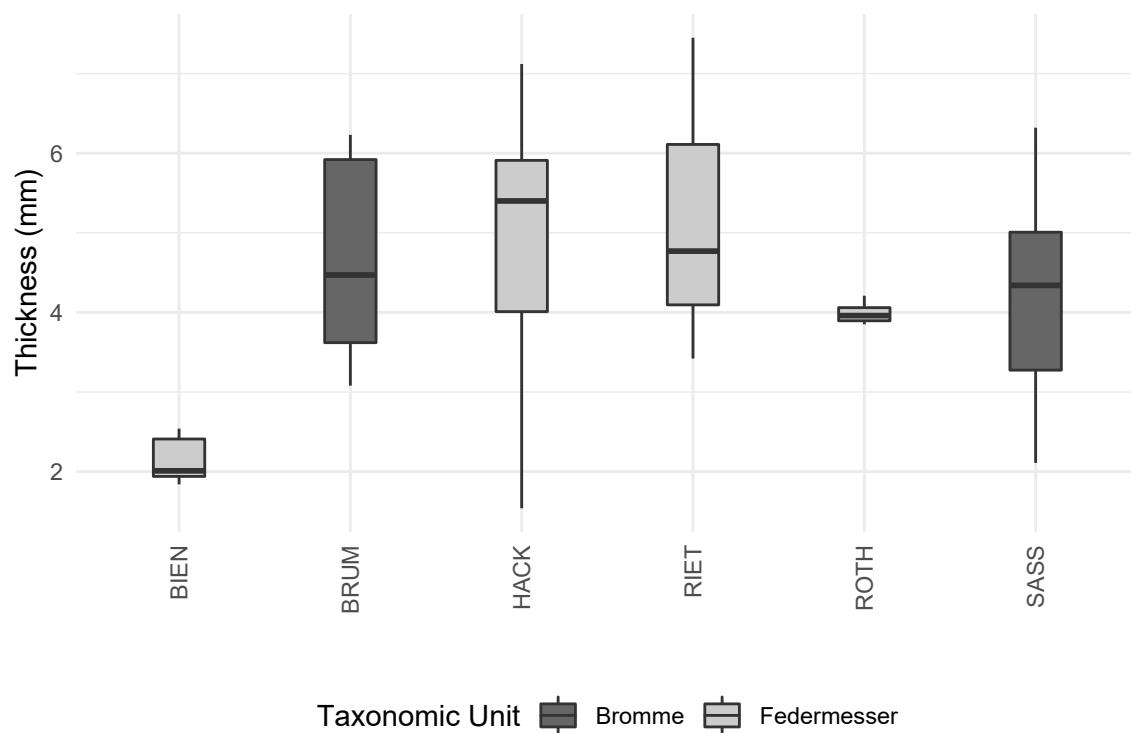
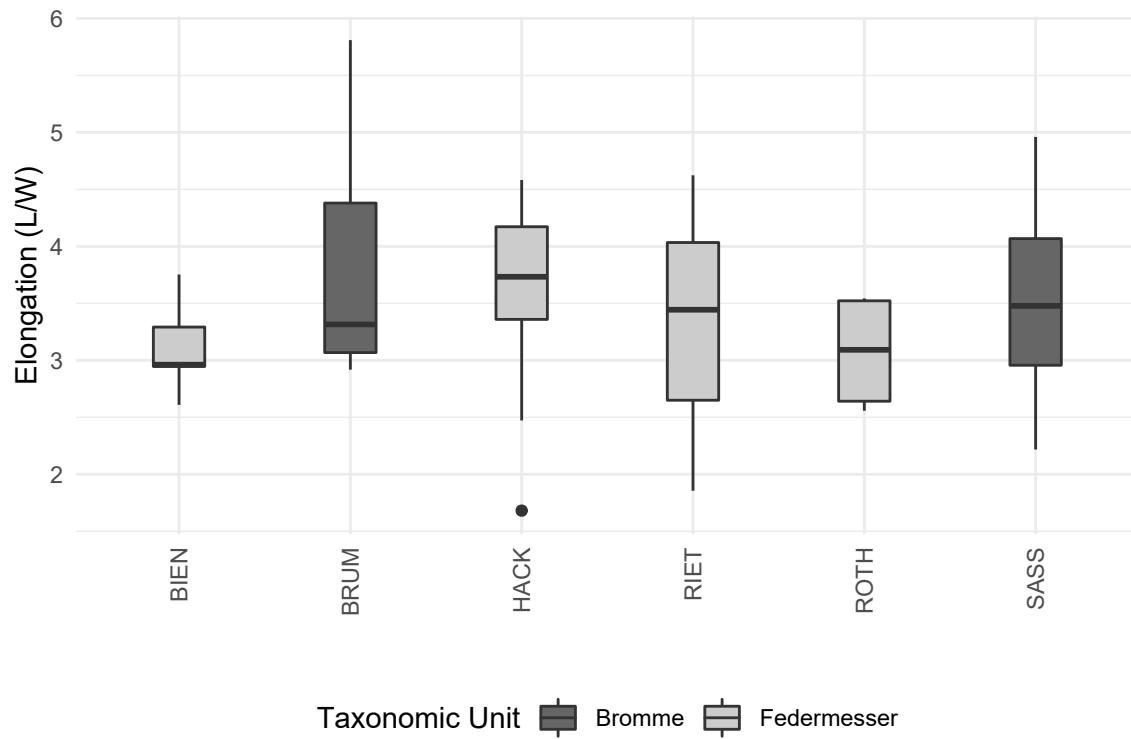
SUB_CATEGORY	n_obs	min	max	mean	med	sd	var
Backed Point (Reclassified)	7	11.38	60.27	30.05	22.98	18.86	355.83
Backed Point (Unclassified)	42	7.28	81.54	26.84	24.38	16.22	263.23
Creswellian Point	5	10.73	19.01	14.13	12.57	3.46	12.00
Federmesser Point	2	16.50	31.94	24.22	24.22	10.92	119.20

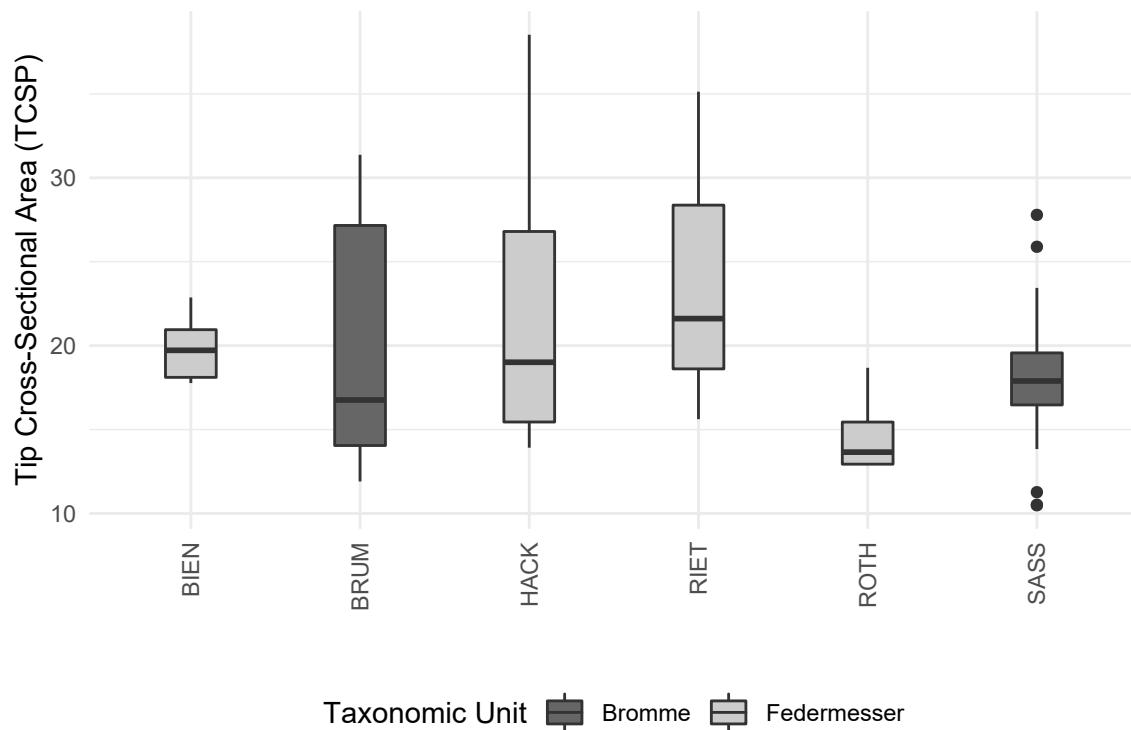
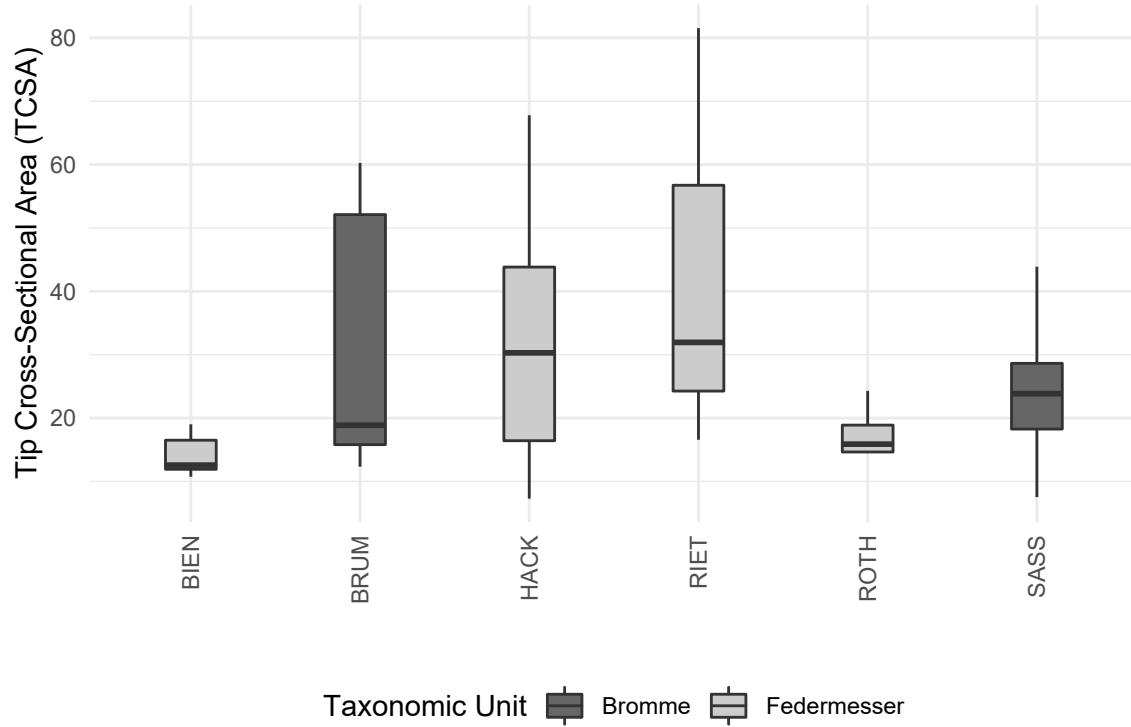
Table 45. Descriptive Statistics: Tip Cross-Sectional Perimeter (TCSP)

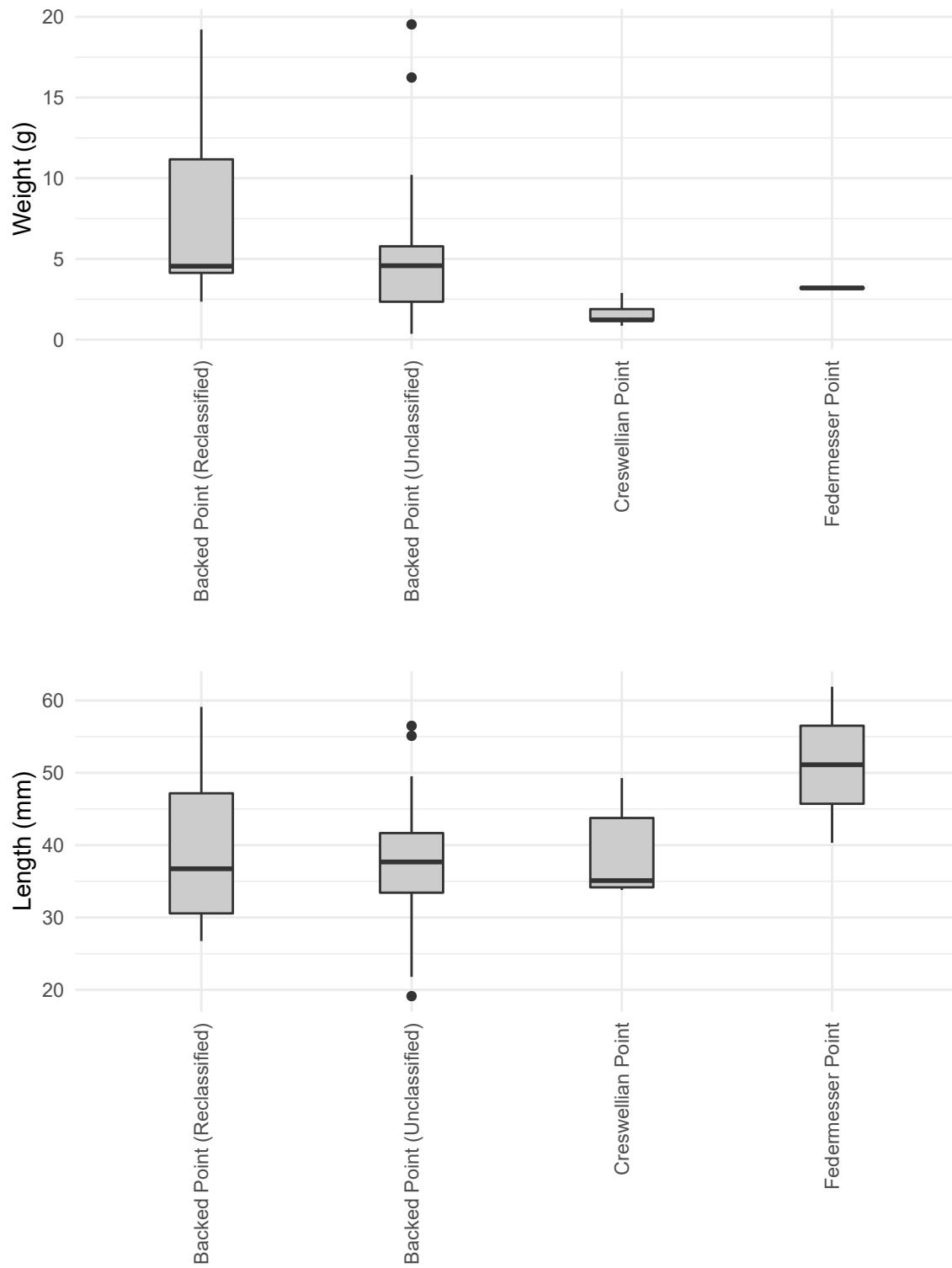
SUB_CATEGORY	n_obs	min	max	mean	med	sd	var
Backed Point (Reclassified)	7	14.59	31.37	22.35	20.28	6.37	40.58
Backed Point (Unclassified)	42	10.49	38.52	18.50	17.22	6.07	36.83
Creswellian Point	5	13.92	22.87	18.48	18.11	3.25	10.56
Federmesser Point	2	20.95	21.61	21.28	21.28	0.47	0.22

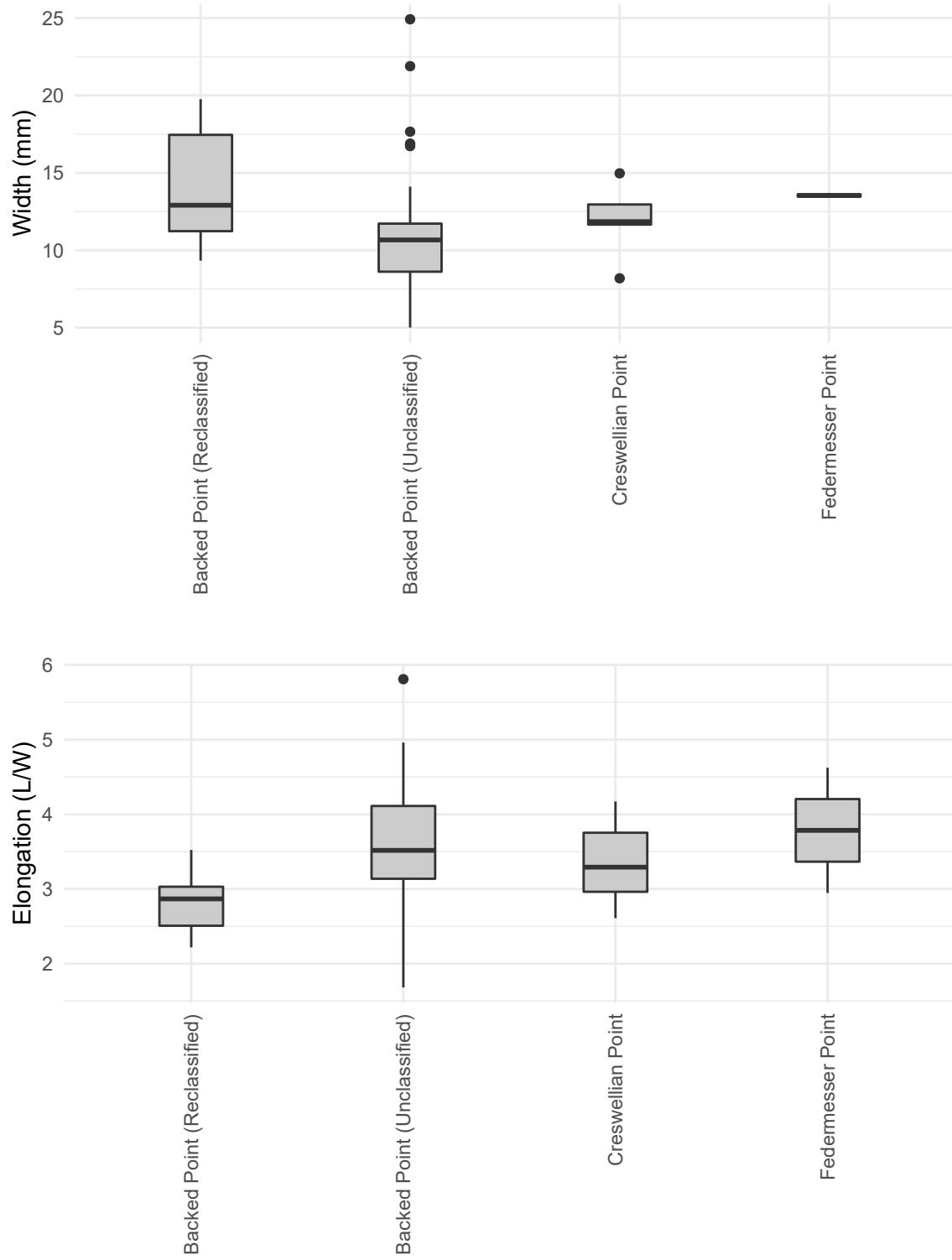


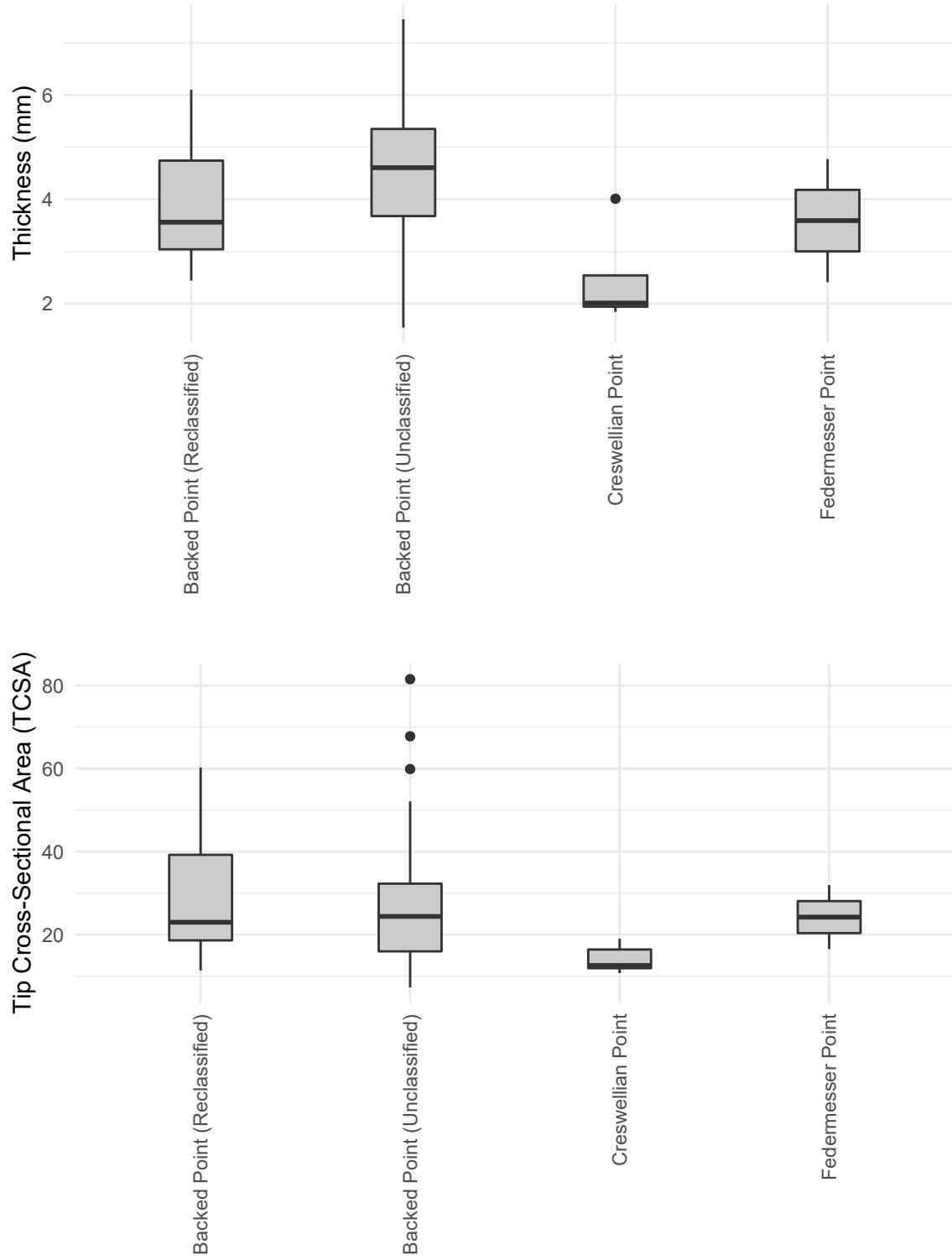


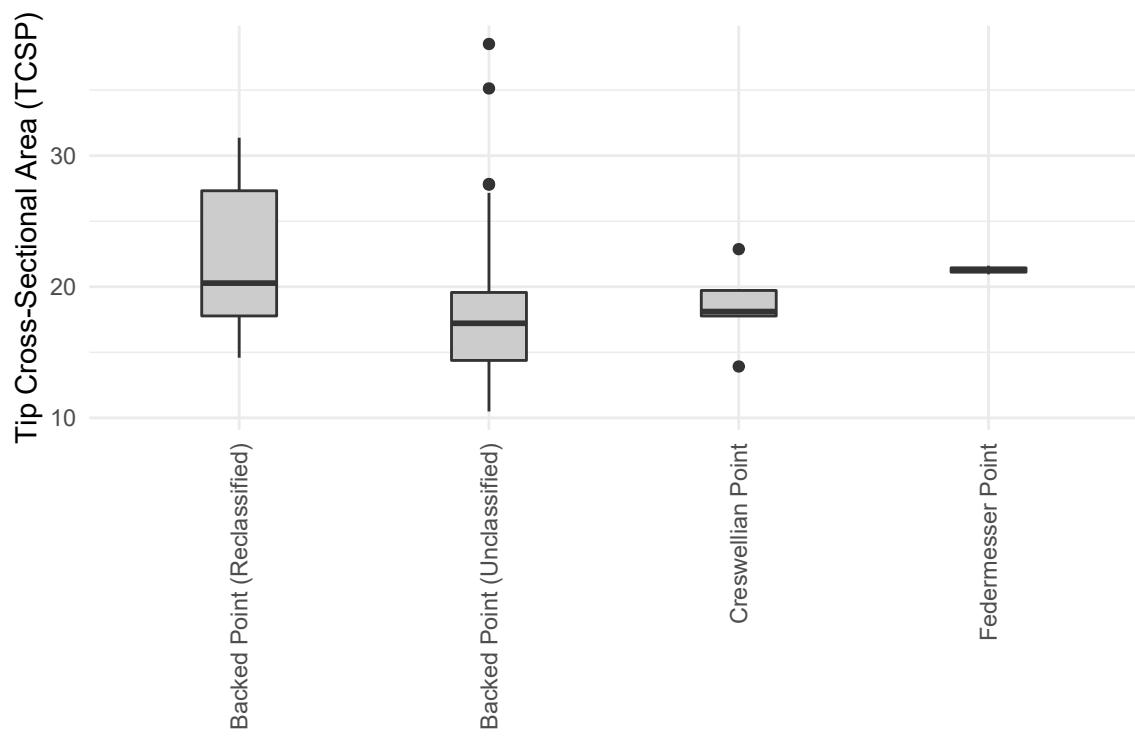


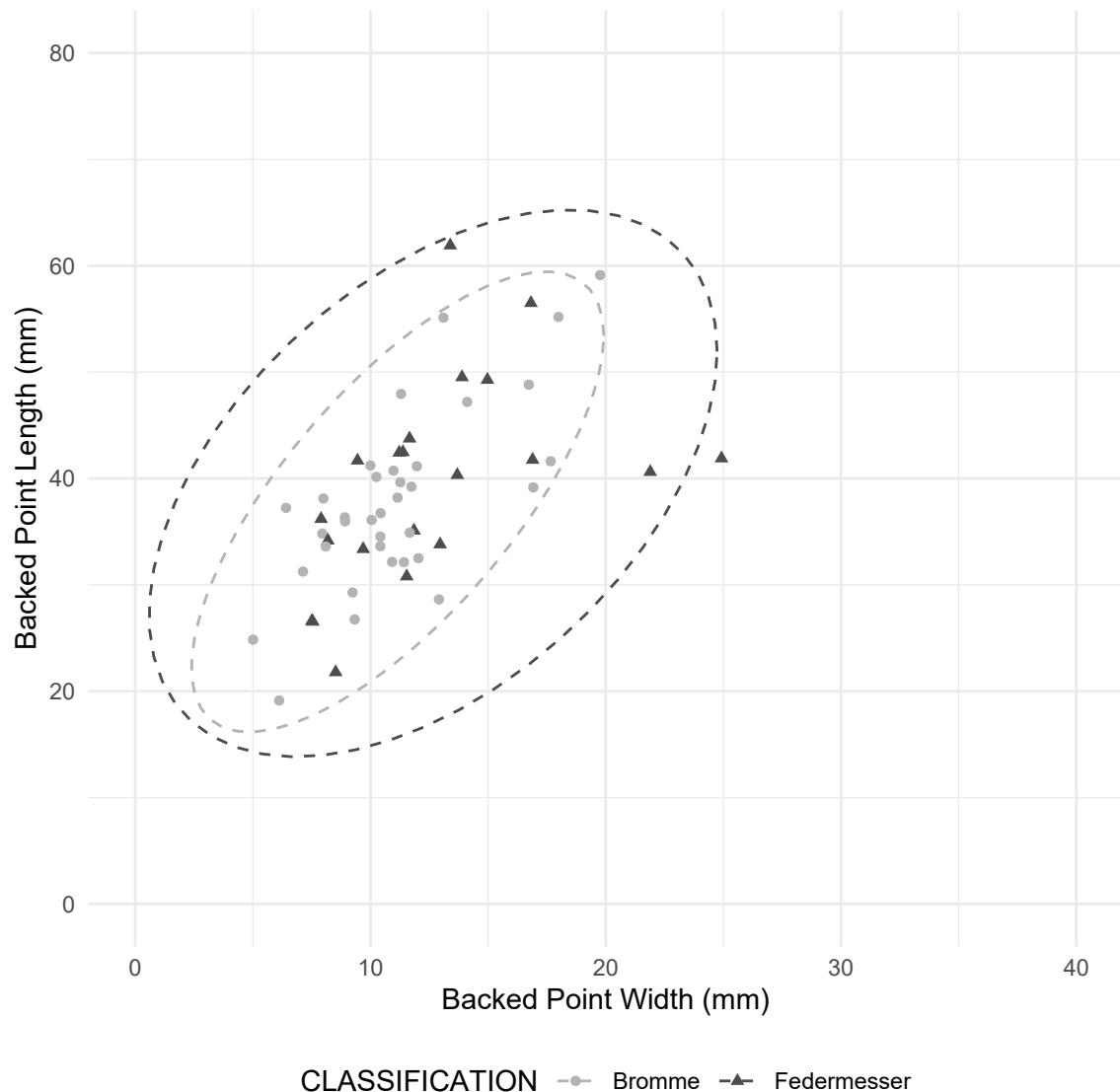


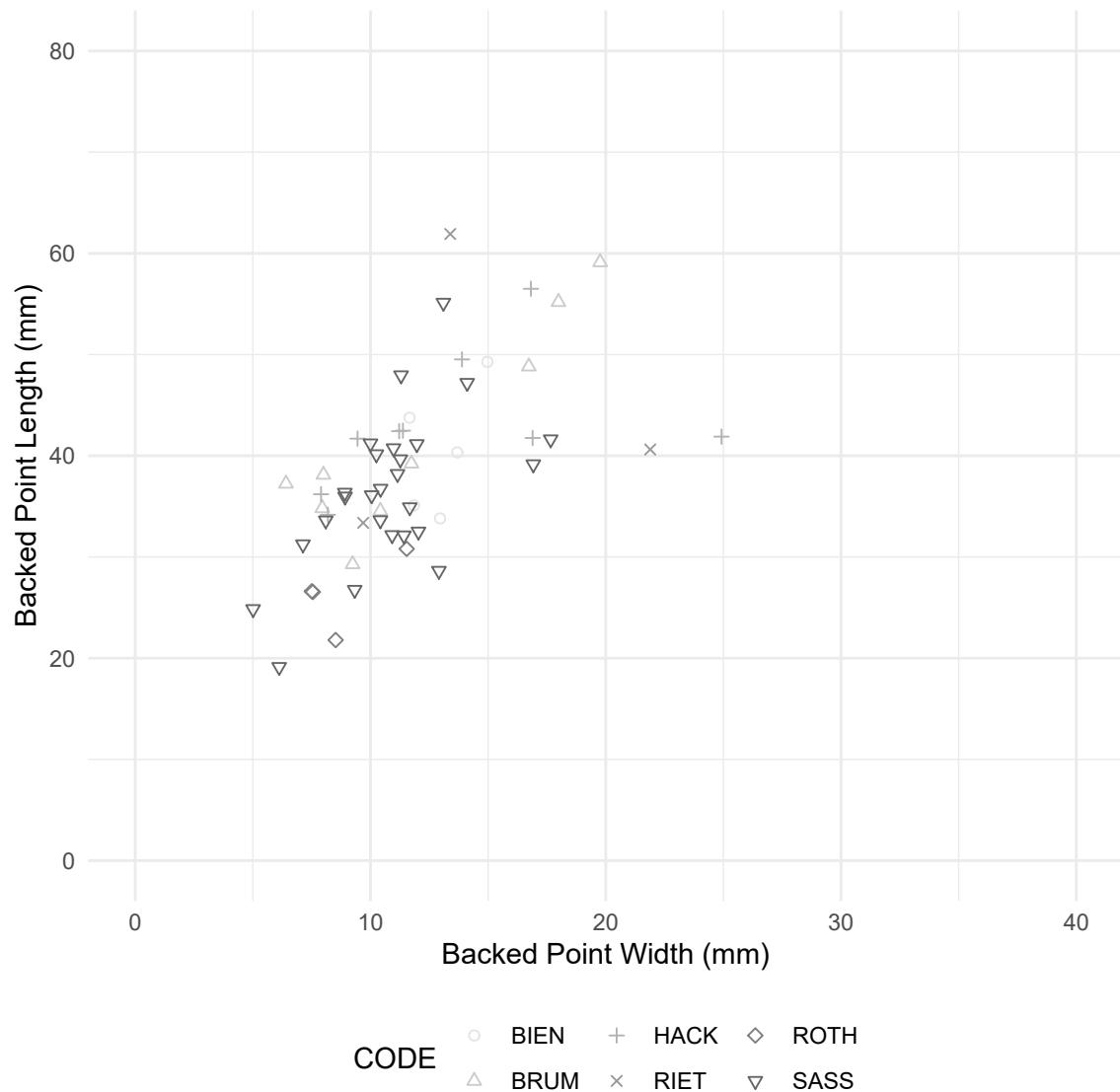


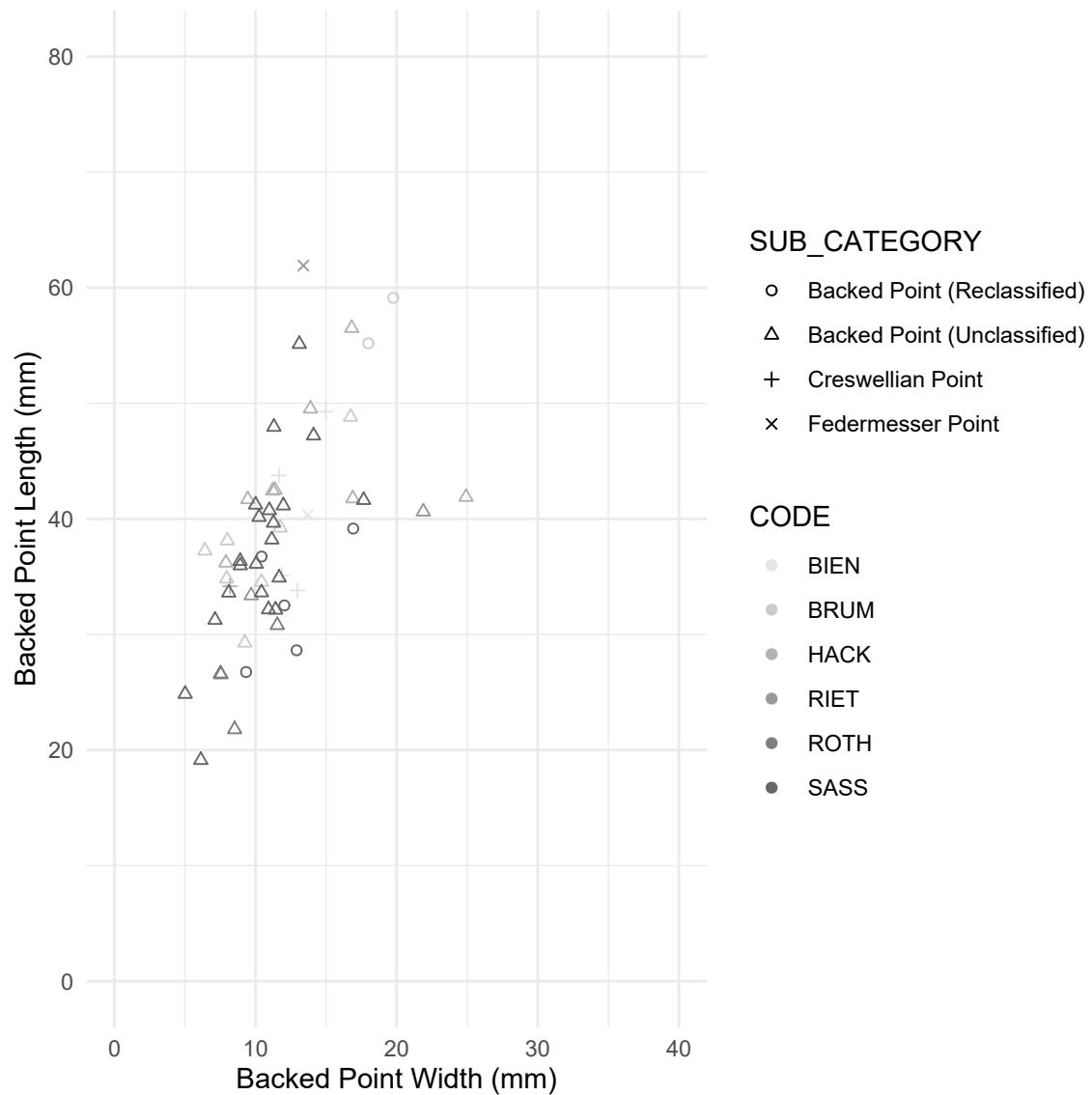


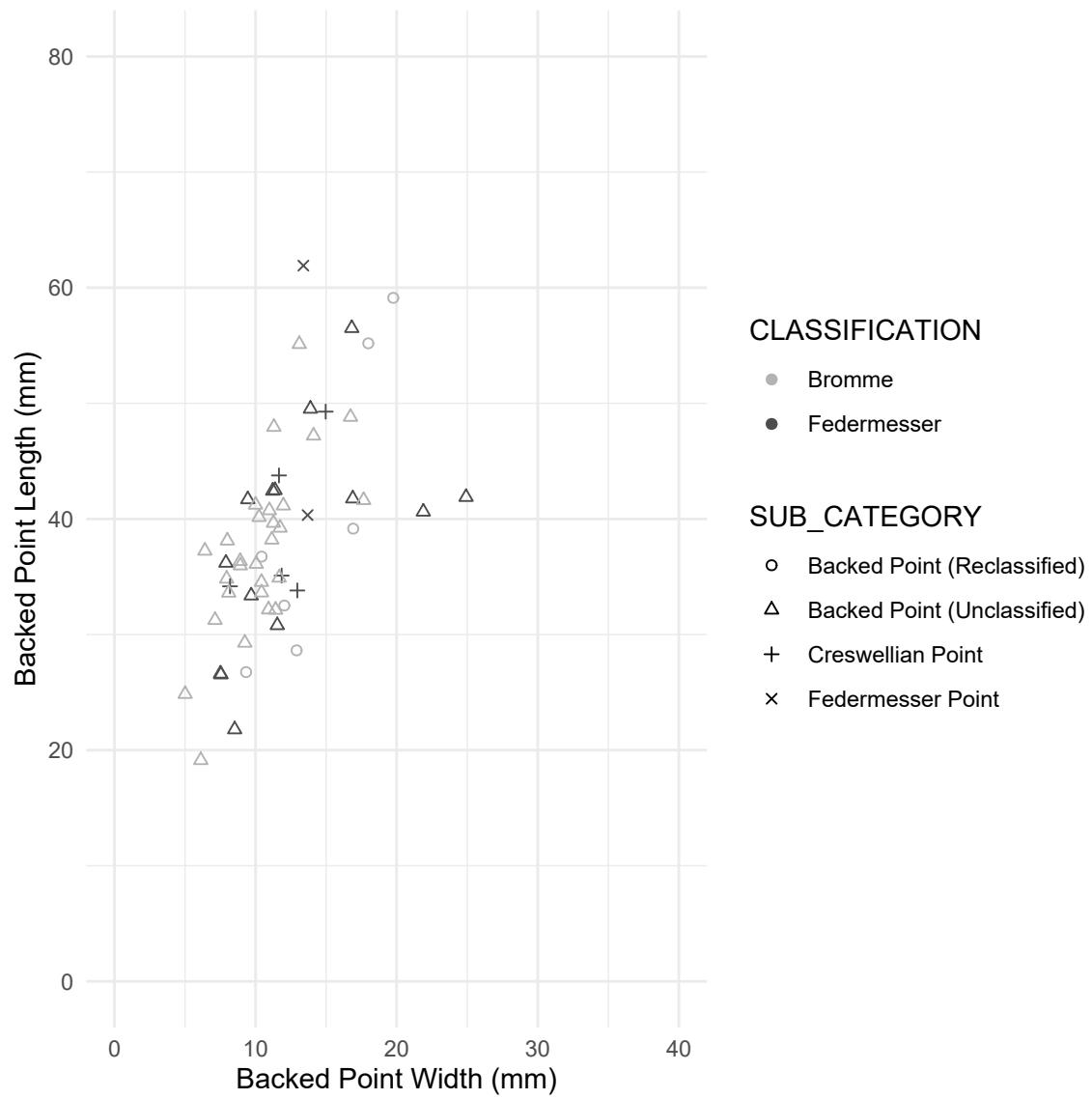


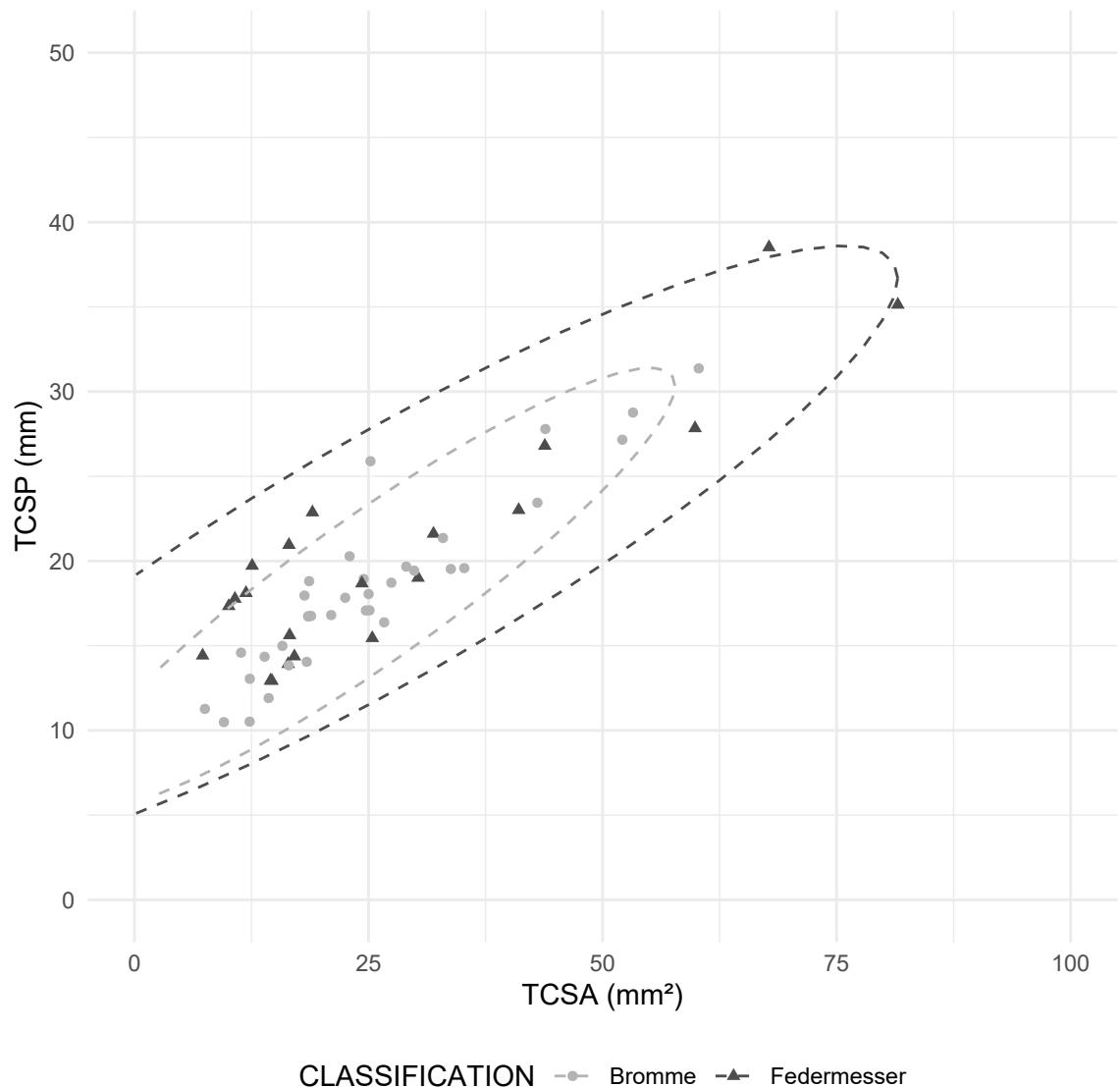


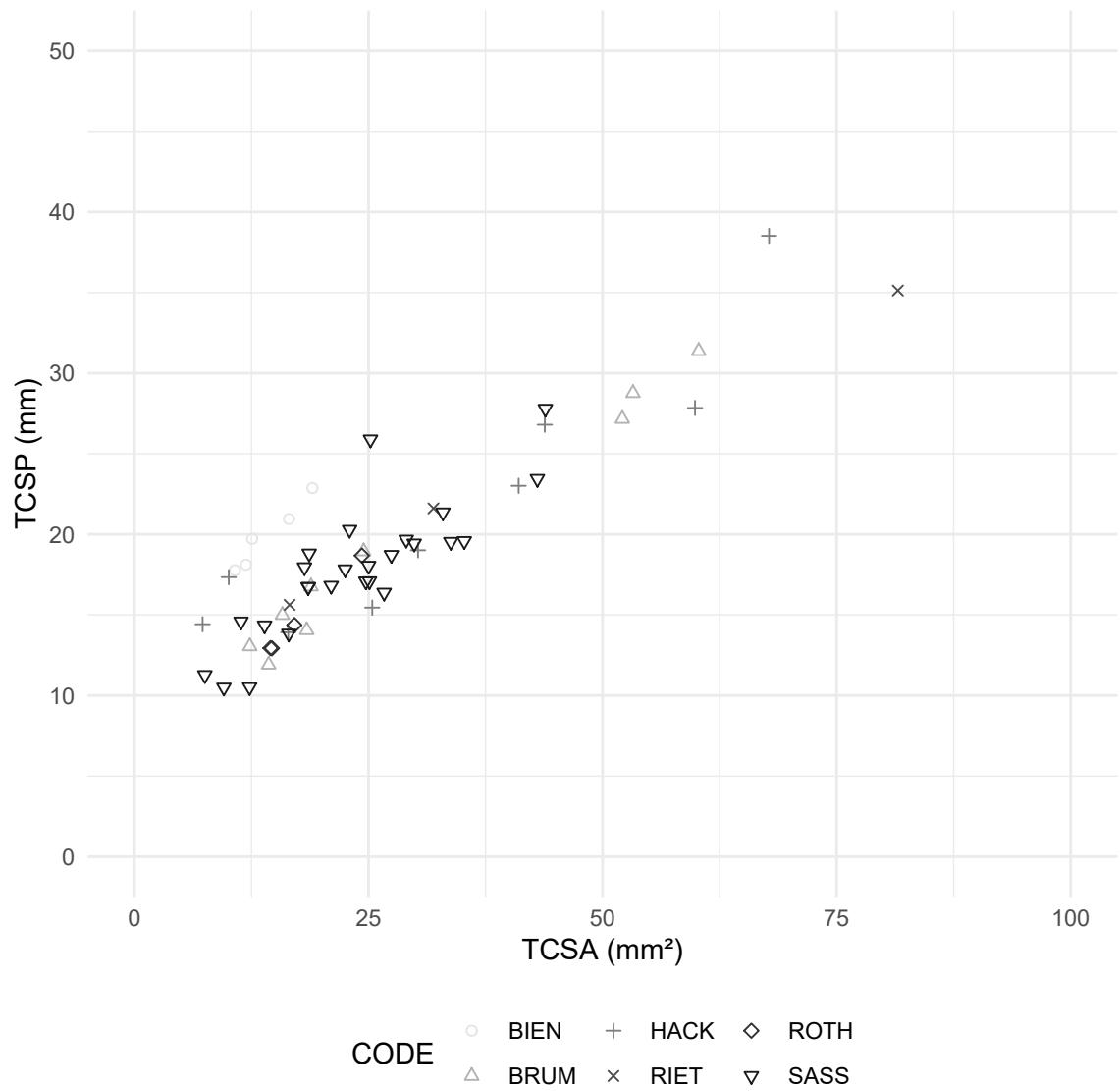


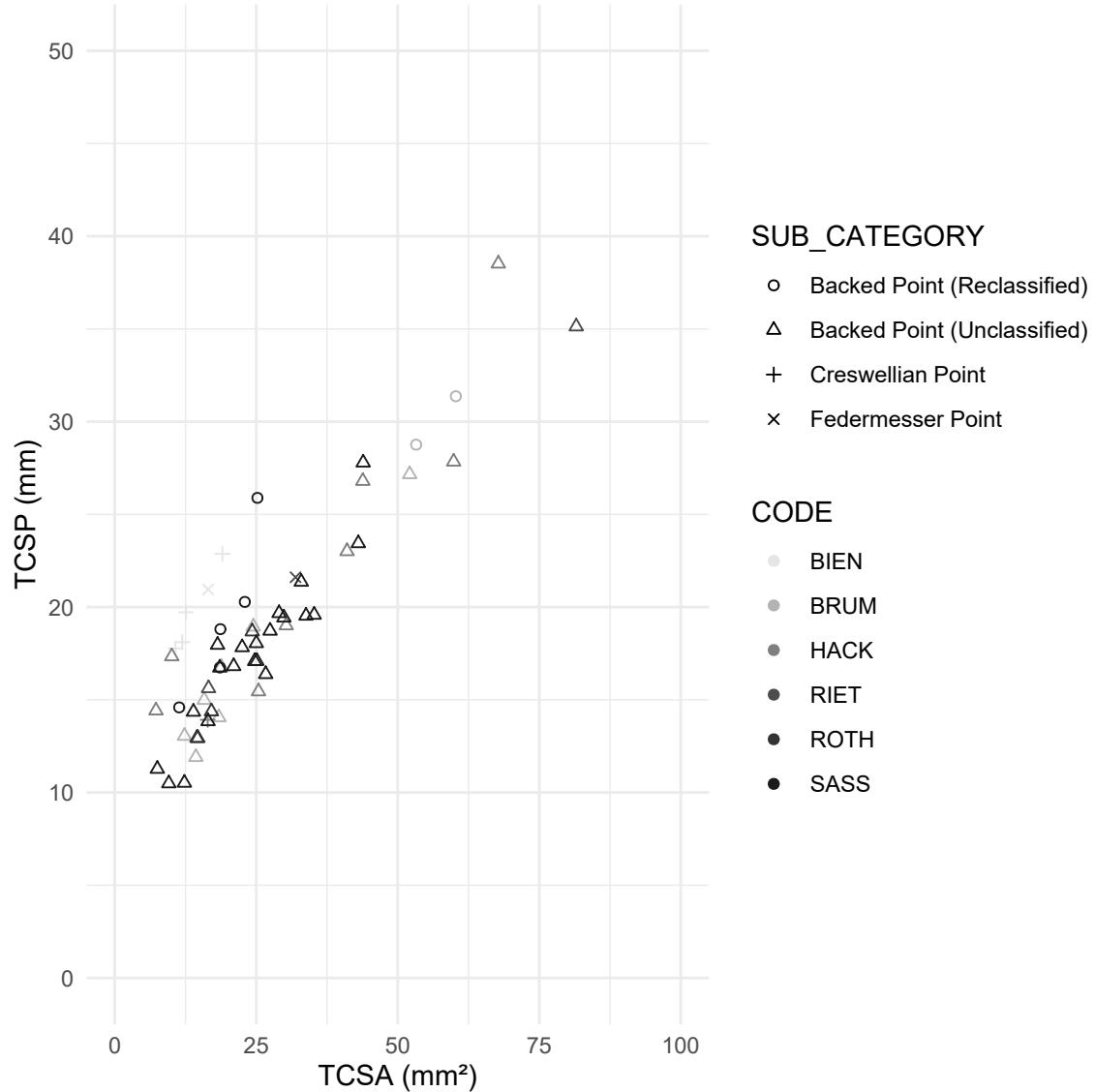


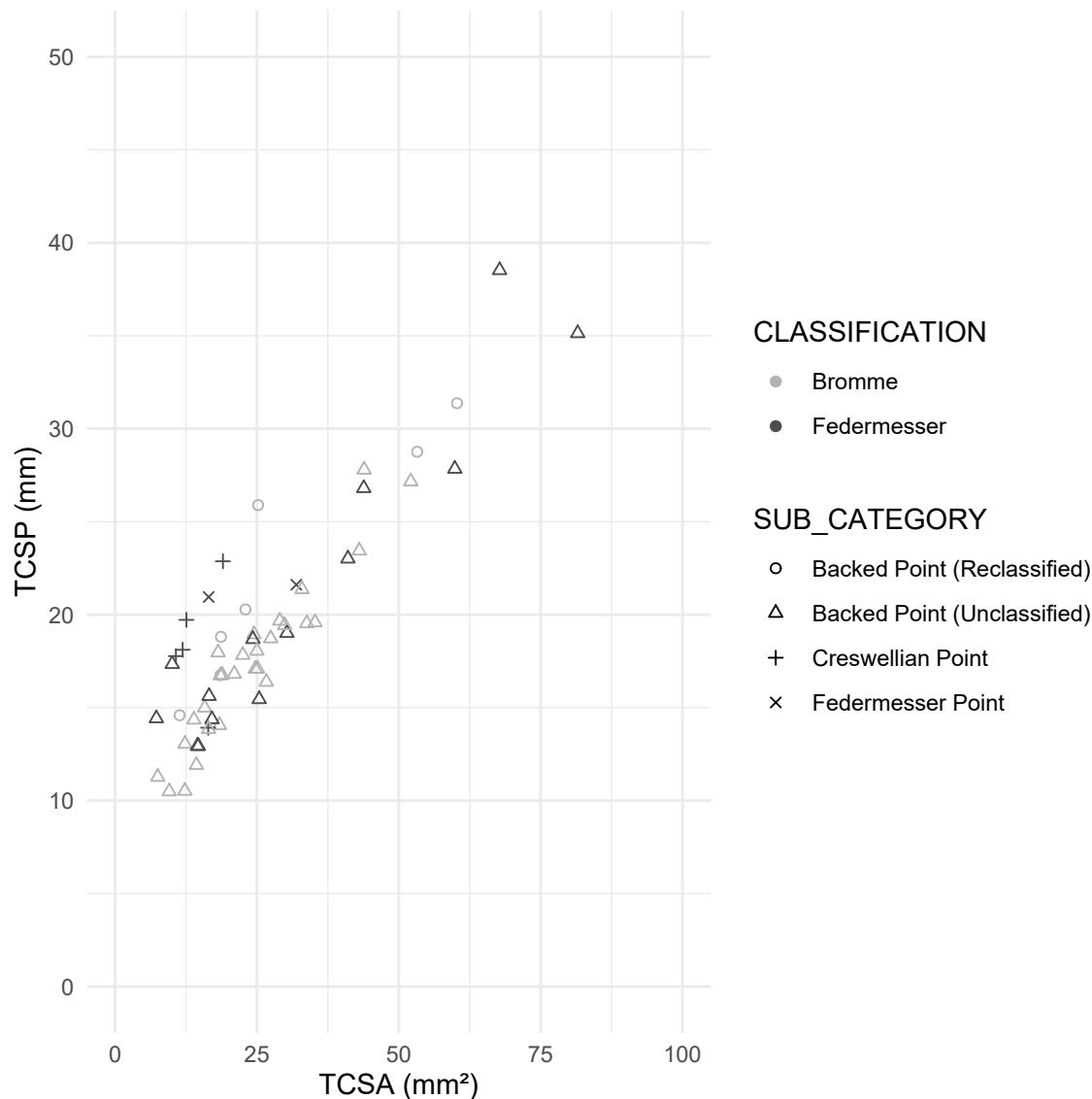












```
##
## Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data: bp_data_excb_clean$WEIGHT and bp_data_excb_clean$CODE
##
##      BIEN BRUM HACK RIET ROTH
## BRUM 0.050 -    -    -    -
## HACK 1.000 0.201 -    -    -
## RIET 1.000 0.398 1.000 -    -
## ROTH 0.993 0.104 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           -  

## 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           -  

## 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           -  

## 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

```

```

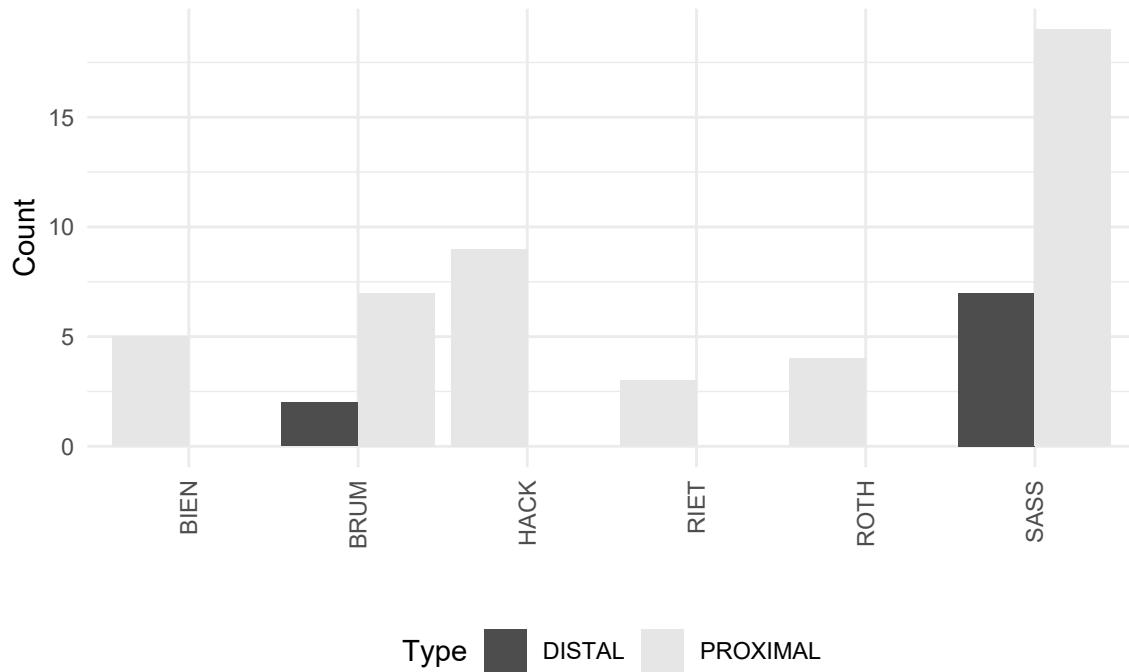
##                                     Backed Point (Unclassified) Creswellian Point
## Backed Point (Unclassified) -                               -
## Creswellian Point          0.028                         -
## Federmesser Point         1.000                         1.000
##
## P value adjustment 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

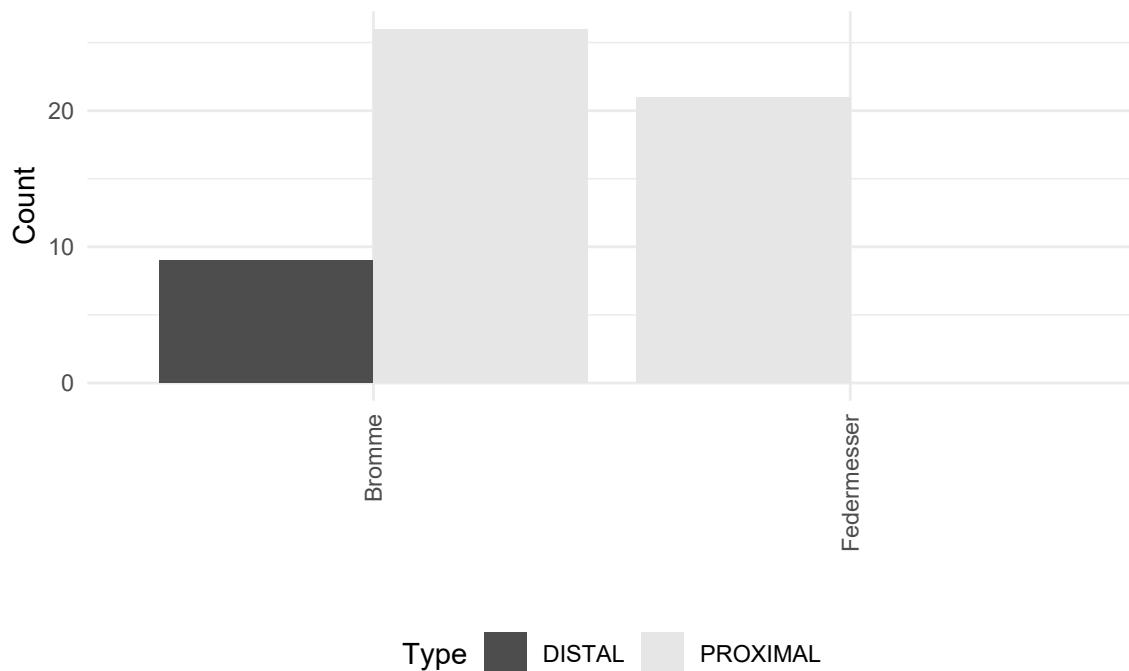
##
## Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data: bp_data_excb_clean$TCSP and bp_data_excb_clean$SUB_CATEGORY
##
##                                     Backed Point (Reclassified)
## Backed Point (Unclassified) 0.6
## Creswellian Point          1.0
## Federmesser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

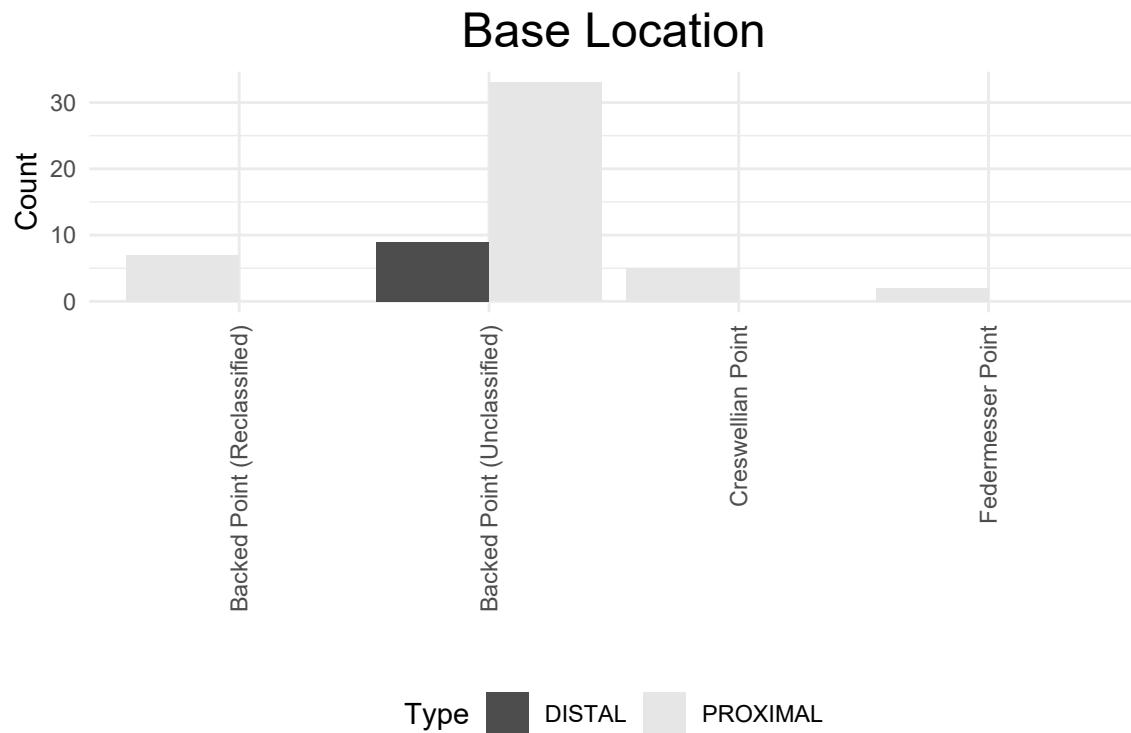
```

## Base Location



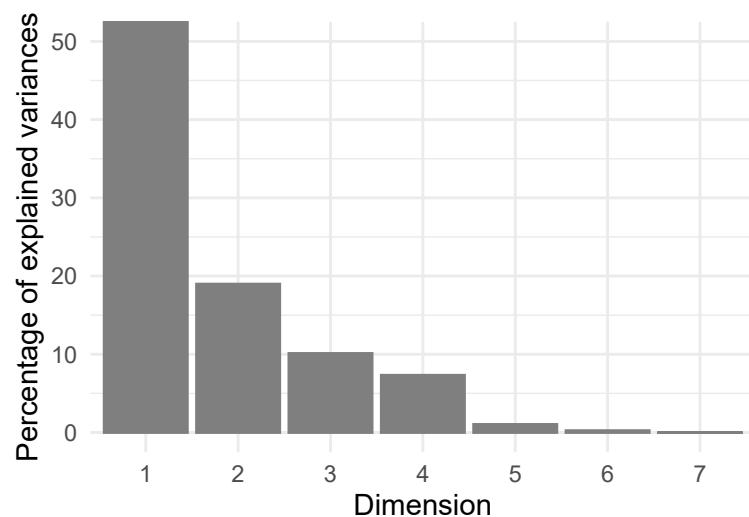
## Base Location



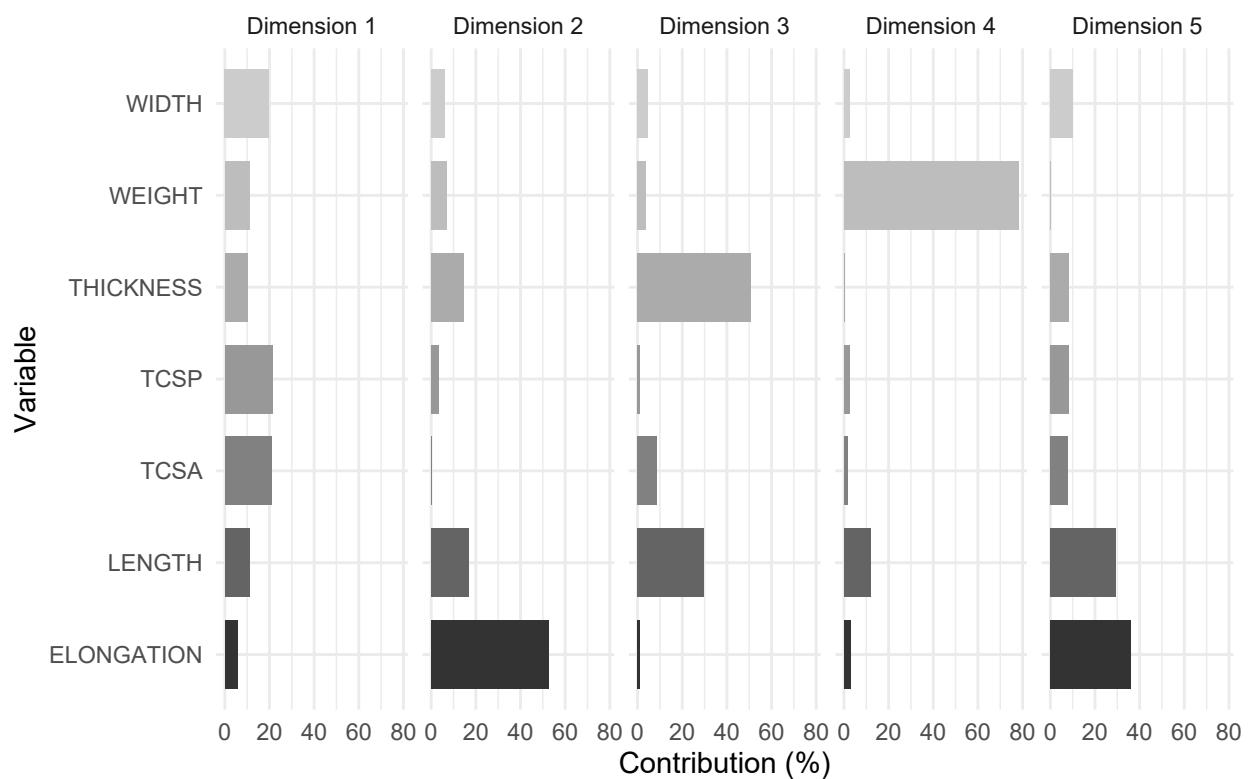


### Principal Component Analysis (PCA)

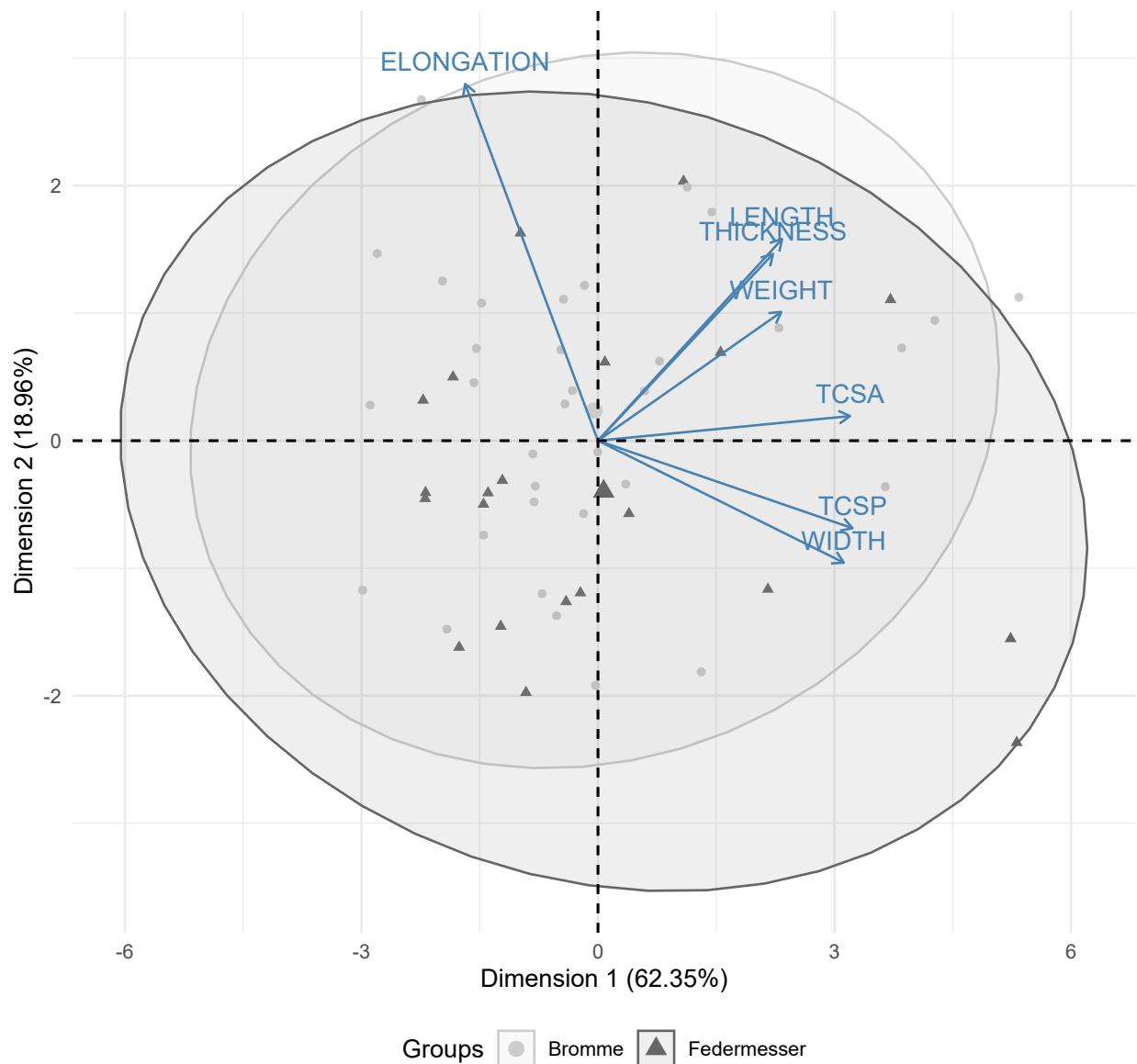
```
## # A tibble: 7 x 4
##   rowname eigenvalue variance cumulative
##   <chr>     <dbl>    <dbl>      <dbl>
## 1 Dim.1     4.37     62.4       62.4
## 2 Dim.2     1.33     19.0       81.3
## 3 Dim.3     0.707    10.1       91.4
## 4 Dim.4     0.512     7.31      98.7
## 5 Dim.5     0.0719    1.03 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



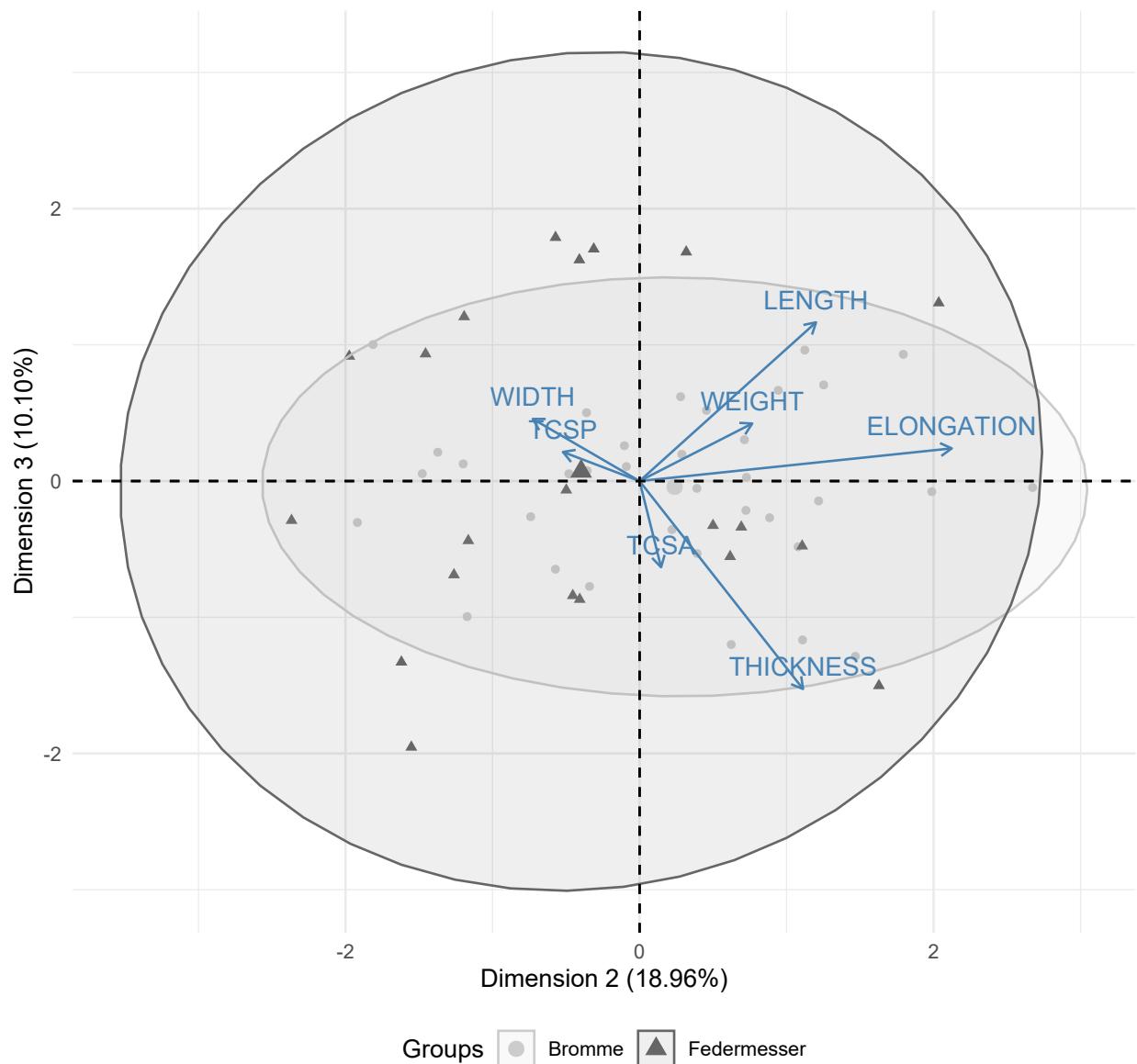
## Contribution of Variables



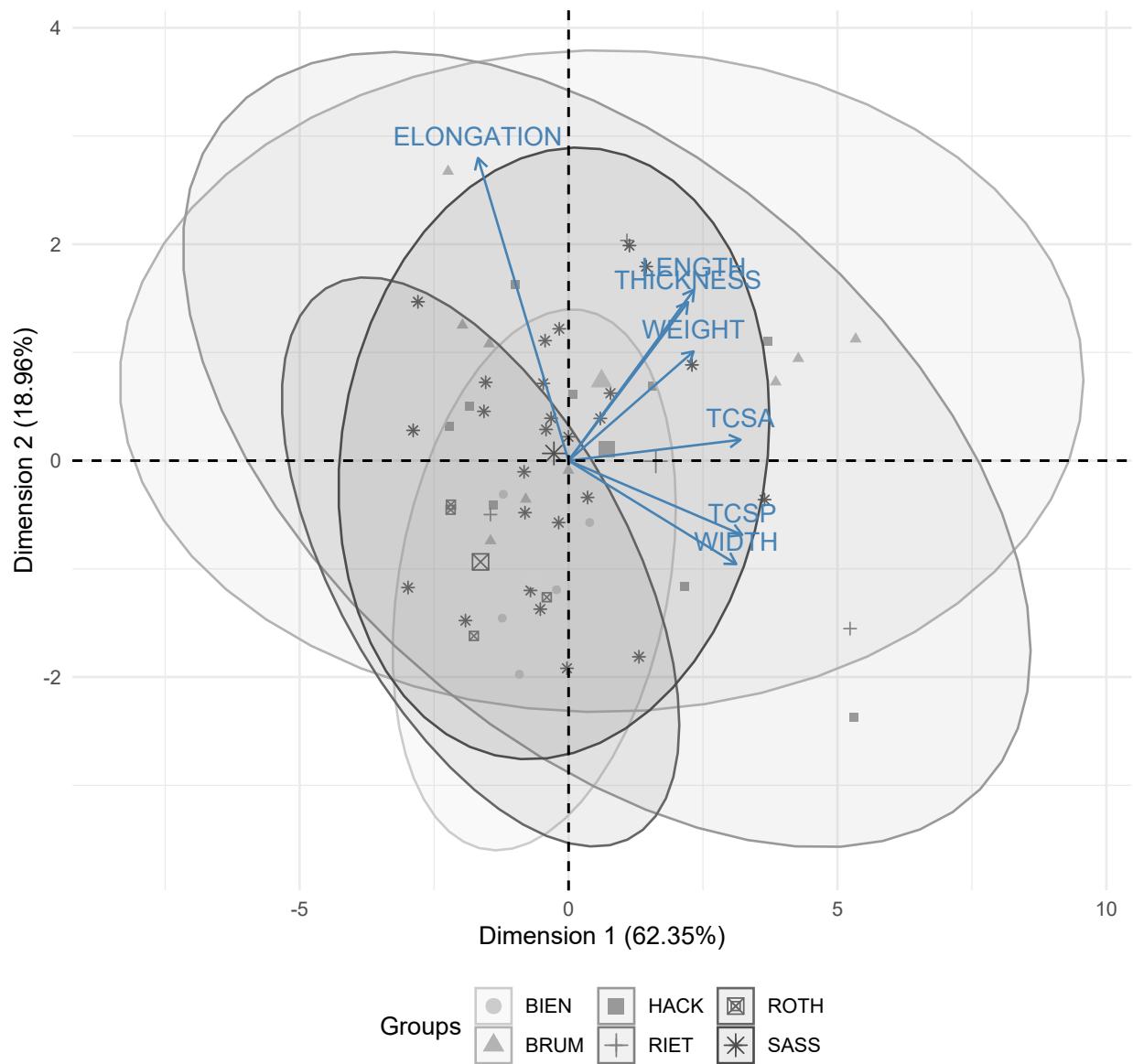
## PCA 1 vs. PCA 2 (Classification)



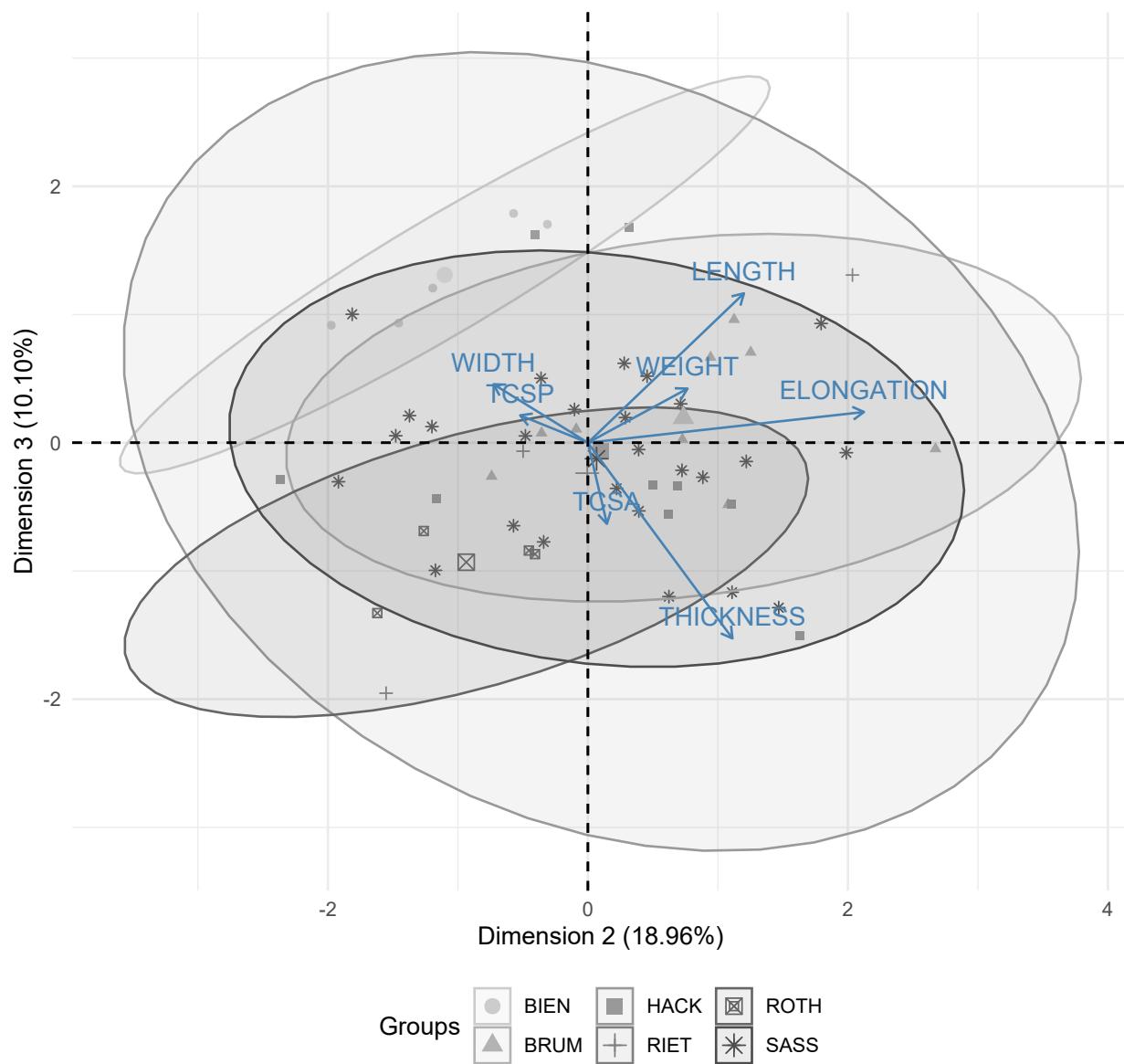
## PCA 2 vs. PCA 3 (Classification)



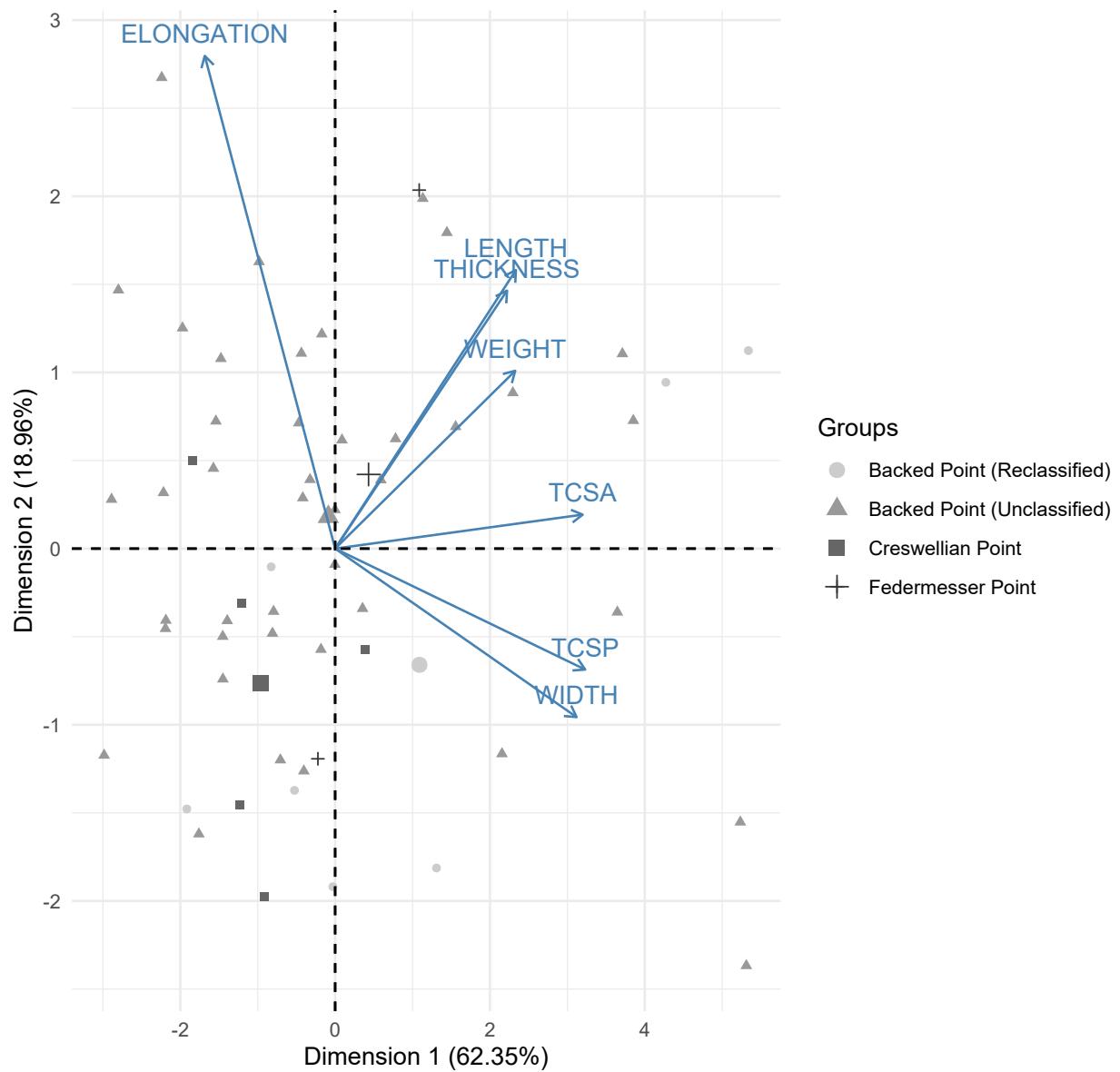
## PCA 1 vs. PCA 2 (Code)



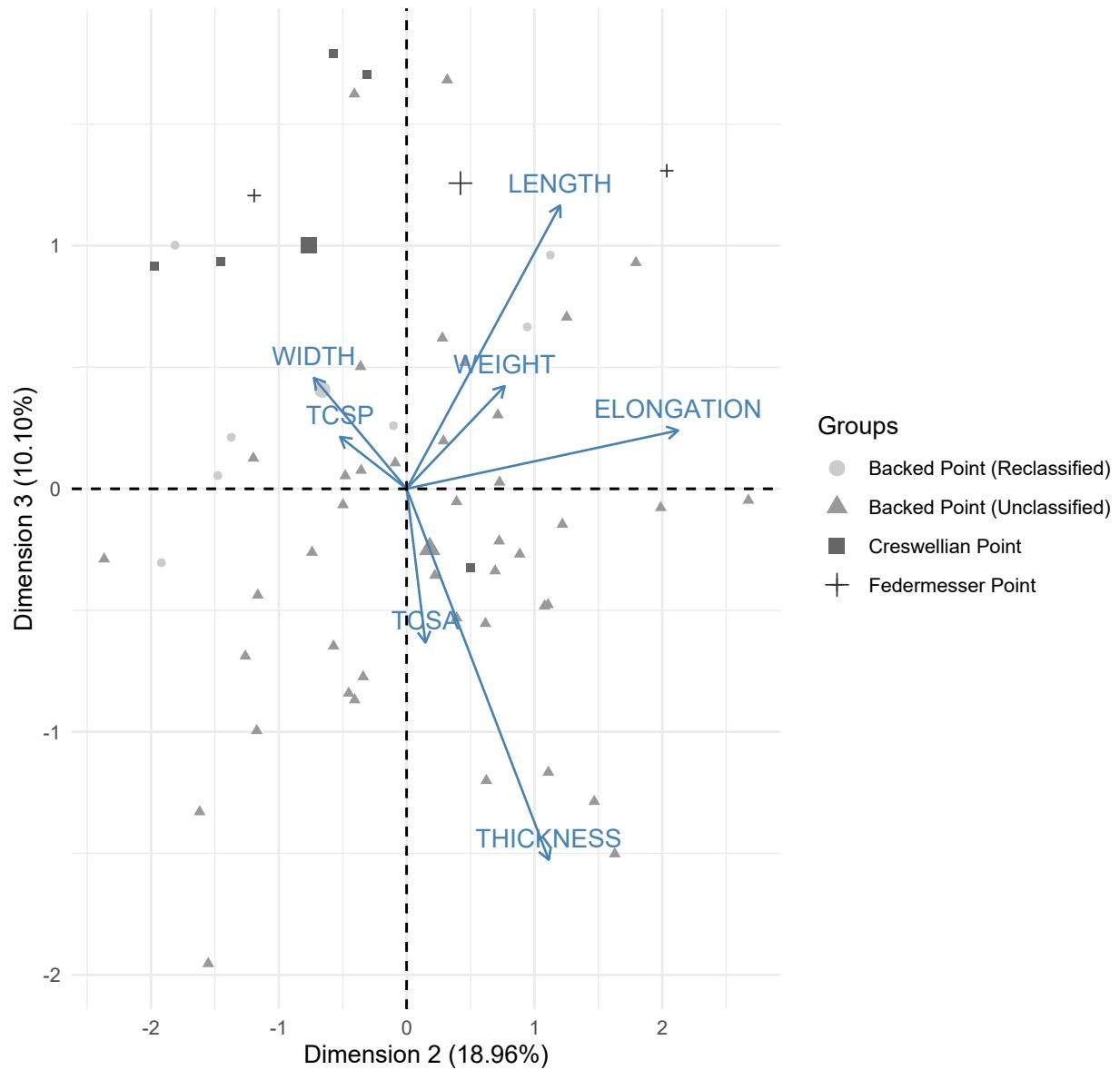
## PCA 2 vs. PCA 3 (Code)



## PCA 1 vs. PCA 2 (Backed Point Variant)



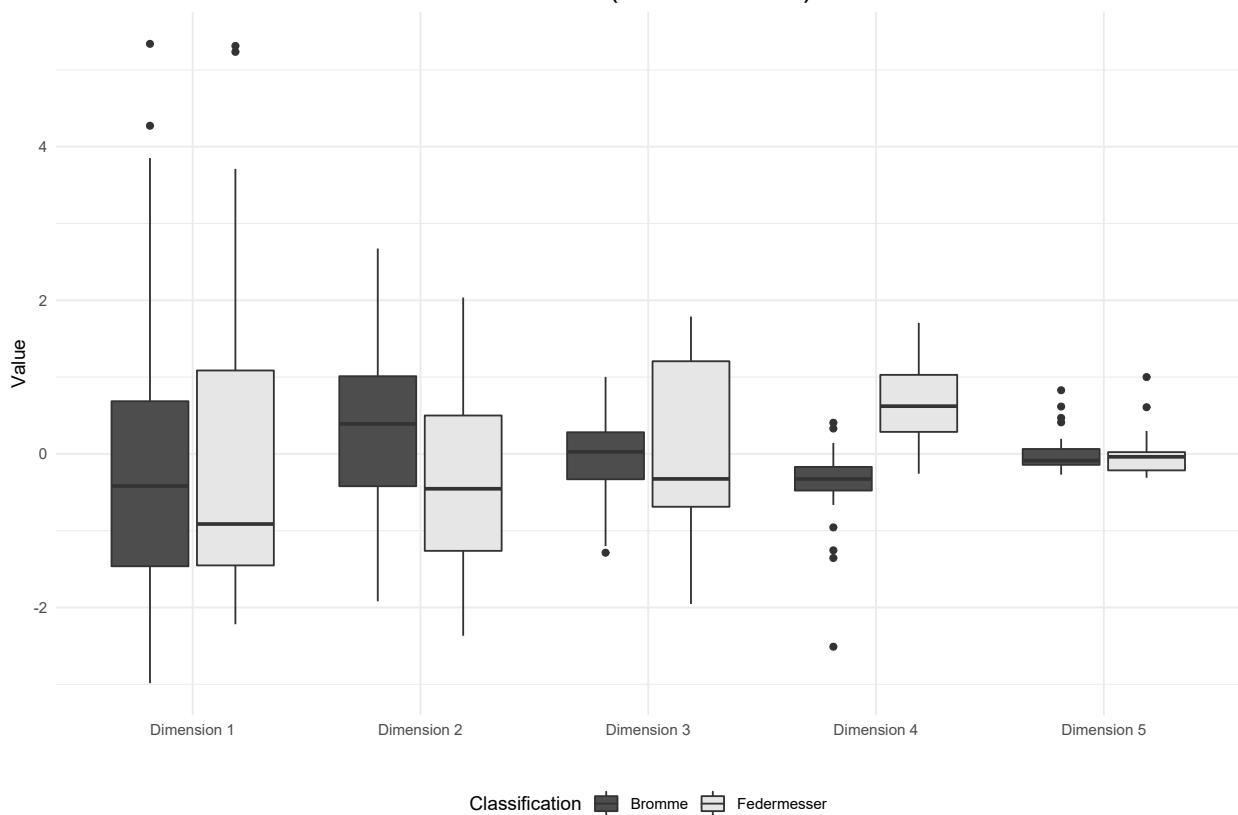
## PCA 2 vs. PCA 3 (Backed Point Variant)



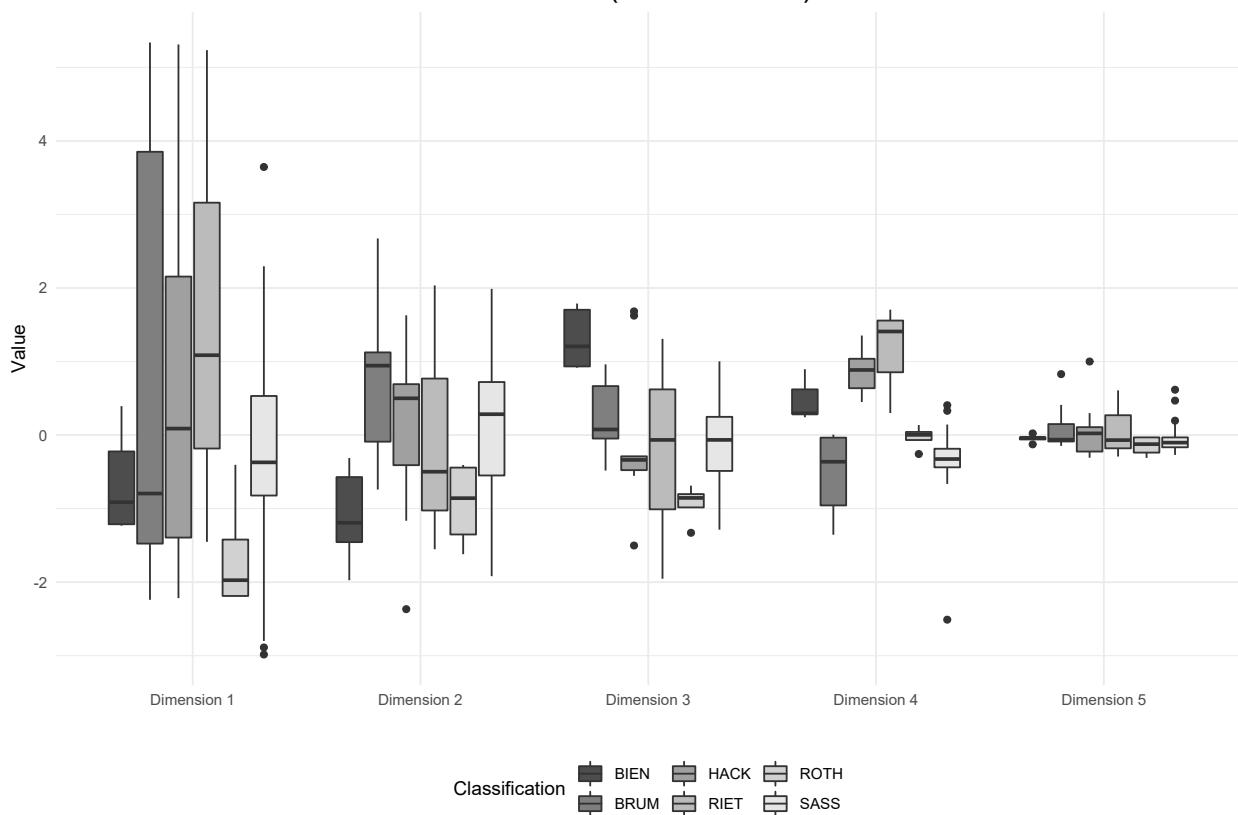
### Groups

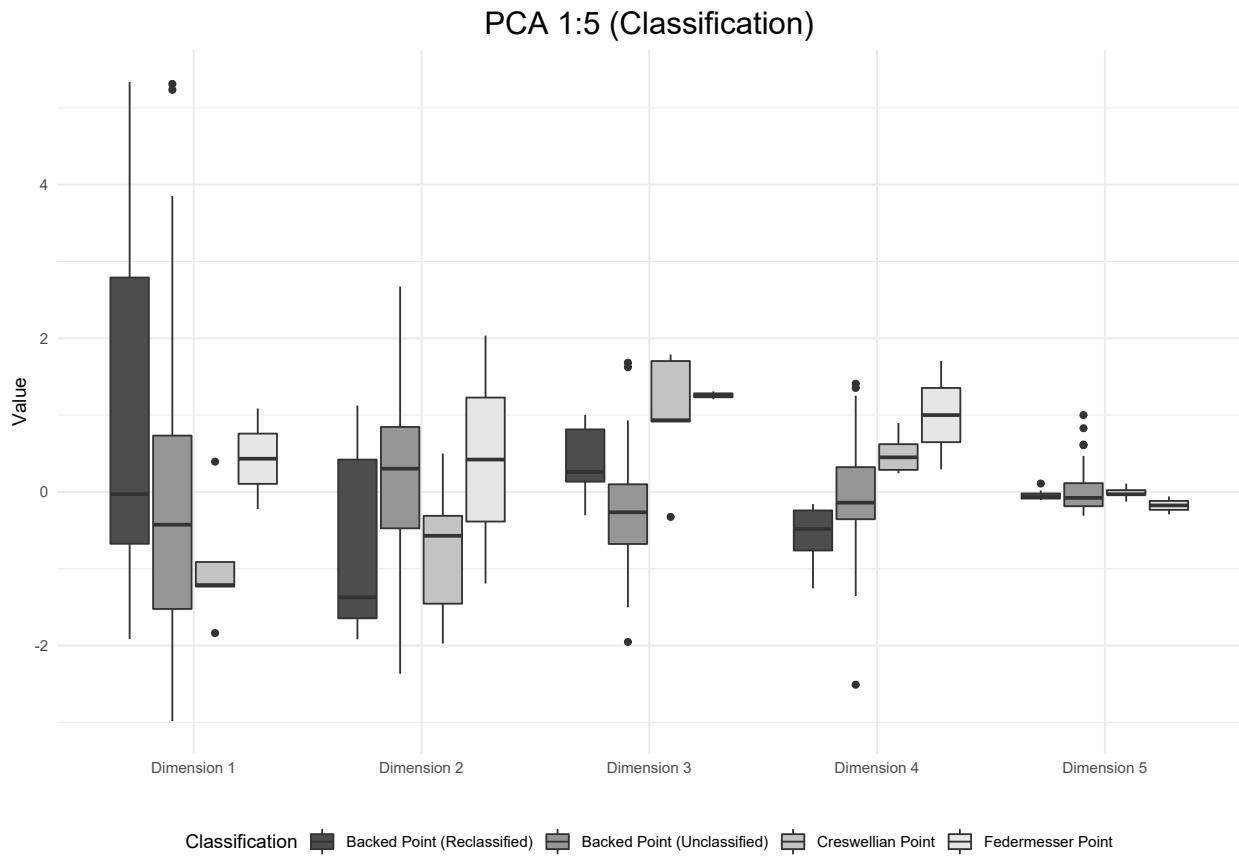
- Backed Point (Reclassified)
- Backed Point (Unclassified)
- Creswellian Point
- Federmesser Point

### PCA 1:5 (Classification)



### PCA 1:5 (Classification)





## 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)	37	0.98	19.53	5.68	4.92	3.31	10.97

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)	37	19.13	55.12	36.64	36	7.76	60.20

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)	37	2.91	17.66	10.71	10.61	2.99	8.92

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)	37	2.22	7.50	3.60	3.52	0.93	0.87

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)	37	2.01	6.32	4.17	4.10	1.13	1.27

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)	37	3.30	43.89	22.82	24.03	9.40	88.42

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)	37	5.61	27.79	17.57	17.83	4.43	19.63

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

CLASSIFICATION	n_obs	min	max	mean	med	sd	var
Bromme	50	0.98	19.53	6.42	4.96	4.14	17.10
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	50	19.13	59.12	37.78	37	8.22	67.6
Federmesser	24	21.79	67.02	40.82	41	10.80	116.7

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

CLASSIFICATION	n_obs	min	max	mean	med	sd	var
Bromme	50	2.91	20.06	11.26	10.95	3.55	12.63
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	50	2.22	7.50	3.56	3.35	0.94	0.88
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	50	2.01	6.32	4.32	4.32	1.13	1.28
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	50	0.00	1.00	0.32	0.32	0.13	0.28
Federmesser	24	0.00	1.00	0.32	0.32	0.13	0.28

Bromme	50	3.30	60.27	25.18	24.60	12.12	146.94
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	50	5.61	31.37	18.43	17.90	5.30	28.10
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
Hamburgian Point	1	9.95	9.95	9.95	9.95	NA	NA

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
Hamburgian Point	1	48.12	48.12	48.12	48	NA	NA

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
Hamburgian Point	1	15.98	15.98	15.98	15.98	NA	NA

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
Hamburgian Point	1	3.01	3.01	3.01	3.01	NA	NA

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

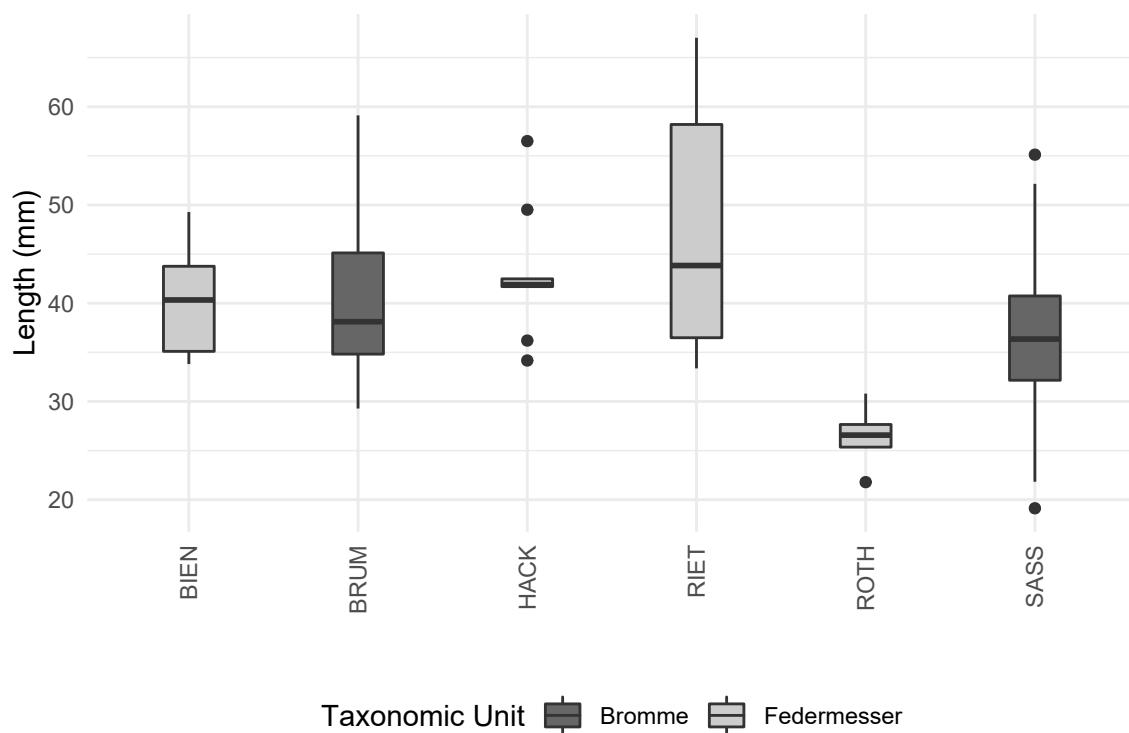
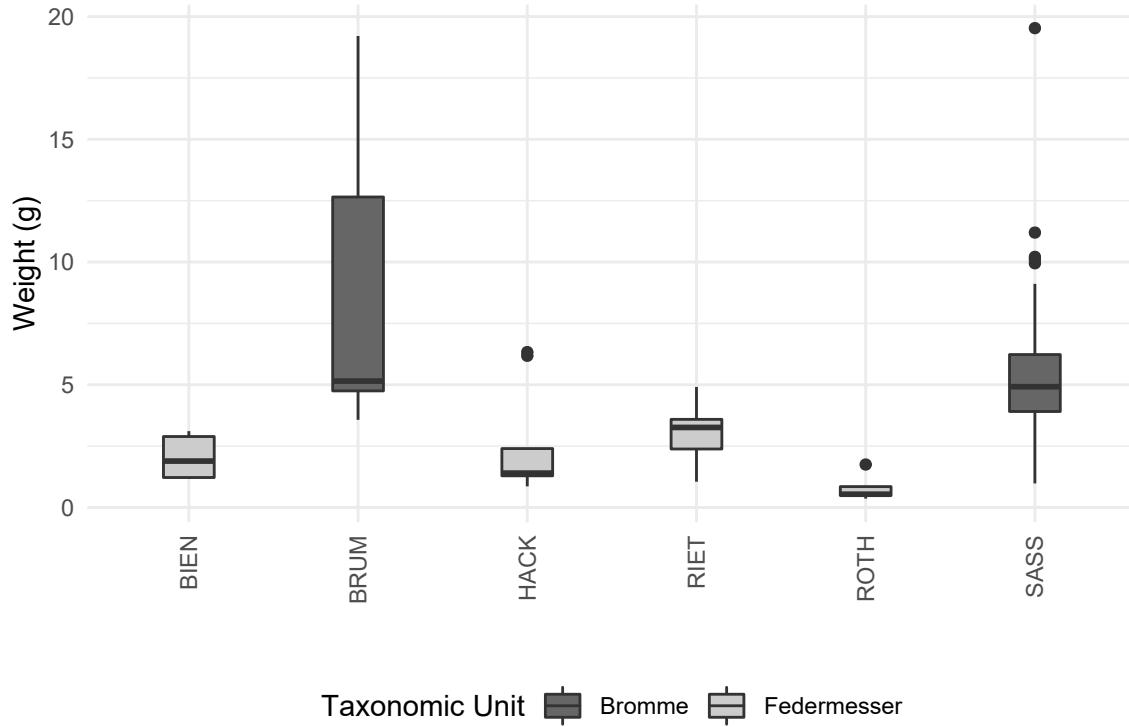
SUB_CATEGORY	n_obs	min	max	mean	med	sd	var
Backed Point (Reclassified)	9	2.44	7.59	4.48	3.56	1.76	3.10
Backed Point (Unclassified)	57	1.54	7.45	4.49	4.54	1.32	1.75
Creswellian Point	5	1.84	4.01	2.47	2.01	0.90	0.82
Federmesser Point	2	2.41	4.77	3.59	3.59	1.67	2.78
Hamburgian Point	1	3.65	3.65	3.65	3.65	NA	NA

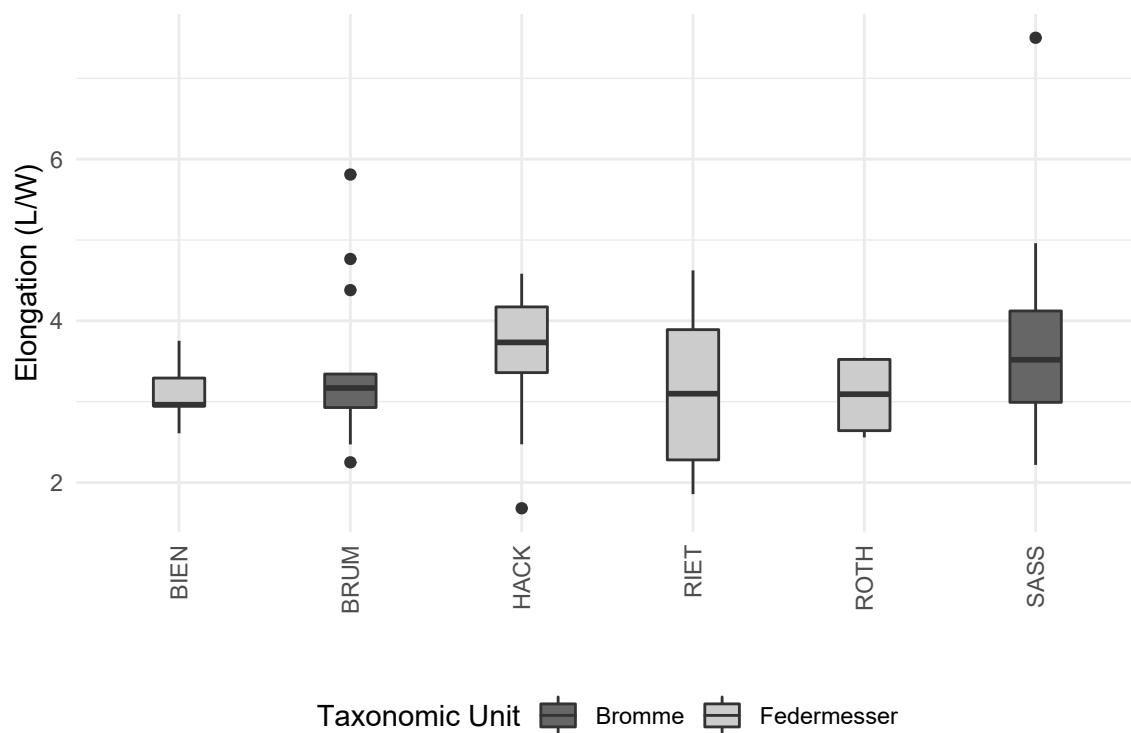
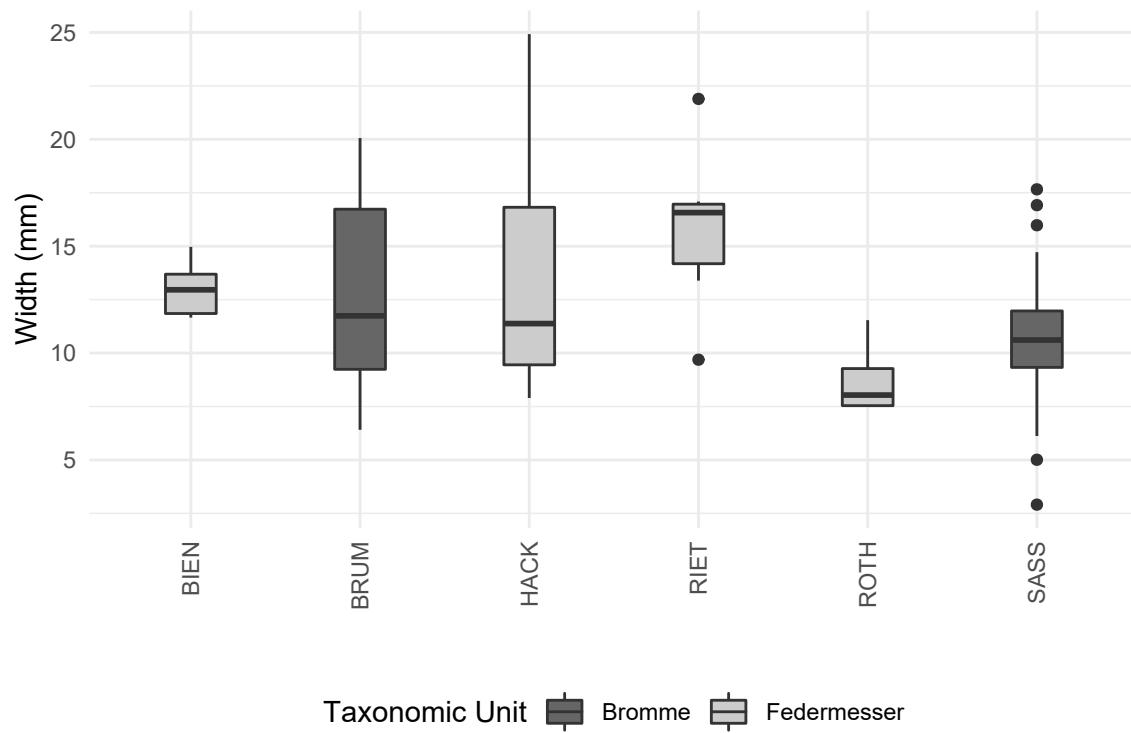
Table 65. Descriptive Statistics: Tip Cross-Sectional Area (TCSA)

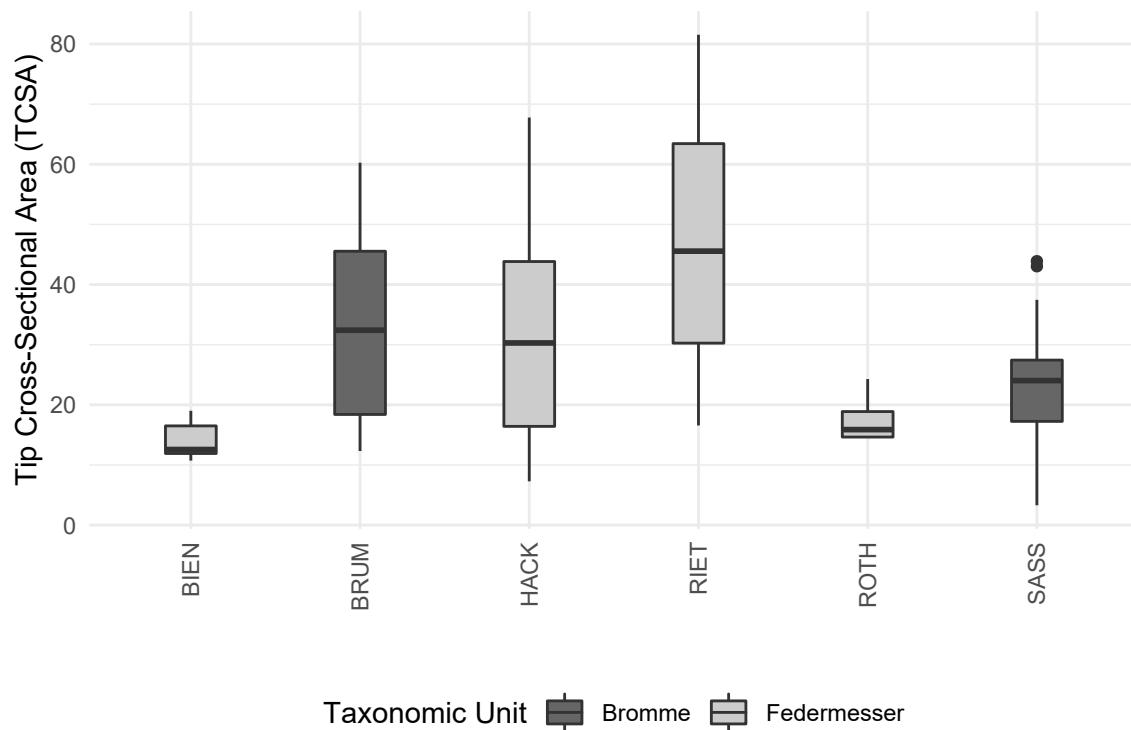
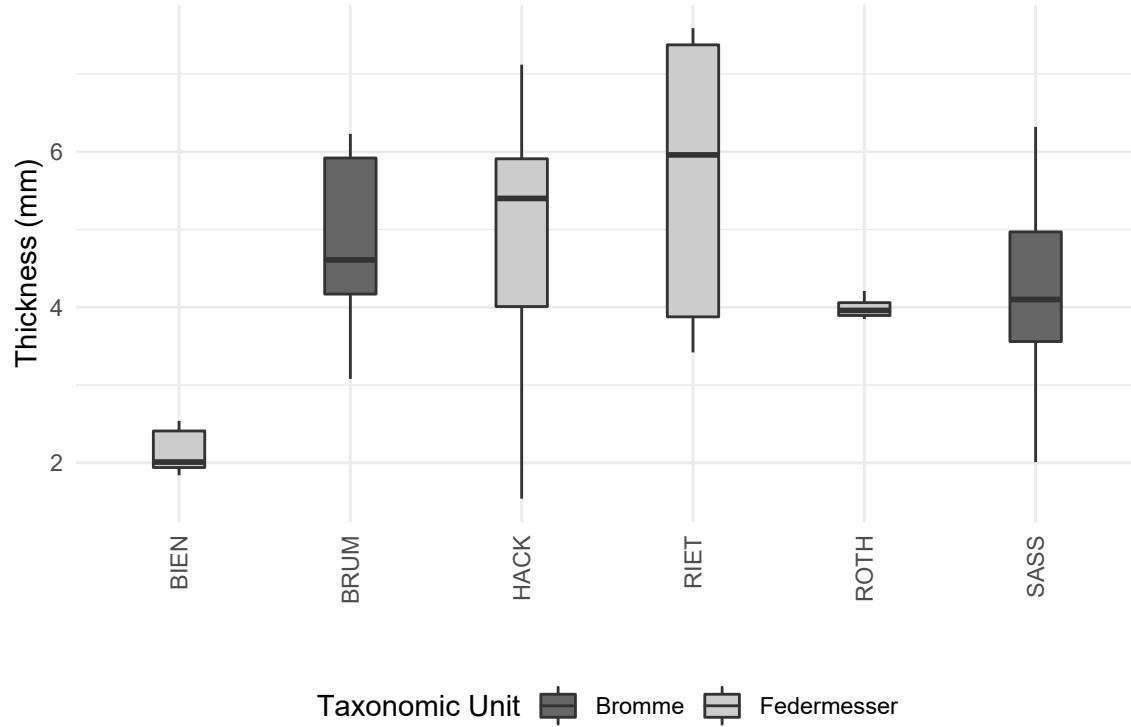
SUB_CATEGORY	n_obs	min	max	mean	med	sd	var
Backed Point (Reclassified)	9	11.38	64.86	33.36	25.09	20.23	409.07
Backed Point (Unclassified)	57	3.30	81.54	26.97	24.72	15.59	243.02
Creswellian Point	5	10.73	19.01	14.13	12.57	3.46	12.00
Federmesser Point	2	16.50	31.94	24.22	24.22	10.92	119.20
Hamburgian Point	1	29.16	29.16	29.16	29.16	NA	NA

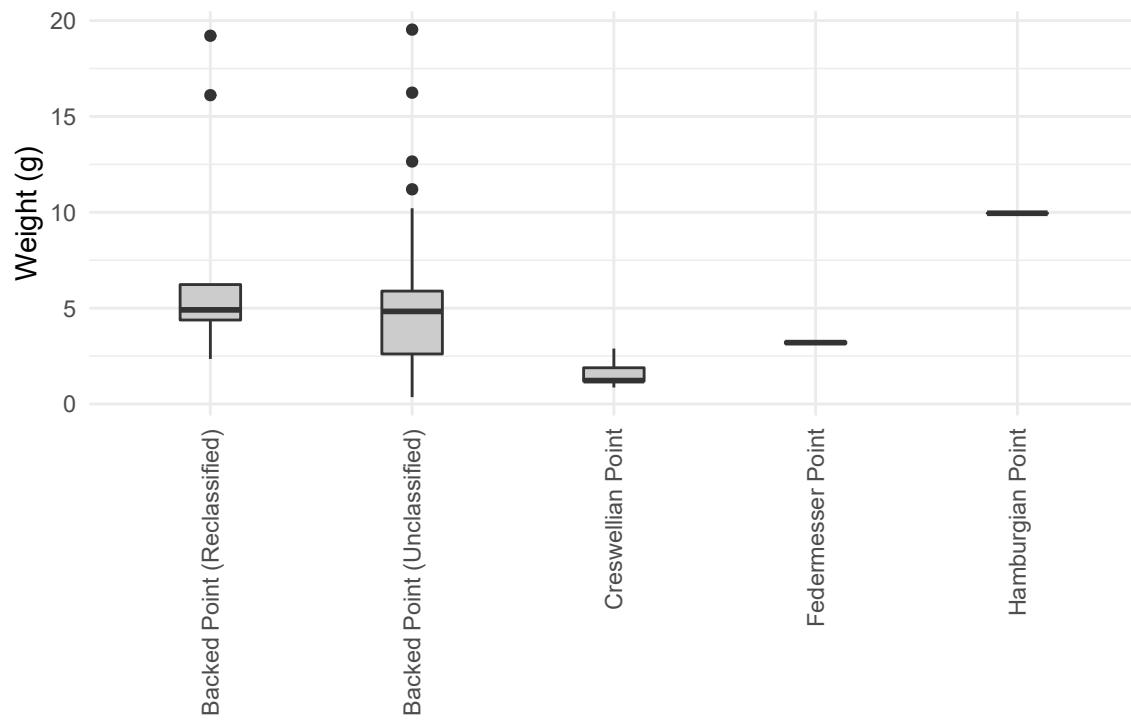
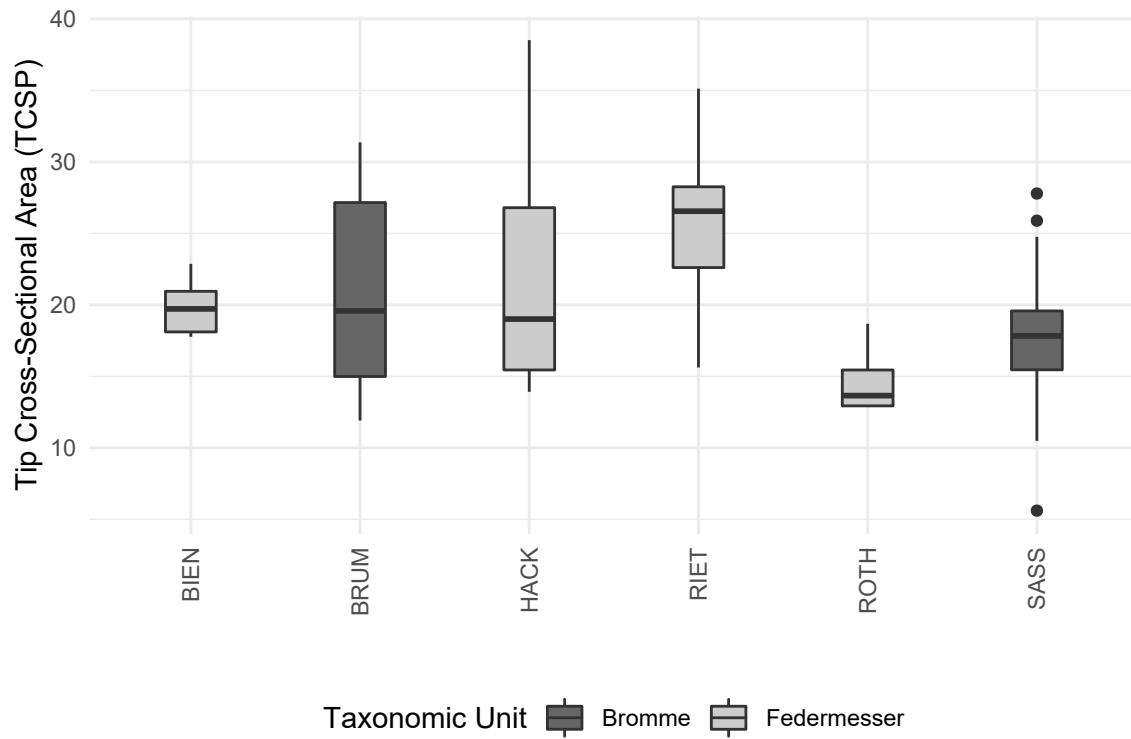
Table 66. Descriptive Statistics: Tip Cross-Sectional Perimeter (TCSP)

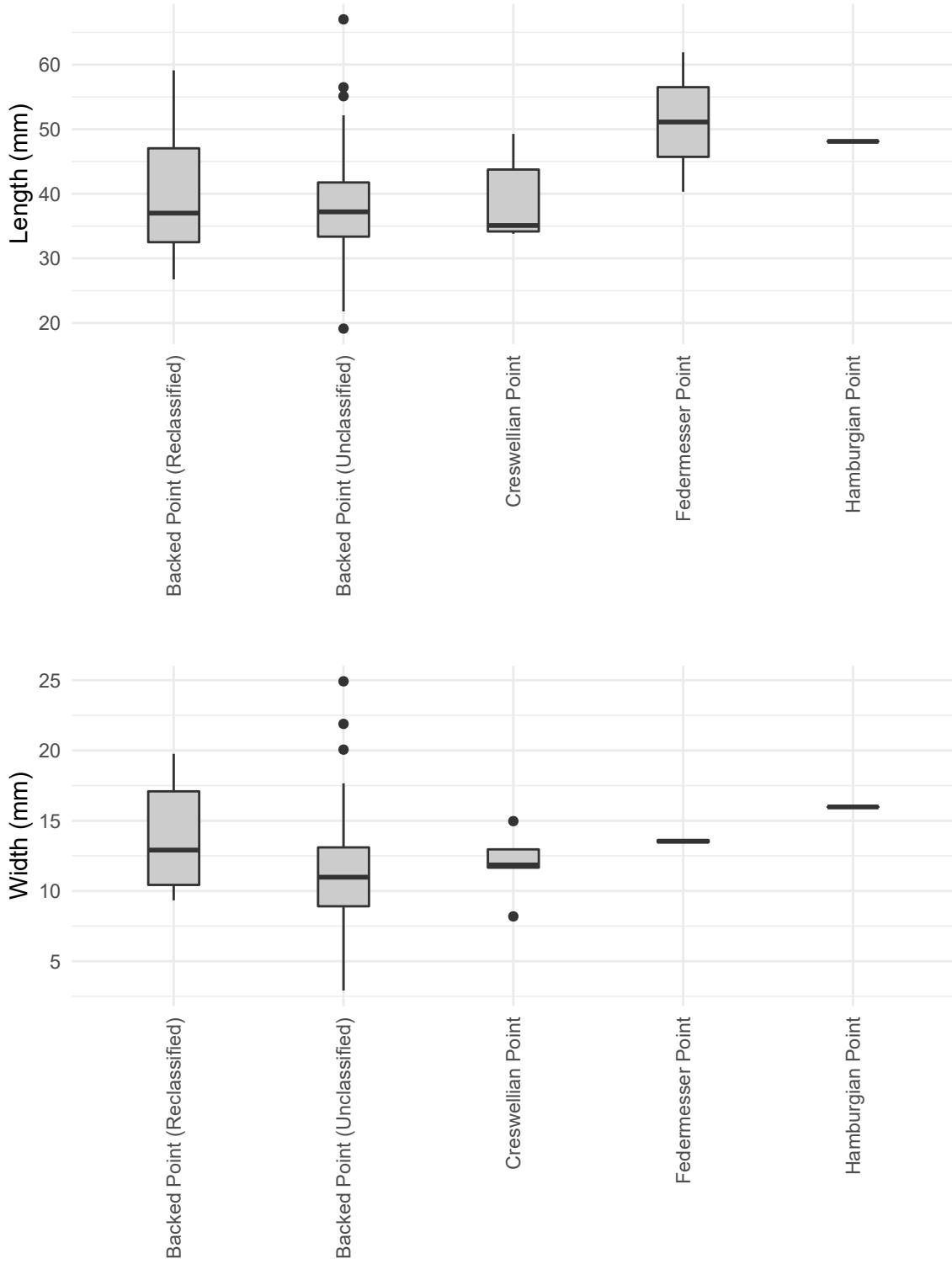
SUB_CATEGORY	n_obs	min	max	mean	med	sd	var
Backed Point (Reclassified)	9	14.59	31.37	22.43	20.28	6.24	38.89
Backed Point (Unclassified)	57	5.61	38.52	18.75	17.84	6.10	37.23
Creswellian Point	5	13.92	22.87	18.48	18.11	3.25	10.56
Federmesser Point	2	20.95	21.61	21.28	21.28	0.47	0.22
Hamburgian Point	1	24.76	24.76	24.76	24.76	NA	NA

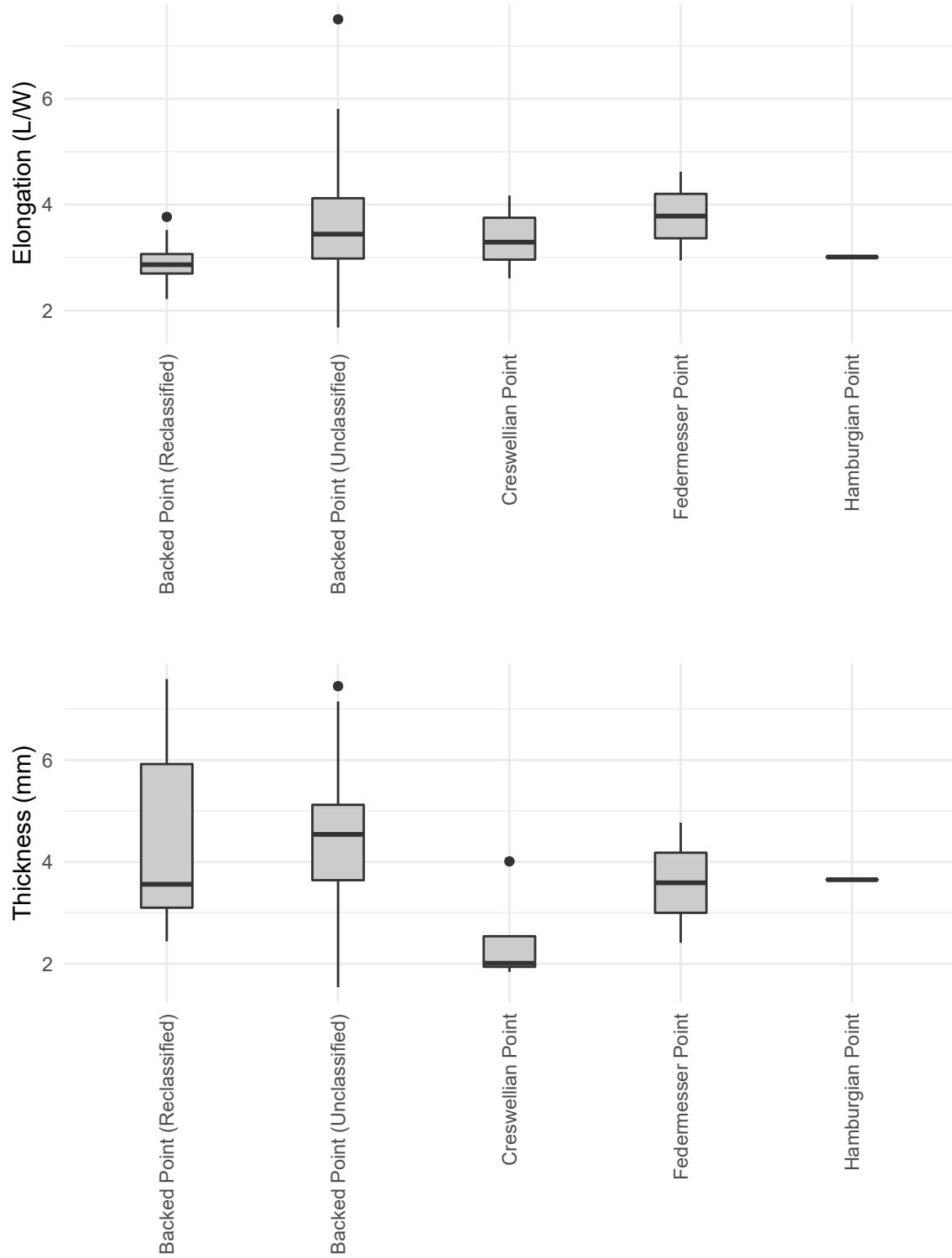


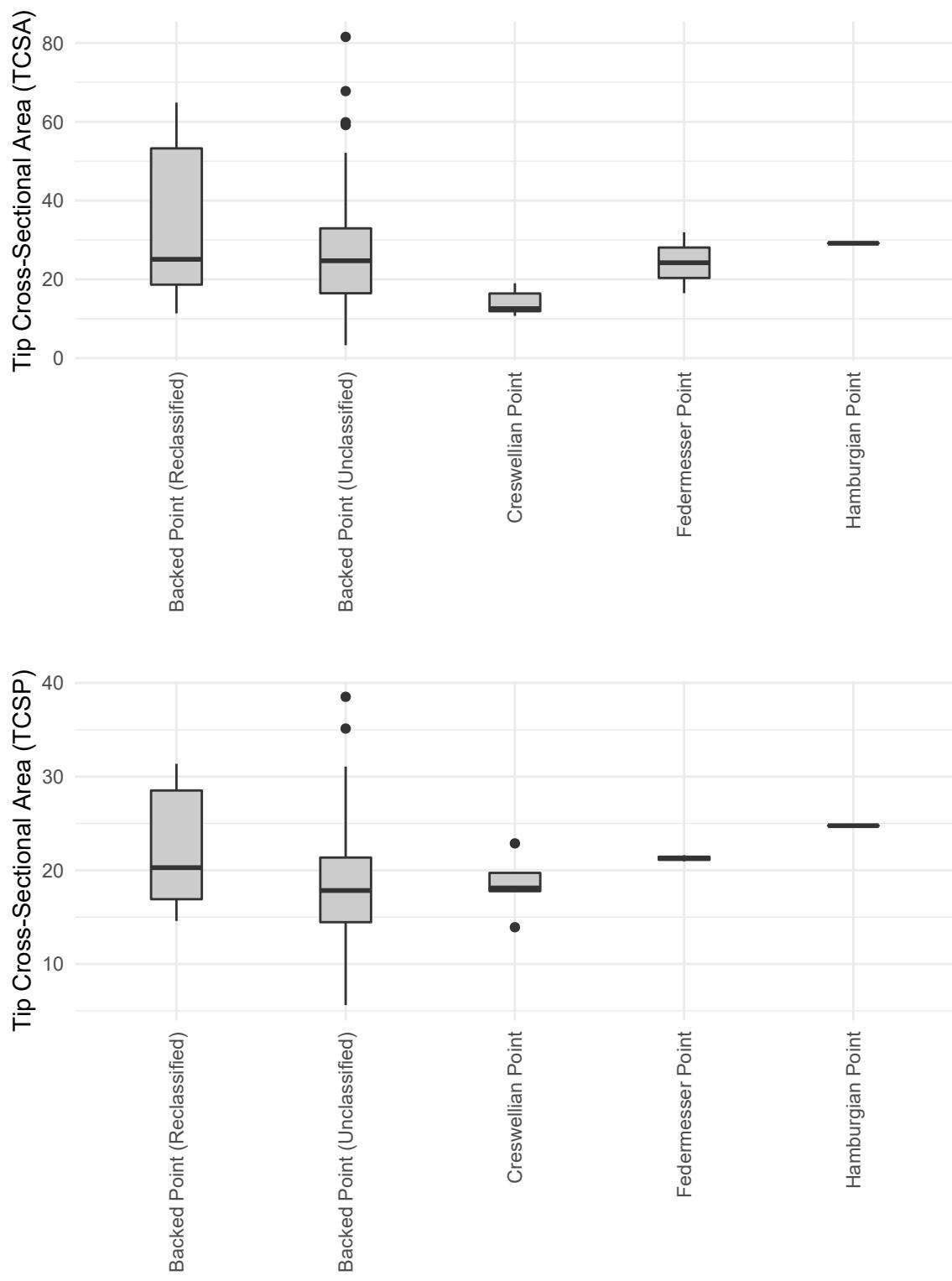


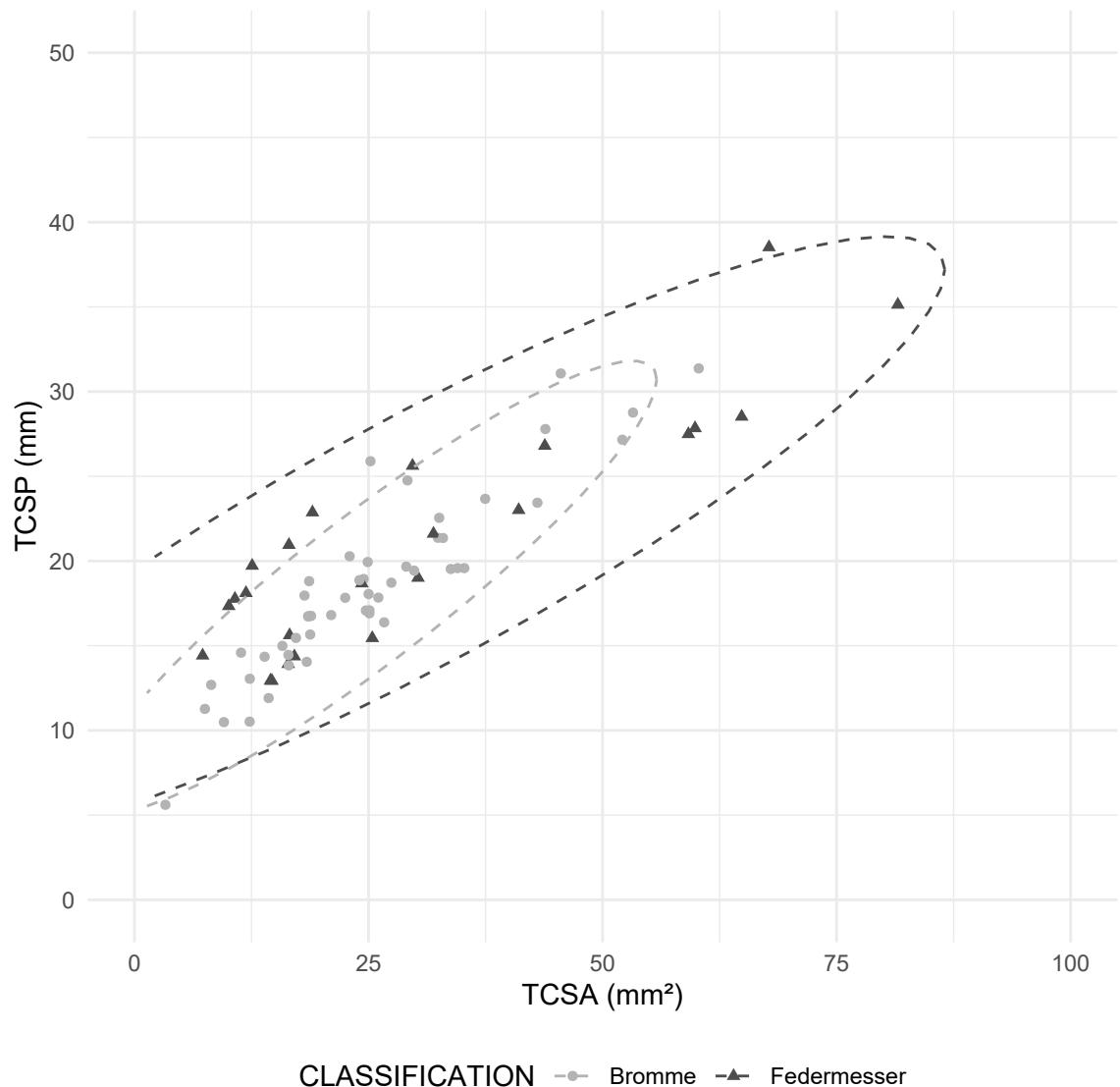


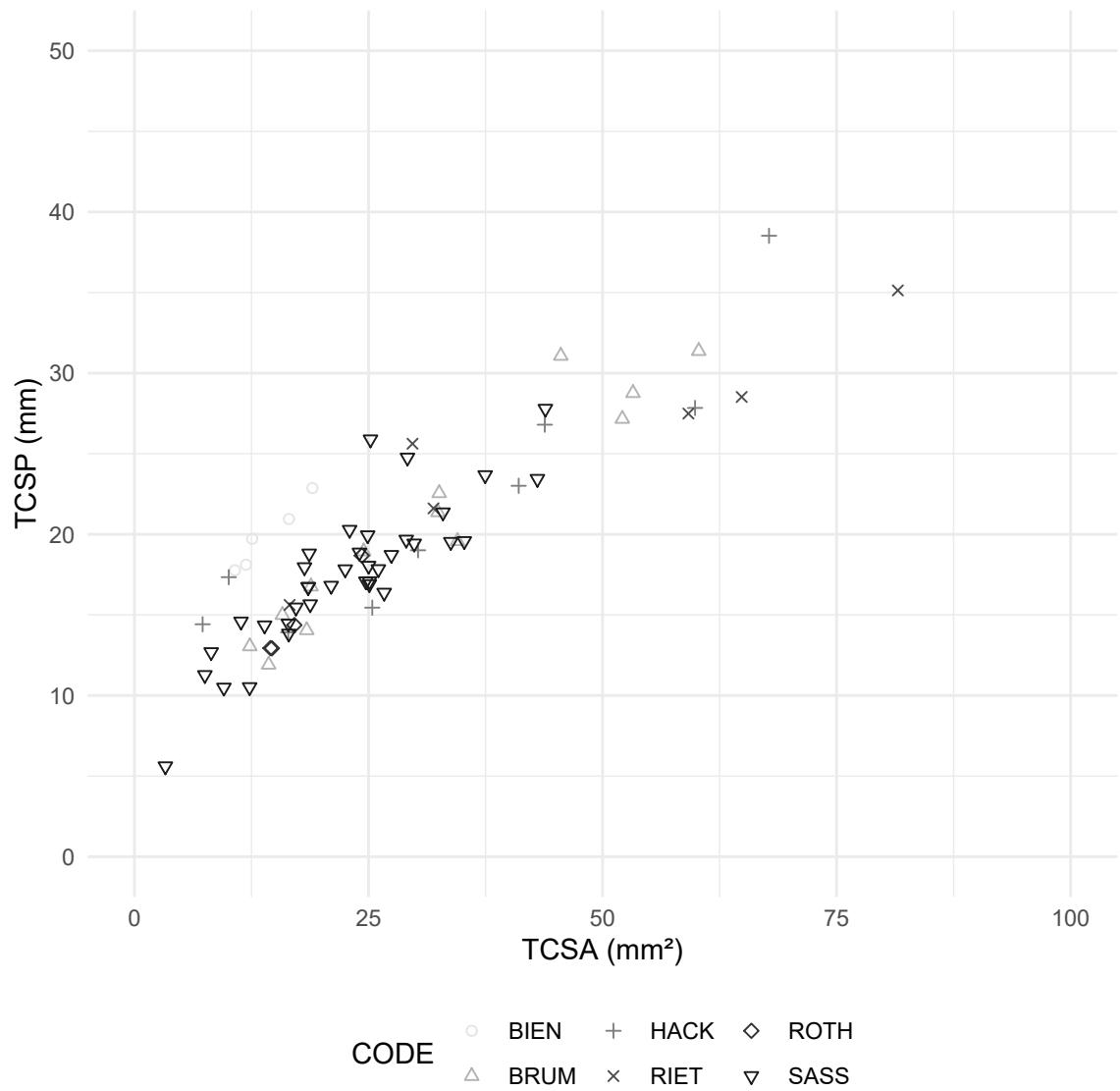


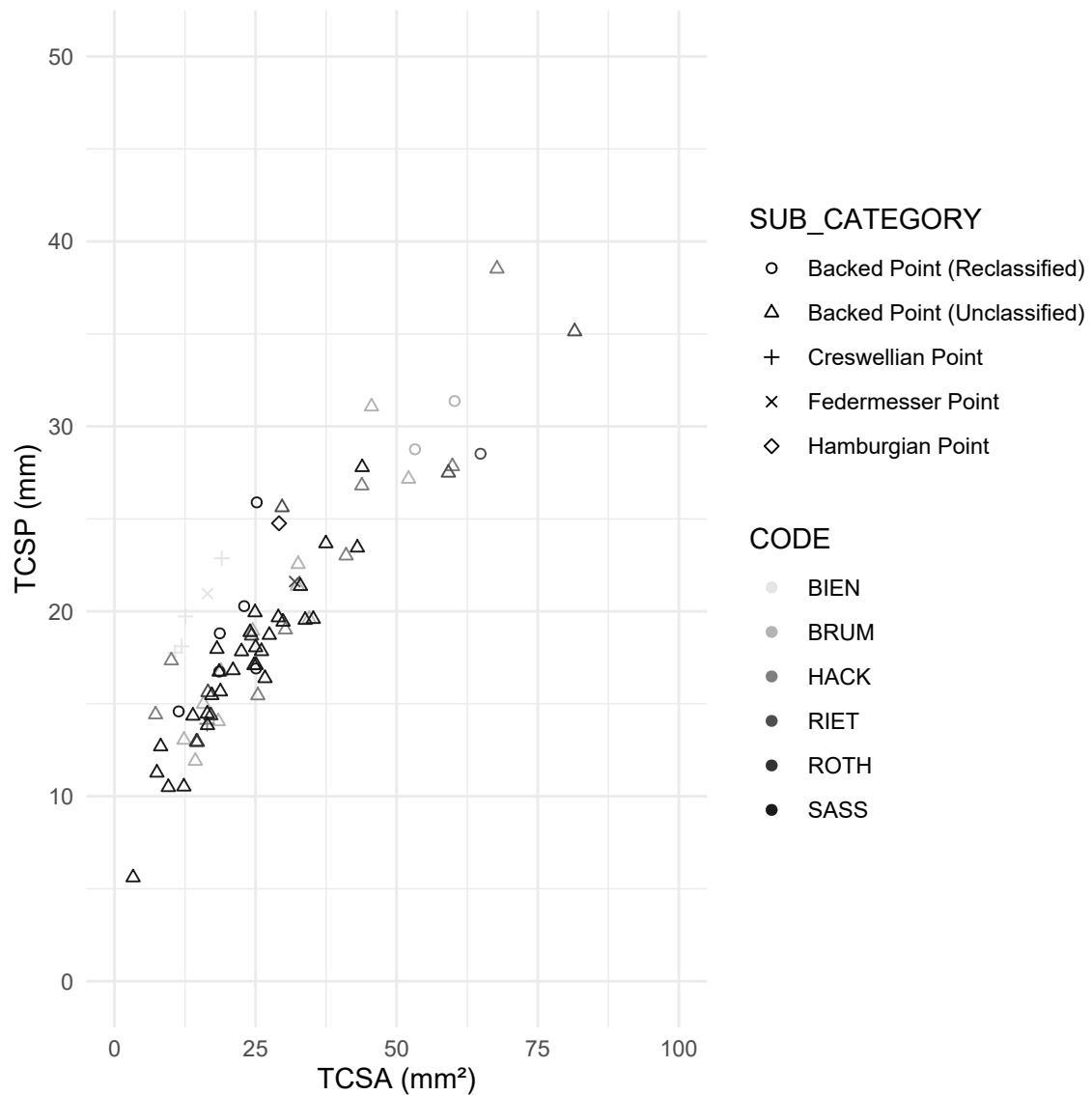


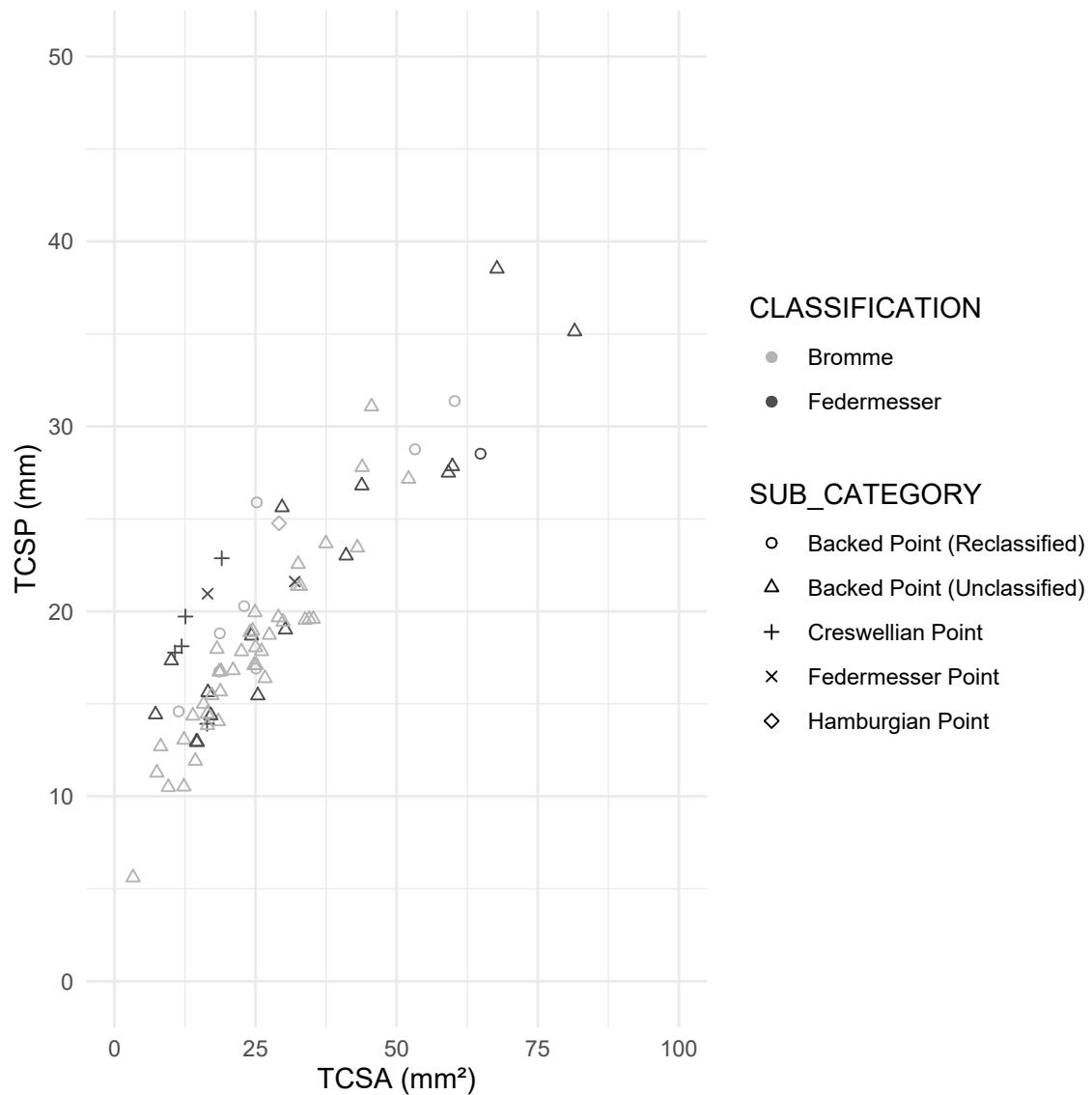










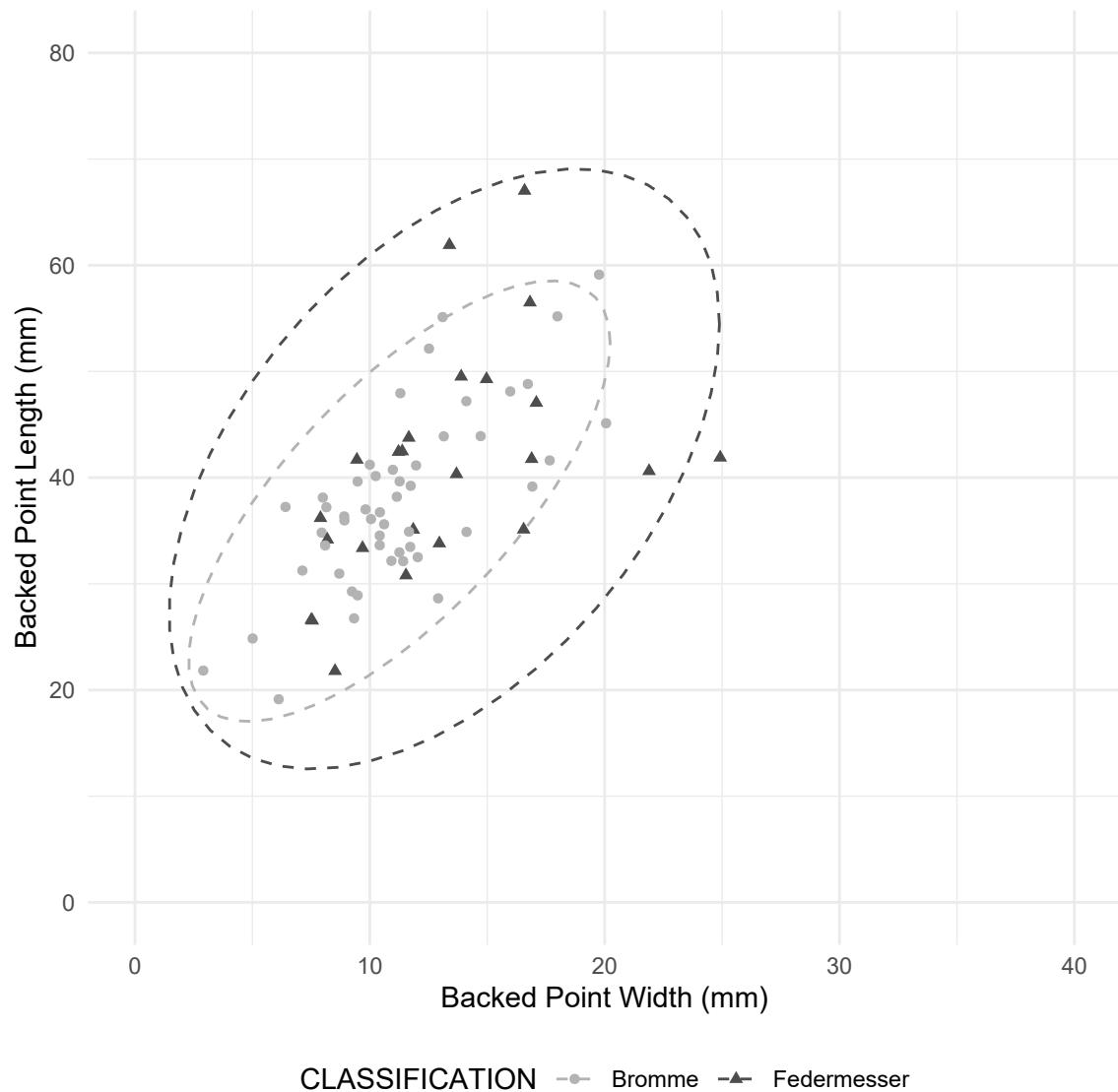


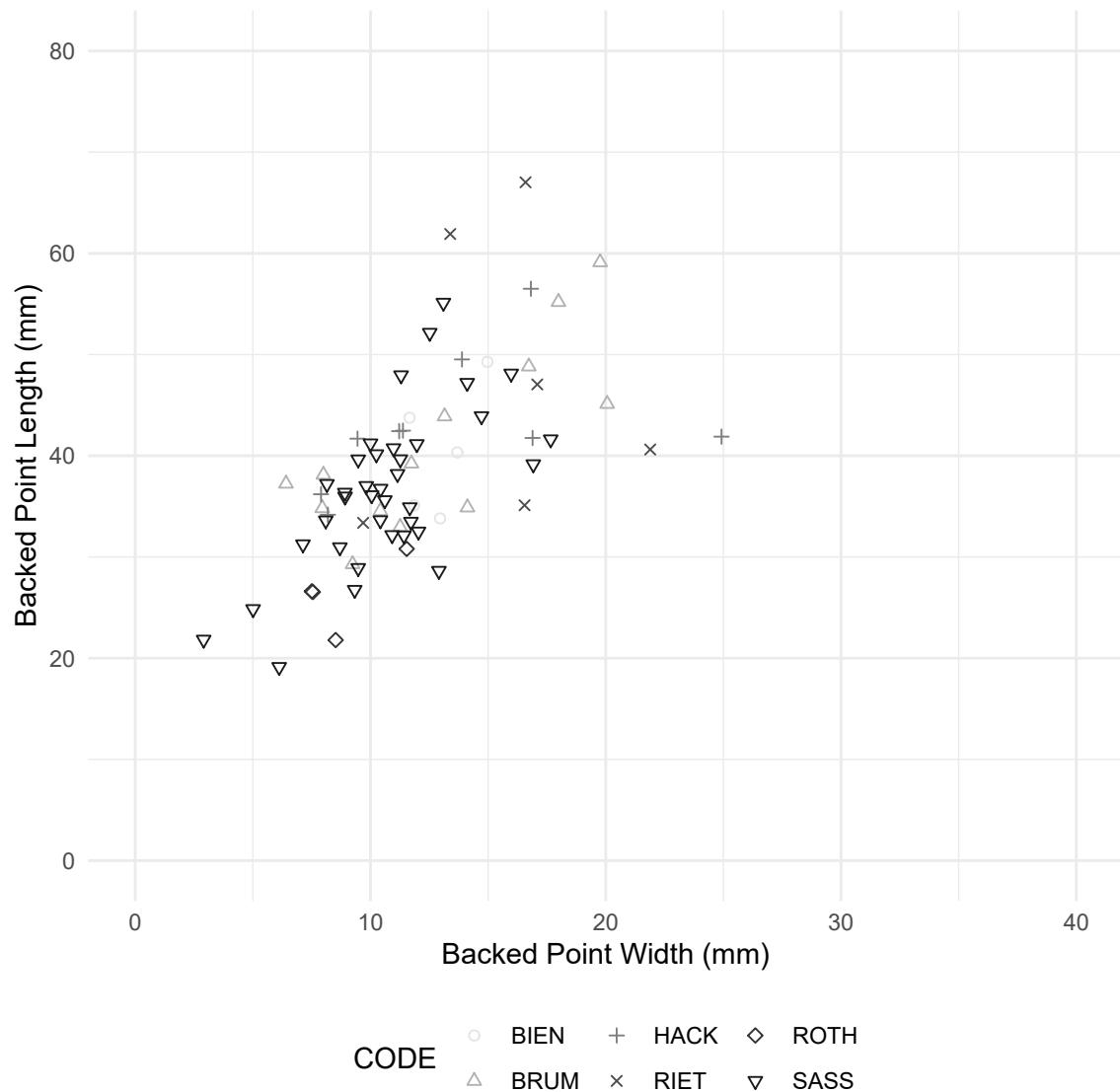
#### CLASSIFICATION

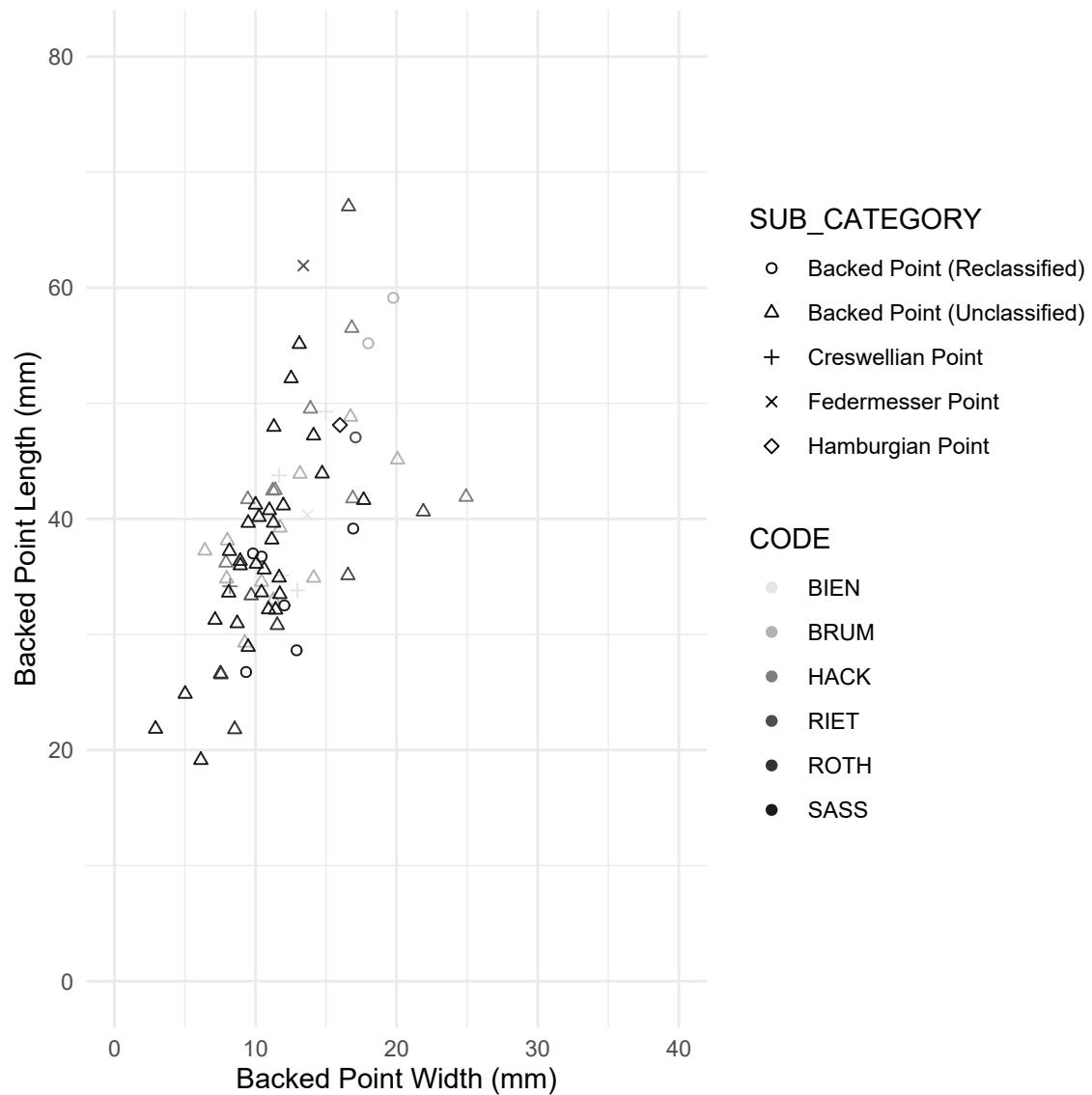
- Bromme
- Federmesser

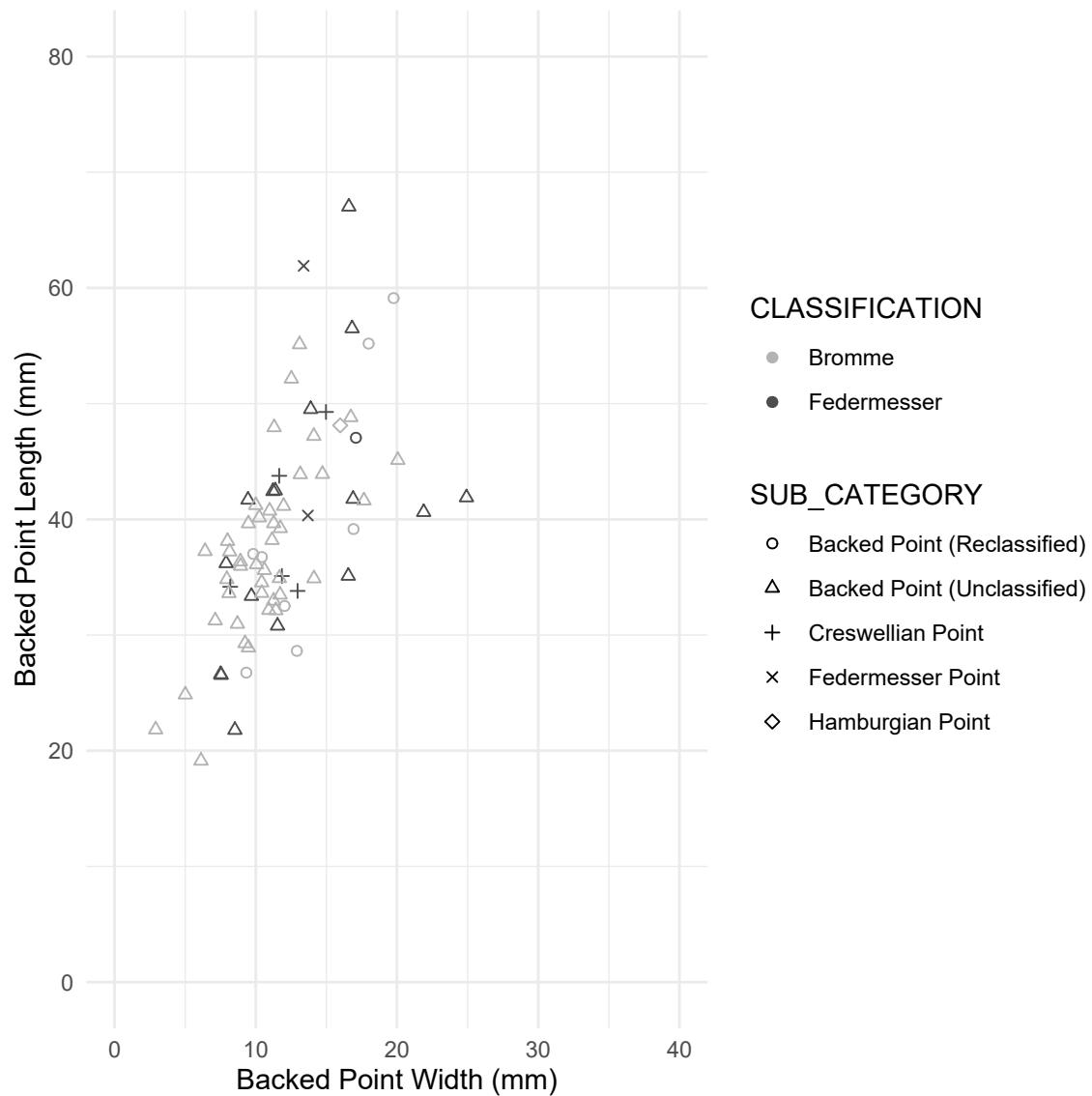
#### SUB\_CATEGORY

- Backed Point (Reclassified)
- △ Backed Point (Unclassified)
- + Creswellian Point
- x Federmesser Point
- ◊ Hamburgian Point









```
##
## Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data: bp_data_incbl_clean$WEIGHT and bp_data_incbl_clean$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 0.028 1.000 0.071 0.223 0.022
##
## P value adjustment method: bonferroni
##
## Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data: bp_data_incbl_clean$LENGTH and bp_data_incbl_clean$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 0.163 1.000 0.118  

##  

## 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 0.44 1.00 1.00 0.12 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 0.015 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 0.59 1.00 1.00 0.22 1.00
##
## P value adjustment method: bonferroni
##
## Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data: bp_data_incbl_clean$TCSP and bp_data_incbl_clean$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 0.12 1.00
##
## P value adjustment method: bonferroni
##
## Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data: bp_data_incbl_clean$WEIGHT and bp_data_incbl_clean$CLASSIFICATION
##
## Bromme
## Federmesser 9.9e-08
##
## P value adjustment method: bonferroni
##
## Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data: bp_data_incbl_clean$LENGTH and bp_data_incbl_clean$CLASSIFICATION
##
## Bromme
## Federmesser 0.21
##
## P value adjustment method: bonferroni
##
## Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data: bp_data_incbl_clean$WIDTH and bp_data_incbl_clean$CLASSIFICATION
##
## Bromme
## Federmesser 0.1
##
## P value adjustment method: bonferroni
##
## Pairwise comparisons using Wilcoxon rank sum test with continuity correction

```

```

##
## data: bp_data_incbl_clean$ELONGATION and bp_data_incbl_clean$CLASSIFICATION
##
##          Bromme
## Federmesser 0.4
##
## P value adjustment method: bonferroni
##
## Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data: bp_data_incbl_clean$THICKNESS and bp_data_incbl_clean$CLASSIFICATION
##
##          Bromme
## Federmesser 0.83
##
## P value adjustment method: bonferroni
##
## Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data: bp_data_incbl_clean$TCSA and bp_data_incbl_clean$CLASSIFICATION
##
##          Bromme
## Federmesser 0.94
##
## P value adjustment method: bonferroni
##
## Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data: bp_data_incbl_clean$TCSP and bp_data_incbl_clean$CLASSIFICATION
##
##          Bromme
## Federmesser 0.16
##
## P value adjustment method: bonferroni
##
## Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data: bp_data_incbl_clean$WEIGHT and bp_data_incbl_clean$SUB_CATEGORY
##
##          Backed Point (Reclassified)
## Backed Point (Unclassified) 1.000
## Creswellian Point          0.051
## Federmesser Point          1.000
## Hamburgian Point          1.000
##          Backed Point (Unclassified) Creswellian Point
## Backed Point (Unclassified) -           -
## Creswellian Point          0.090           -
## Federmesser Point          1.000           0.814
## Hamburgian Point          1.000           1.000
##          Federmesser Point
## Backed Point (Unclassified) -
## Creswellian Point          -

```

```

## Federmesser Point      -
## Hamburgian Point     1.000
##
## P value adjustment method: bonferroni
##
## Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data: bp_data_incbl_clean$LENGTH and bp_data_incbl_clean$SUB_CATEGORY
##
##                               Backed Point (Reclassified)
## Backed Point (Unclassified) 1
## Creswellian Point          1
## Federmesser Point          1
## Hamburgian Point           1
##                               Backed Point (Unclassified) Creswellian Point
## Backed Point (Unclassified) -          -
## Creswellian Point          1          -
## Federmesser Point          1          1
## Hamburgian Point           1          1
##                               Federmesser Point
## Backed Point (Unclassified) -
## Creswellian Point          -
## Federmesser Point          -
## Hamburgian Point           1
##
## P value adjustment method: bonferroni
##
## Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data: bp_data_incbl_clean$WIDTH and bp_data_incbl_clean$SUB_CATEGORY
##
##                               Backed Point (Reclassified)
## Backed Point (Unclassified) 0.52
## Creswellian Point          1.00
## Federmesser Point          1.00
## Hamburgian Point           1.00
##                               Backed Point (Unclassified) Creswellian Point
## Backed Point (Unclassified) -          -
## Creswellian Point          1.00
## Federmesser Point          1.00          1.00
## Hamburgian Point           1.00          1.00
##                               Federmesser Point
## Backed Point (Unclassified) -
## Creswellian Point          -
## Federmesser Point          -
## Hamburgian Point           1.00
##
## P value adjustment method: bonferroni
##
## Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data: bp_data_incbl_clean$ELONGATION and bp_data_incbl_clean$SUB_CATEGORY

```

```

##                                     Backed Point (Reclassified)
## Backed Point (Unclassified) 0.26
## Creswellian Point          1.00
## Federmesser Point          1.00
## Hamburgian Point           1.00
##                                     Backed Point (Unclassified) Creswellian Point
## Backed Point (Unclassified) -
##                               - 
## Creswellian Point          1.00
##                               - 
## Federmesser Point          1.00
##                               1.00
## Hamburgian Point           1.00
##                               1.00
##                                     Federmesser Point
## Backed Point (Unclassified) -
##                               - 
## Creswellian Point          -
##                               - 
## Federmesser Point          -
##                               - 
## Hamburgian Point           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          0.327
## Federmesser Point          1.000
## Hamburgian Point           1.000
##                                     Backed Point (Unclassified) Creswellian Point
## Backed Point (Unclassified) -
##                               - 
## Creswellian Point          0.045
##                               - 
## Federmesser Point          1.000
##                               1.000
## Hamburgian Point           1.000
##                               1.000
##                                     Federmesser Point
## Backed Point (Unclassified) -
##                               - 
## Creswellian Point          -
##                               - 
## Federmesser Point          -
##                               - 
## Hamburgian Point           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          0.33
## Federmesser Point          1.00
## Hamburgian Point           1.00
##                                     Backed Point (Unclassified) Creswellian Point
## Backed Point (Unclassified) -
##                               - 
## Creswellian Point          0.26
##                               - 

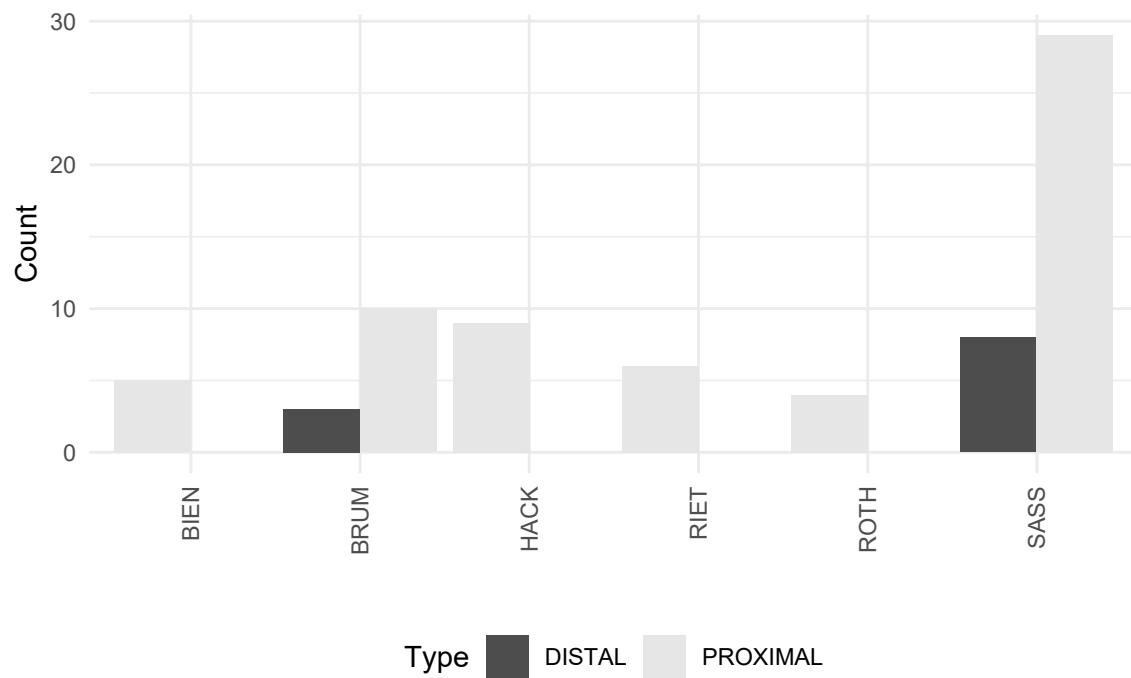
```

```

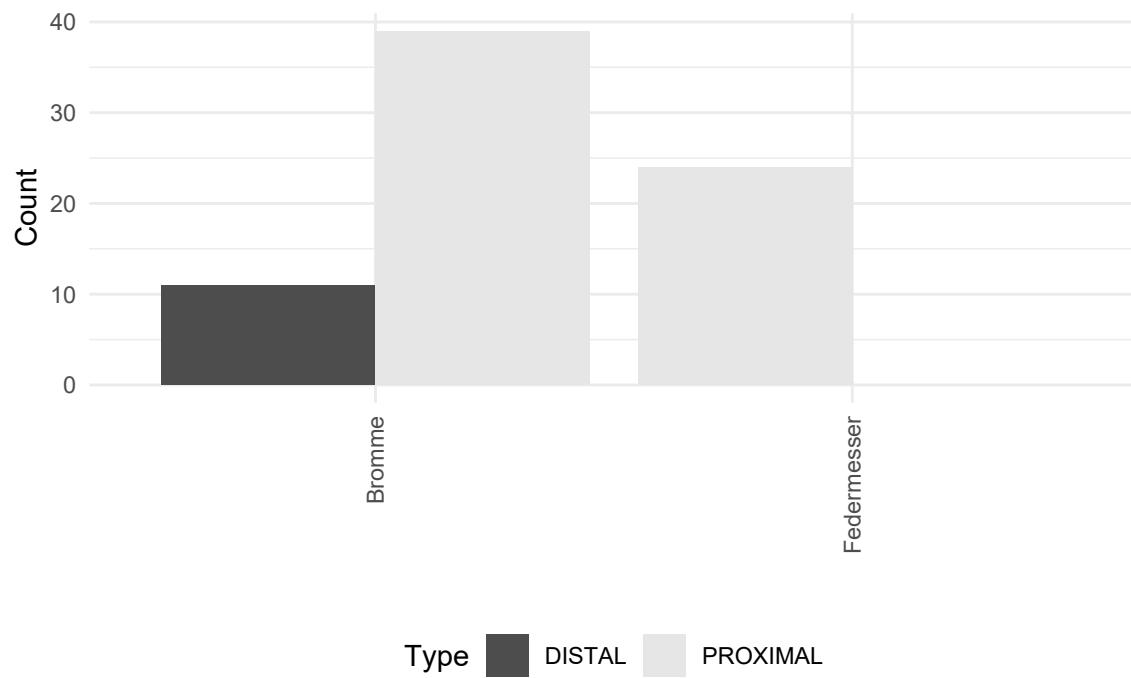
## Federmesser Point      1.00      1.00
## Hamburgian Point     1.00      1.00
##
##                               Federmesser Point
## Backed Point (Unclassified) -
## Creswellian Point        -
## Federmesser Point        -
## Hamburgian Point        1.00
##
## P value adjustment method: bonferroni
##
## Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data: bp_data_incbl_clean$TCSP and bp_data_incbl_clean$SUB_CATEGORY
##
##                               Backed Point (Reclassified)
## Backed Point (Unclassified) 0.89
## Creswellian Point          1.00
## Federmesser Point          1.00
## Hamburgian Point          1.00
##                               Backed Point (Unclassified) Creswellian Point
## Backed Point (Unclassified) -           -
## Creswellian Point          1.00           -
## Federmesser Point          1.00           1.00
## Hamburgian Point          1.00           1.00
##                               Federmesser Point
## Backed Point (Unclassified) -
## Creswellian Point          -
## Federmesser Point          -
## Hamburgian Point          1.00
##
## P value adjustment method: bonferroni

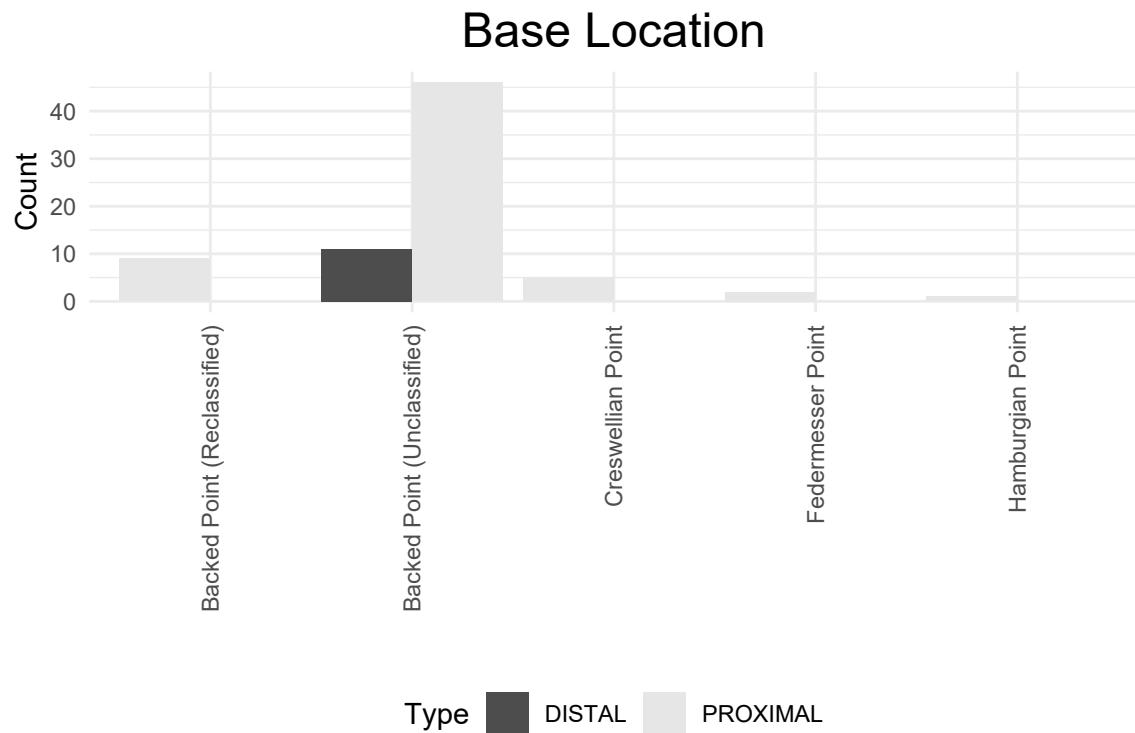
```

## Base Location



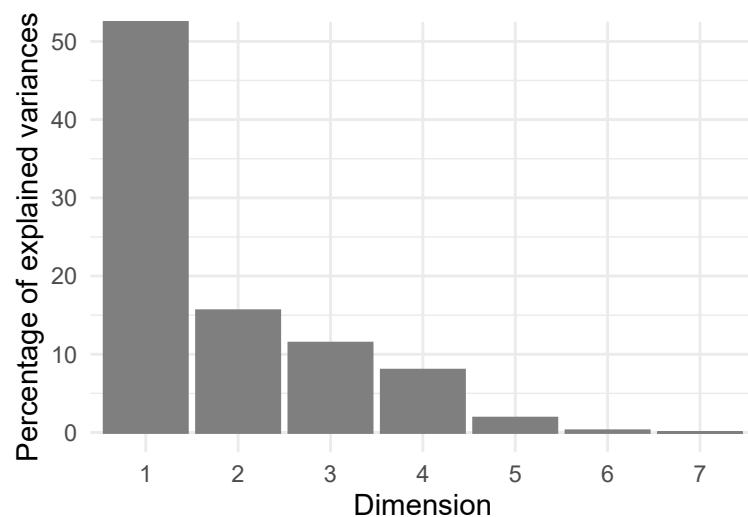
## Base Location



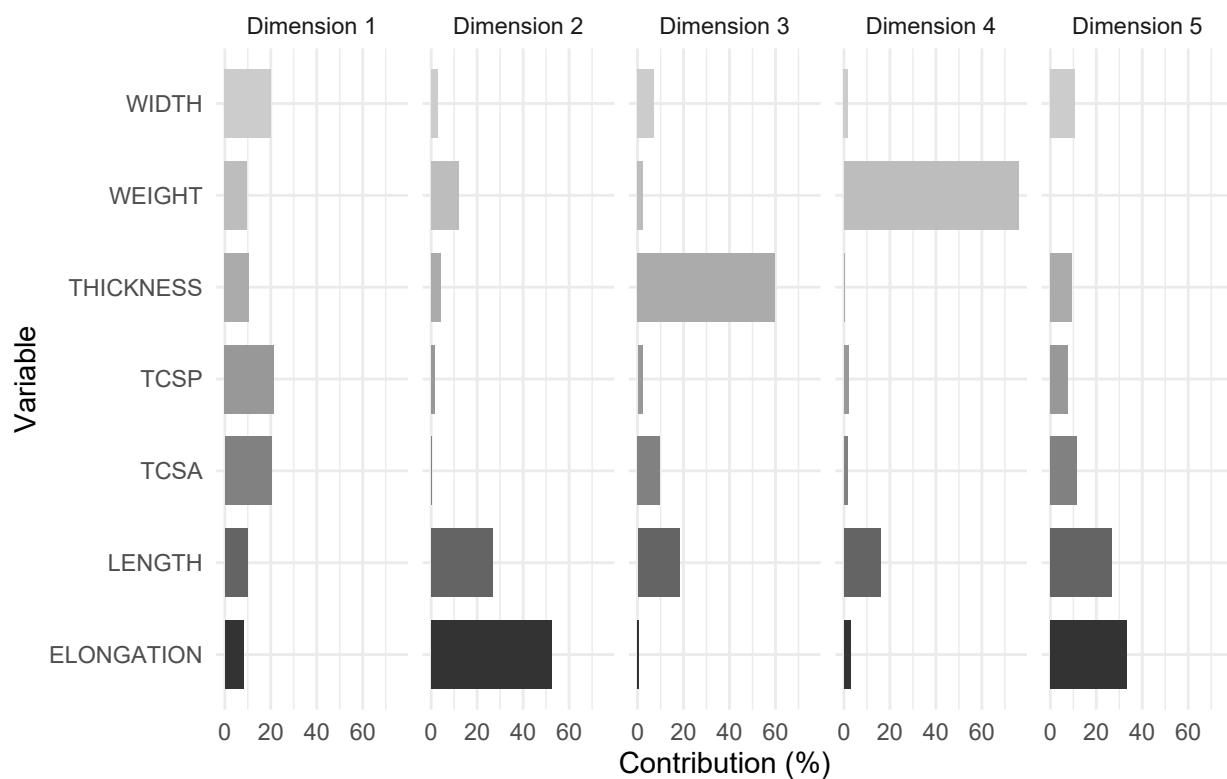


### Principal Component Analysis (PCA)

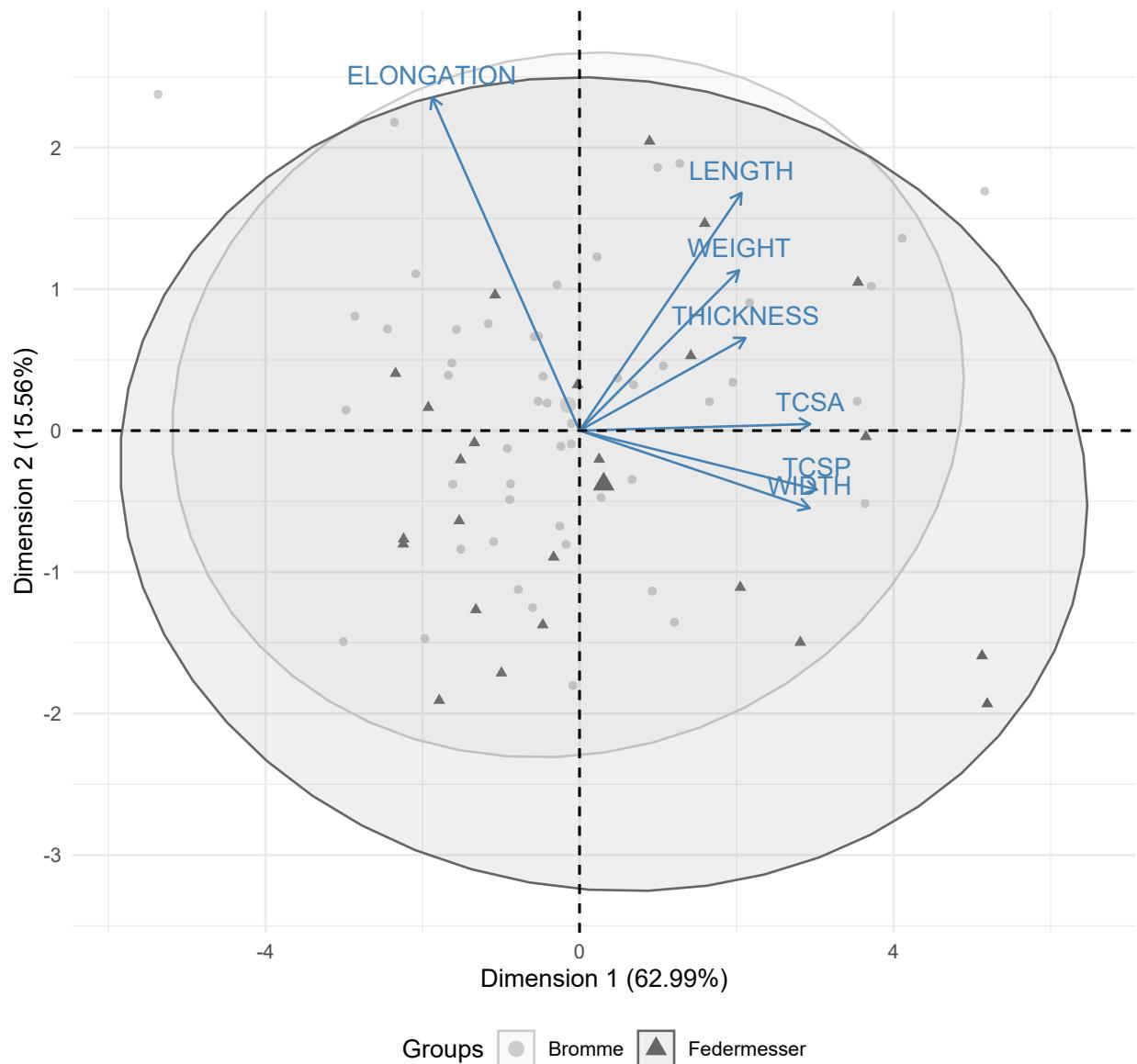
```
## # A tibble: 7 x 4
##   rowname eigenvalue variance cumulative
##   <chr>     <dbl>    <dbl>      <dbl>
## 1 Dim.1     4.41     63.0      63.0
## 2 Dim.2     1.09     15.6      78.6
## 3 Dim.3     0.800    11.4      90.0
## 4 Dim.4     0.558    7.97      97.9
## 5 Dim.5     0.128    1.84      99.8
## 6 Dim.6     0.0151   0.216     100.
## 7 Dim.7     0.000132 0.00189   100.
```



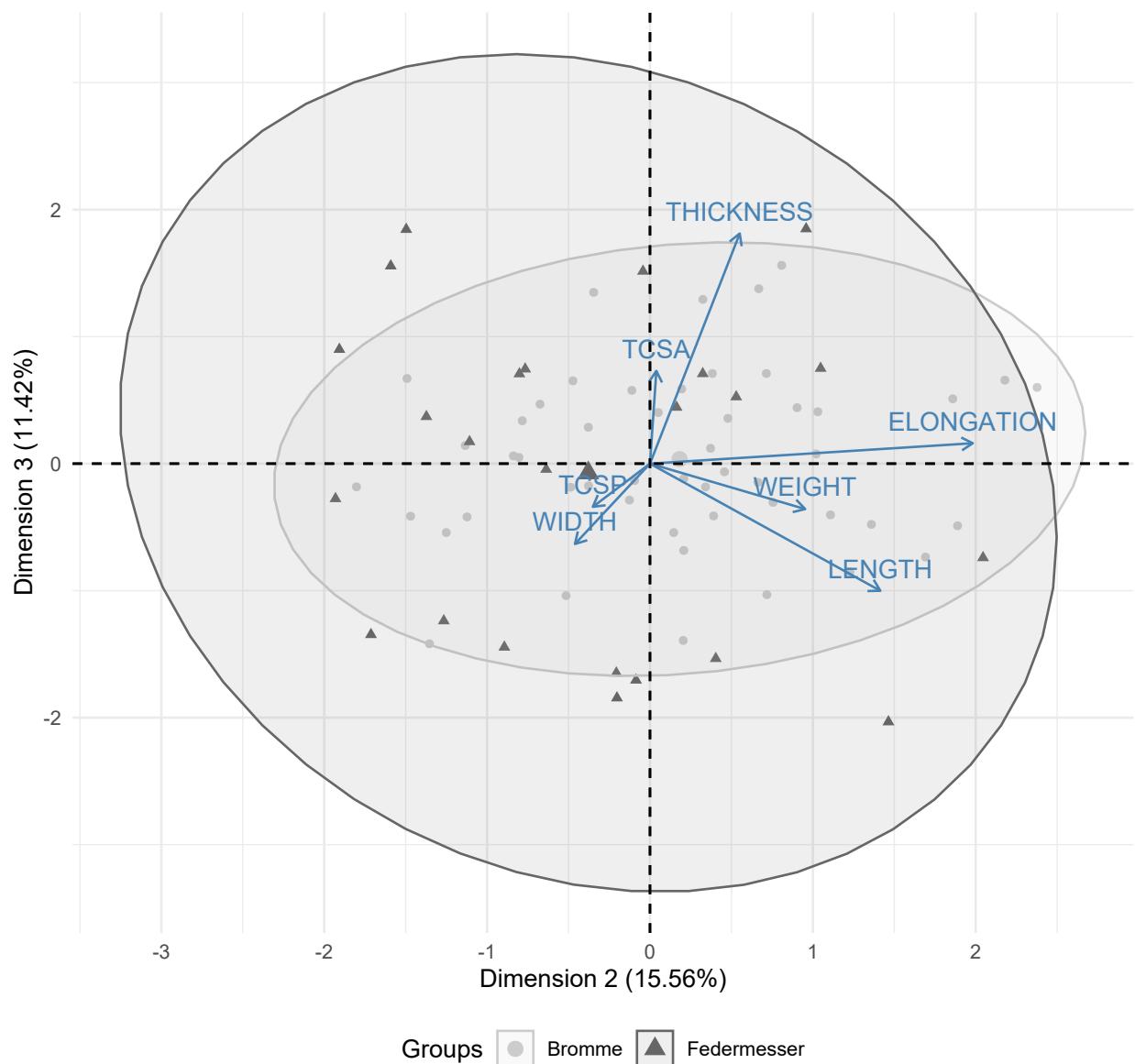
## Contribution of Variables



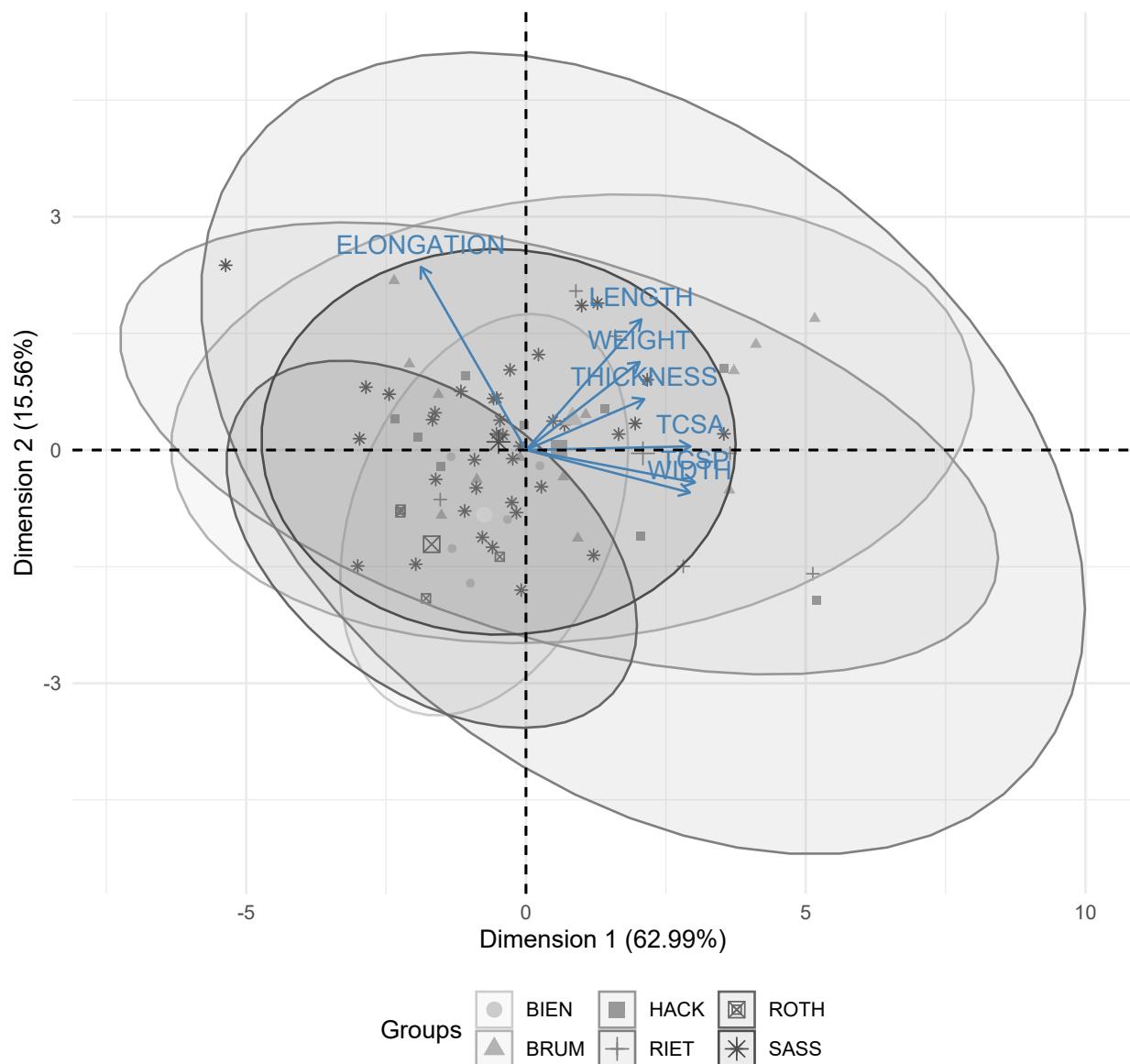
## PCA 1 vs. PCA 2 (Classification)



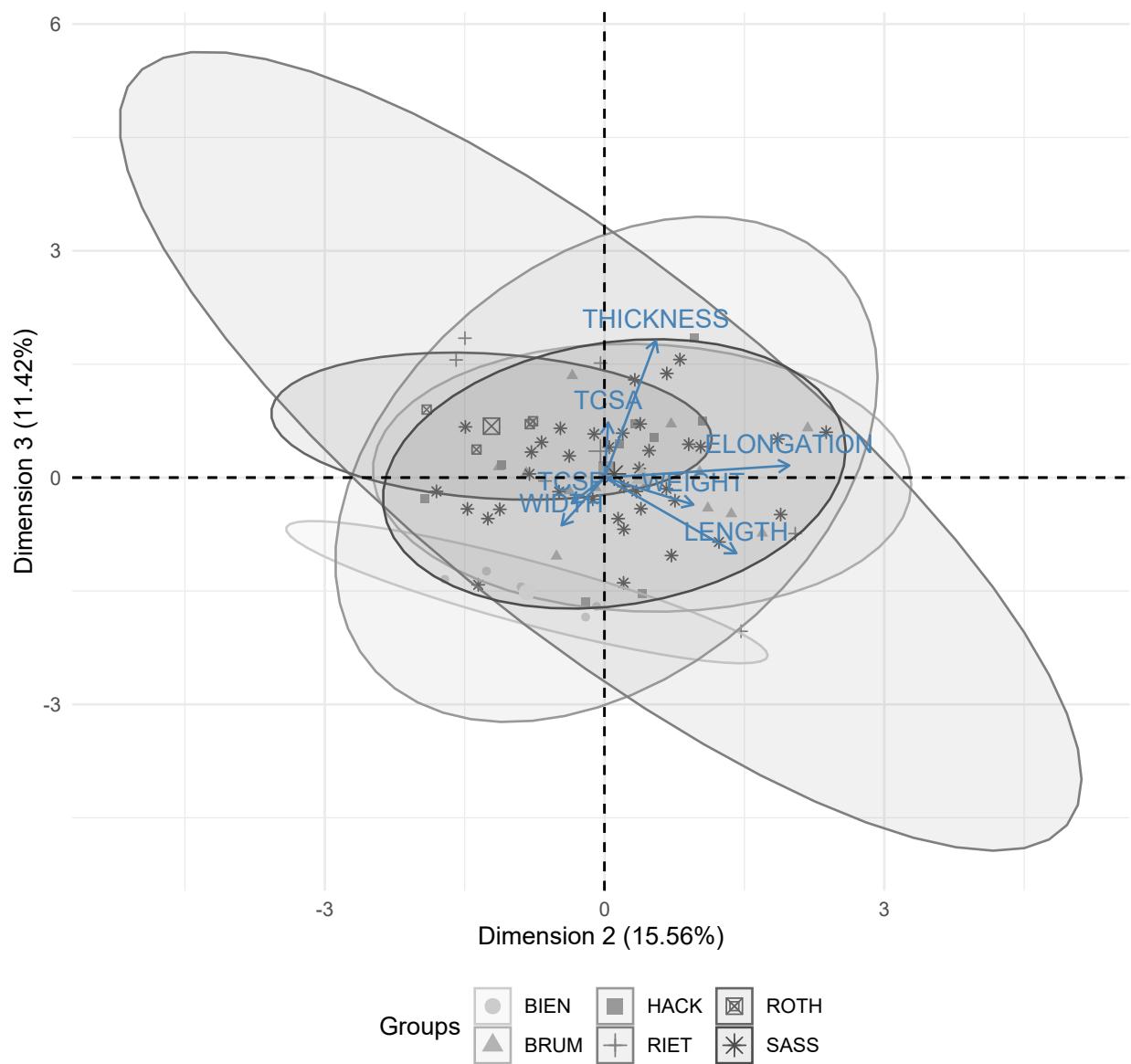
## PCA 2 vs. PCA 3 (Classification)



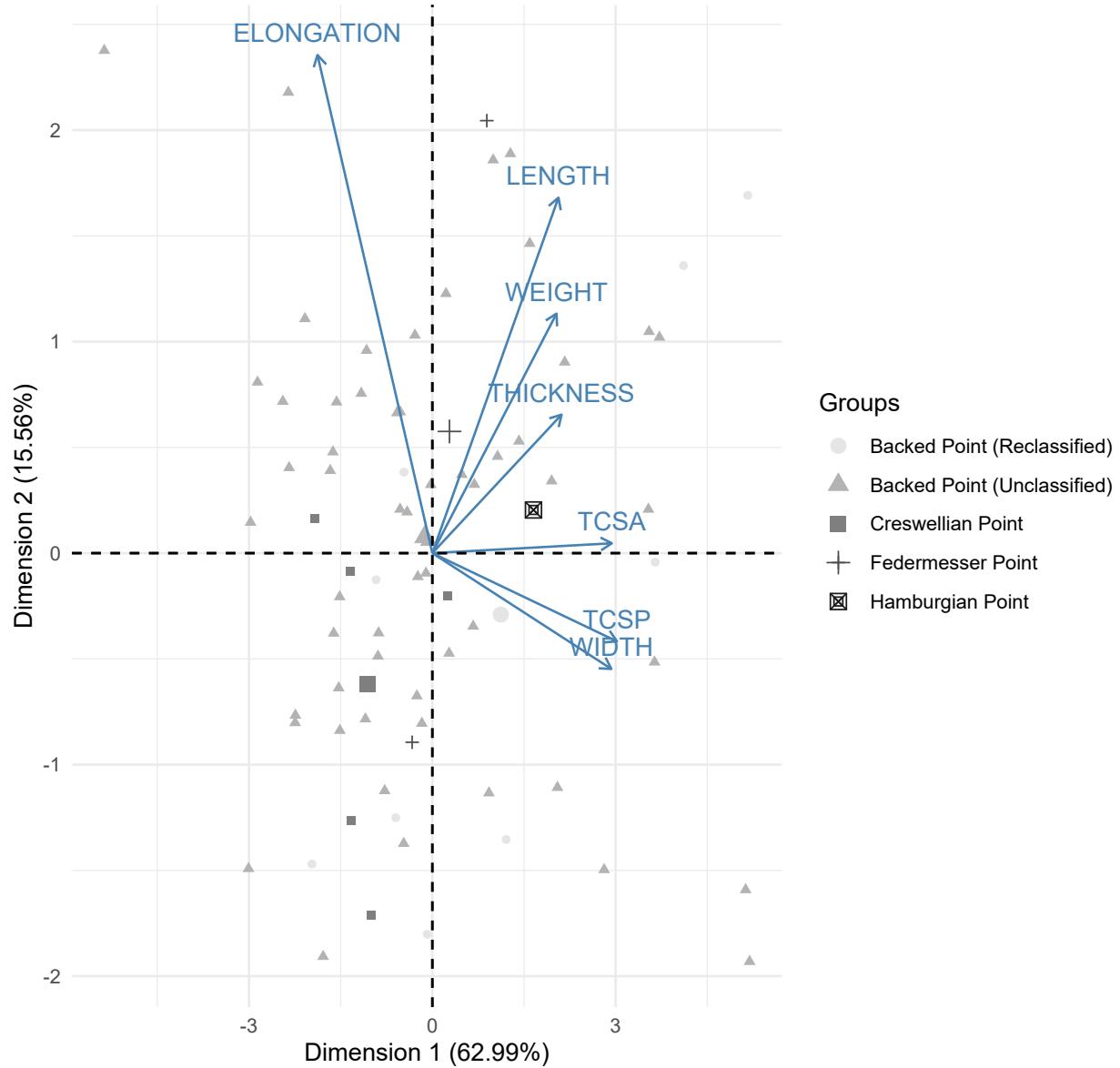
## PCA 1 vs. PCA 2 (Code)



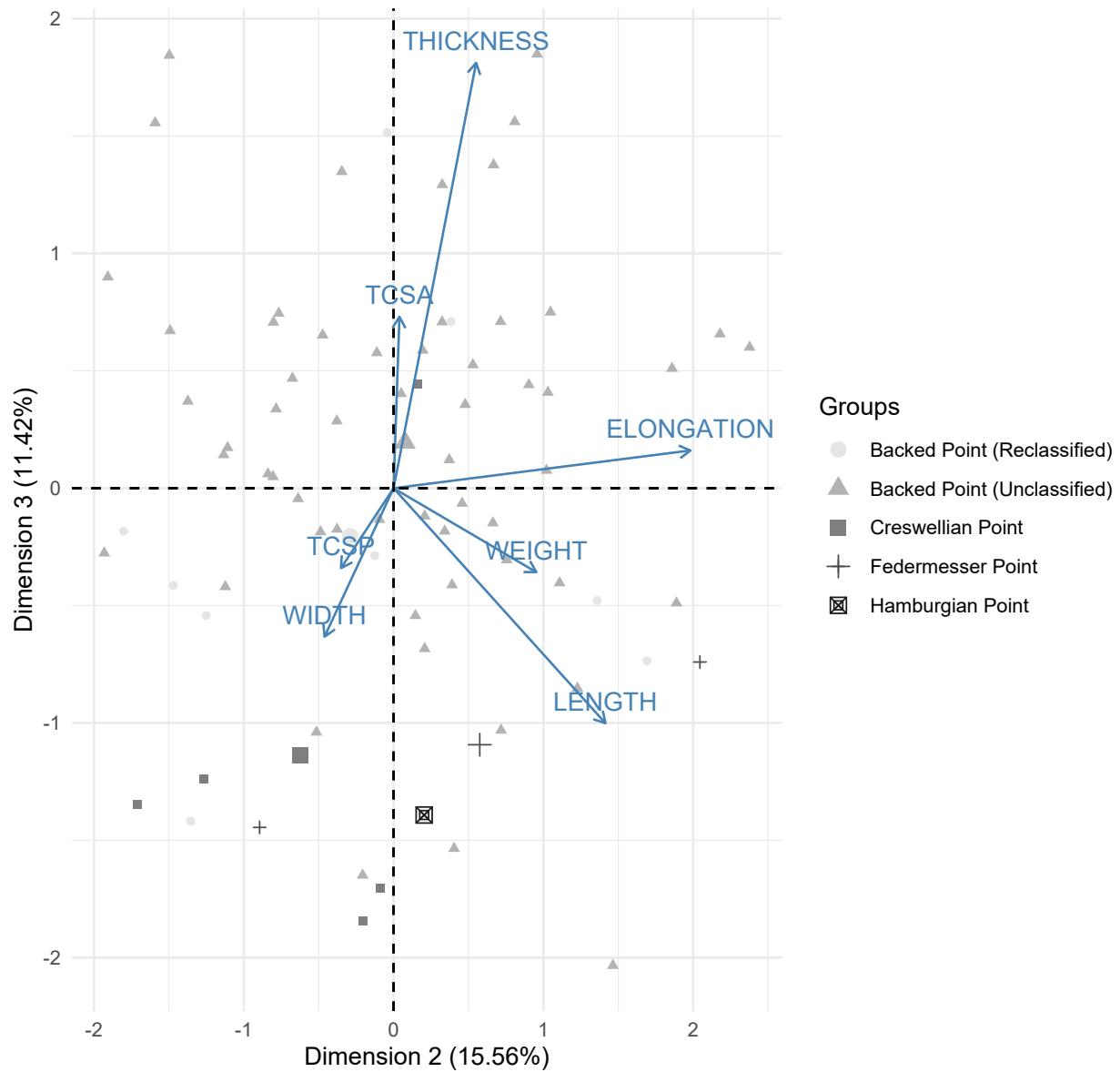
## PCA 2 vs. PCA 3 (Code)



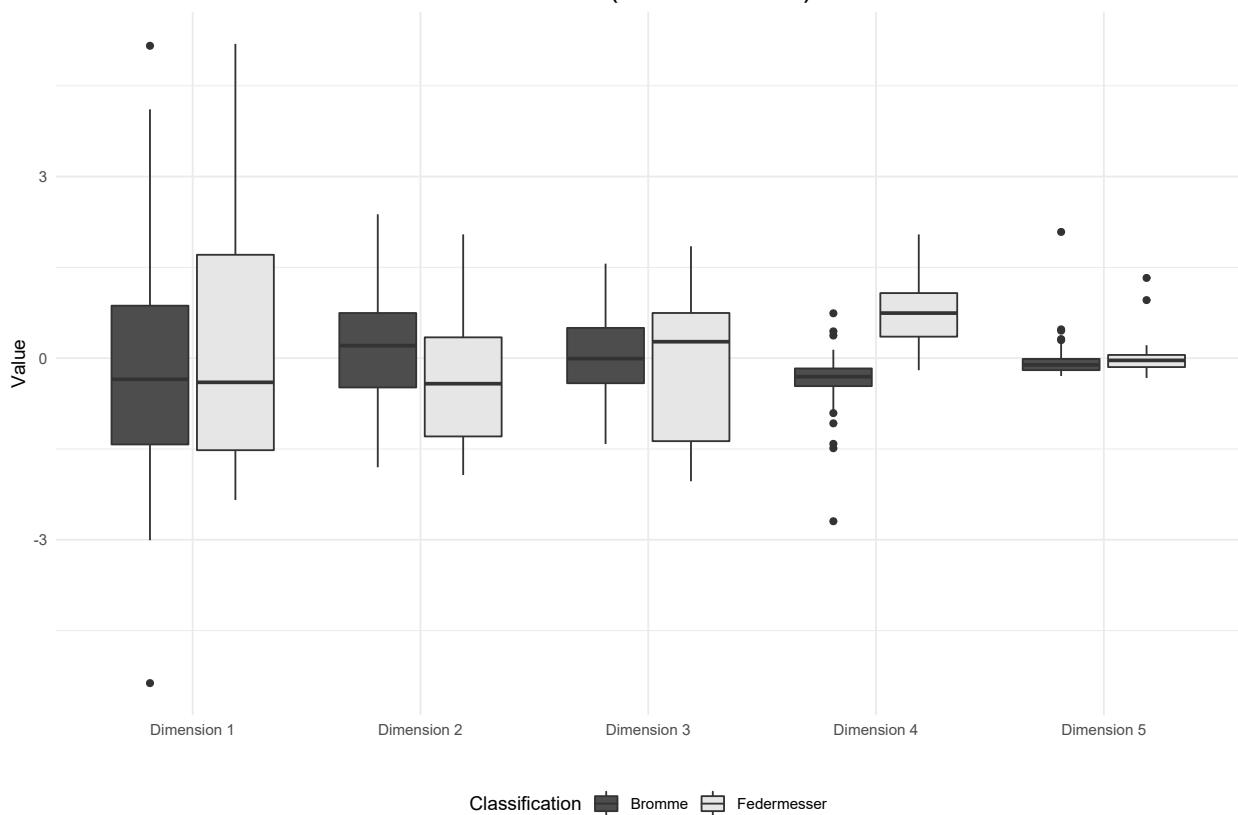
## PCA 1 vs. PCA 2 (Backed Point Variant)



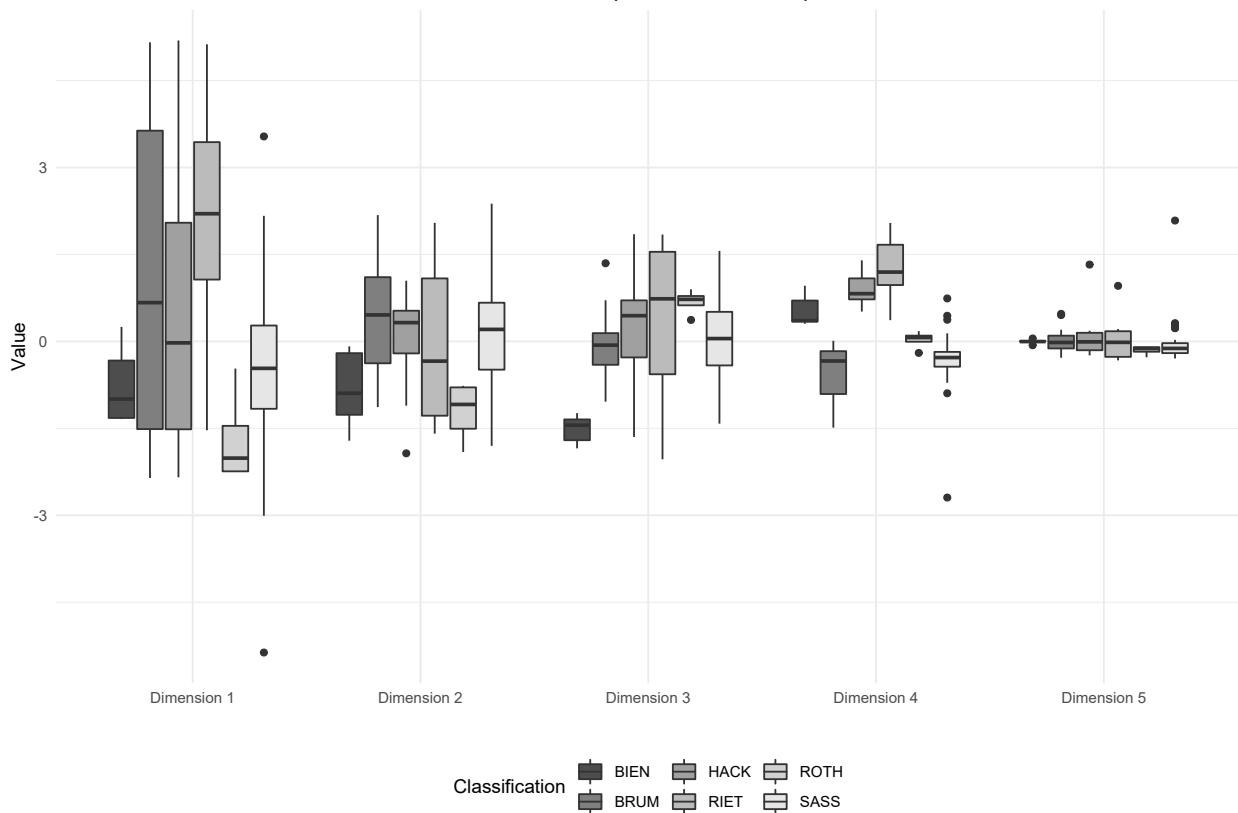
## PCA 2 vs. PCA 3 (Backed Point Variant)



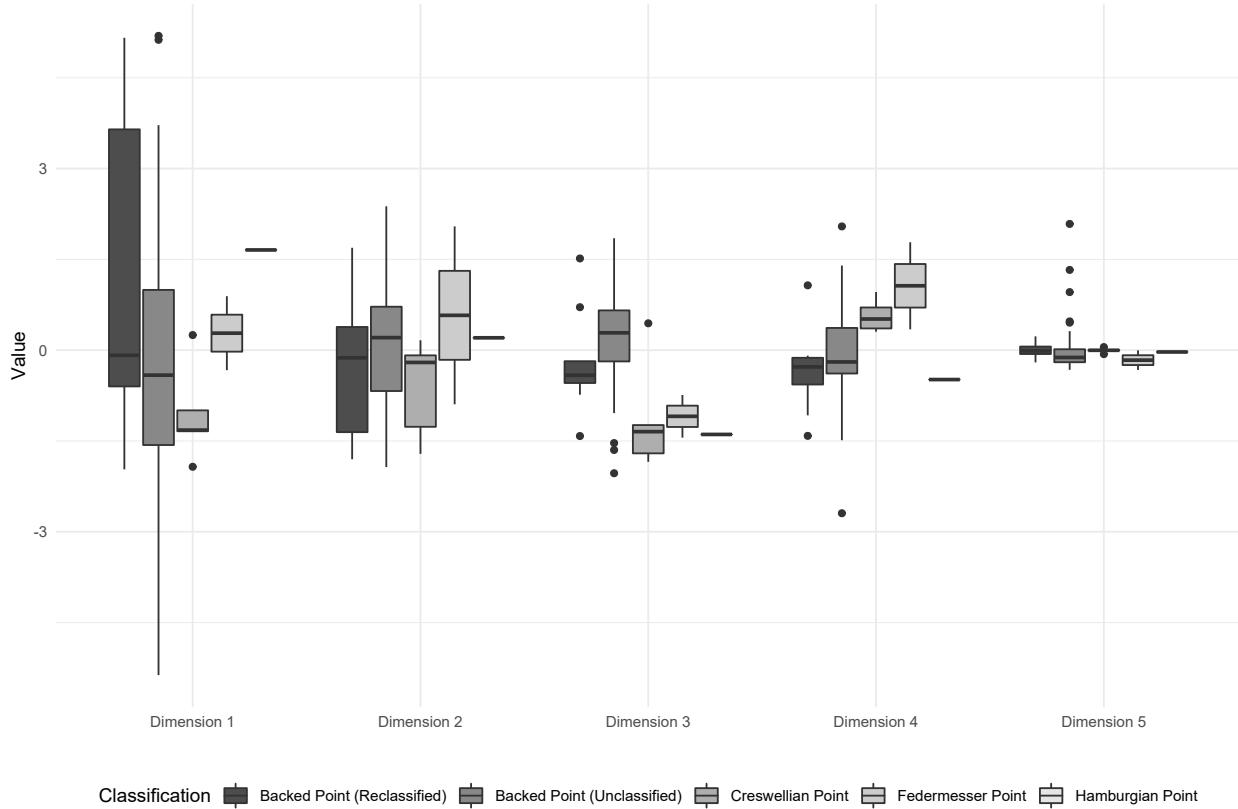
### PCA 1:5 (Classification)



### PCA 1:5 (Classification)



PCA 1:5 (Classification)



## 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)

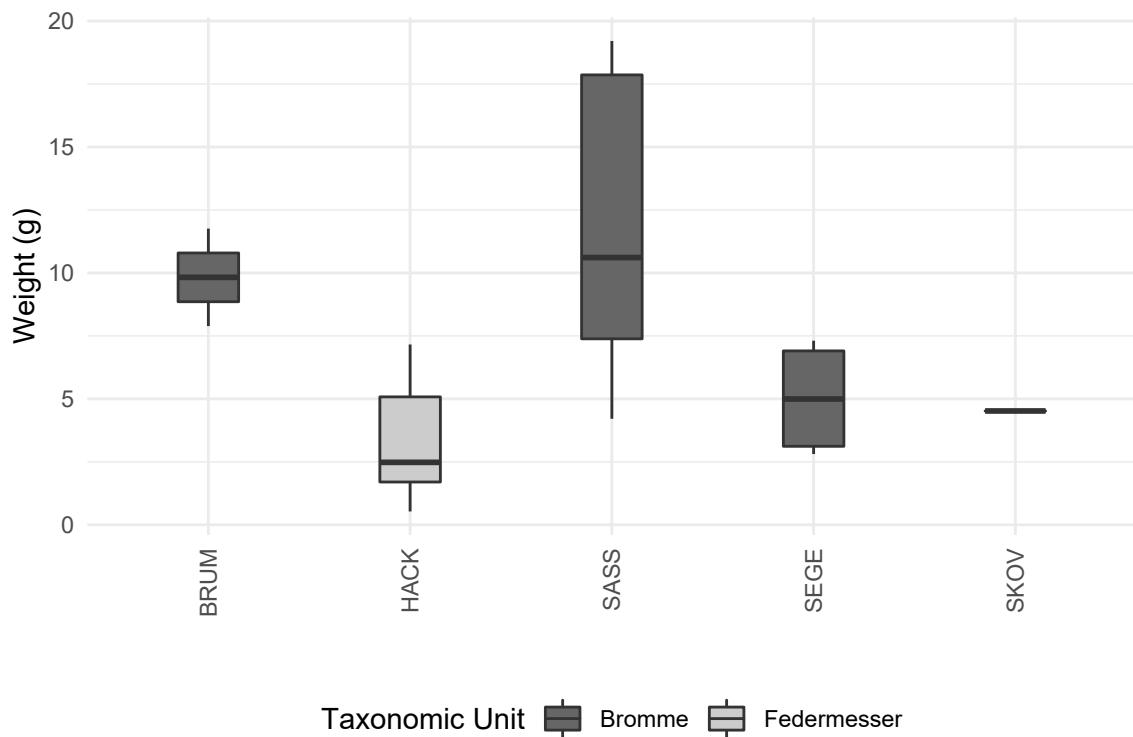
SUB_CATEGORY	n_obs	min	max	mean	med	sd	var
Ahrensburgian Point	3	1.65	3.12	2.37	2.34	0.74	0.54
Bromme Point	6	4.92	6.03	5.52	5.54	0.46	0.21
Chwalibogowice Point	1	3.45	3.45	3.45	3.45	NA	NA
Swidry Point	1	4.52	4.52	4.52	4.52	NA	NA
Tanged Point (Unclassified)	13	3.74	7.18	5.17	5.10	1.06	1.13

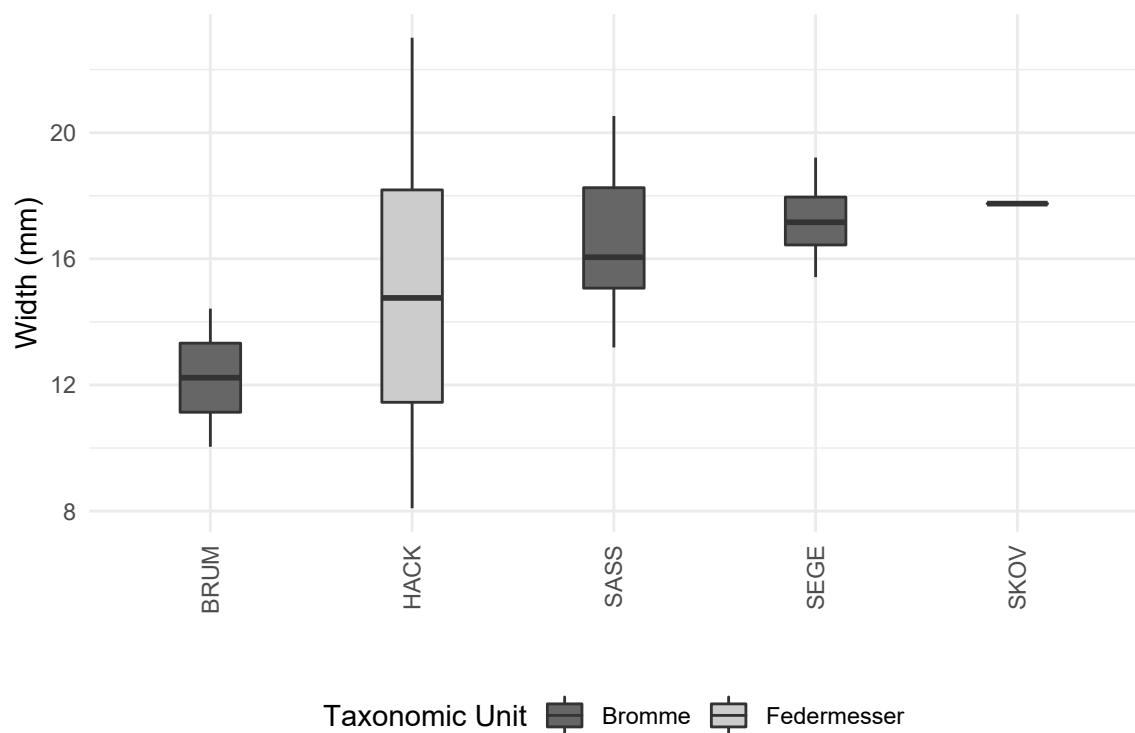
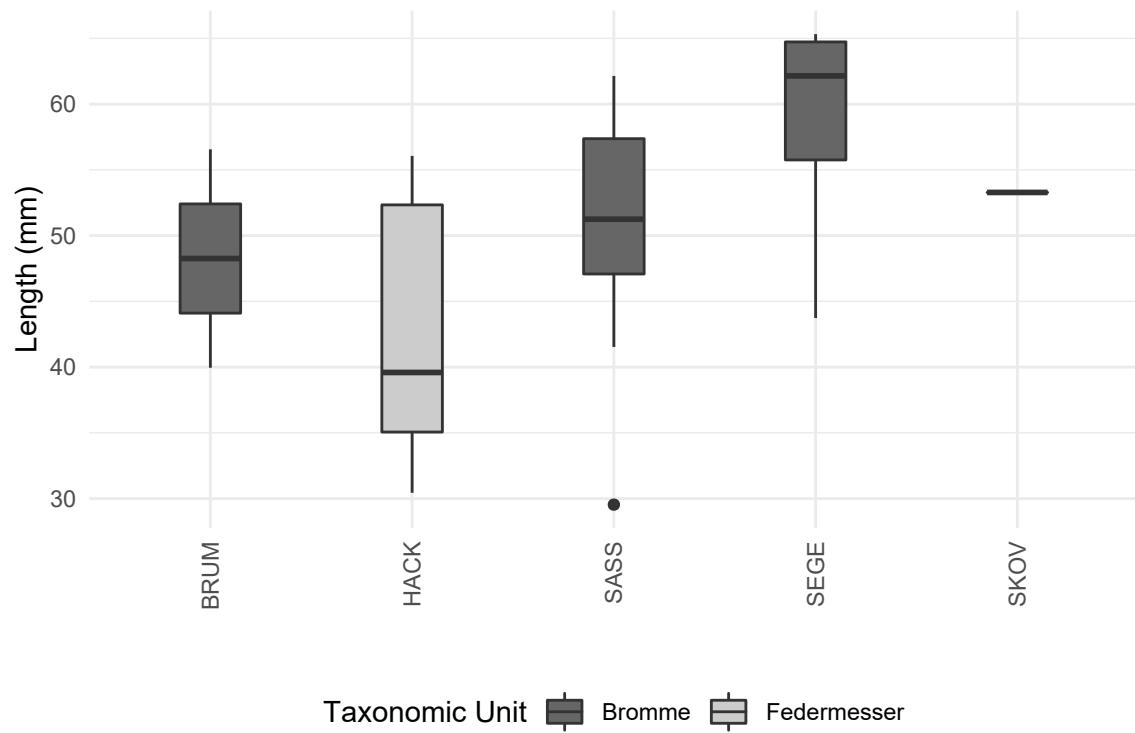
Table 85. Descriptive Statistics: Tip Cross-Sectional Area (TCSA)

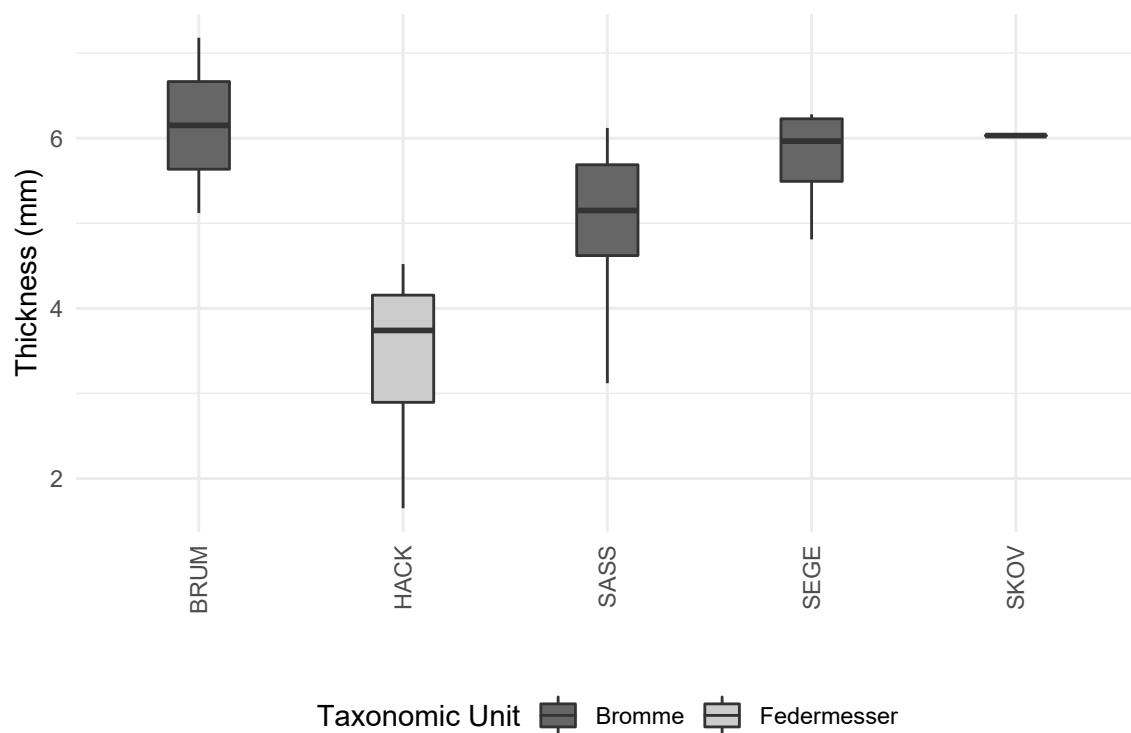
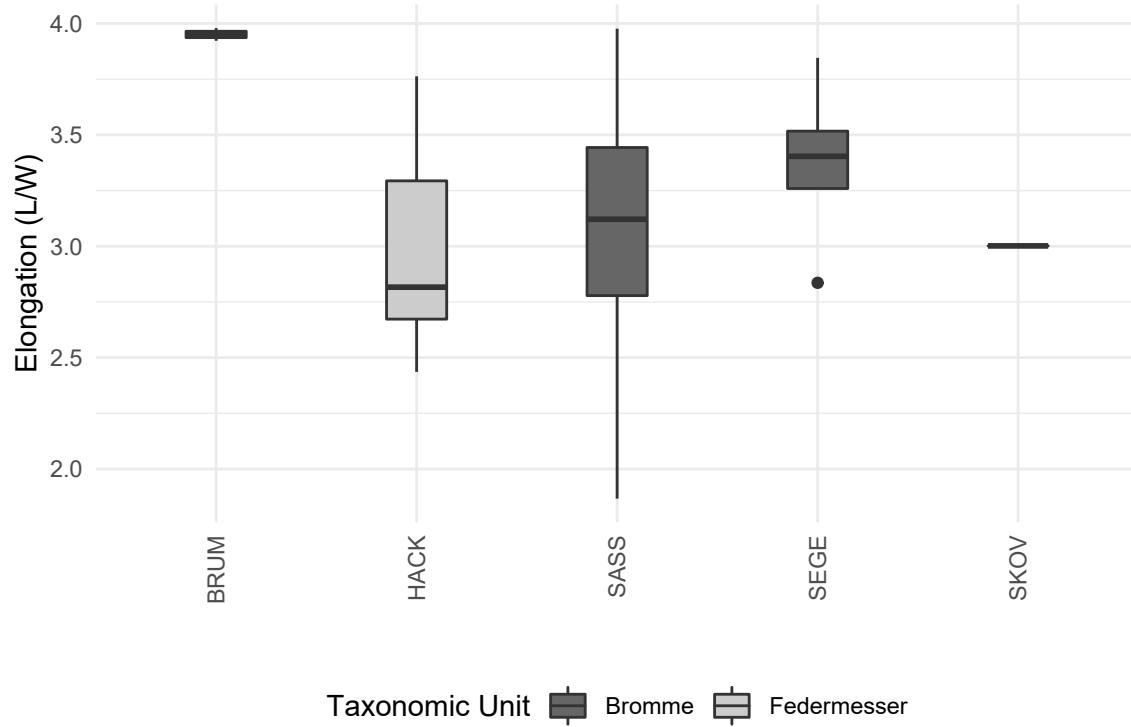
SUB_CATEGORY	n_obs	min	max	mean	med	sd	var
Ahrensburgian Point	3	6.67	24.68	16.21	17.27	9.05	81.94
Bromme Point	6	34.69	59.95	48.27	49.97	9.01	81.21
Chwalibogowice Point	1	16.01	16.01	16.01	16.01	NA	NA
Swidry Point	1	29.81	29.81	29.81	29.81	NA	NA
Tanged Point (Unclassified)	13	25.47	57.83	42.45	41.31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

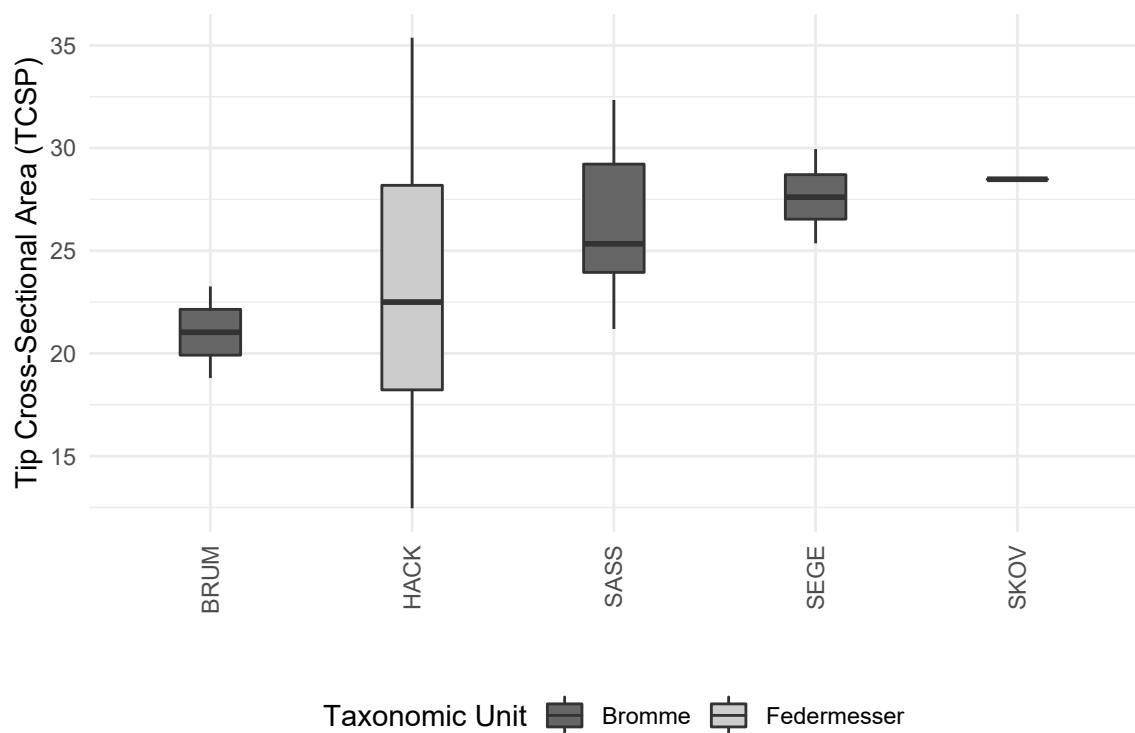
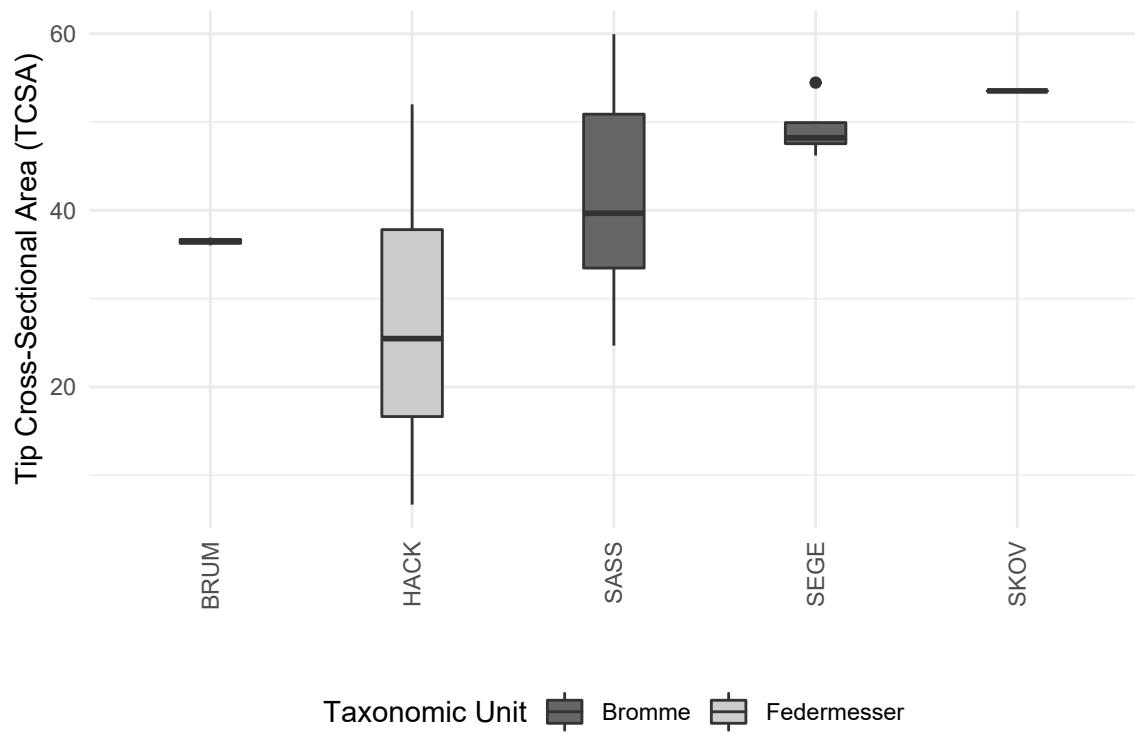
Table 86. Descriptive Statistics: Tip Cross-Sectional Perimeter (TCSP)

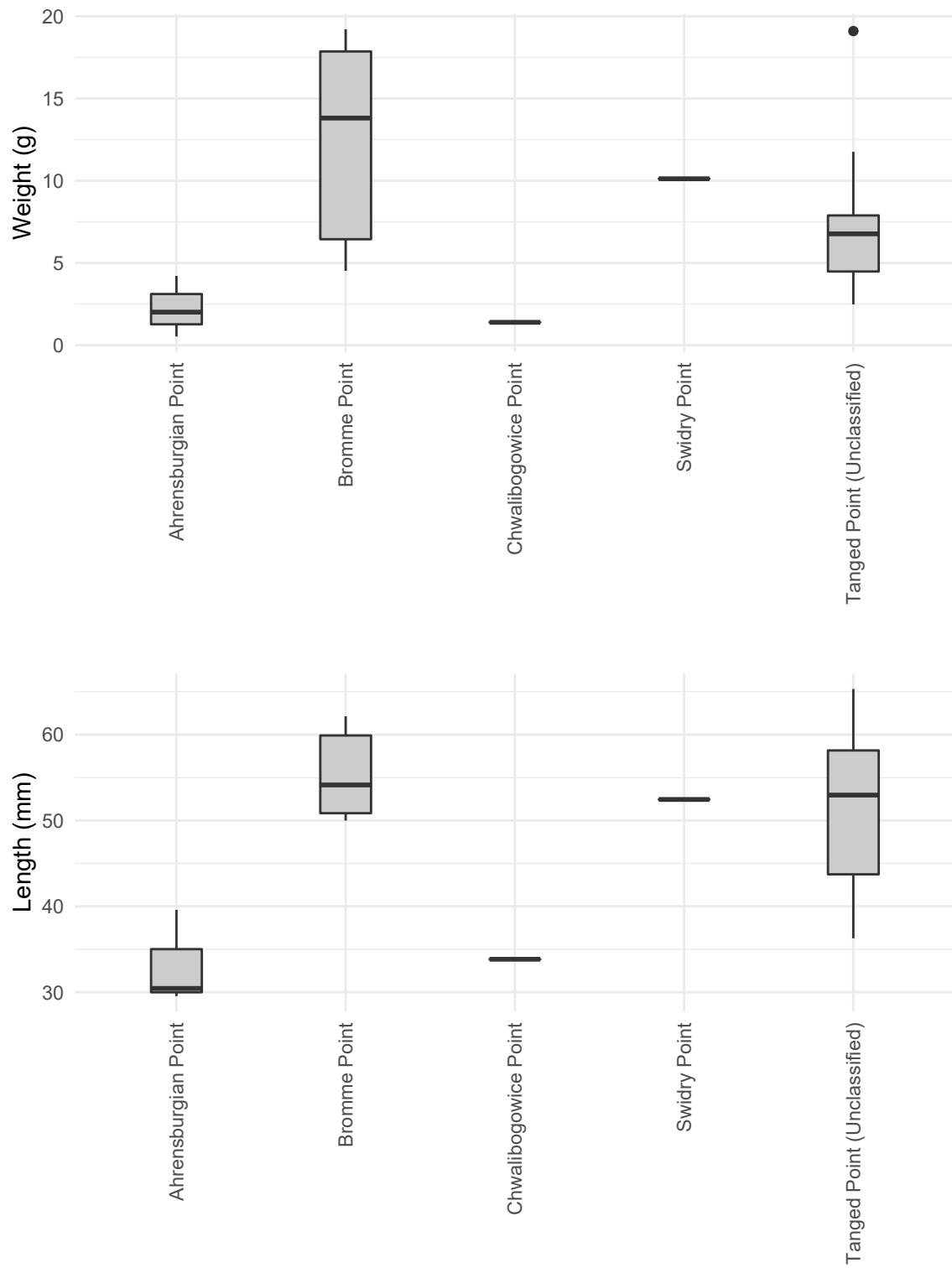
SUB_CATEGORY	n_obs	min	max	mean	med	sd	var
Ahrensburgian Point	3	12.46	24.32	19.76	22.50	6.39	40.80
Bromme Point	6	22.70	32.34	27.74	27.44	3.59	12.92
Chwalibogowice Point	1	15.06	15.06	15.06	15.06	NA	NA
Swidry Point	1	21.19	21.19	21.19	21.19	NA	NA
Tanged Point (Unclassified)	13	18.80	35.37	26.53	26.93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

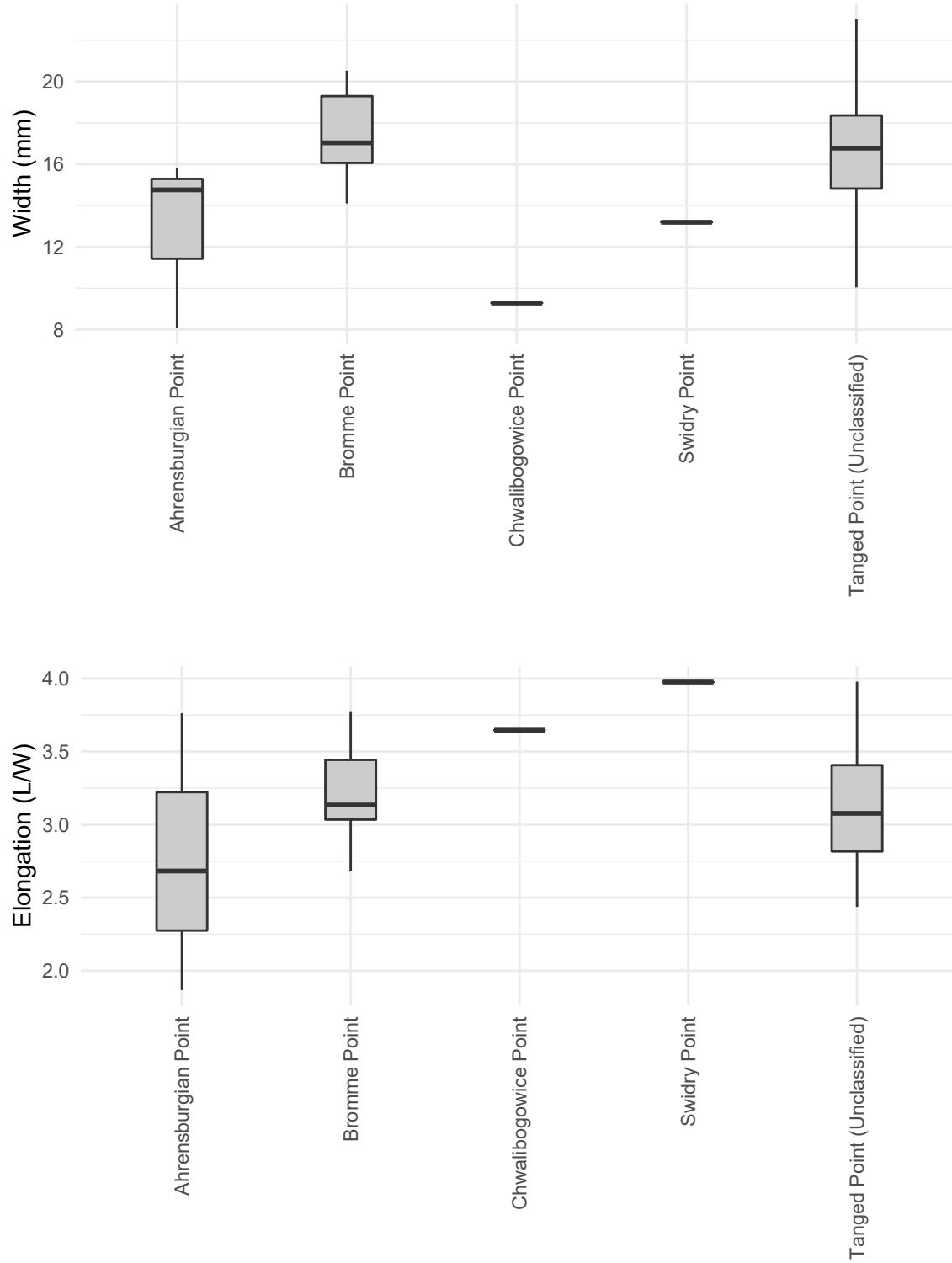


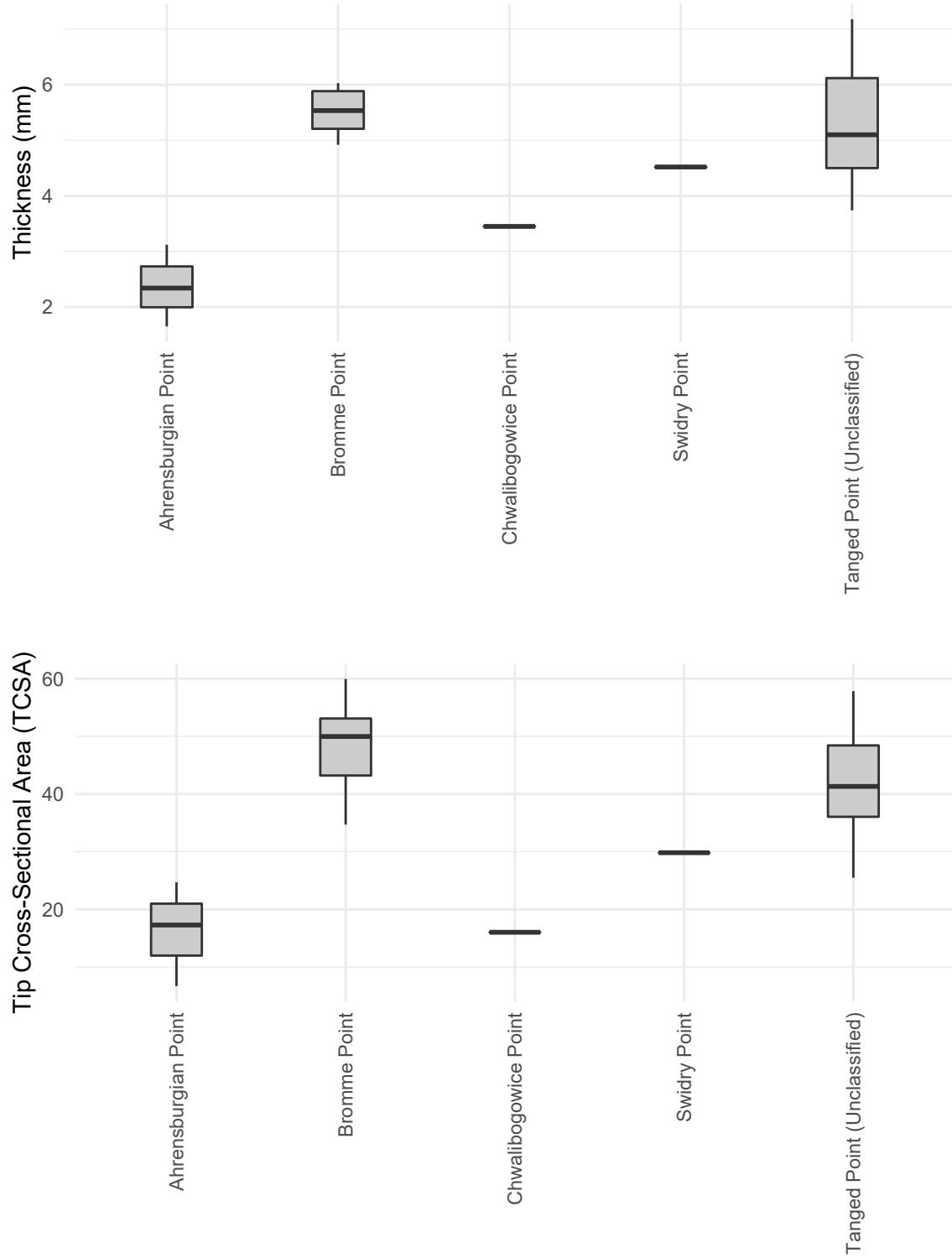


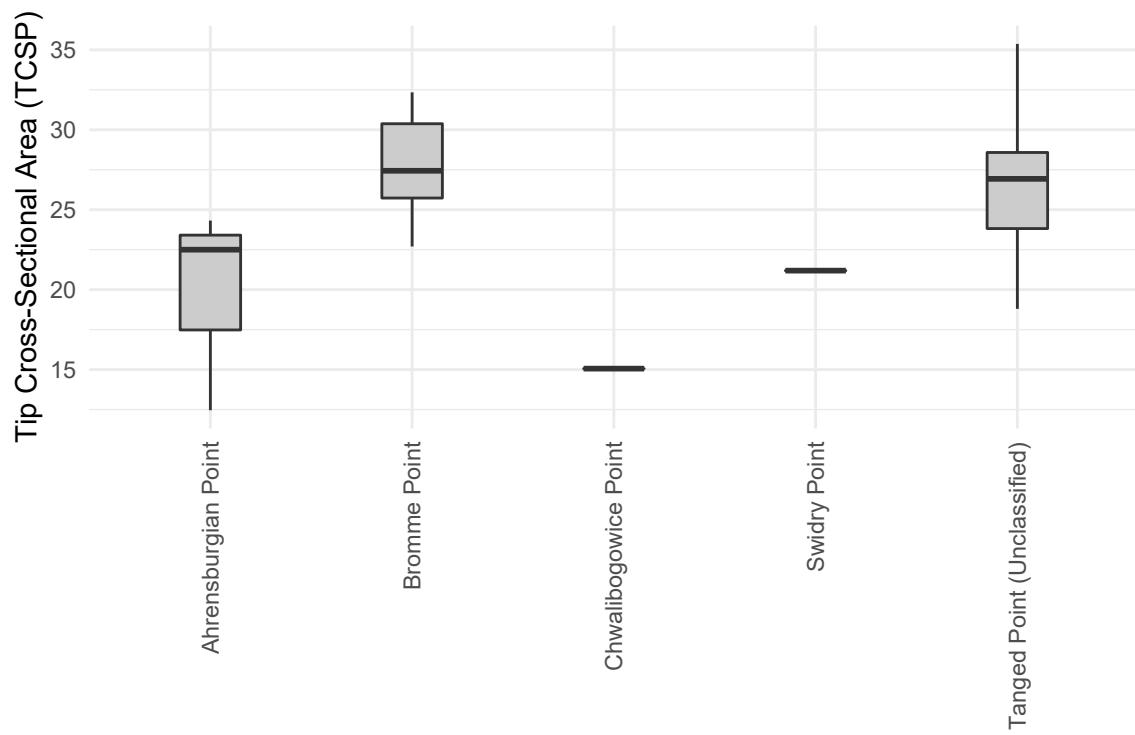




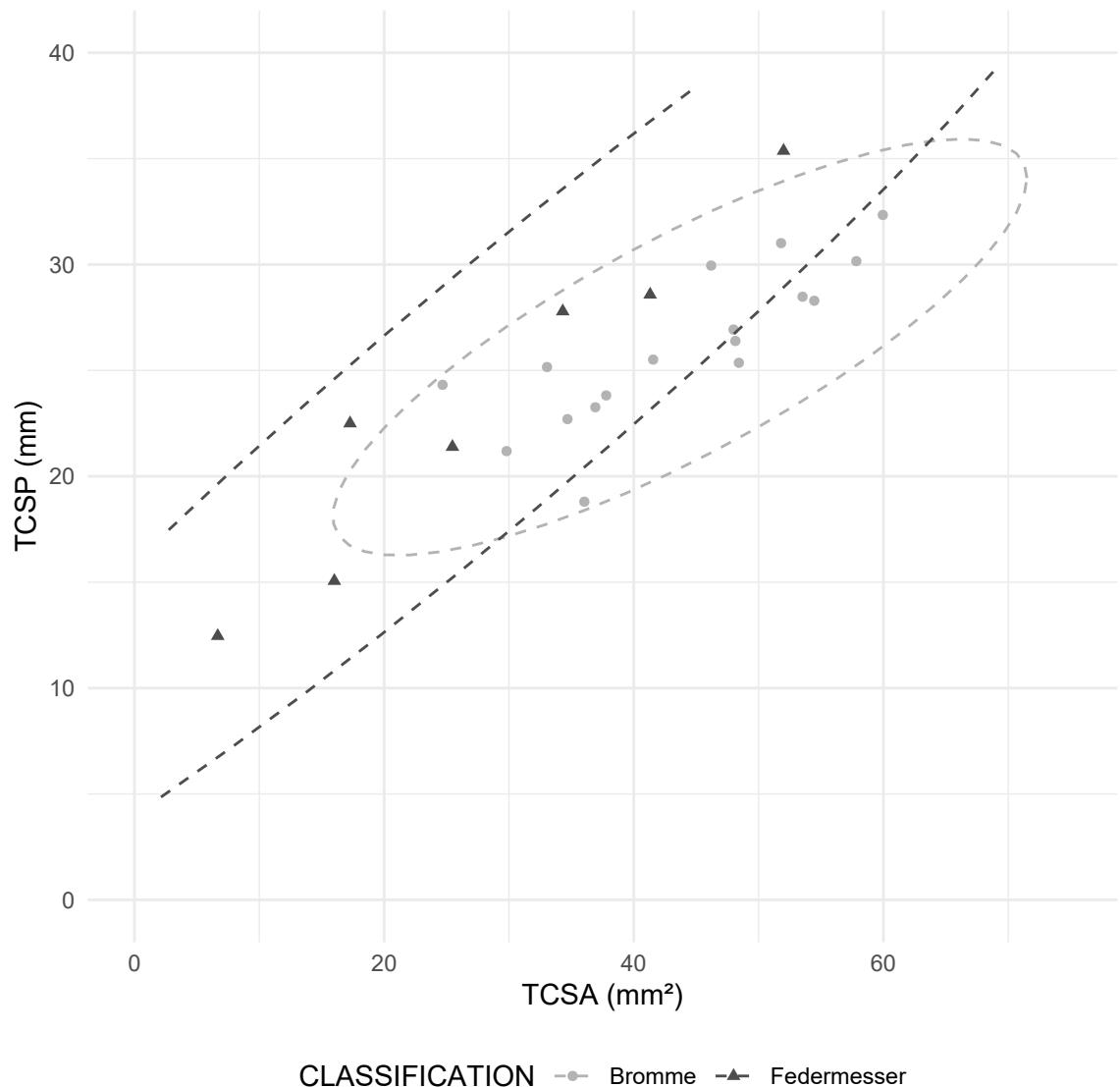


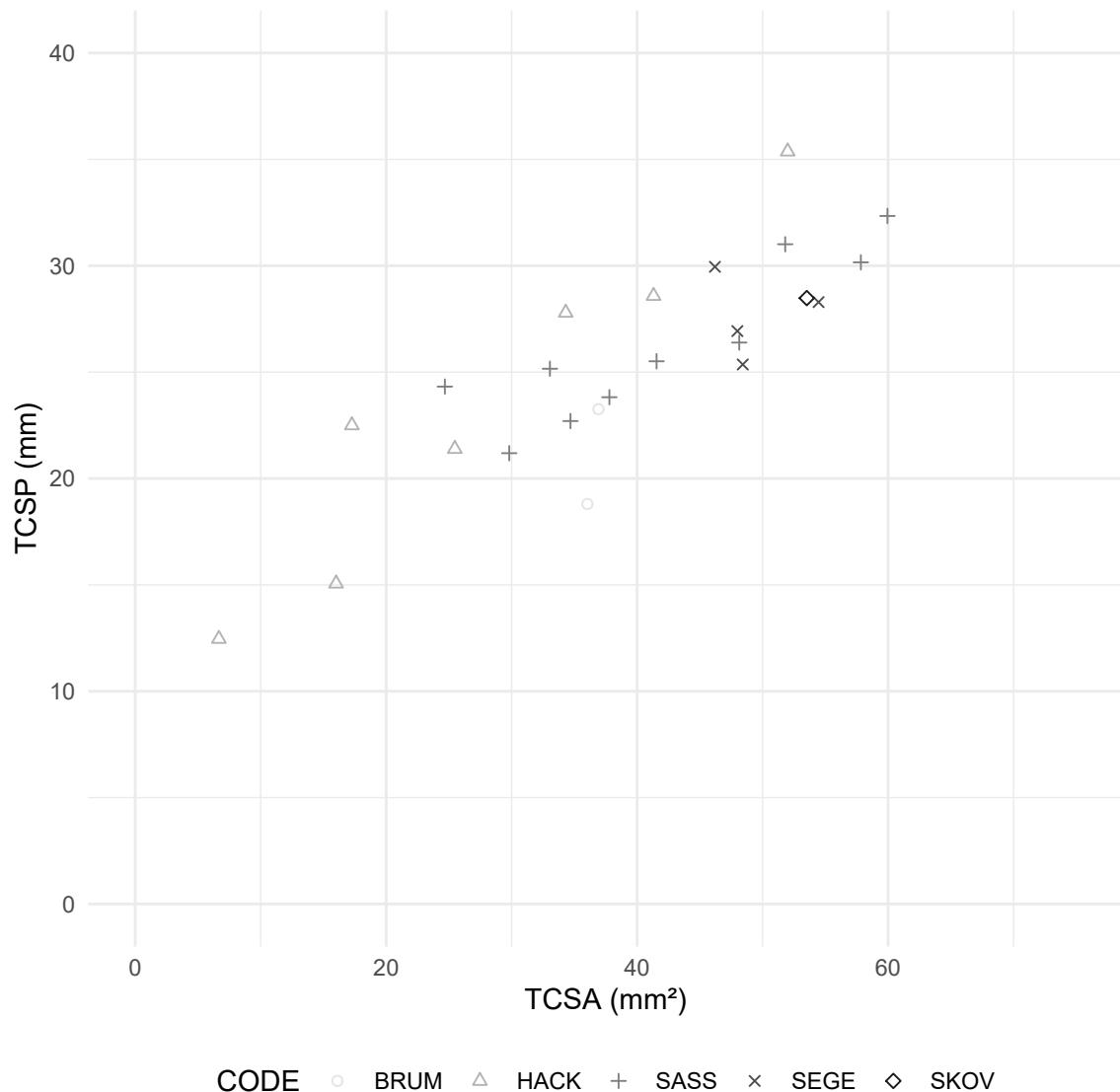


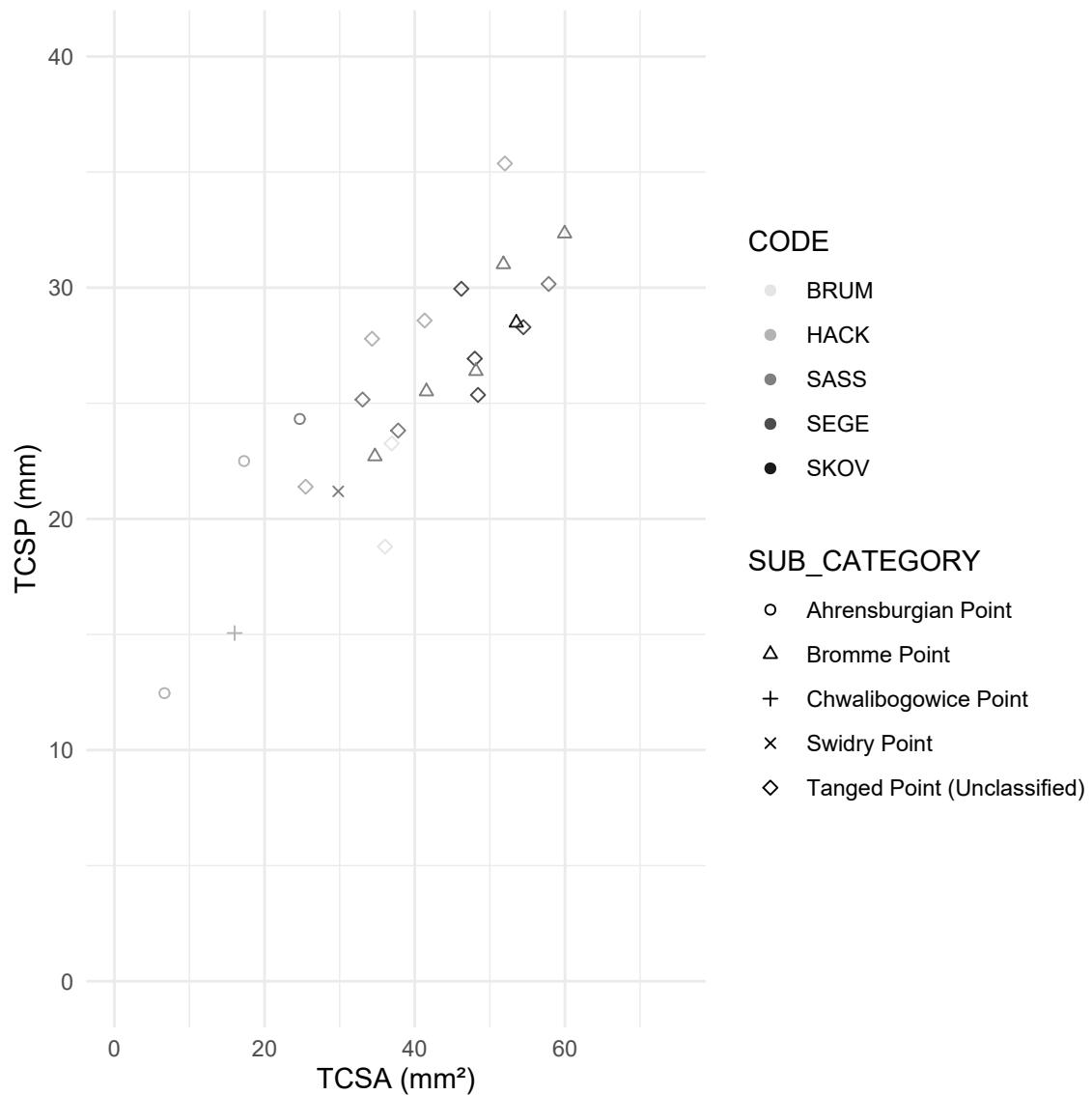


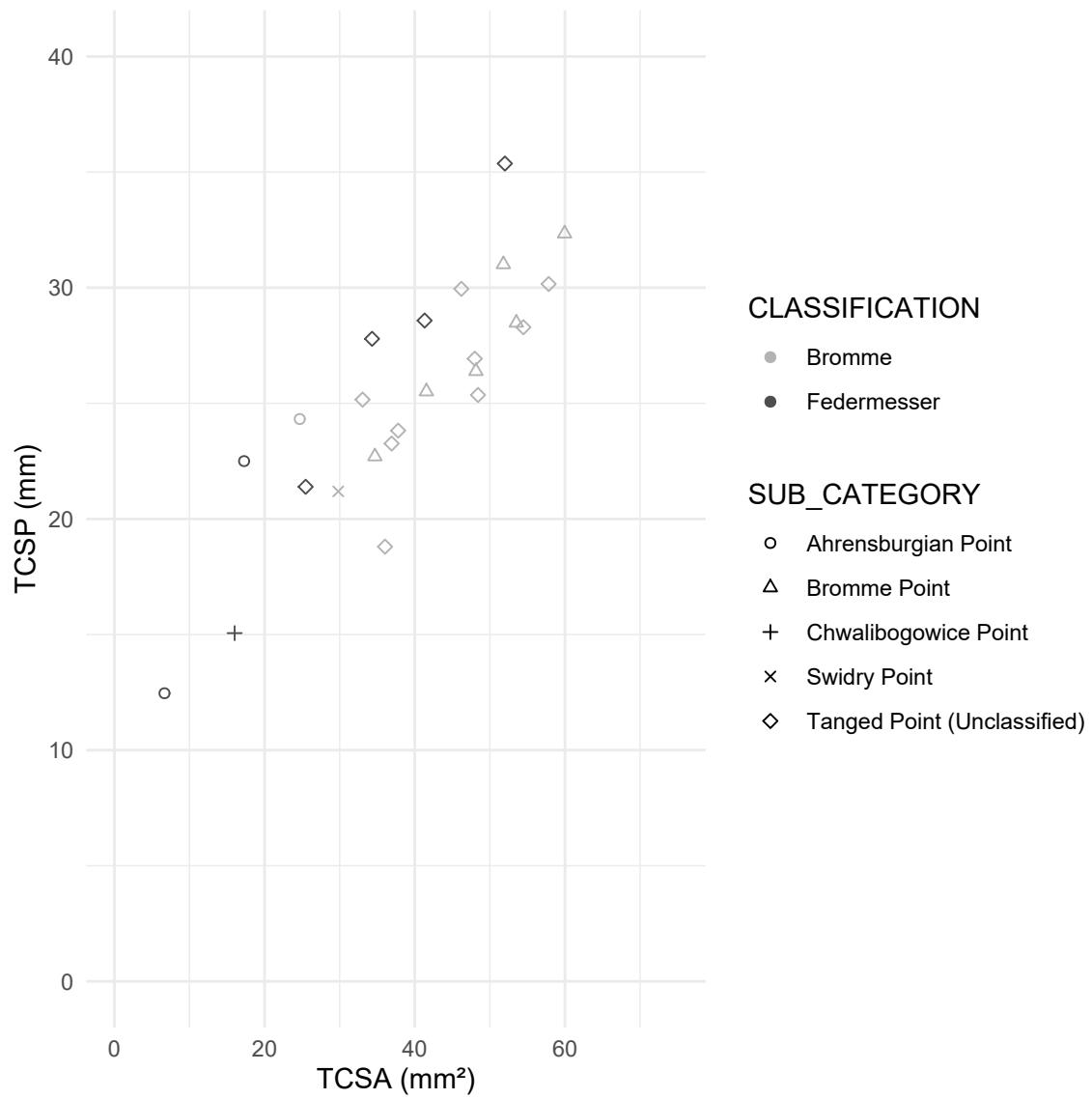


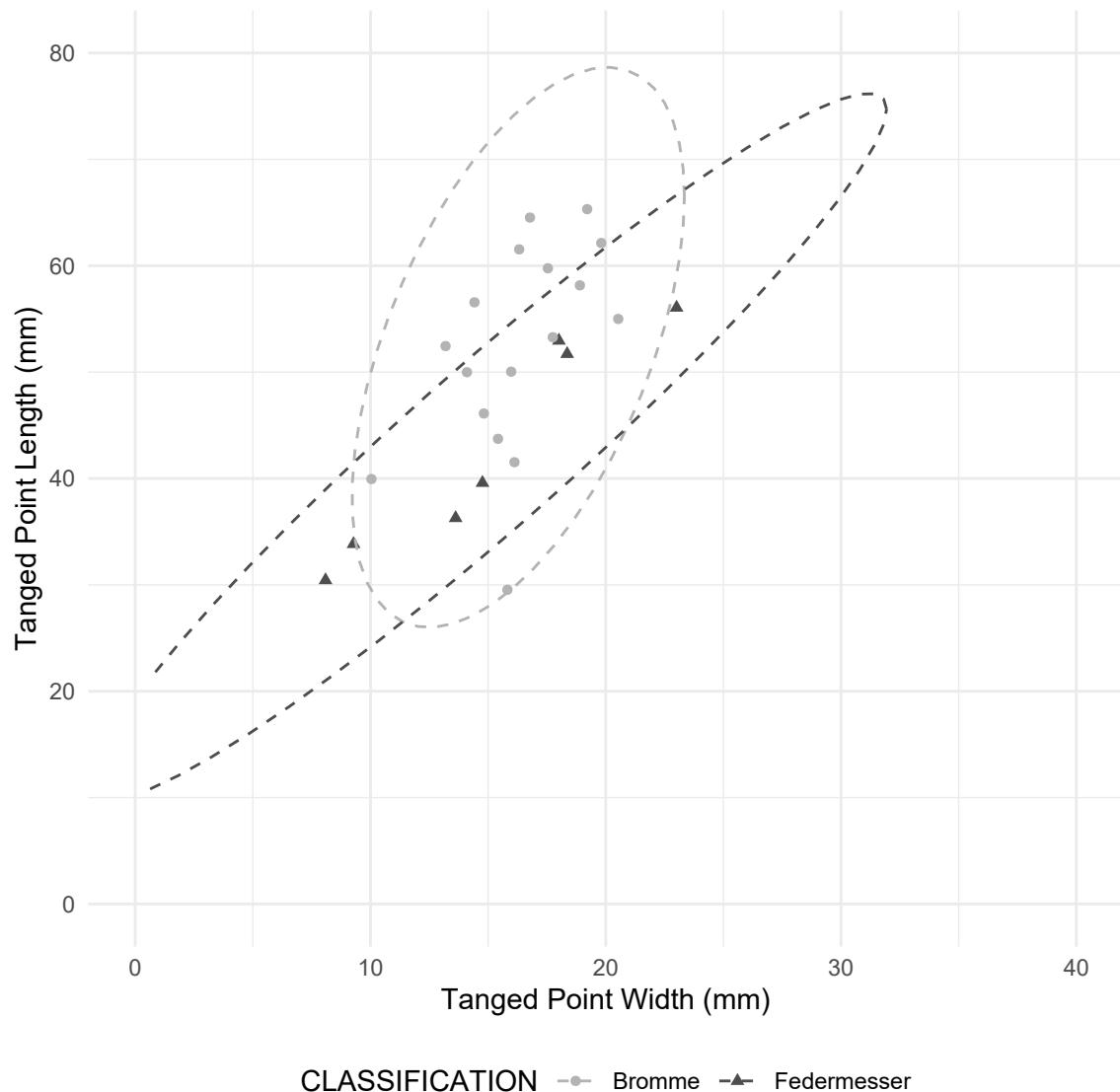
```
## Warning: Removed 15 row(s) containing missing values (geom_path).
```

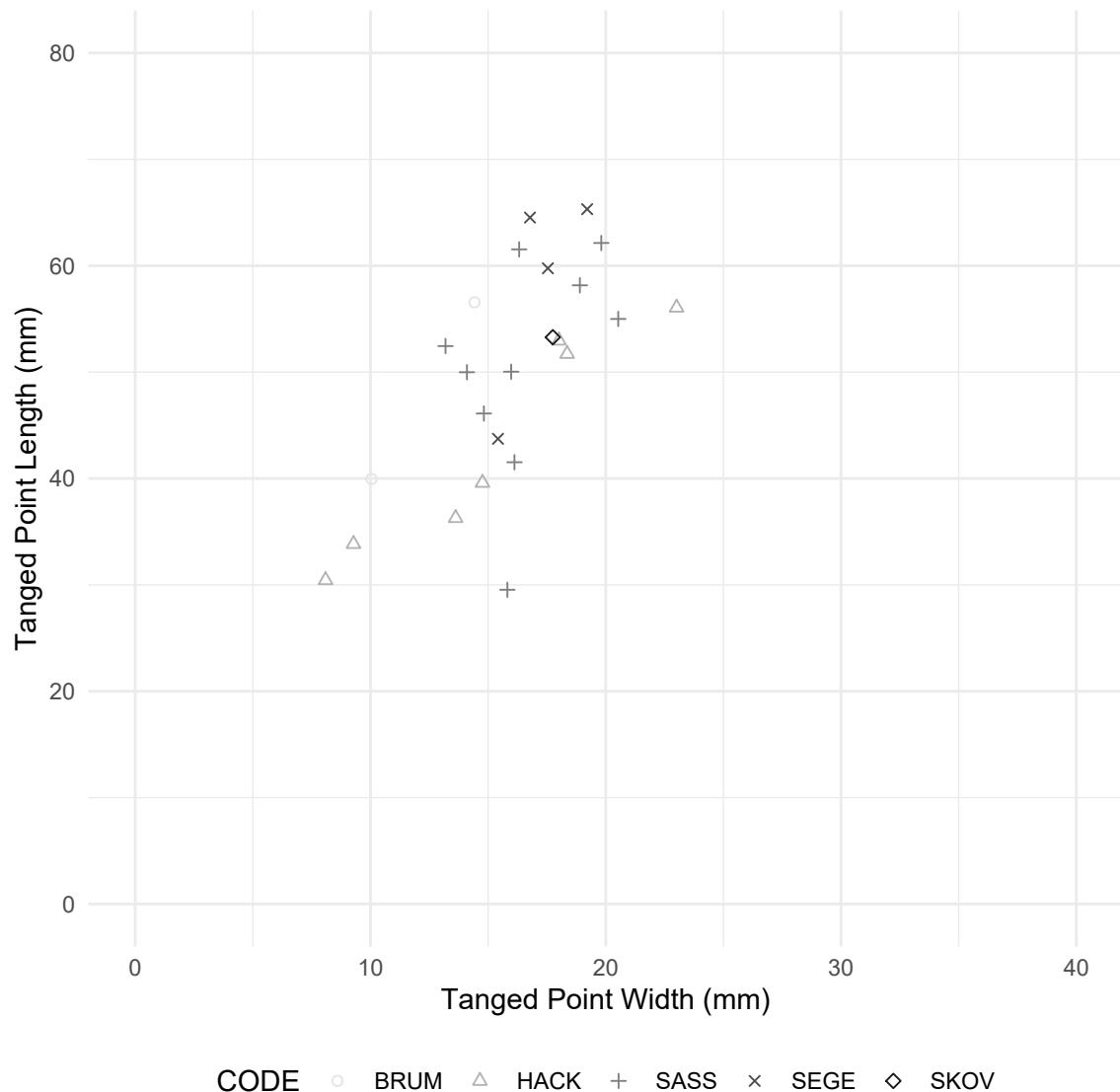


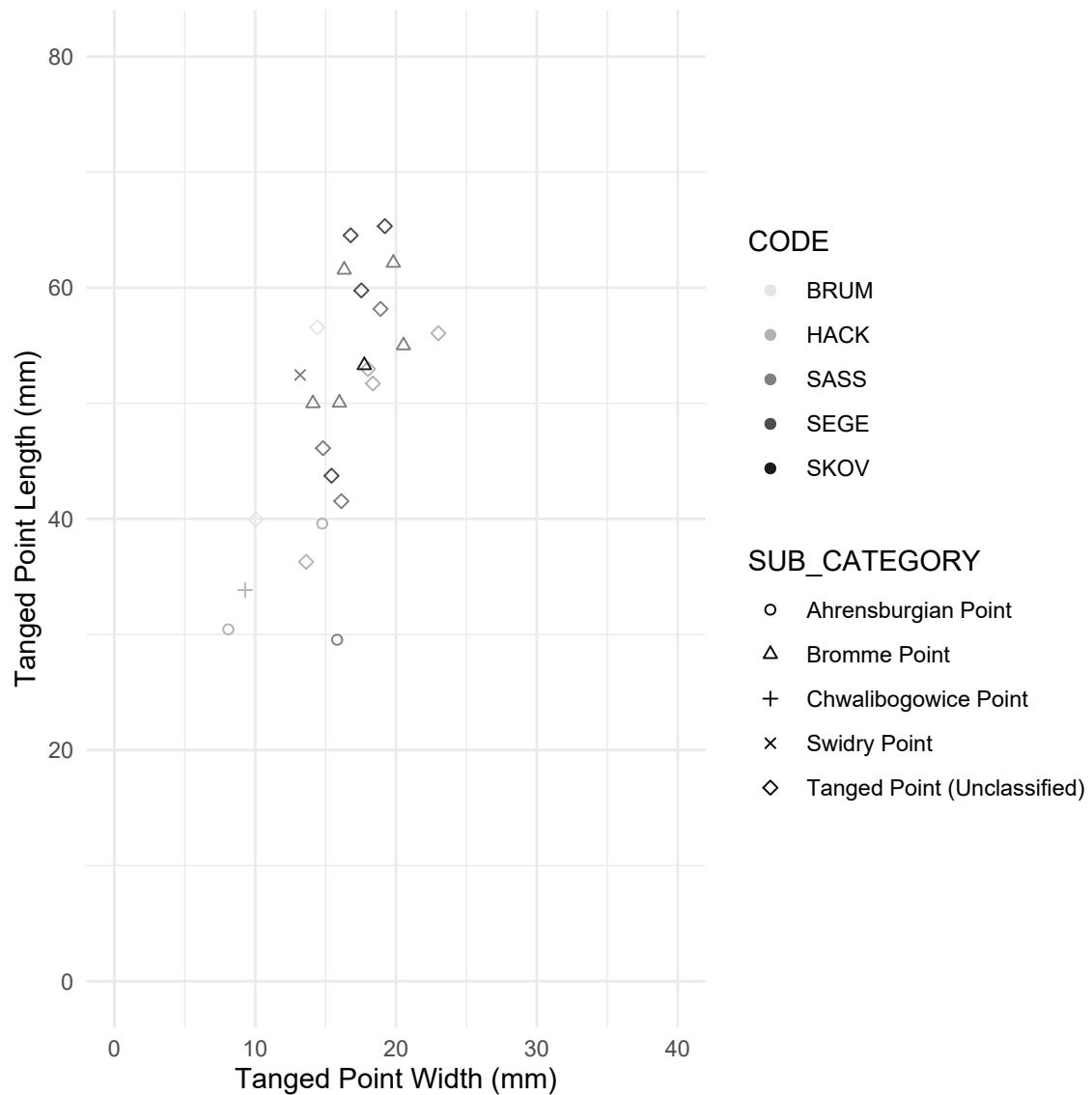


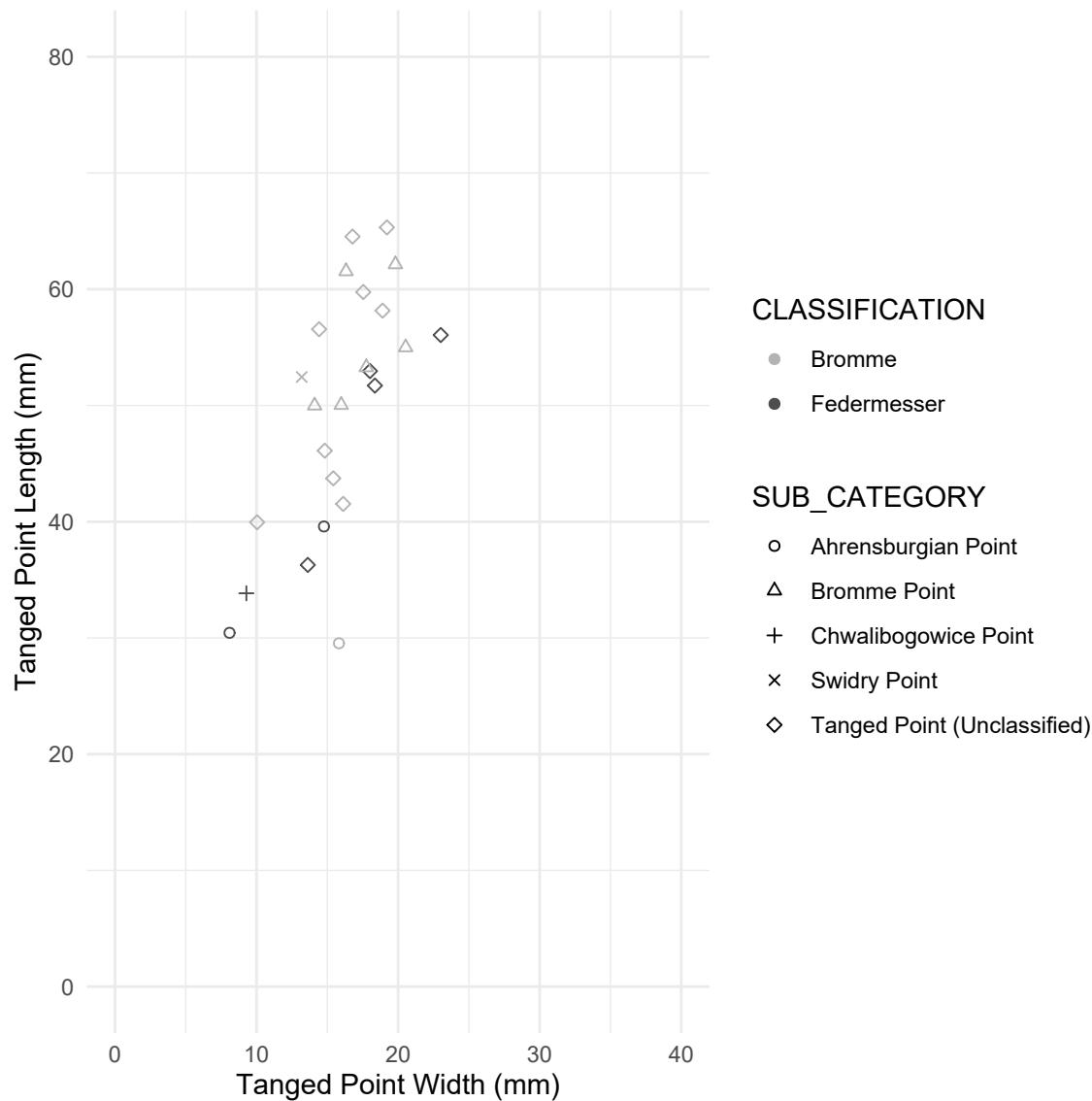












```
##
## Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data: tp_data_excb_clean$WEIGHT and tp_data_excb_clean$CODE
##
##      BRUM HACK SASS SEGE
## HACK 0.570 -   -   -
## SASS 1.000 0.054 -   -
## SEGE 1.000 1.000 0.562 -
## SKOV 1.000 1.000 1.000 1.000
##
## P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

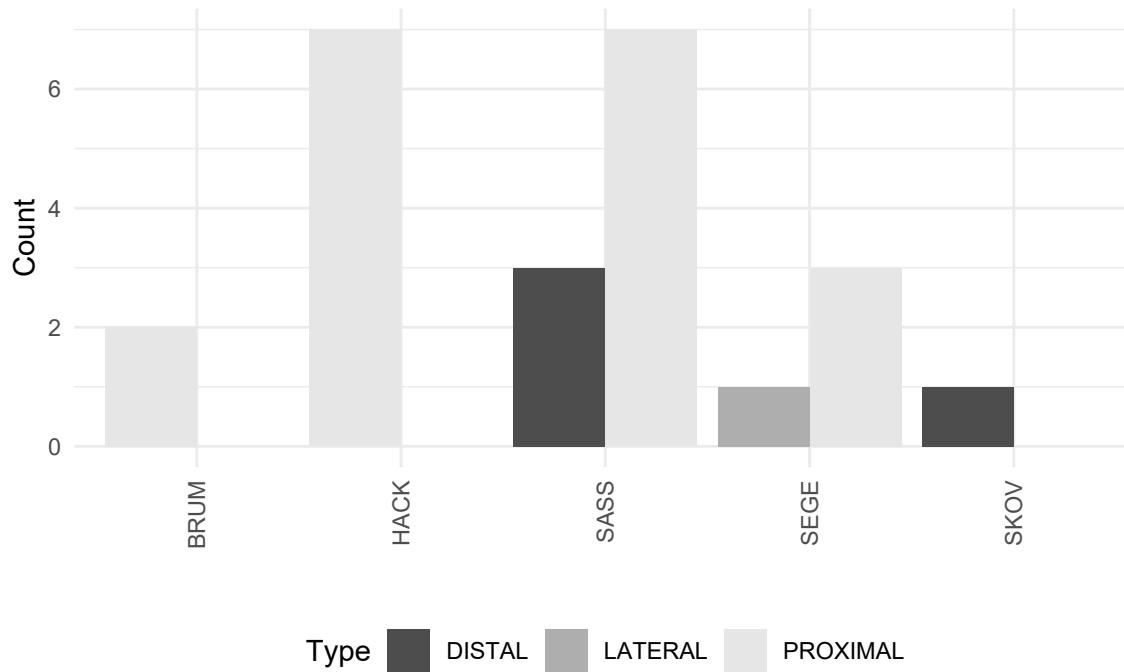
```

```

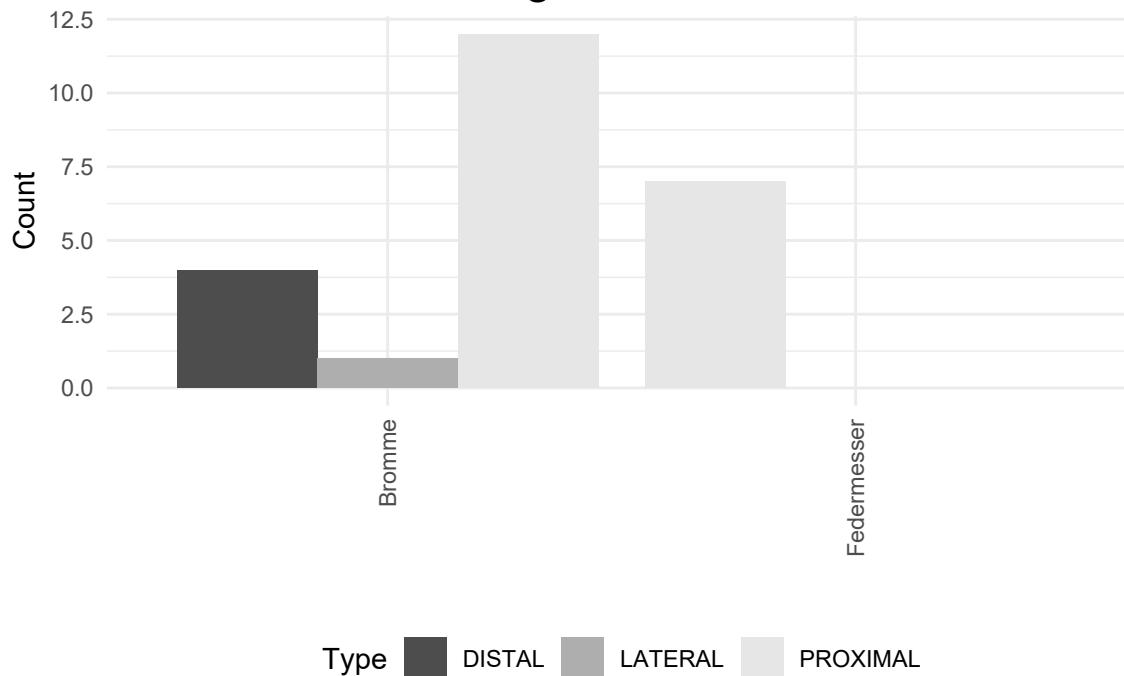
## Tanged Point (Unclassified) 0.11          1.00
##                               Chwalibogowice Point Swidry Point
## Bromme Point                 -             -
## Chwalibogowice Point        -             -
## Swidry Point                1.00           -
## Tanged Point (Unclassified) 1.00           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

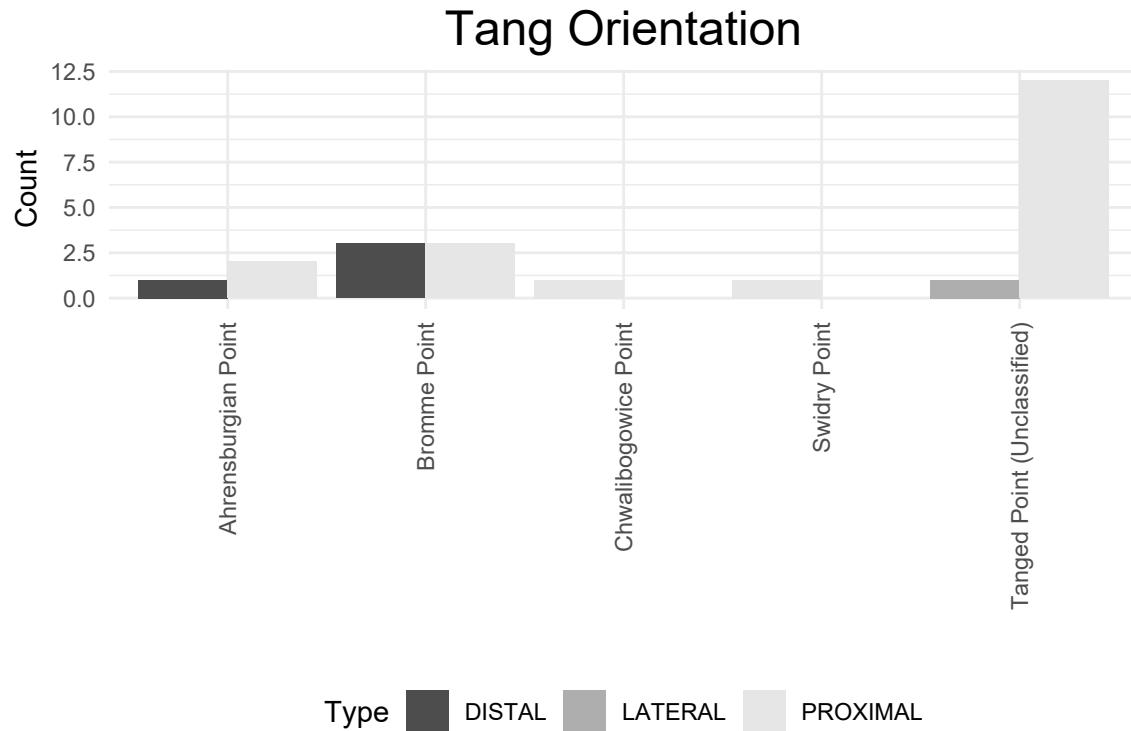
```

## Tang Orientation



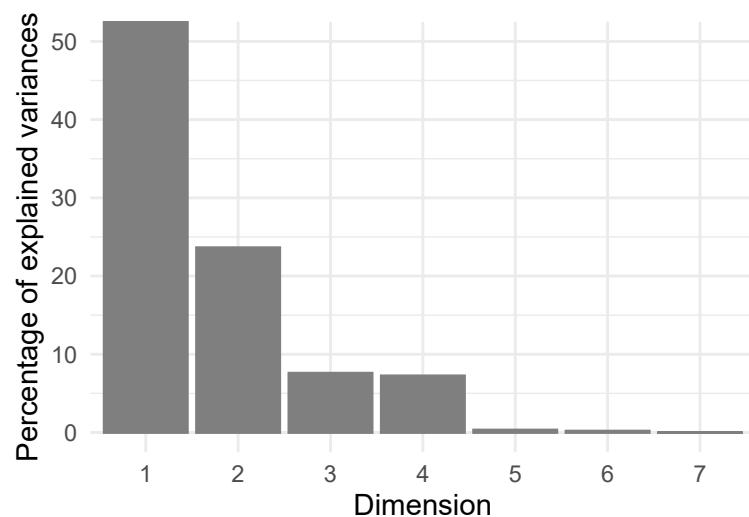
## Tang Orientation



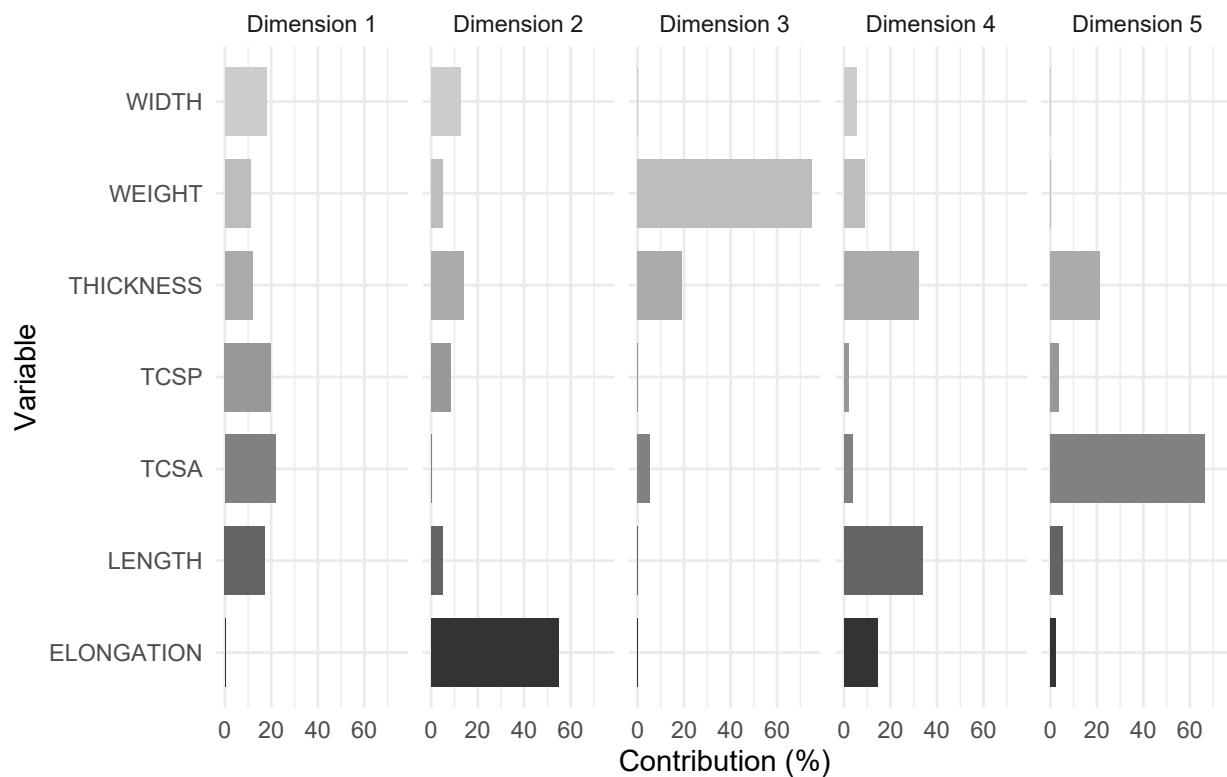


### Principal Component Analysis (PCA)

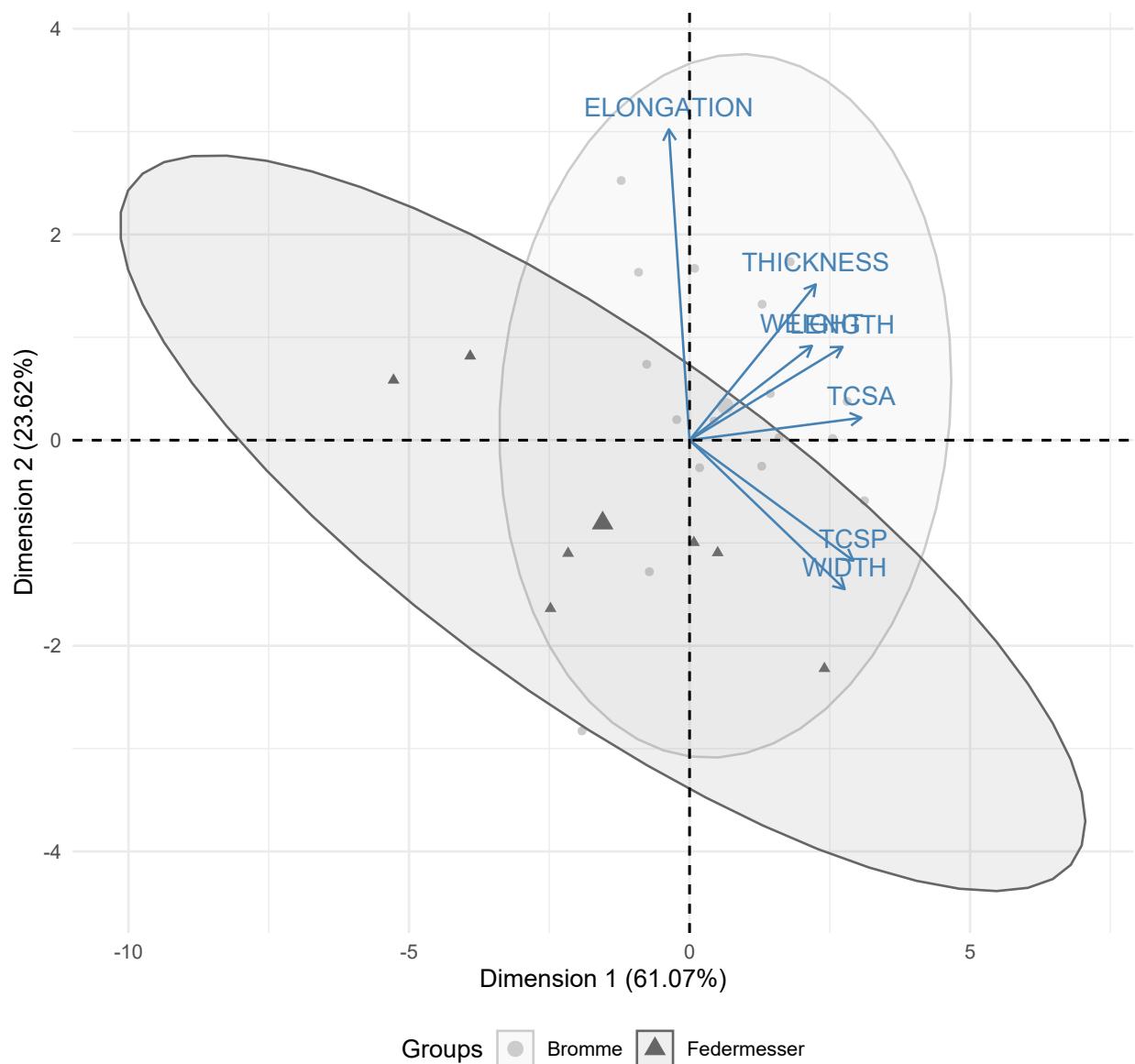
```
## # A tibble: 7 x 4
##   rowname eigenvalue variance cumulative
##   <chr>     <dbl>    <dbl>      <dbl>
## 1 Dim.1     4.28     61.1       61.1
## 2 Dim.2     1.65     23.6       84.7
## 3 Dim.3     0.530    7.58       92.3
## 4 Dim.4     0.507    7.24       99.5
## 5 Dim.5     0.0218   0.312 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



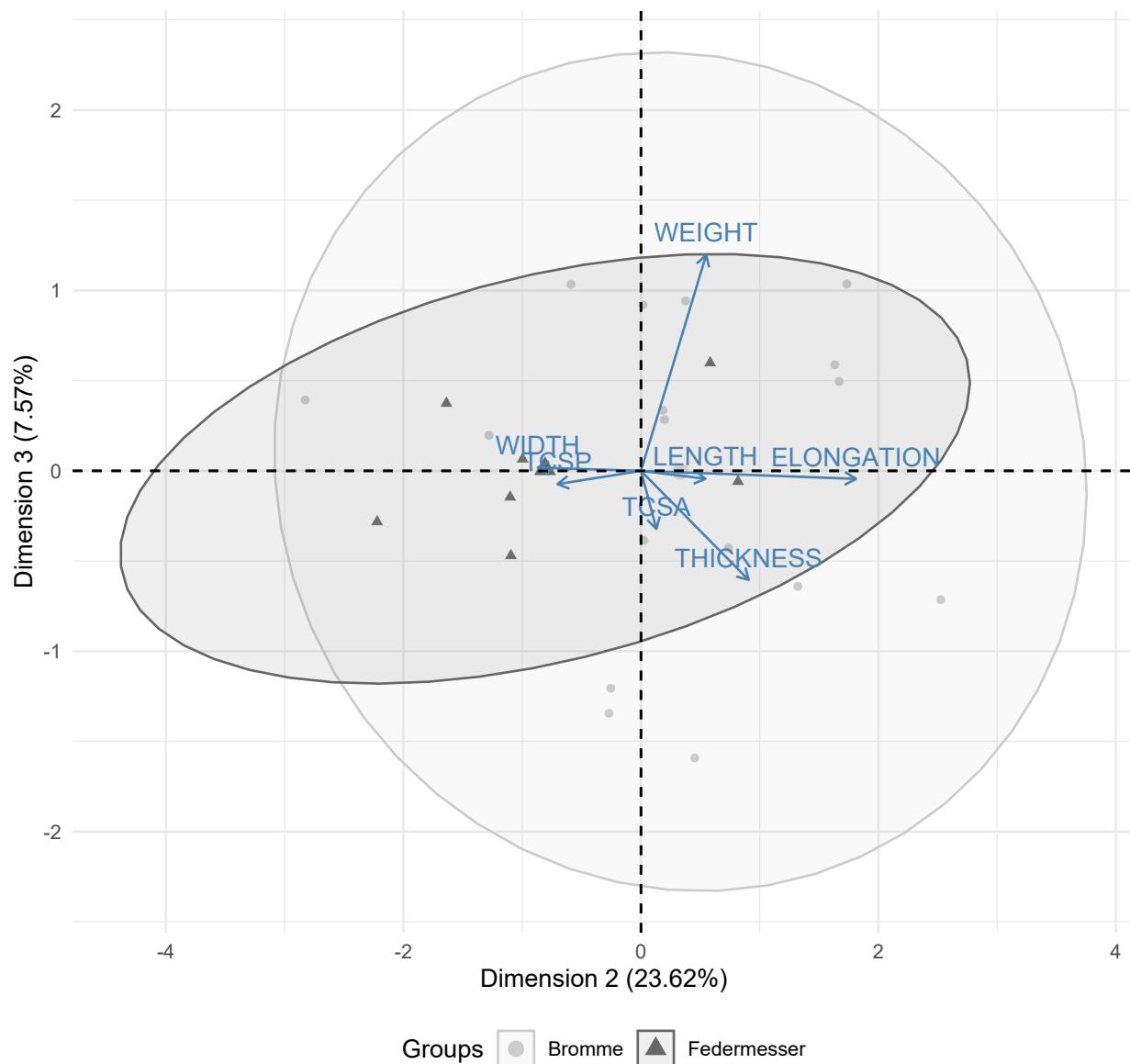
## Contribution of Variables



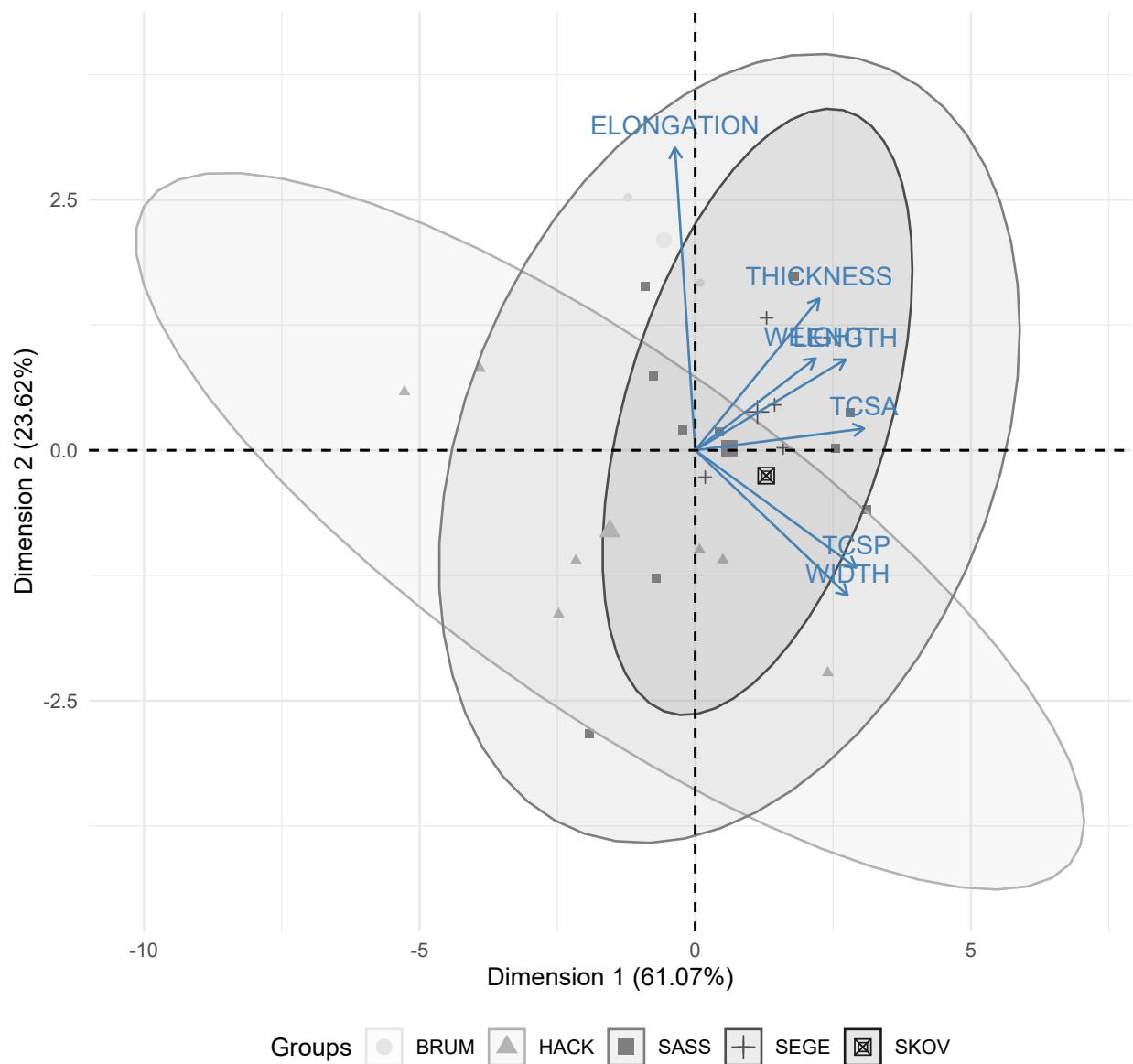
## PCA 1 vs. PCA 2 (Classification)



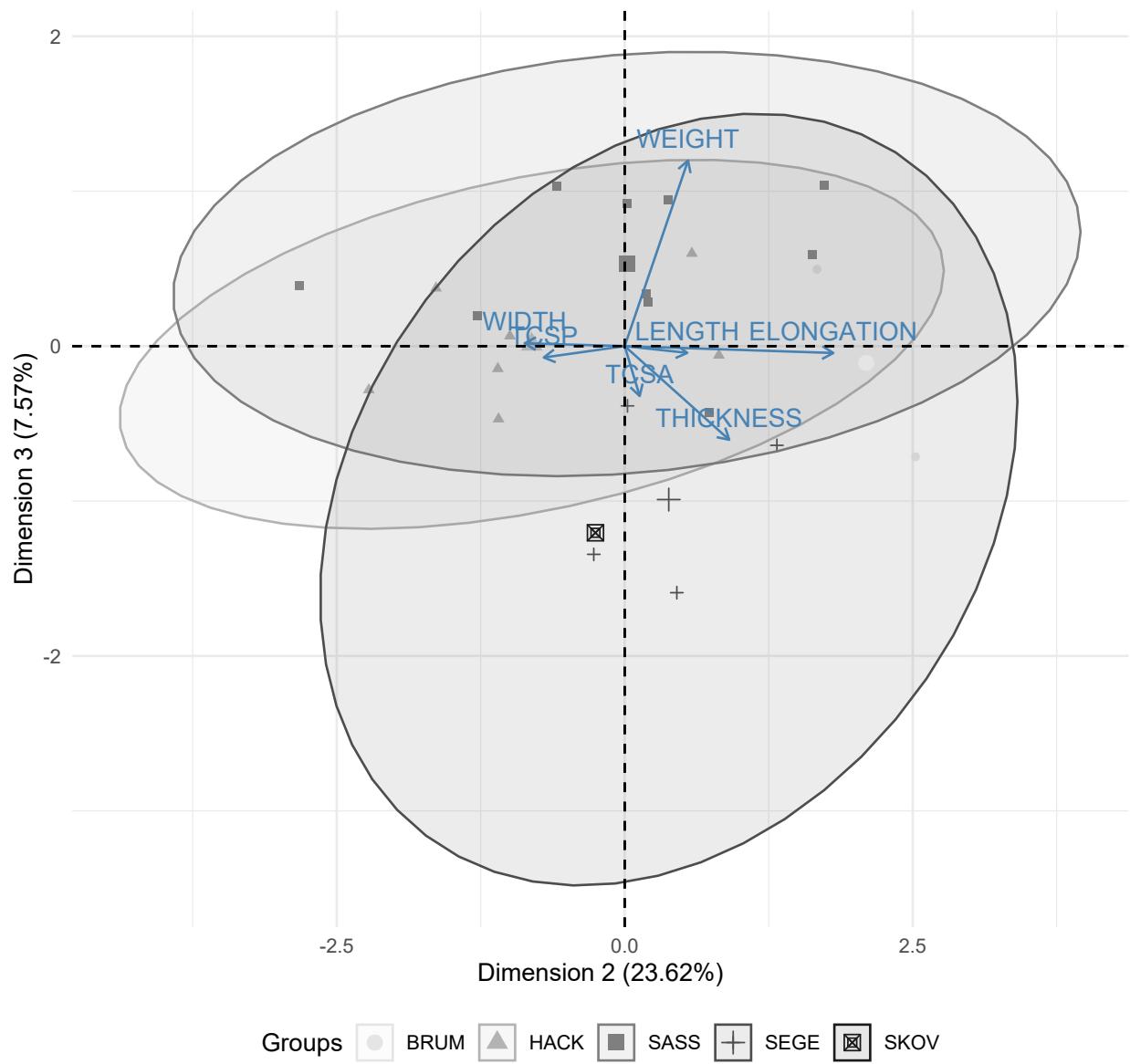
## PCA 2 vs. PCA 3 (Classification)



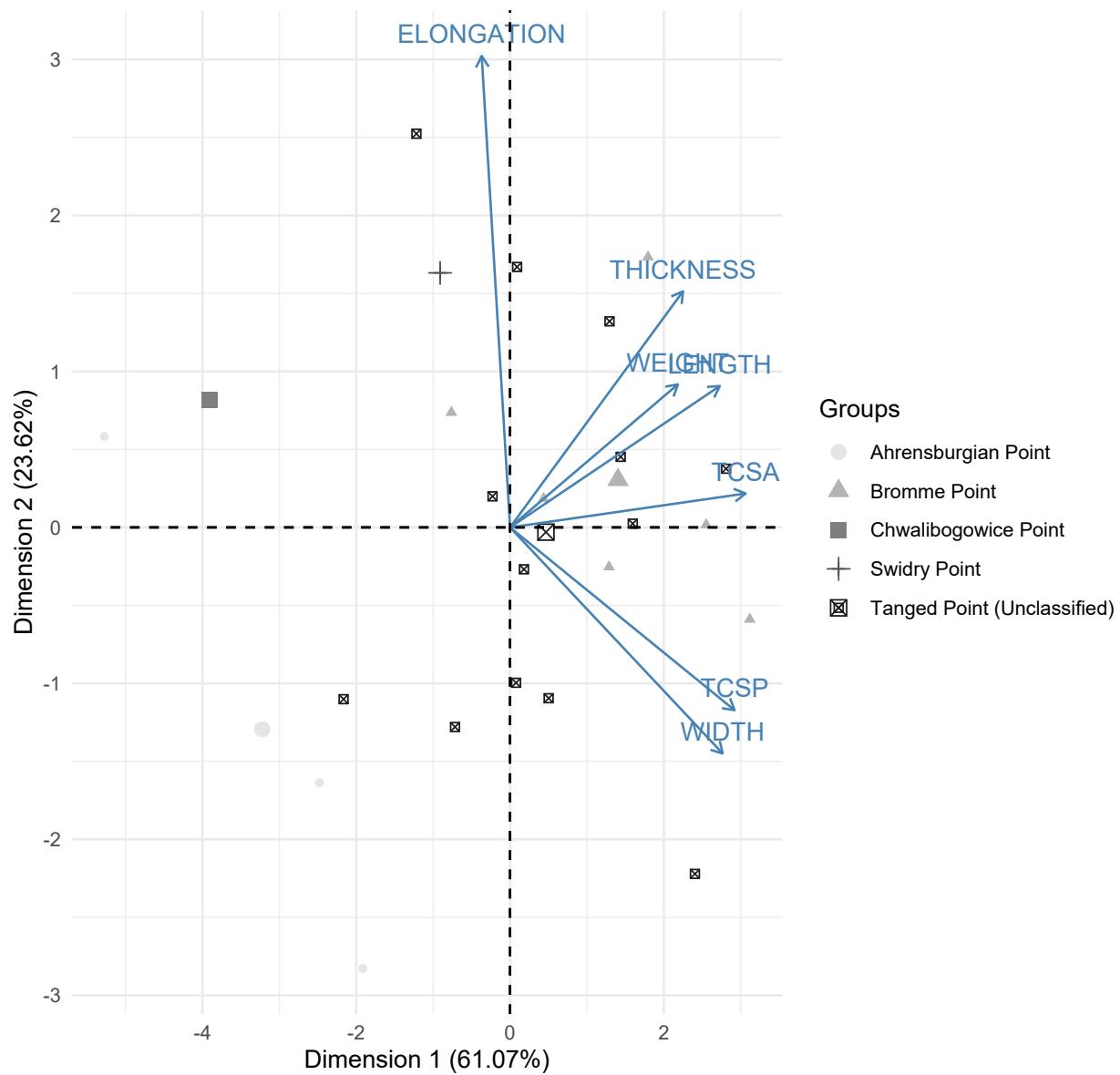
## PCA 1 vs. PCA 2 (Code)



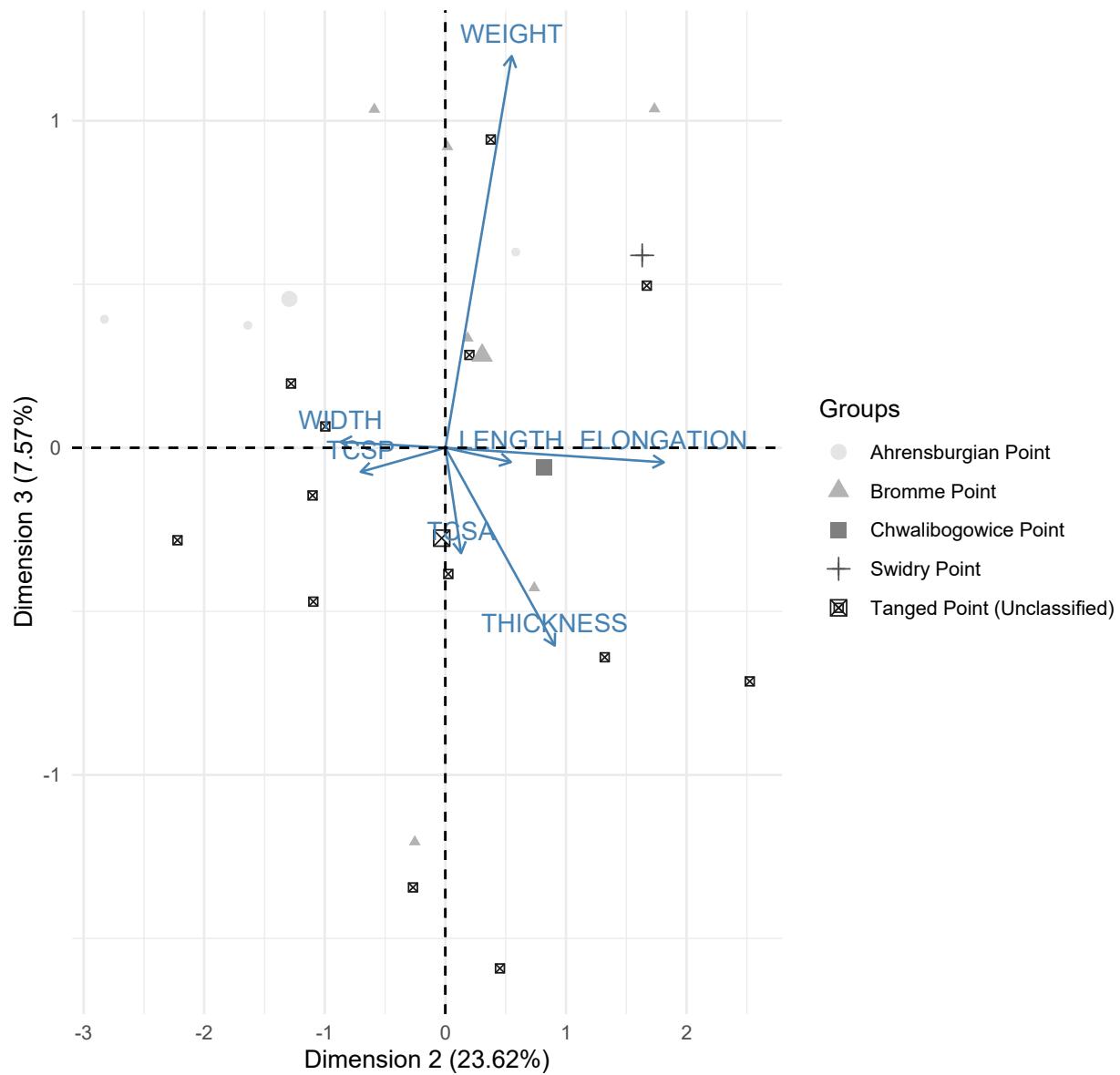
### PCA 2 vs. PCA 3 (Code)



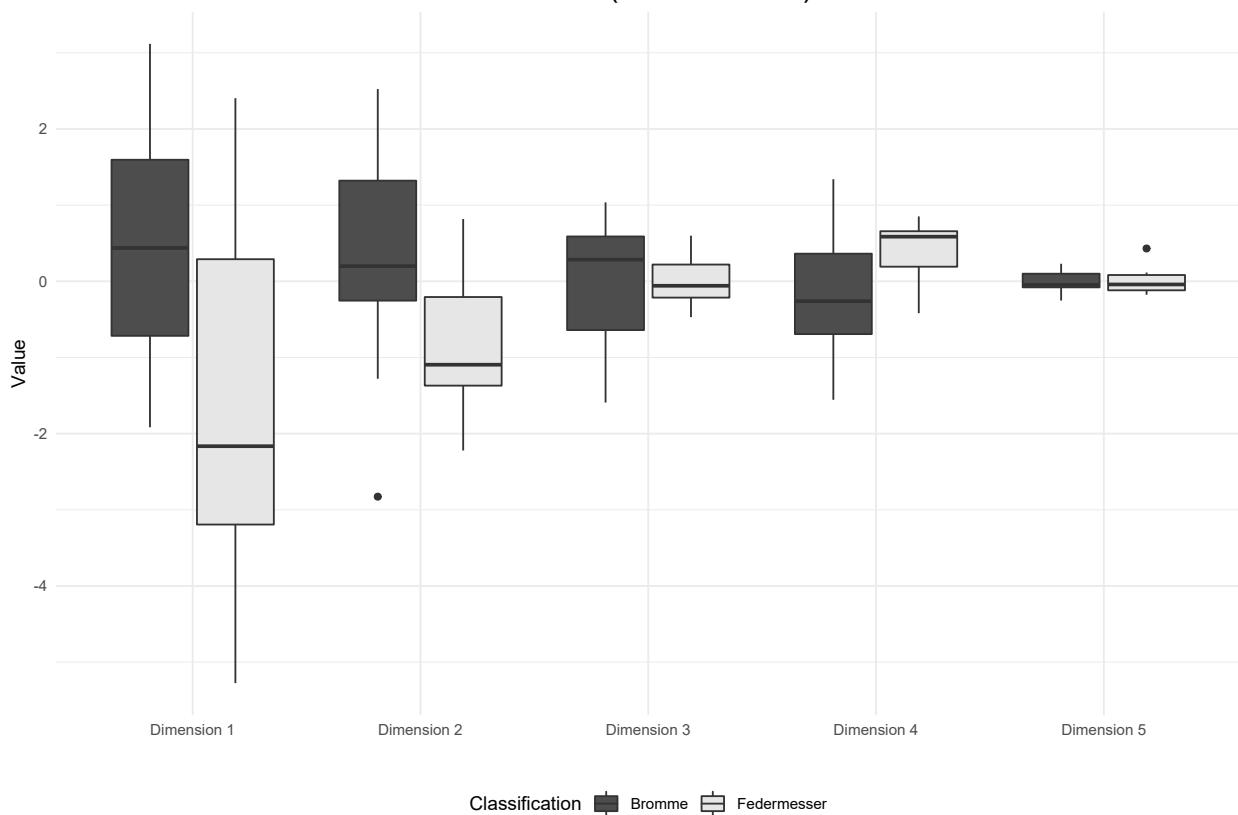
## PCA 1 vs. PCA 2 (Tanged Point Variant)



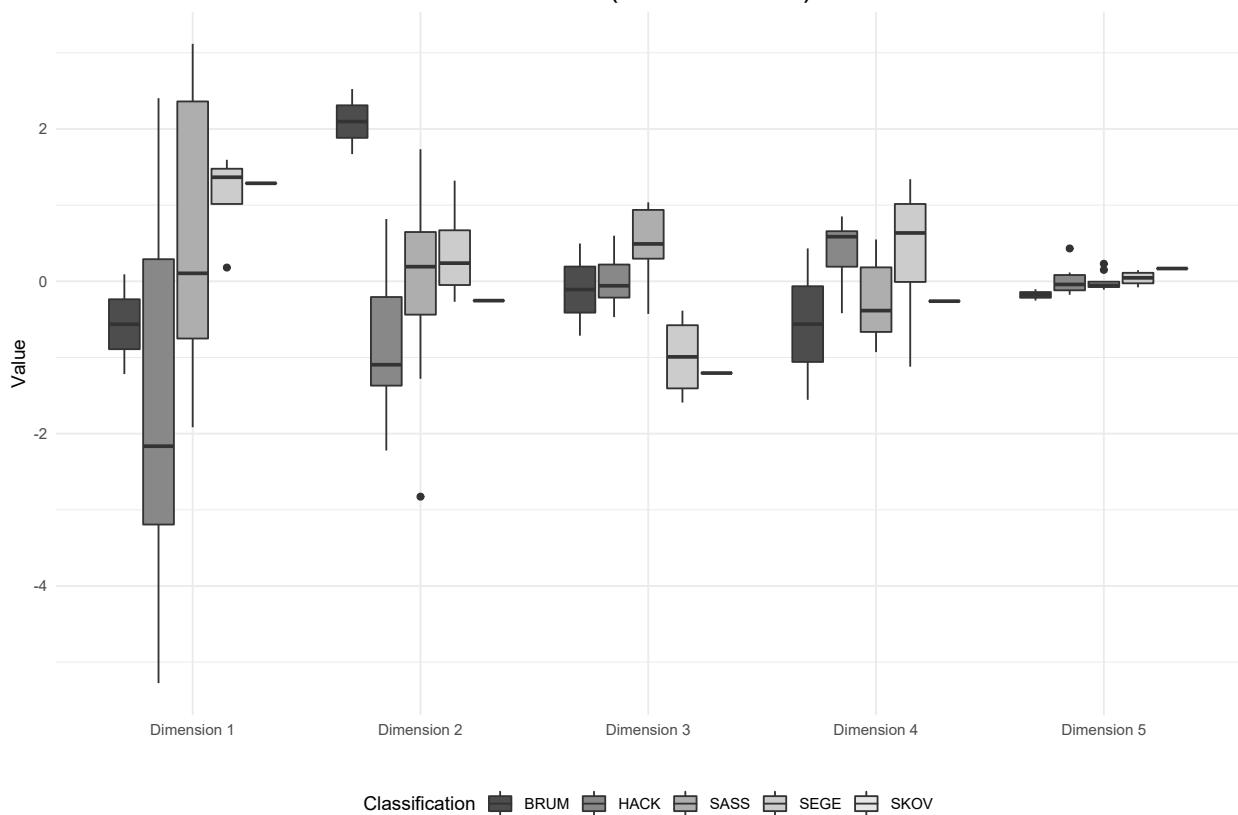
## PCA 2 vs. PCA 3 (Tanged Point Variant)

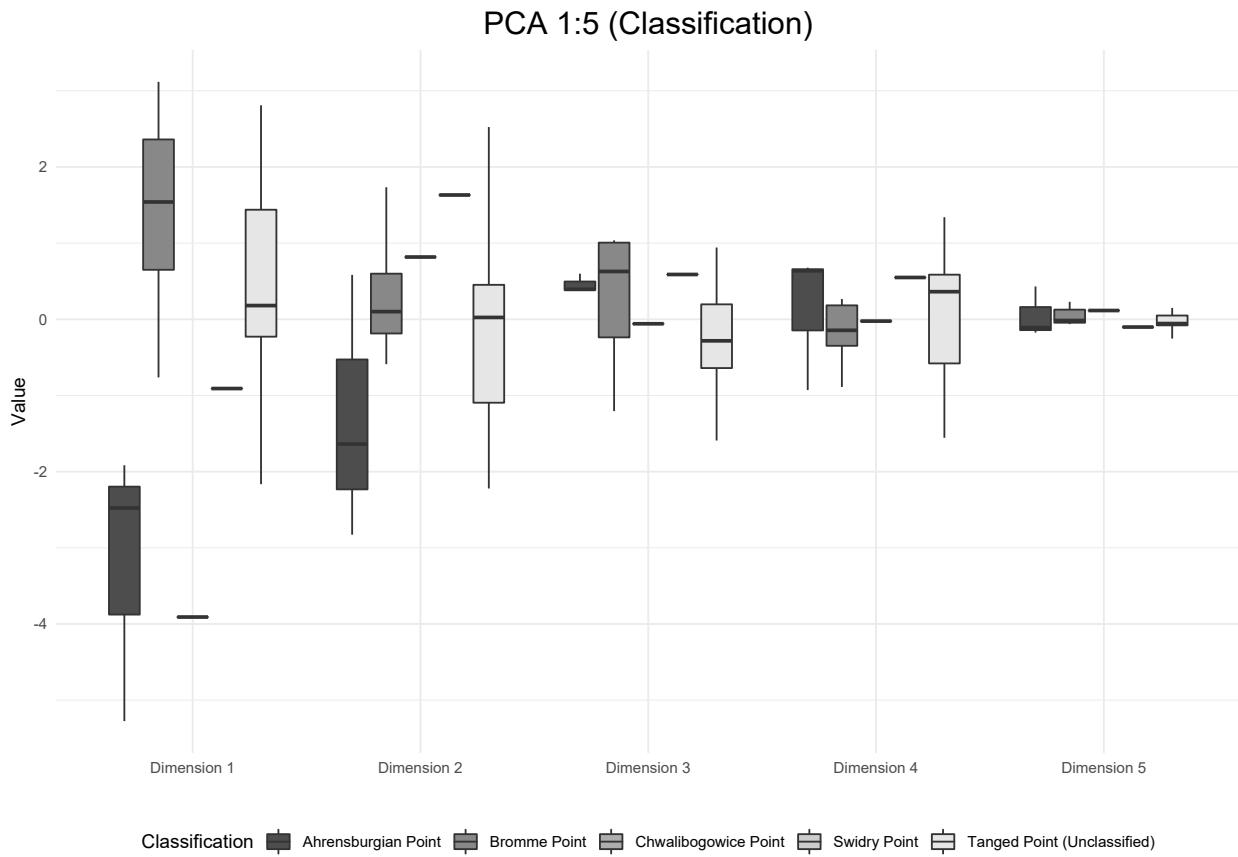


### PCA 1:5 (Classification)



### PCA 1:5 (Classification)





## 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)

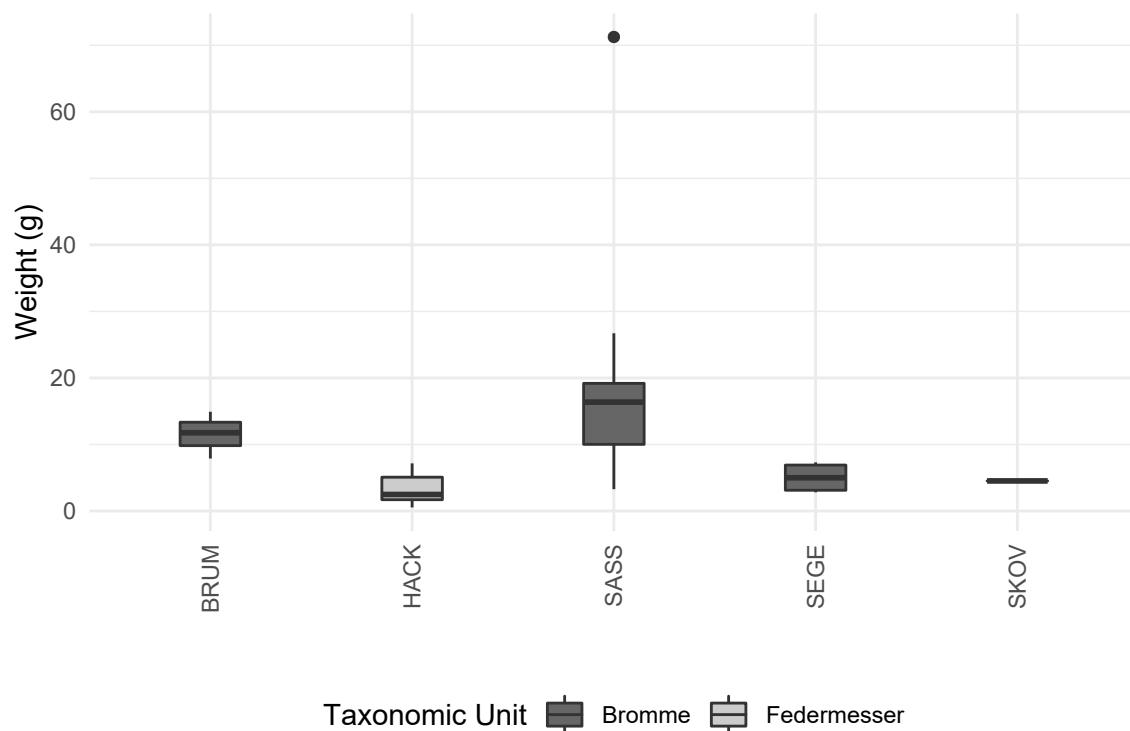
SUB_CATEGORY	n_obs	min	max	mean	med	sd	var
Ahrensburgian Point	3	1.65	3.12	2.37	2.34	0.74	0.54
Bromme Point	12	3.21	6.03	5.17	5.16	0.74	0.54
Chwalibogowice Point	1	3.45	3.45	3.45	3.45	NA	NA
Swidry Point	1	4.52	4.52	4.52	4.52	NA	NA
Tanged Point (Unclassified)	20	3.74	8.96	5.49	5.12	1.46	2.14

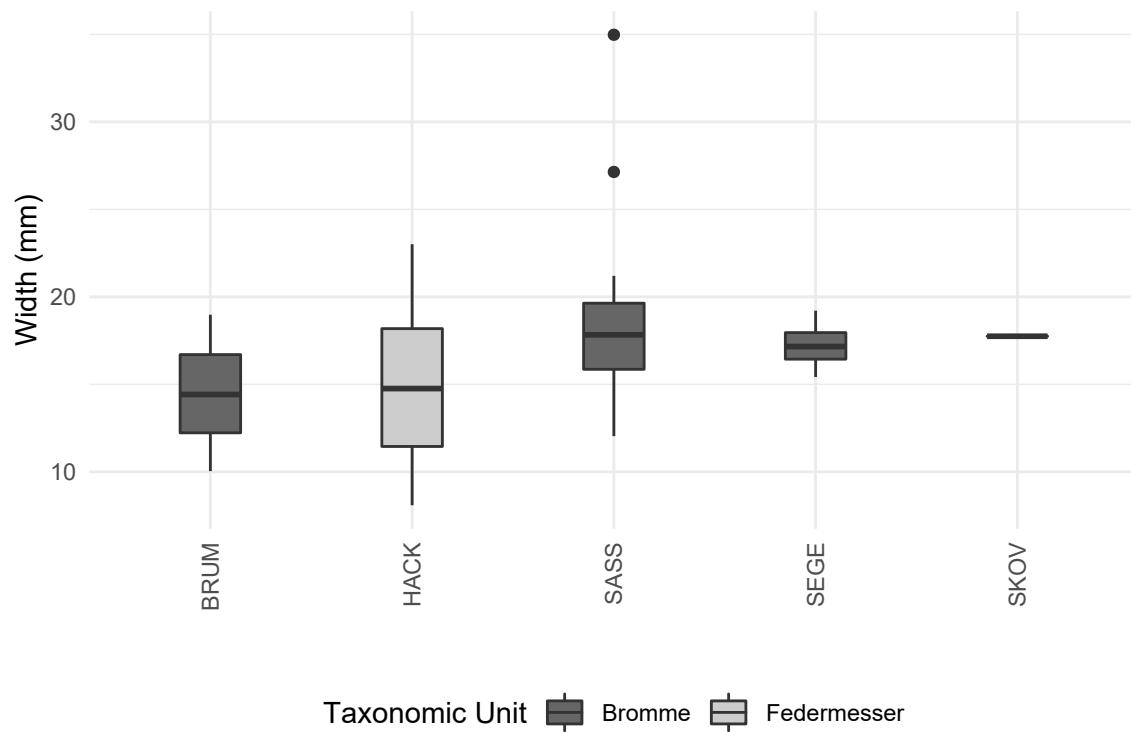
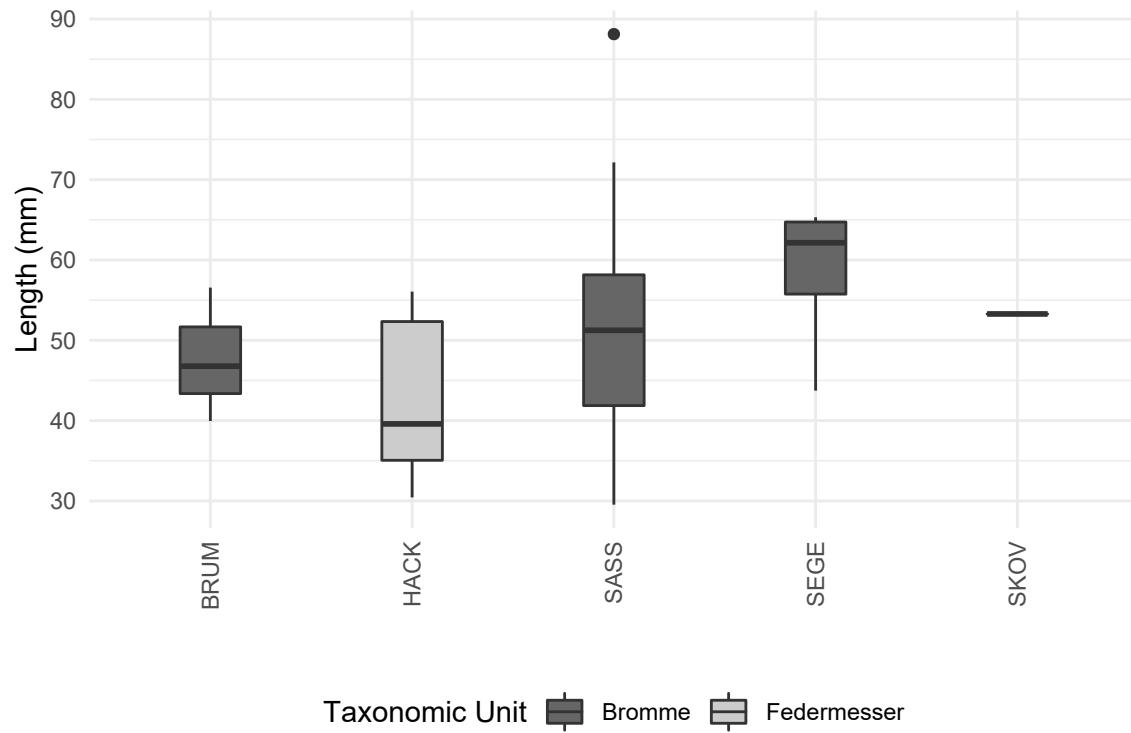
Table 105. Descriptive Statistics: Tip Cross-Sectional Area (TCSA)

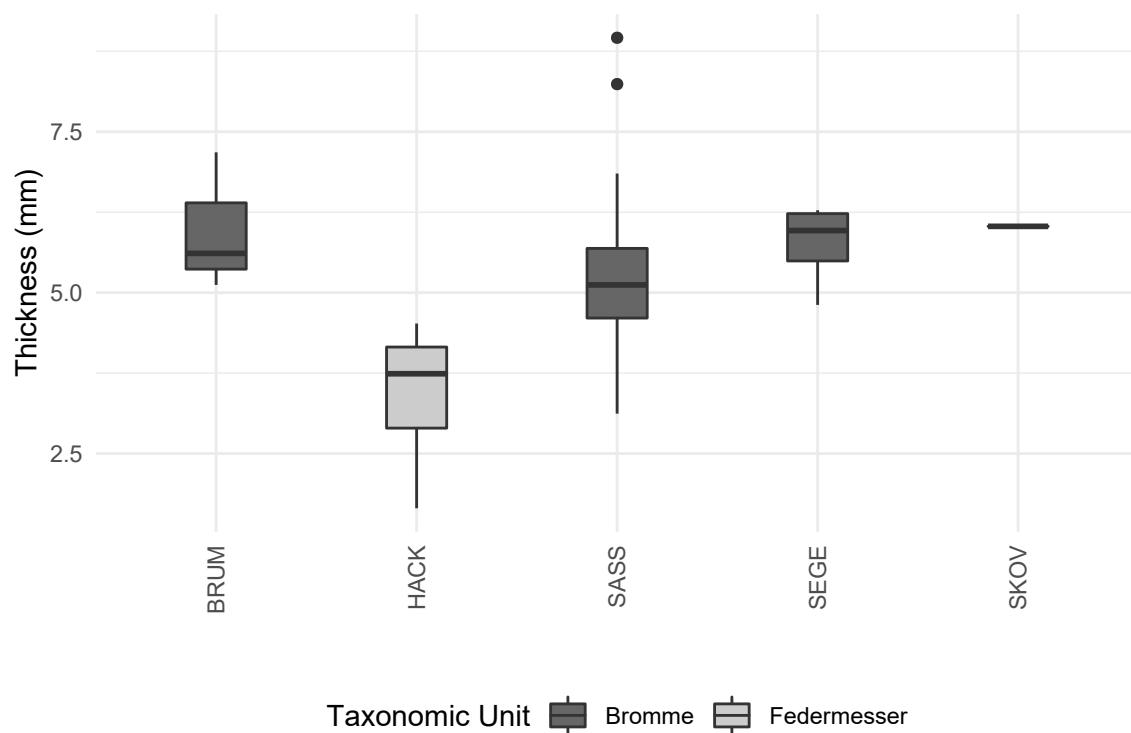
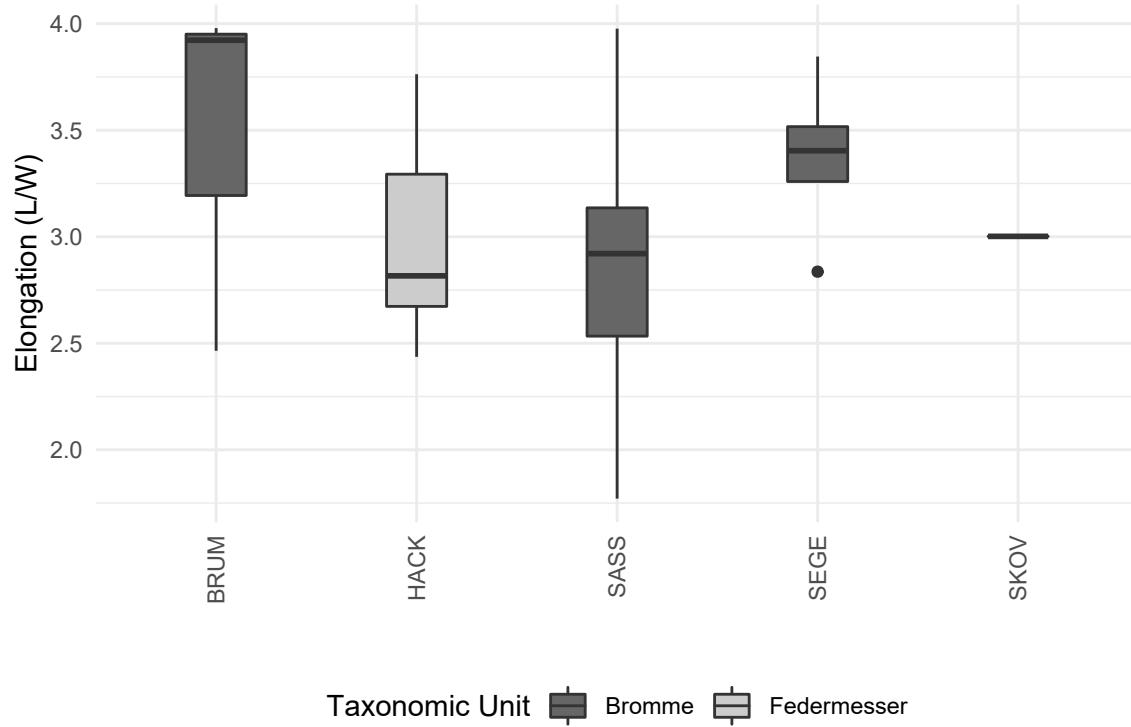
SUB_CATEGORY	n_obs	min	max	mean	med	sd	var
Ahrensburgian Point	3	6.67	24.68	16.21	17.27	9.05	81.94
Bromme Point	12	34.03	65.95	48.44	48.50	9.48	89.80
Chwalibogowice Point	1	16.01	16.01	16.01	16.01	NA	NA
Swidry Point	1	29.81	29.81	29.81	29.81	NA	NA
Tanged Point (Unclassified)	20	24.99	144.12	49.48	45.55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

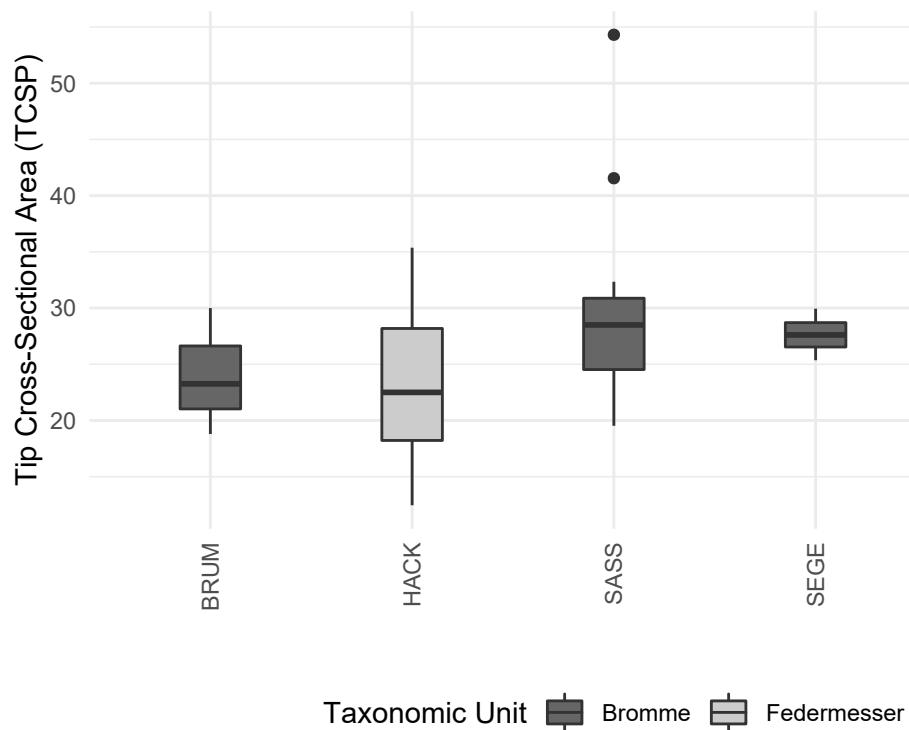
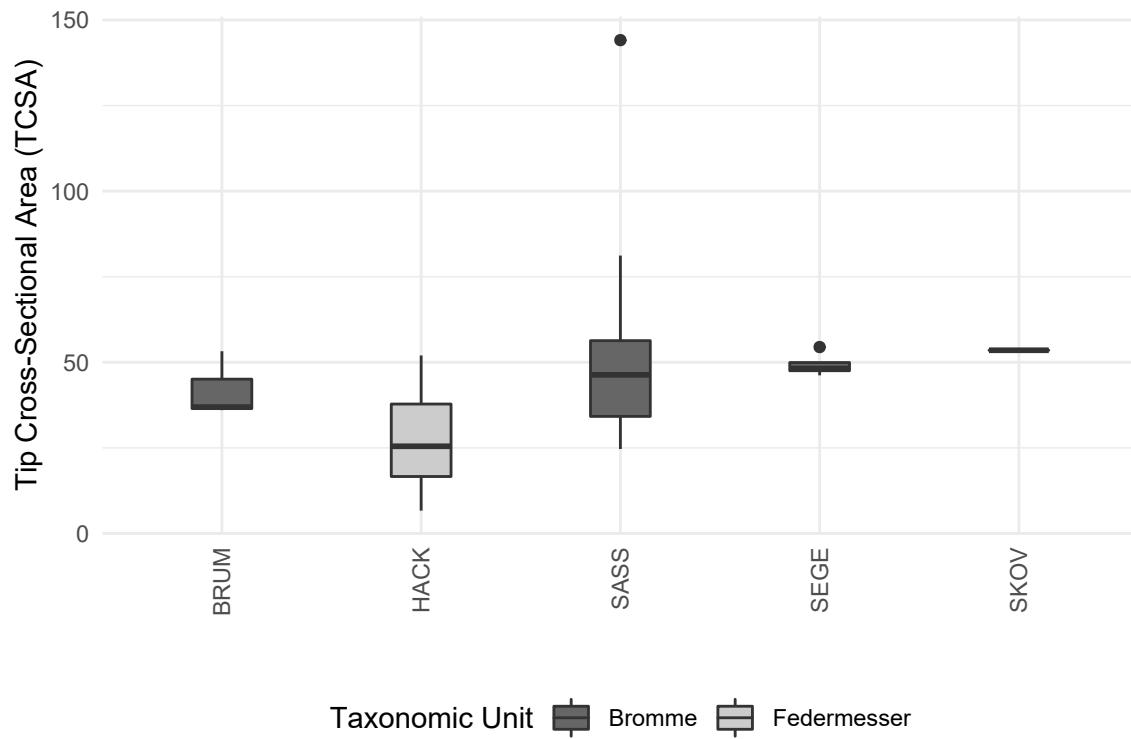
Table 106. Descriptive Statistics: Tip Cross-Sectional Perimeter (TCSP)

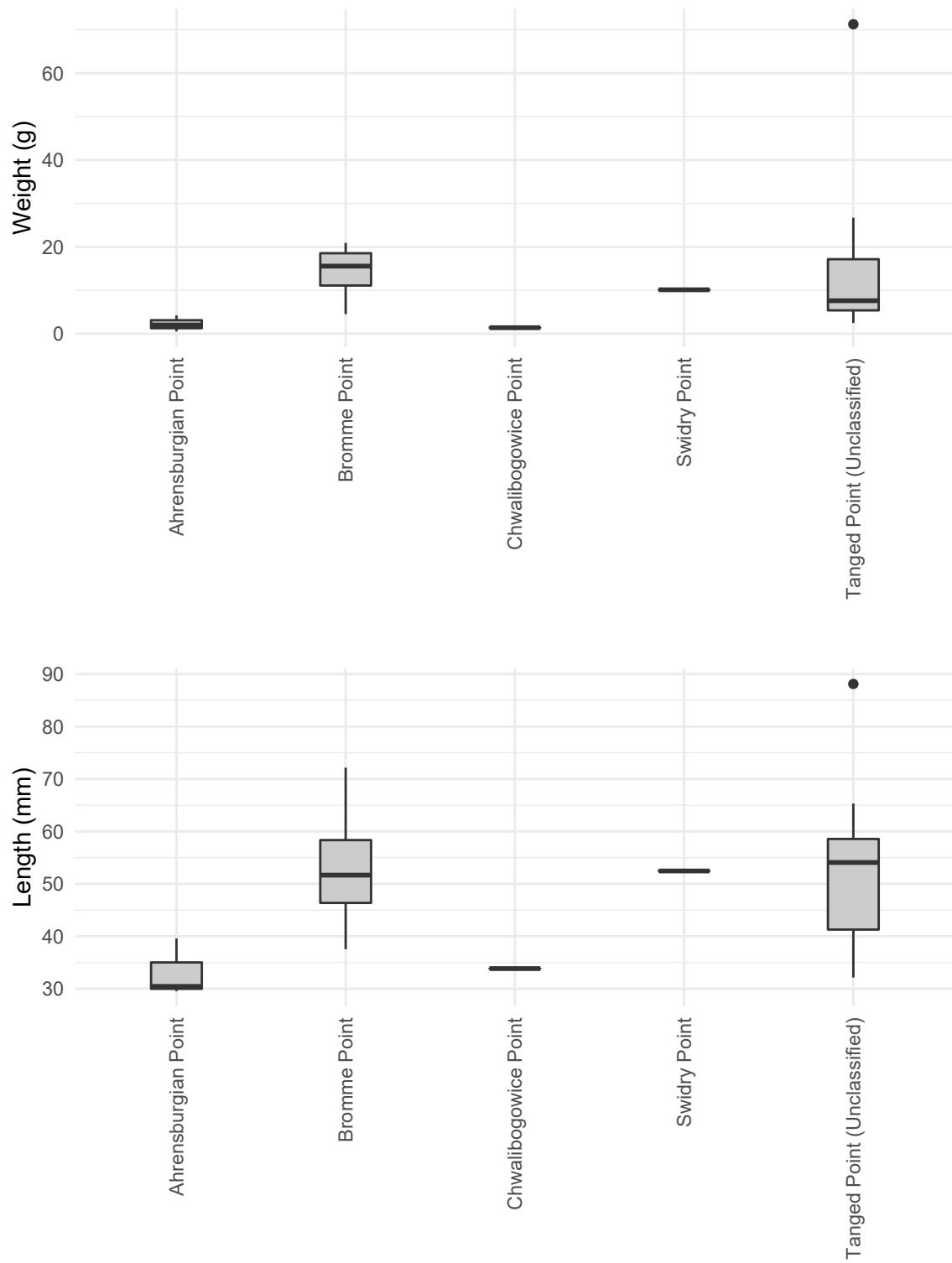
SUB_CATEGORY	n_obs	min	max	mean	med	sd	var
Ahrensburgian Point	3	12.46	24.32	19.76	22.50	6.39	40.80
Bromme Point	12	22.70	41.55	29.67	29.65	4.76	22.68
Chwalibogowice Point	1	15.06	15.06	15.06	15.06	NA	NA
Swidry Point	1	21.19	21.19	21.19	21.19	NA	NA
Tanged Point (Unclassified)	20	18.80	54.31	27.99	27.74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

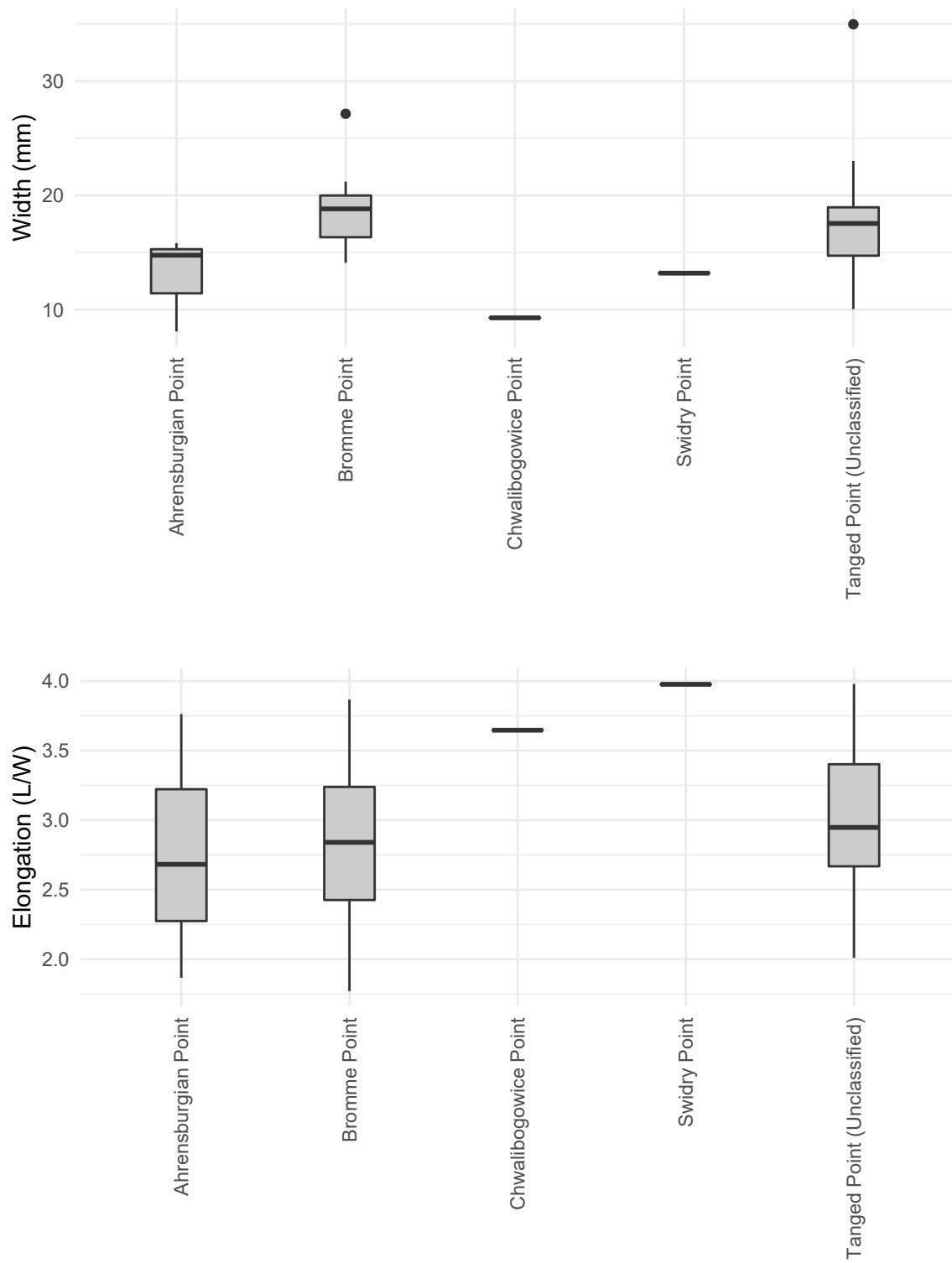


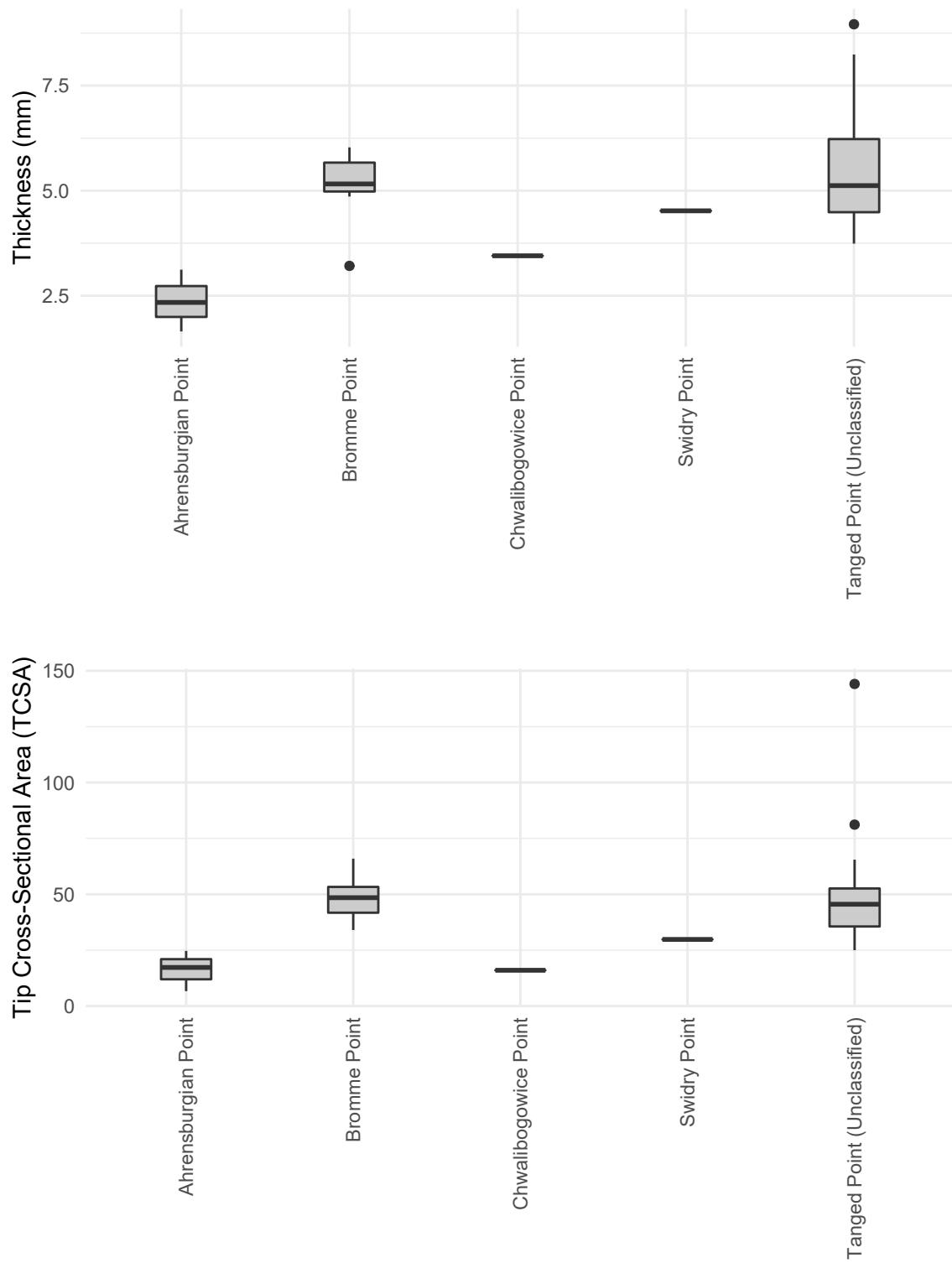


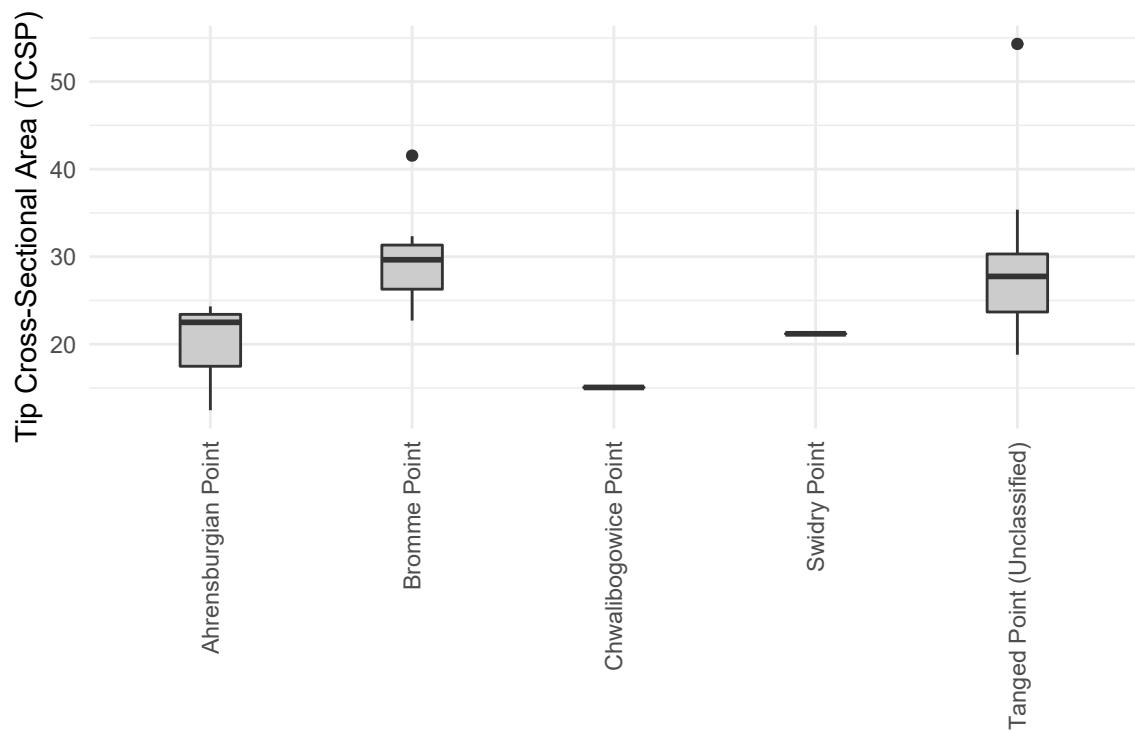


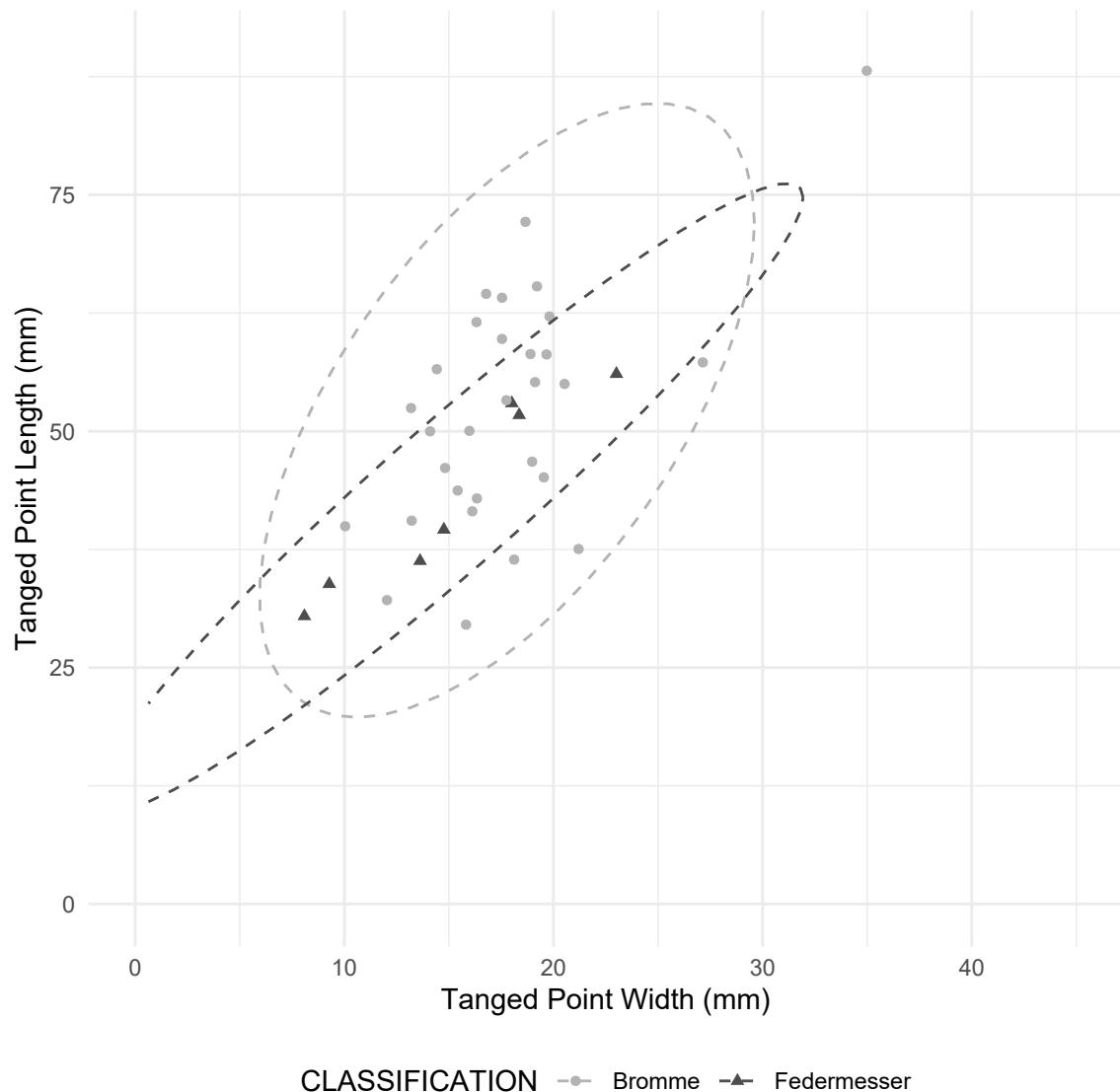


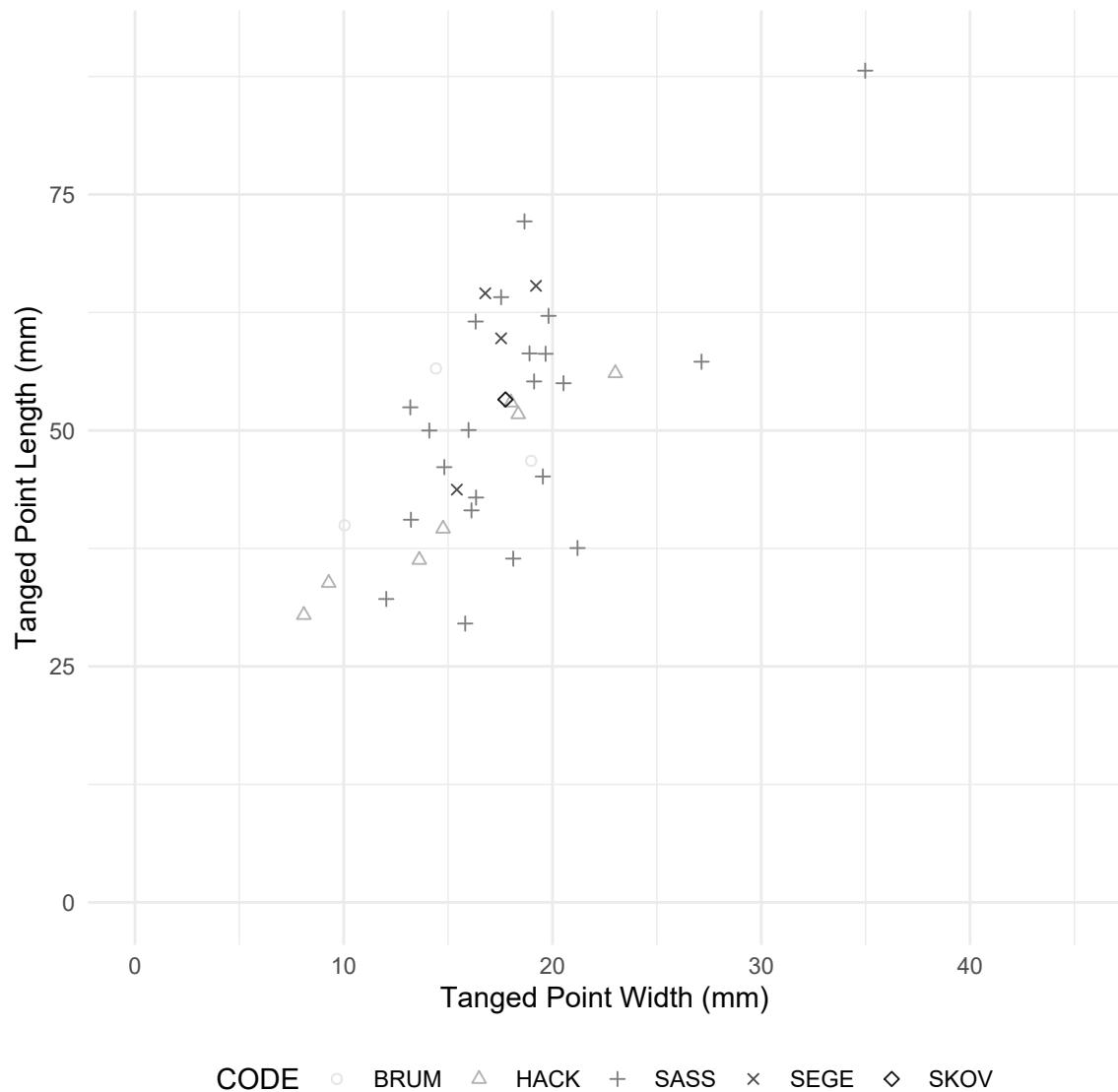


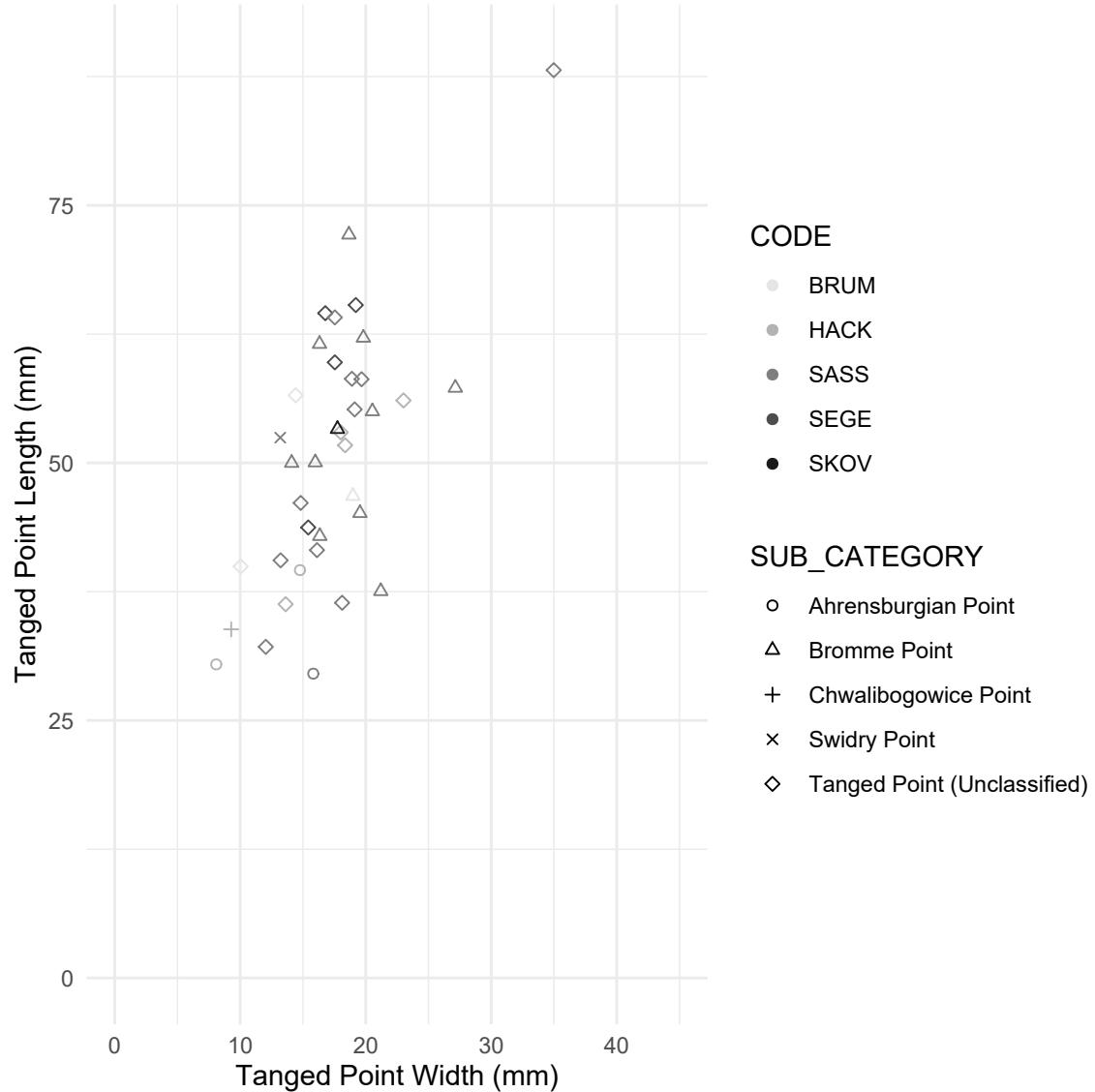


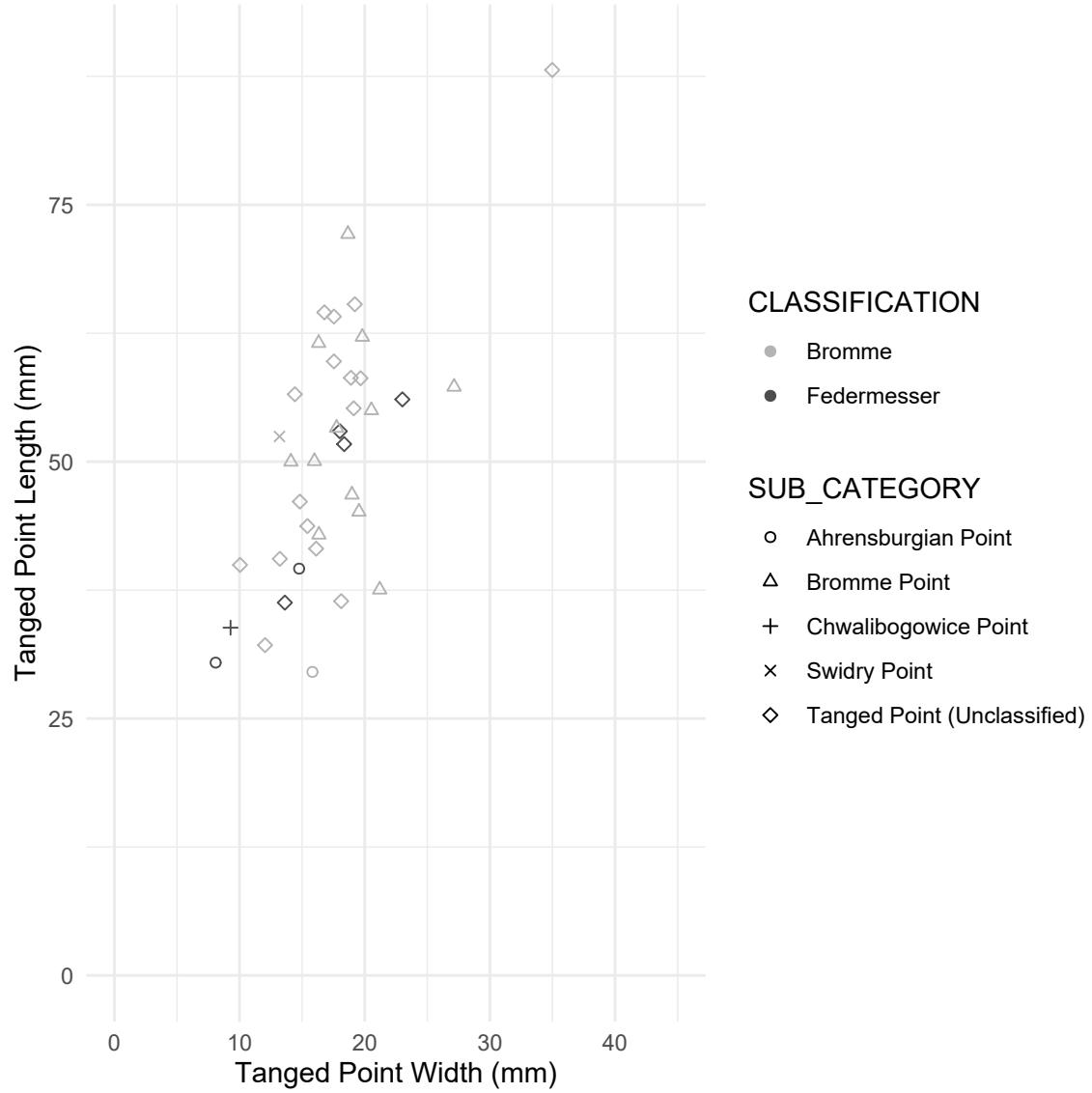


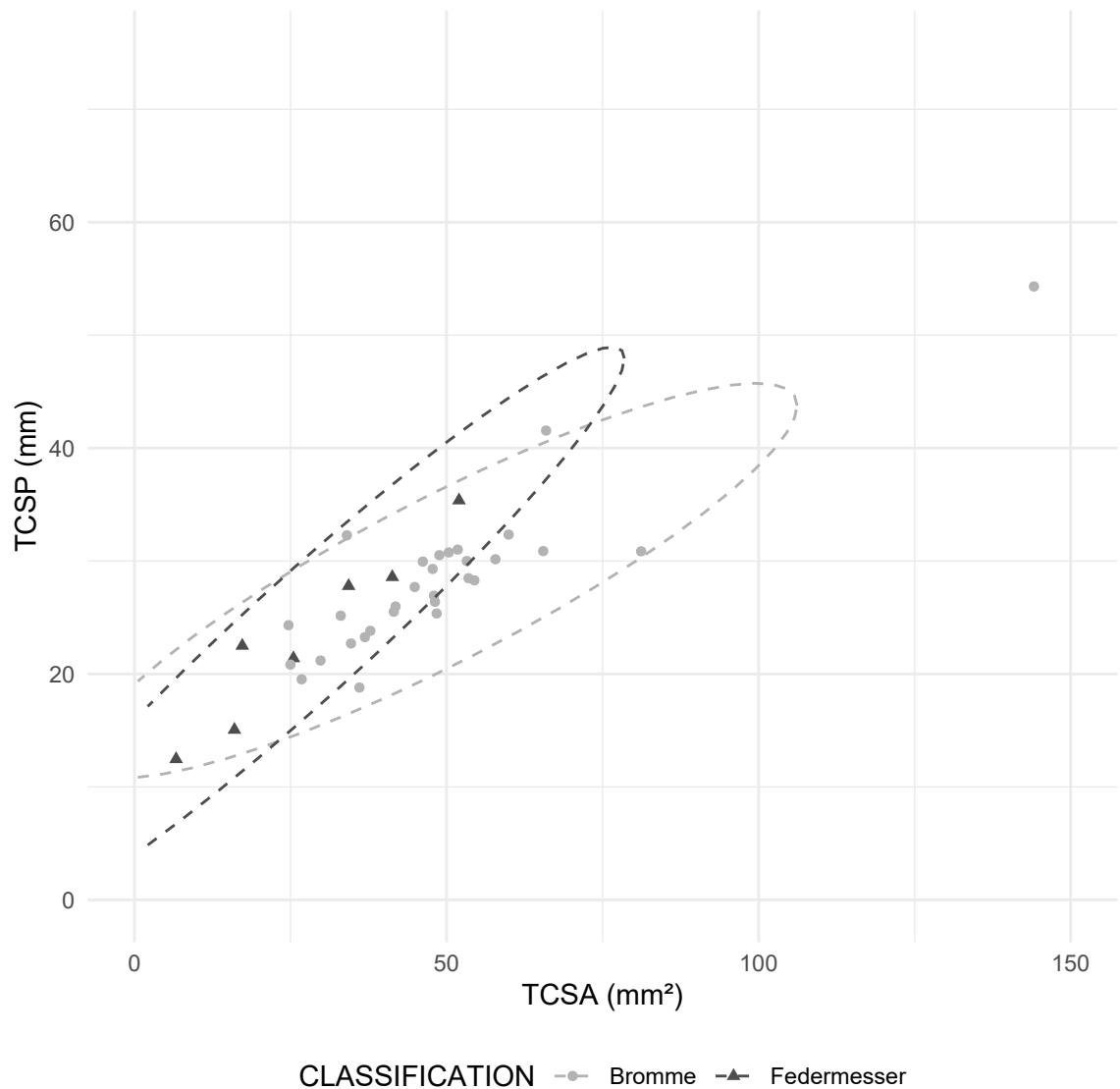


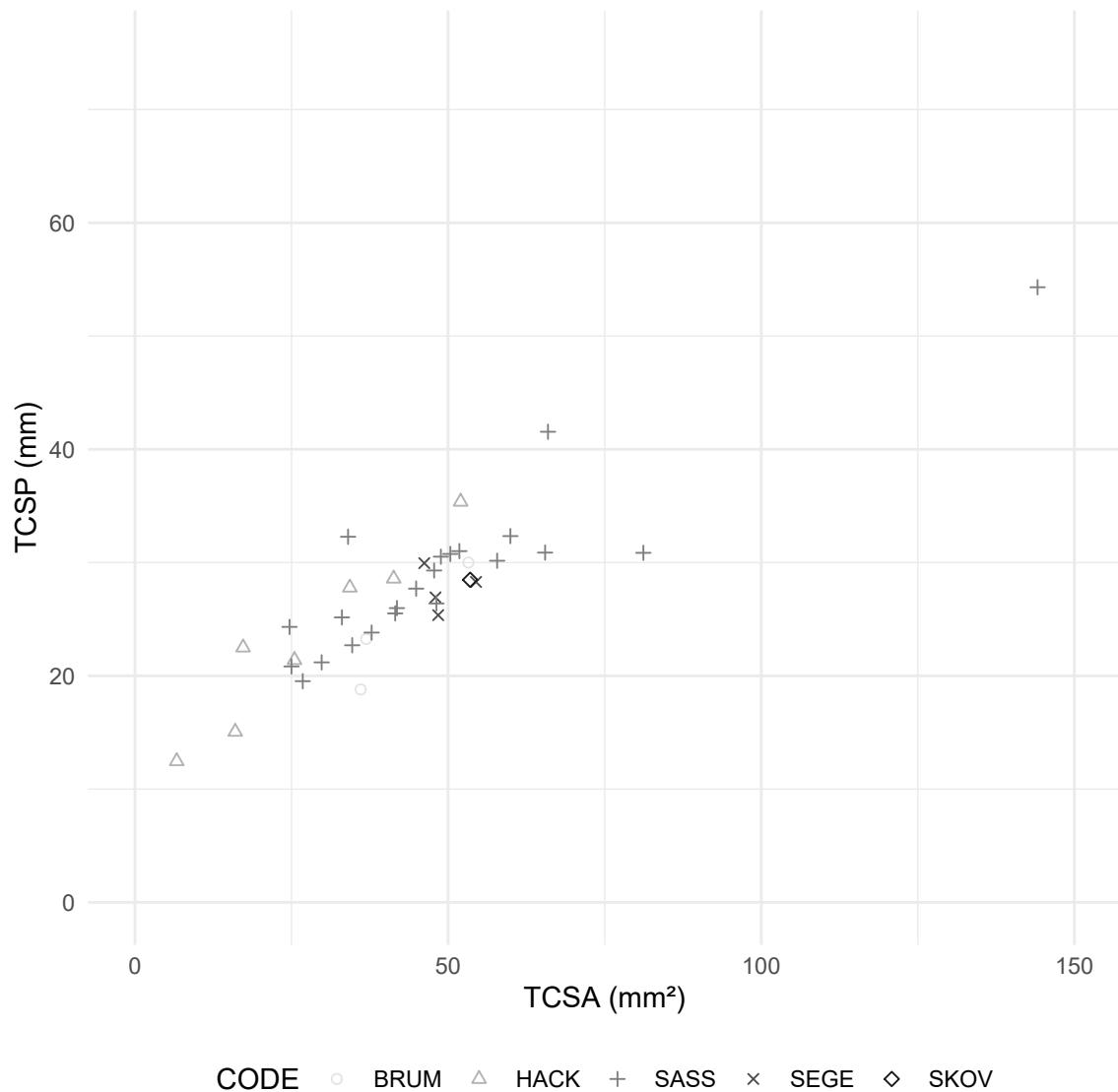


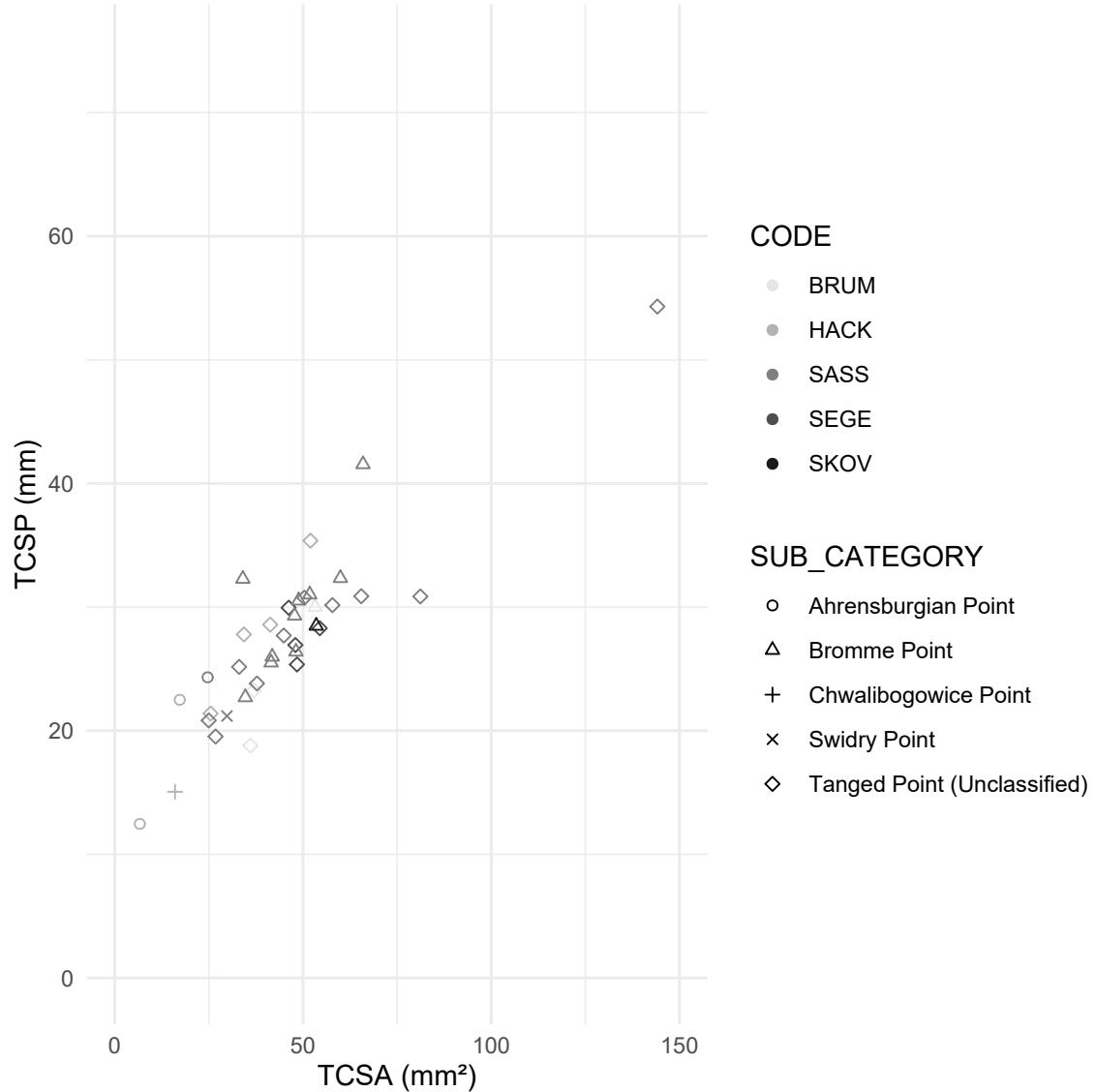


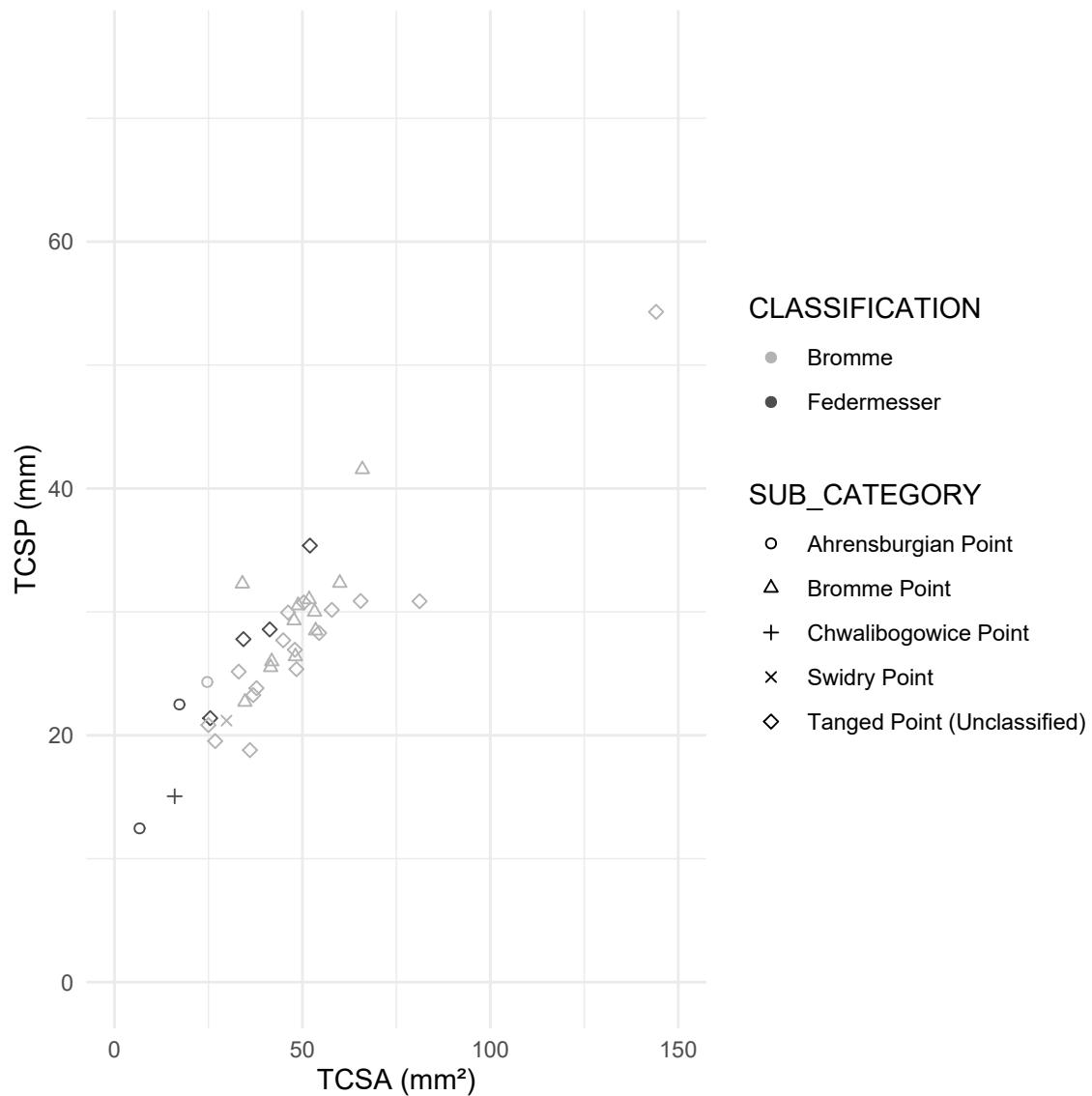












```
##
## Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data: tp_data_incbl_clean$WEIGHT and tp_data_incbl_clean$CODE
##
##      BRUM    HACK    SASS    SEGE
## HACK 0.2265 -      -      -
## SASS 1.0000 0.0058 -      -
## SEGE 0.5183 1.0000 0.1164 -
## SKOV 1.0000 1.0000 1.0000 1.0000
##
## P value adjustment method: bonferroni
##
## Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data: tp_data_incbl_clean$LENGTH and tp_data_incbl_clean$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_incbl_clean$WIDTH and tp_data_incbl_clean$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_incbl_clean$ELONGATION and tp_data_incbl_clean$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_incbl_clean$THICKNESS and tp_data_incbl_clean$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_incbl_clean$TCSA and tp_data_incbl_clean$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_inc_b_clean$TCSP and tp_data_inc_b_clean$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_inc_b_clean$WEIGHT and tp_data_inc_b_clean$CLASSIFICATION
##
##          Bromme
## Federmesser 8e-04
##
## P value adjustment method: bonferroni
##
## Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data: tp_data_inc_b_clean$LENGTH and tp_data_inc_b_clean$CLASSIFICATION
##
##          Bromme
## Federmesser 0.06
##
## P value adjustment method: bonferroni
##
## Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data: tp_data_inc_b_clean$WIDTH and tp_data_inc_b_clean$CLASSIFICATION
##
##          Bromme
## Federmesser 0.22
##
## P value adjustment method: bonferroni
##
## Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data: tp_data_inc_b_clean$ELONGATION and tp_data_inc_b_clean$CLASSIFICATION
##
##          Bromme
## Federmesser 0.74
##
## P value adjustment method: bonferroni

```

```

## 
## Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data: tp_data_incbl_clean$THICKNESS and tp_data_incbl_clean$CLASSIFICATION
##
##          Bromme
## Federmesser 0.00073
##
## P value adjustment method: bonferroni
##
## Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data: tp_data_incbl_clean$TCSA and tp_data_incbl_clean$CLASSIFICATION
##
##          Bromme
## Federmesser 0.011
##
## P value adjustment method: bonferroni
##
## Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data: tp_data_incbl_clean$TCSP and tp_data_incbl_clean$CLASSIFICATION
##
##          Bromme
## Federmesser 0.16
##
## P value adjustment method: bonferroni
##
## Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data: tp_data_incbl_clean$WEIGHT and tp_data_incbl_clean$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_incbl_clean$LENGTH and tp_data_incbl_clean$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_incbl_clean$WIDTH and tp_data_incbl_clean$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_incbl_clean$ELONGATION and tp_data_incbl_clean$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_incbl_clean$THICKNESS and tp_data_incbl_clean$SUB_CATEGORY
##
##                               Ahrensburgian Point Bromme Point
## Bromme Point              0.11          -
## Chwalibogowice Point     1.00          1.00
## Swidry Point              1.00          1.00

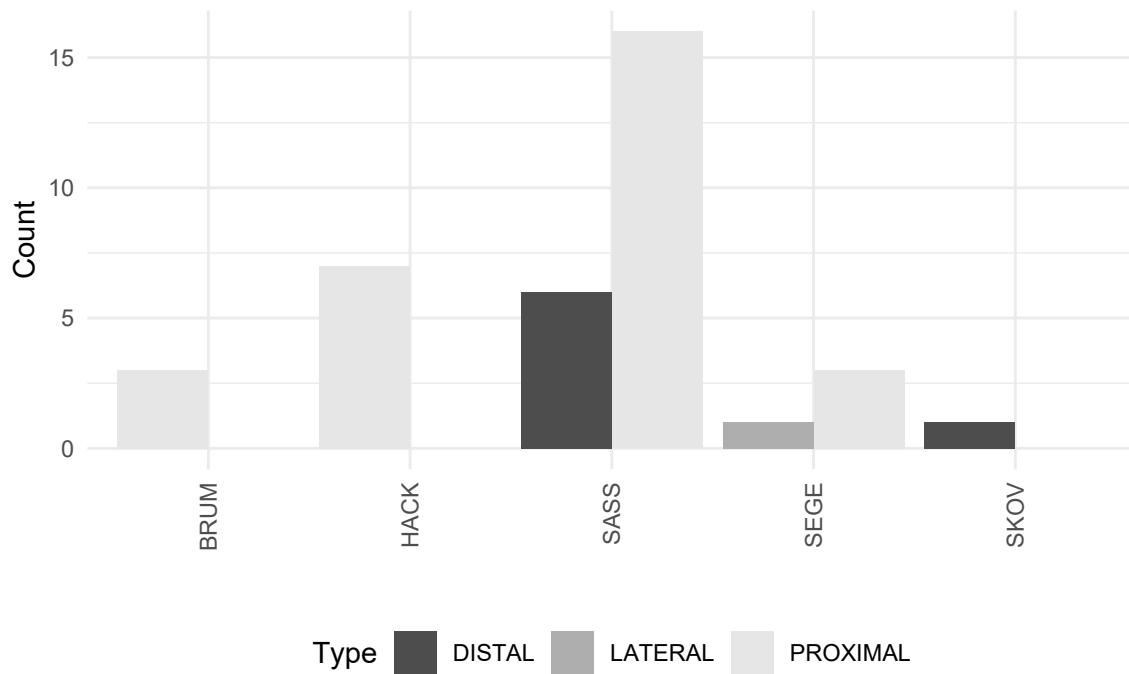
```

```

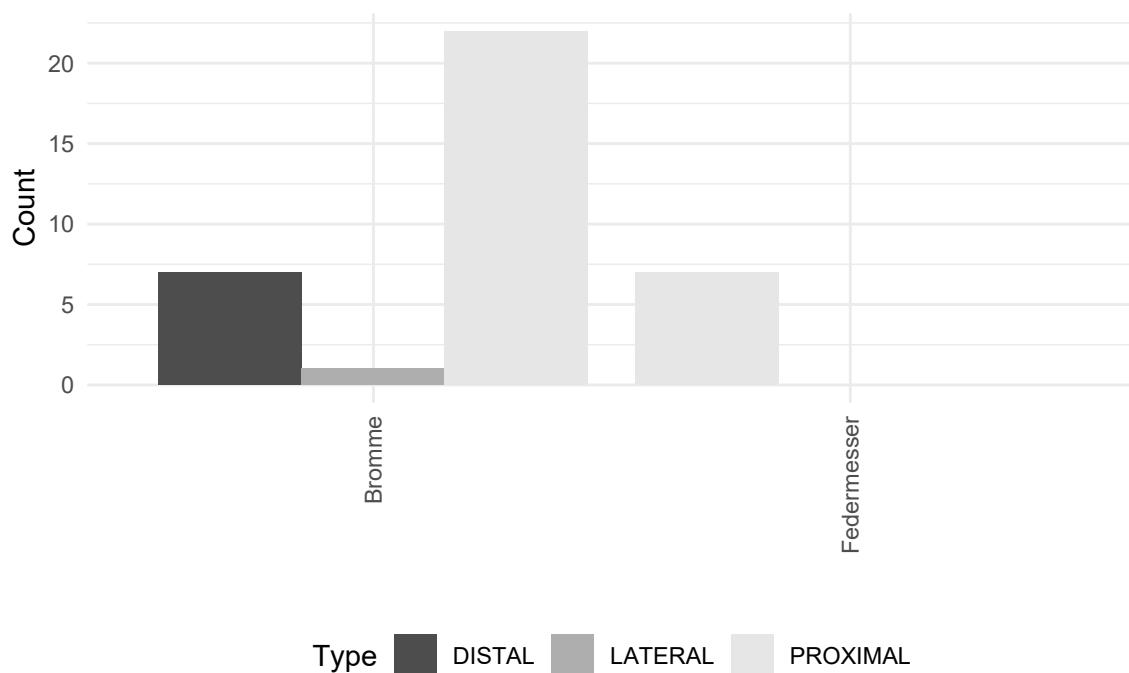
## Tanged Point (Unclassified) 0.07           1.00
##                                     Chwalibogowice Point Swidry Point
## Bromme Point                  -           -
## Chwalibogowice Point          -           -
## Swidry Point                 1.00          -
## Tanged Point (Unclassified) 1.00           1.00
##
## P value adjustment method: bonferroni
##
## Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data: tp_data_incbl_clean$TCSA and tp_data_incbl_clean$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_incbl_clean$TCSP and tp_data_incbl_clean$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

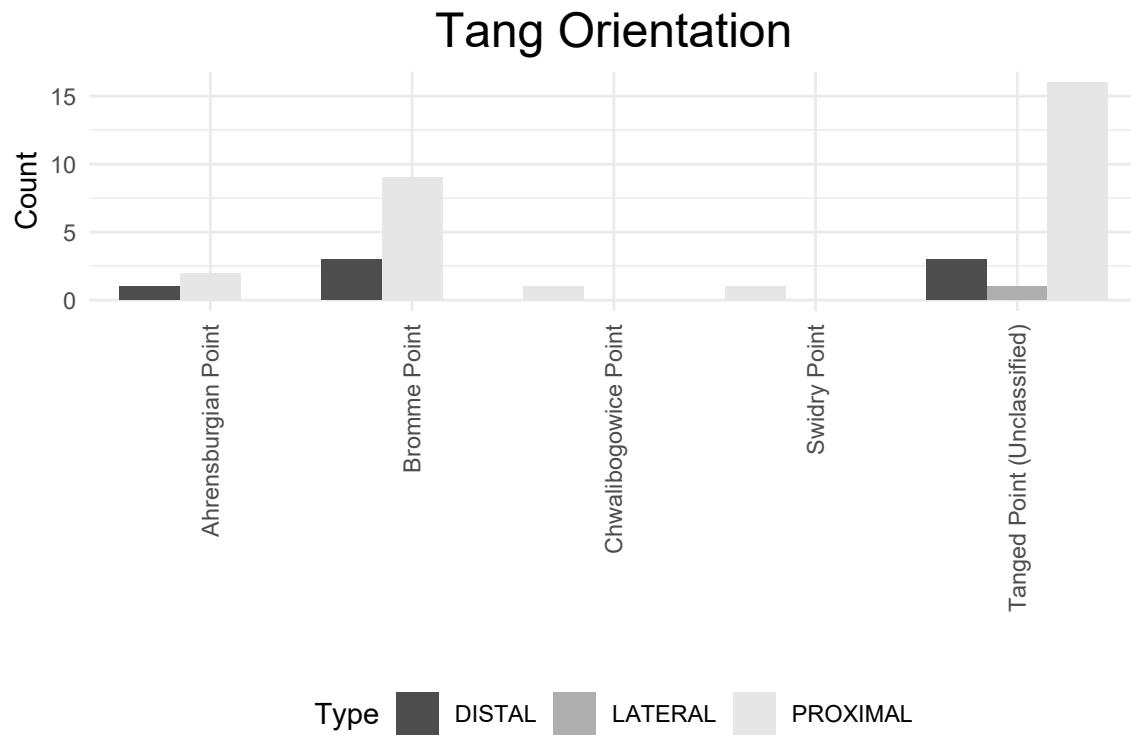
```

### Tang Orientation



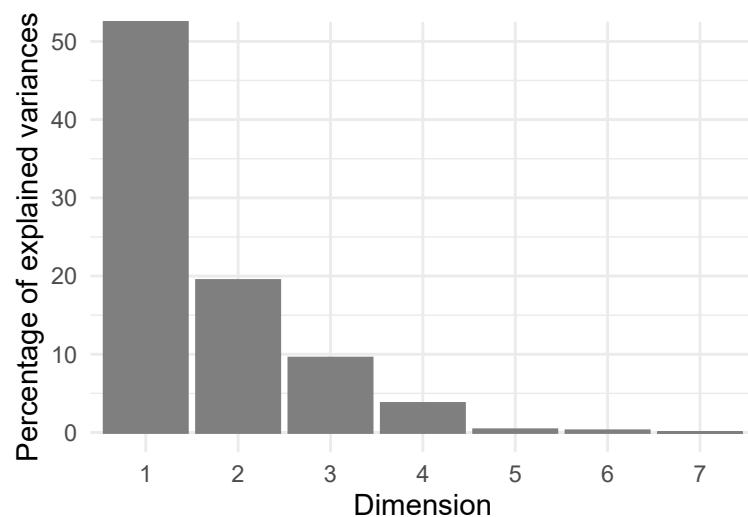
### Tang Orientation



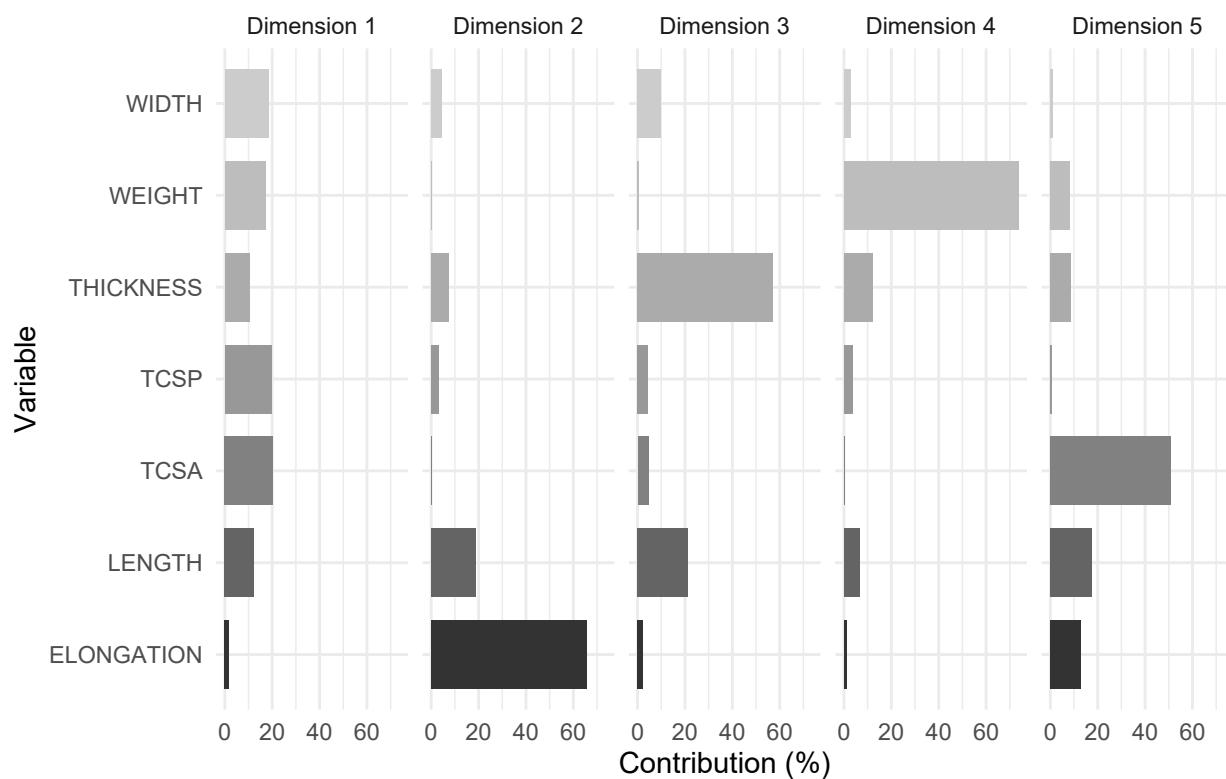


### Principal Component Analysis (PCA)

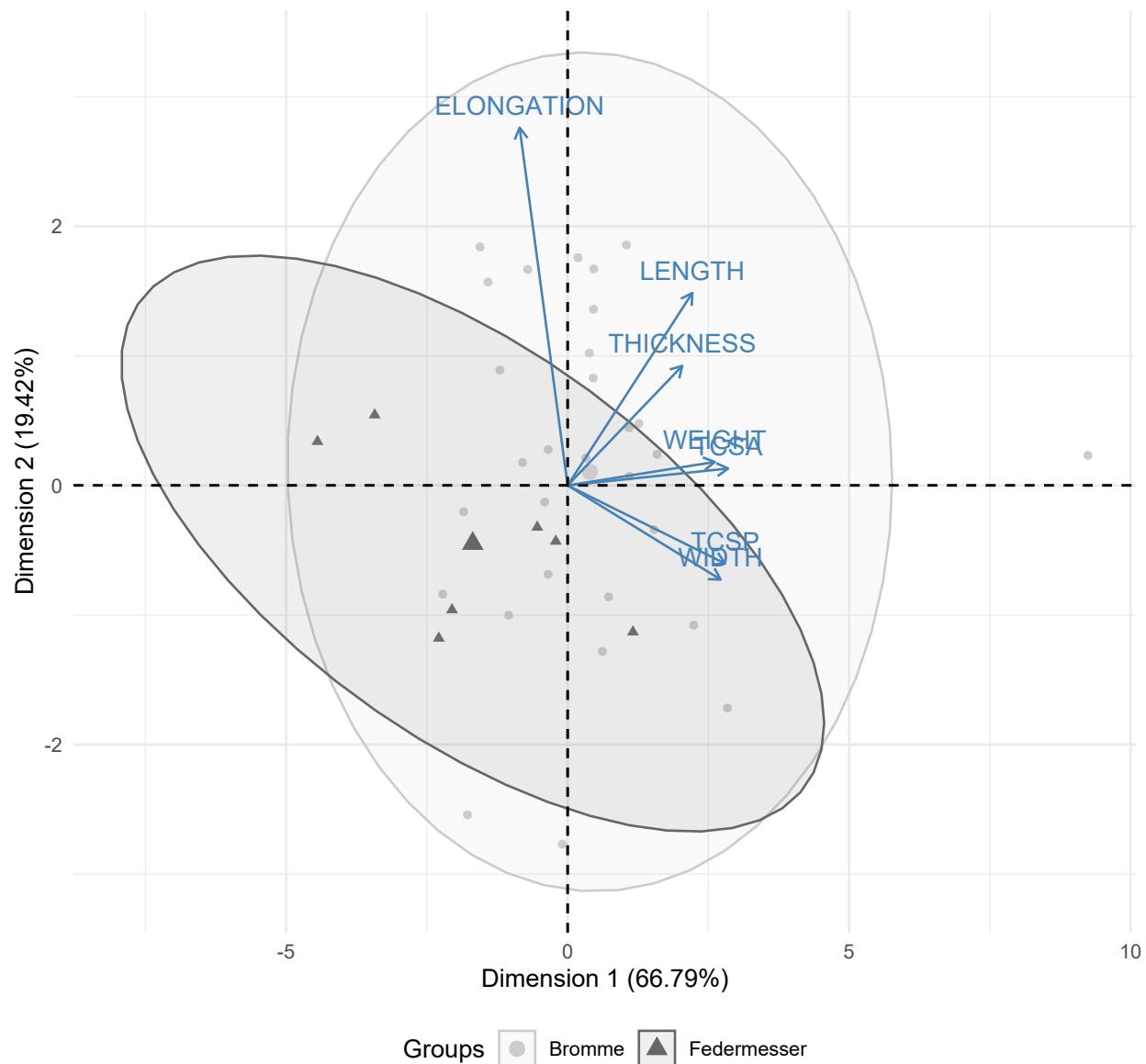
```
## # A tibble: 7 x 4
##   rowname eigenvalue variance cumulative
##   <chr>     <dbl>    <dbl>      <dbl>
## 1 Dim.1     4.68     66.8       66.8
## 2 Dim.2     1.36     19.4       86.2
## 3 Dim.3     0.666    9.51       95.7
## 4 Dim.4     0.260    3.71       99.4
## 5 Dim.5     0.0242   0.346 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



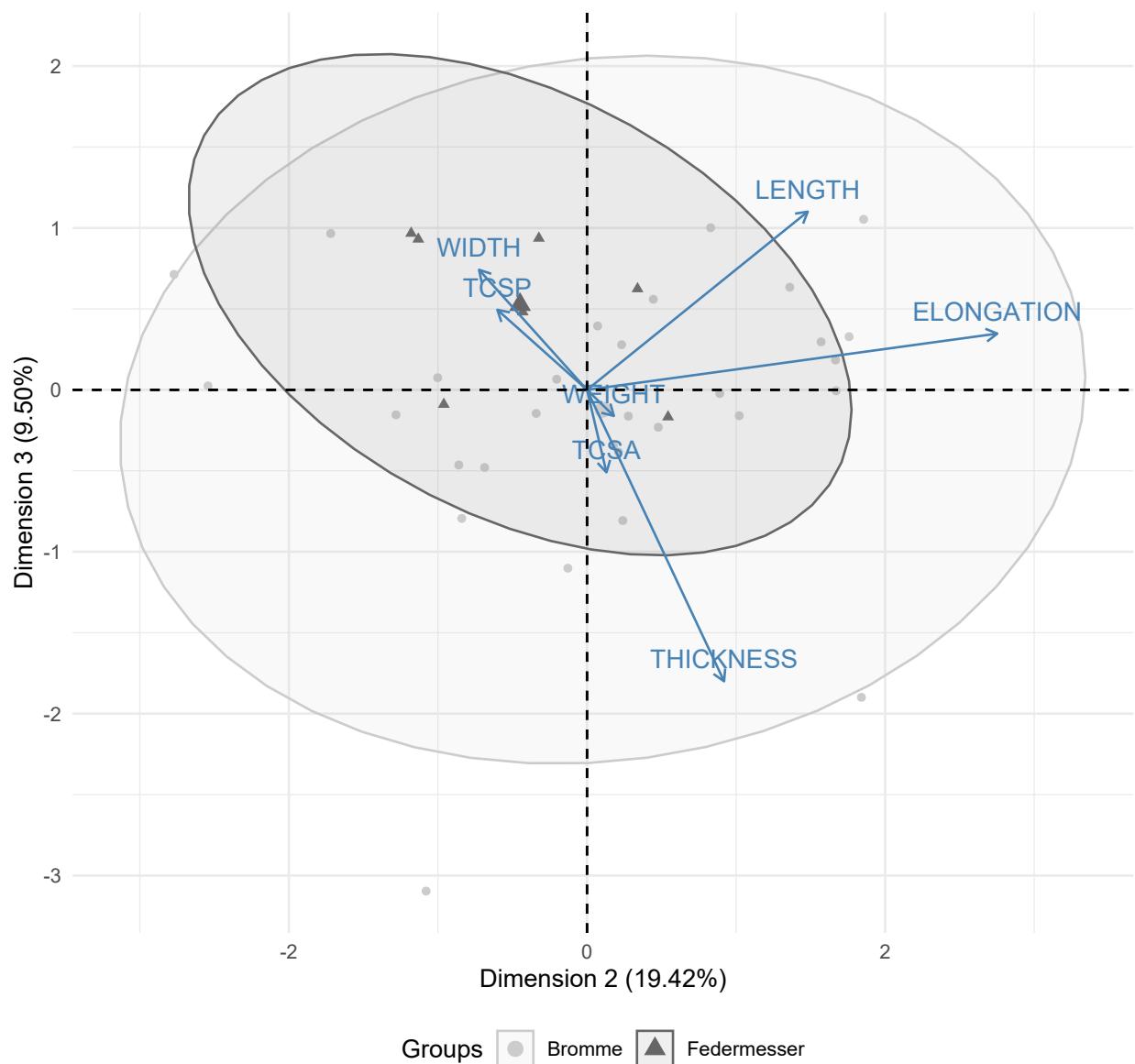
## Contribution of Variables



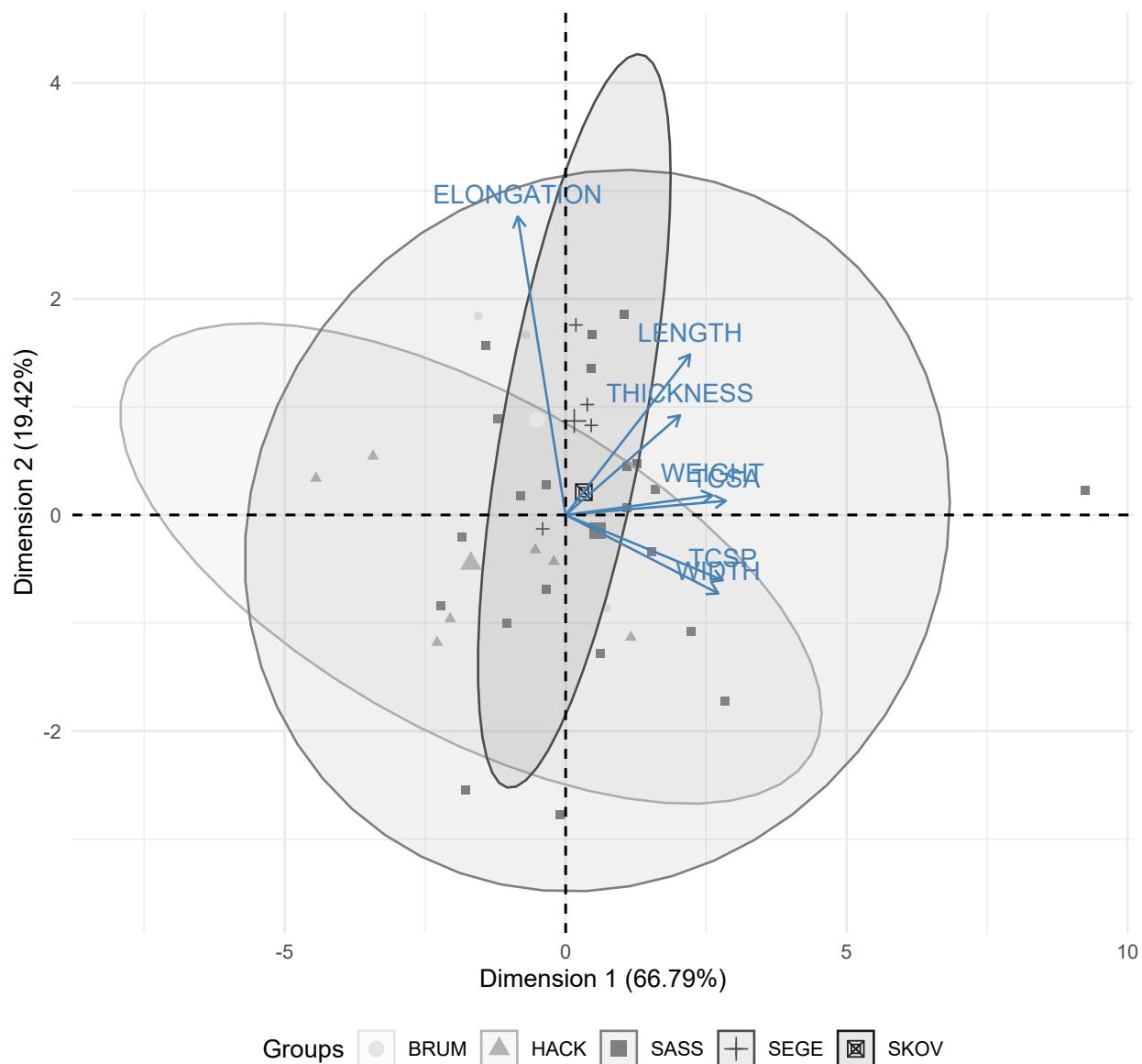
### PCA 1 vs. PCA 2 (Classification)



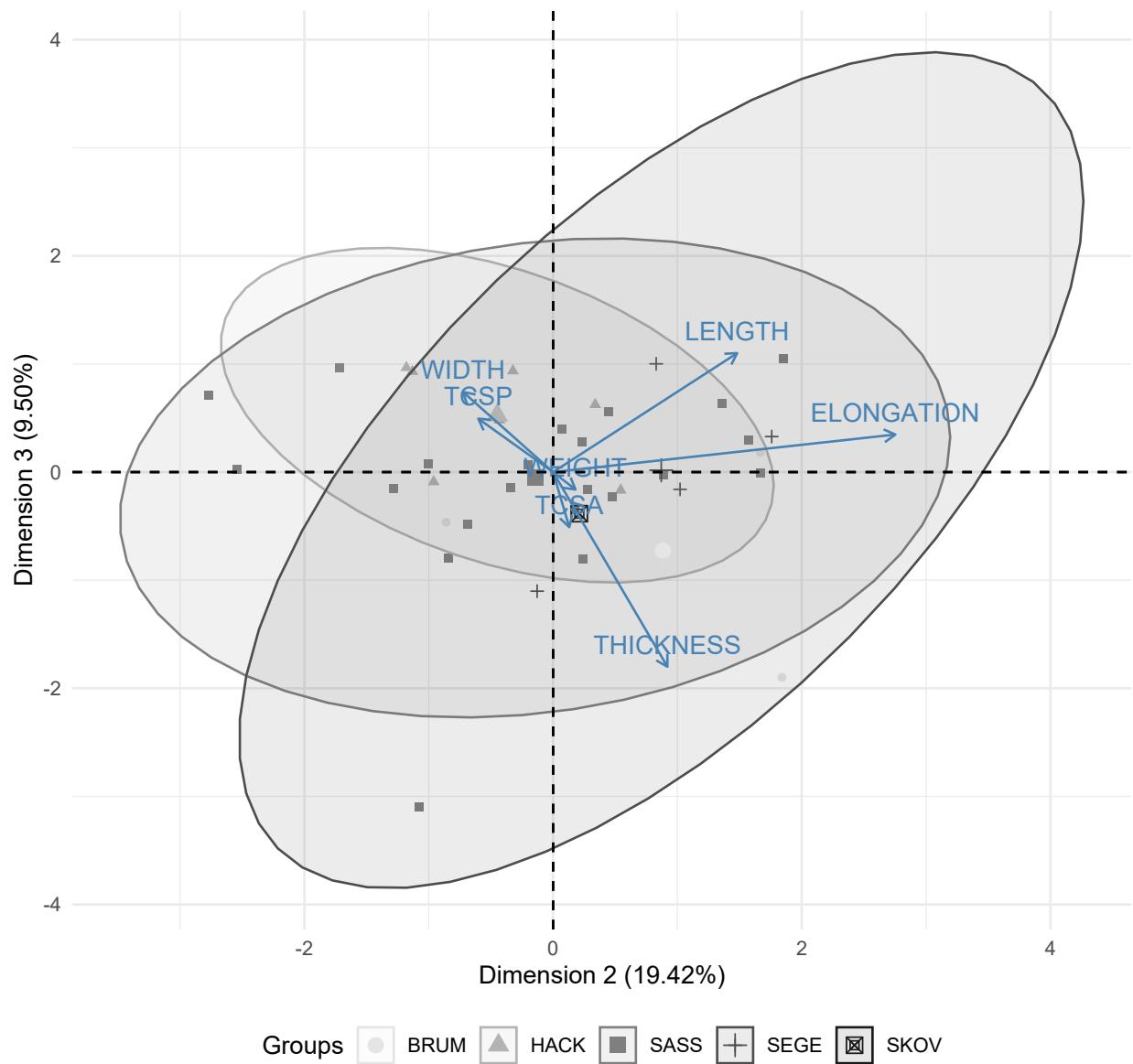
### PCA 2 vs. PCA 3 (Classification)



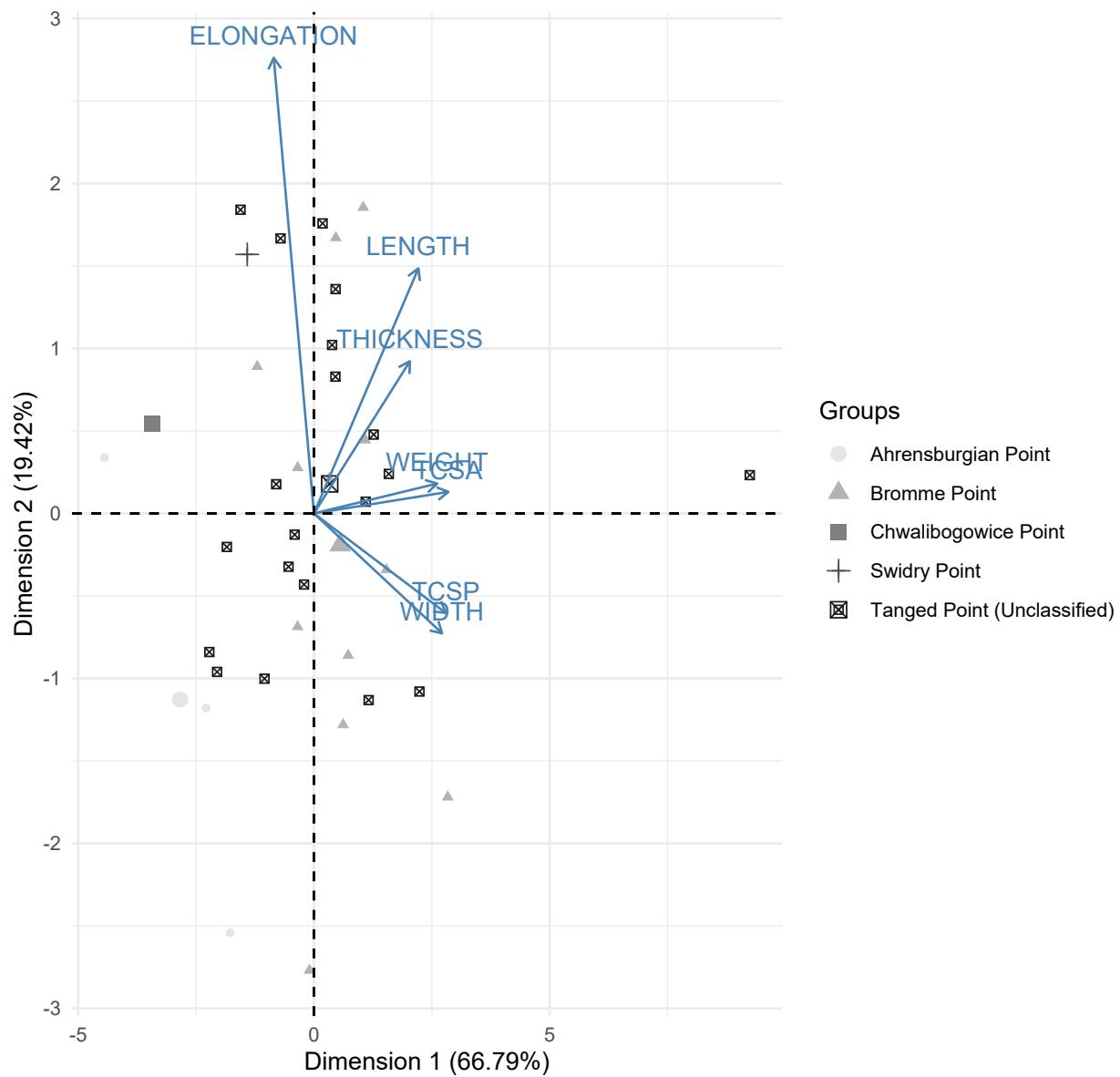
## PCA 1 vs. PCA 2 (Code)



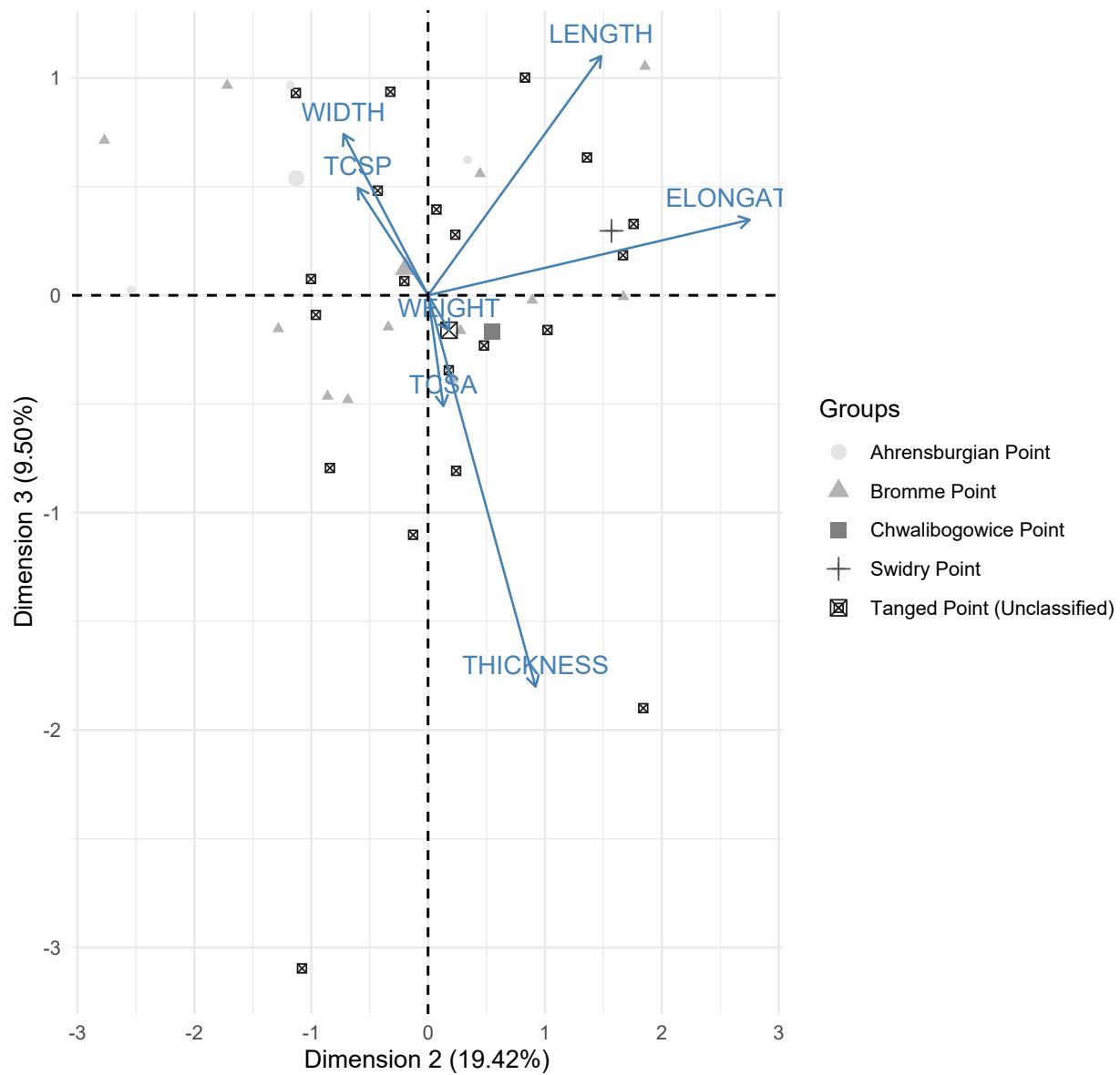
## PCA 2 vs. PCA 3 (Code)



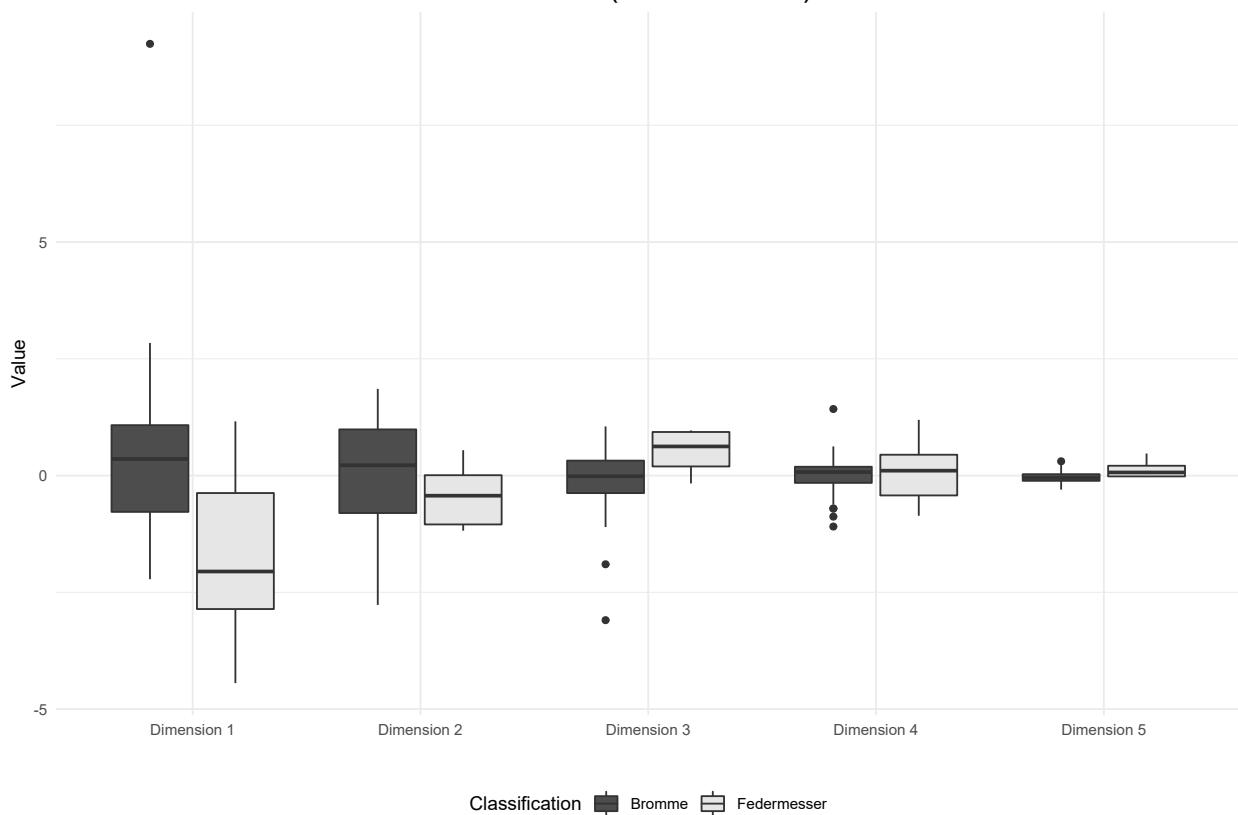
## PCA 1 vs. PCA 2 (Tanged Point Variant)



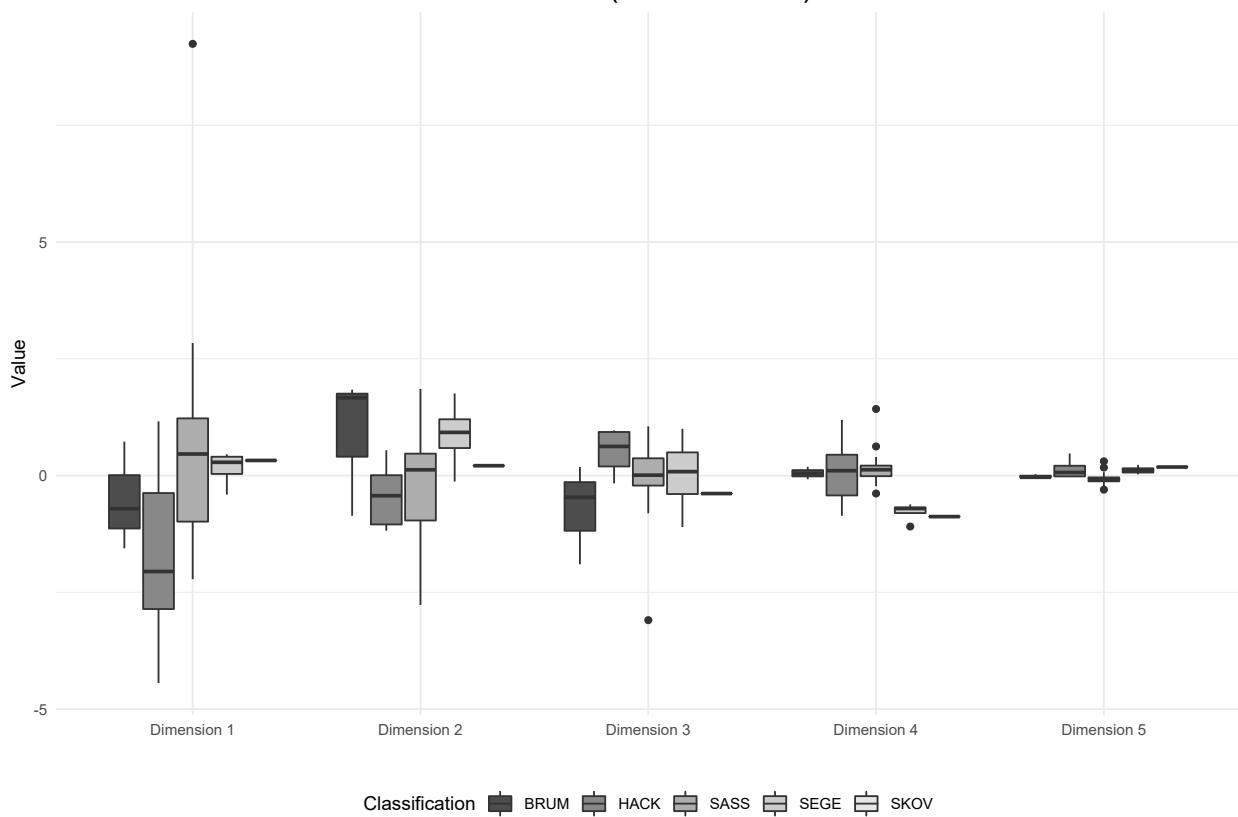
## PCA 2 vs. PCA 3 (Tanged Point Variant)



### PCA 1:5 (Classification)



### PCA 1:5 (Classification)



### PCA 1:5 (Classification)

