

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 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 pereceived 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) **Brümmerhof (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
Brümmerhof (FStNr. 16)	13	6	NA	3
Häcklingen (FStNr. 19)	9	43	8	7
Rietberg (1)	4	61	5	NA
Rietberg (2)	2	11	NA	NA
Rothenkirchen	4	11	2	NA
Sassenholz (FStNr. 78)	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

Classification	Technology			
	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: Excavation ; 2: Surface Collection
<i>CLASSIFICATION</i>	Taxonomic Unit e.g. Bromme
<i>BP_ASSOCIATION</i>	Association of backed points - 1: Yes ; 2: No
<i>TP_ASSOCIATION</i>	Association of tanged points - 1: Yes ; 2: No
<i>POINT_TYPE</i>	Point type - 1: Backed Point ; 2: Tanged Point
<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: Full Cortical Dorsal Face (FC) ; 2: Two Dorsal Faces - One Cortex (TDOC) ; 3: Three Dorsal Faces - One Cortex (THDOC) ; 4: Two Dorsal Faces - No Cortex (TDNC) ; 5: Three Dorsal Faces - No Cortex (THDNC) ; 6: Multiple Dorsal Faces (MDF) ; 7: Bilateral Crested Blade (BCB) ; 8: Crested Blade - One Flaked And One Uncortical (CBOU) ; 9: Crested Blade - Three Flaked Faces (CBTHF) ; 10: Crested Blade - One Flaked And One Cortical (CBOFOC) ; 11: Crested Blade - Flaked And Trimmed (CBFT)
<i>BLADE_DET</i>	Blade determination - 1: Ideal (ID) ; 2: Feathered (FE) ; 3: Plunged (PL) ; 4: Hinged (HI)
<i>BLADE_CURV</i>	Blade curvature - 1: Straight (ST) ; 2: Distal (DI) ; 3: Even (EV) ; 4: Ventral ‘Belly’ (VB)
<i>DORSAL_PATTERN</i>	Dorsal scar pattern - 1: Centripetal (CE) ; 2: 3-Way Centripetal (TWC) ; 3: Bidirectional (BI) ; 4: Convergent (CON) ; 5: Convergent And Bidirectional (CONBI) ; 6: Convergent And Perpendicular (CONPE) ; 7: Double Perpendicular (DP) ; 8: Straight And Perpendicular (SAP) ; 9: Unidirectional (UNI) ; 10: Undetermined (UND)
<i>BULB_MORPH</i>	Bulb and lip characteristics - 1: Bulb Formation (BF) ; 2: Pronounced Bulb Formation (PBF) ; 3: Bulb And Lip Formation (BLF) ; 4: Lip Formation (LF) ; 5: Pronounced Lip Formation (PLF) ; 6: Diffused Bulb (DB) ; 7: No Bulb Or Lip (NBOL)
<i>CONUS_FORM</i>	Cone Formation - 1: No Formation (NFO) ; 2: Ring Crack On Butt (RCB) ; 3: Ring Crack And Ventral Fissures (RCVF) ; 4: Detached Bulb (DB)
<i>BUTT_MORPH</i>	Butt morphology - 1: Large And Thick Butt (LTB) ; 2: Large Oval Butt (LOB) ; 3: Thin Oval Butt (TOB) ; 4: Small Thick Butt (STB) ; 5: Small Butt (SB) ; 6: Punctiform Butt (PUNB) ; 7: Broken/Absent Butt (BAB)
<i>BUTT_PREP_1</i>	Butt preparation #1 - 1: Plain (PLA) ; 2: Facetted With Two Scars (FTS) ; 3: Facetted With Greater Than Two Scars (FGTTS) ; 4: Broken (B)
<i>BUTT_PREP_2</i>	Butt preparation #2 - 1: Cortical Unprepared (CU) ; 2: Non-Cortical Unprepared (NCU) ; 3: Dorsal Trimming (DT) ; 4: Dorsal Abrasion (DA) ; 5: Dorsal Abrasion And Grinding (DAG) ; 6: Dorsal Abrasion And Trimming (DATR) ; 7: Dorsal Abrasion, Trimming And Grinding (DATG) ; 8: Broken (B)

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

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

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

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

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

Attribute	Variable(s)
<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) Proximal ; 2) Distal ; 3) Lateral
<i>TCSA</i>	Maximum tip cross-sectional area (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) Yes (Y) ; 2) No (N)

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

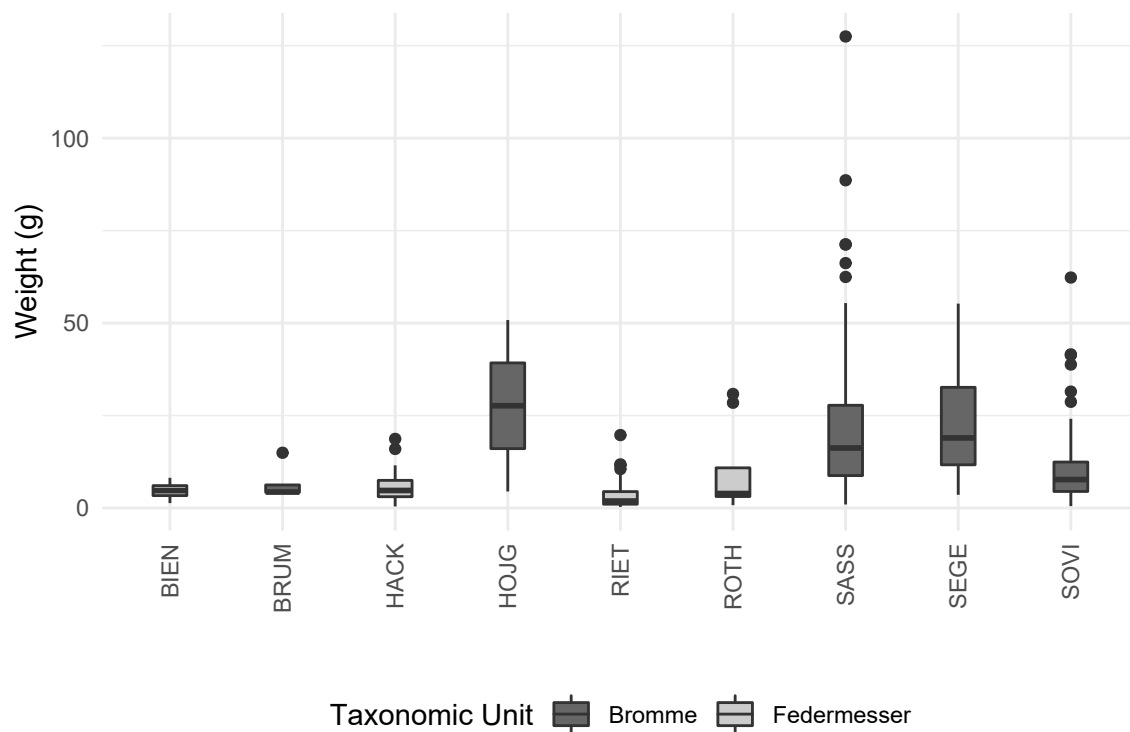
Table 7. Descriptive Statistics: Blade Thickness (mm)

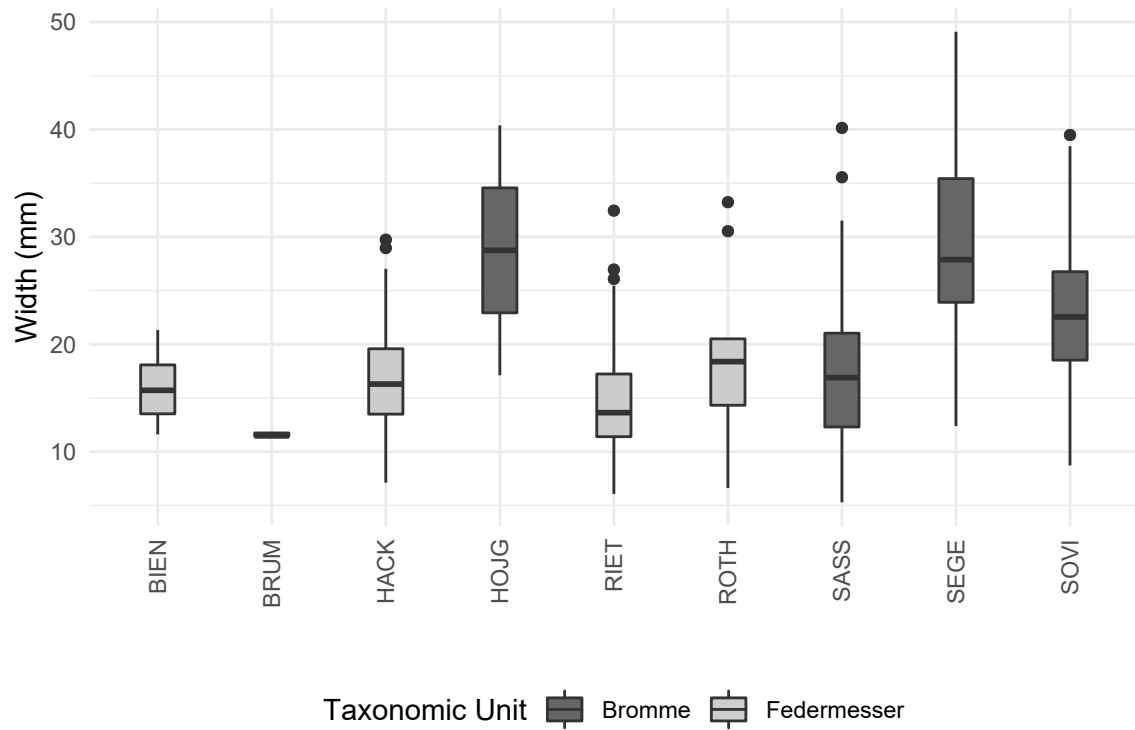
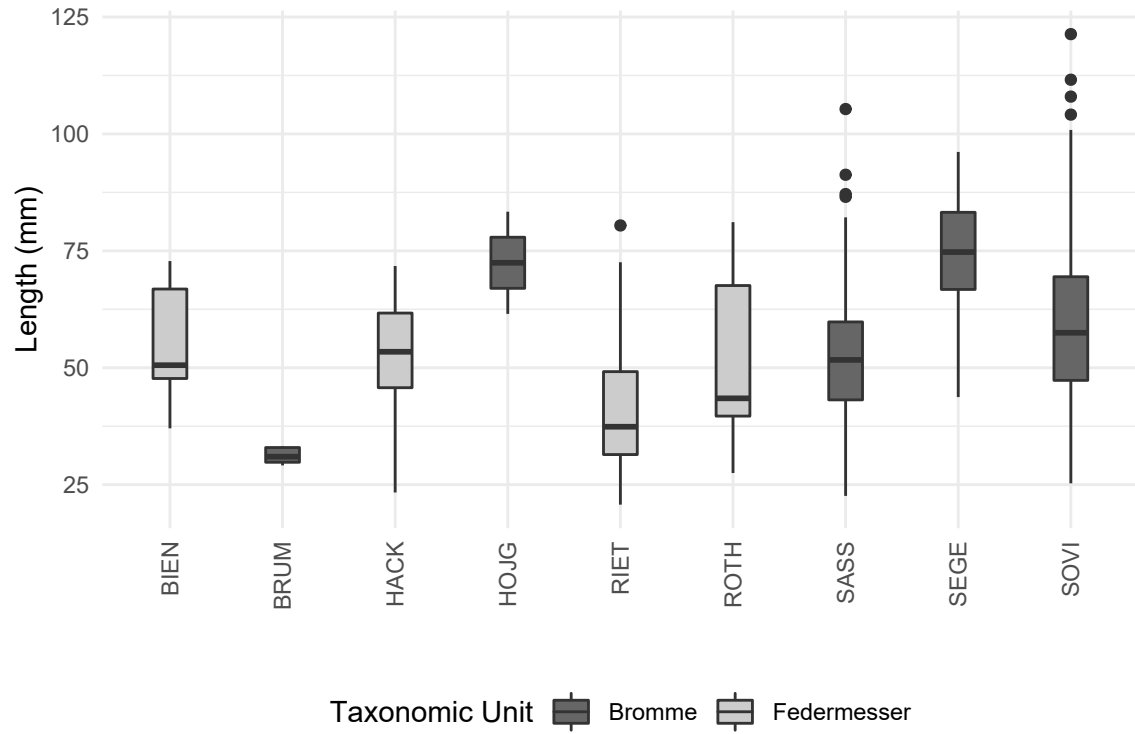
CONTEXT	n_obs	min	max	mean	med	sd	var
Bienenbüttel (FStNr. 15)	12	2.70	12.02	6.48	5.54	2.53	6.41
Brümmerhof (FStNr. 16)	5	3.92	5.90	4.74	4.21	0.95	0.91
Häcklingen (FStNr. 19)	34	2.42	11.21	5.58	5.52	1.90	3.60
Højgård	2	6.90	17.79	12.34	12.34	7.70	59.30
Rietberg (1)	46	1.72	51.18	7.19	4.45	9.71	94.35
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

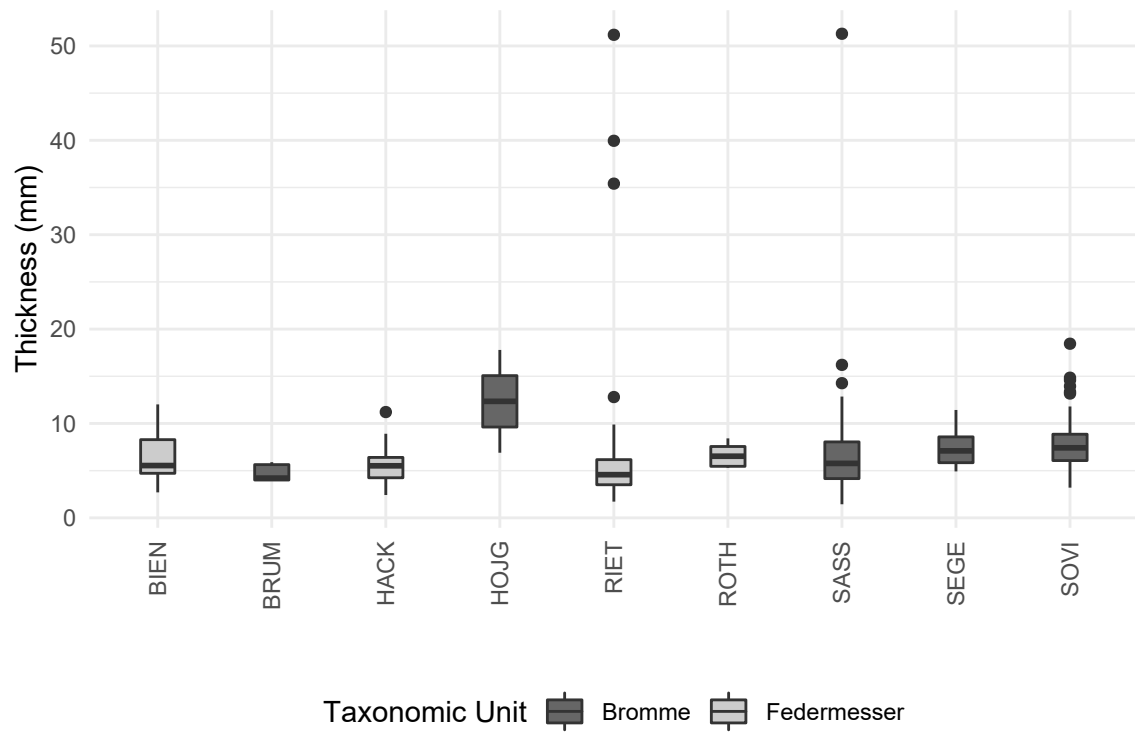
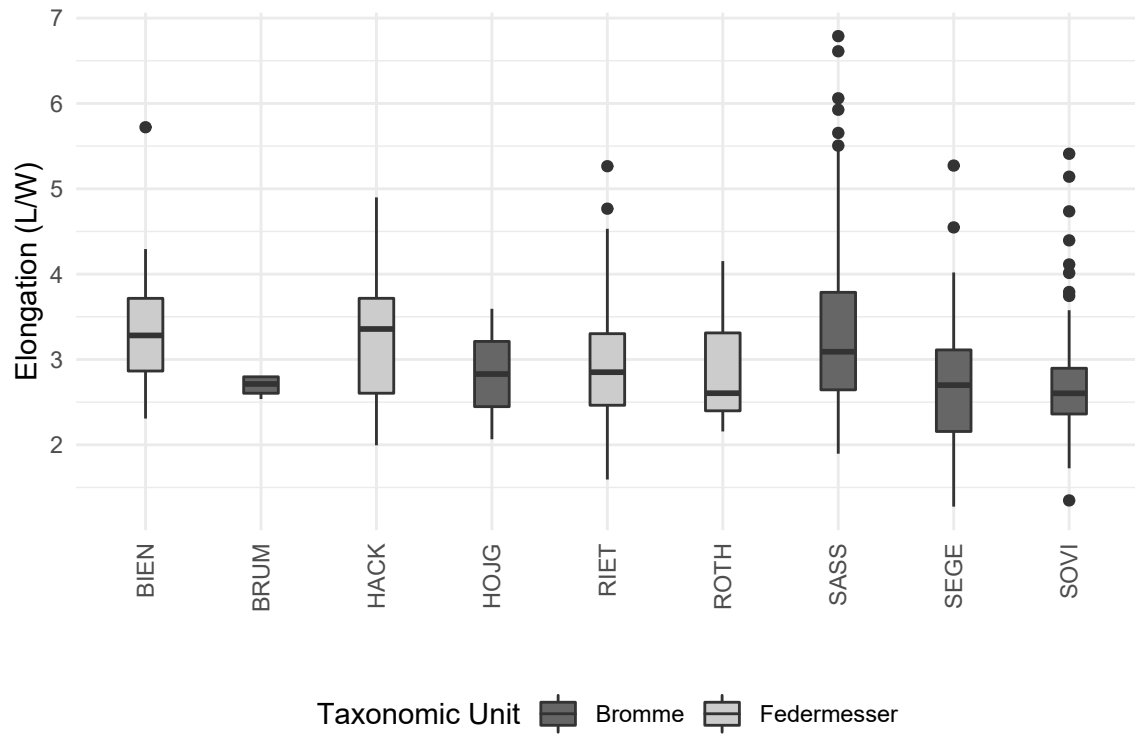
Table 8. Descriptive Statistics: Blade Platform Depth (mm)

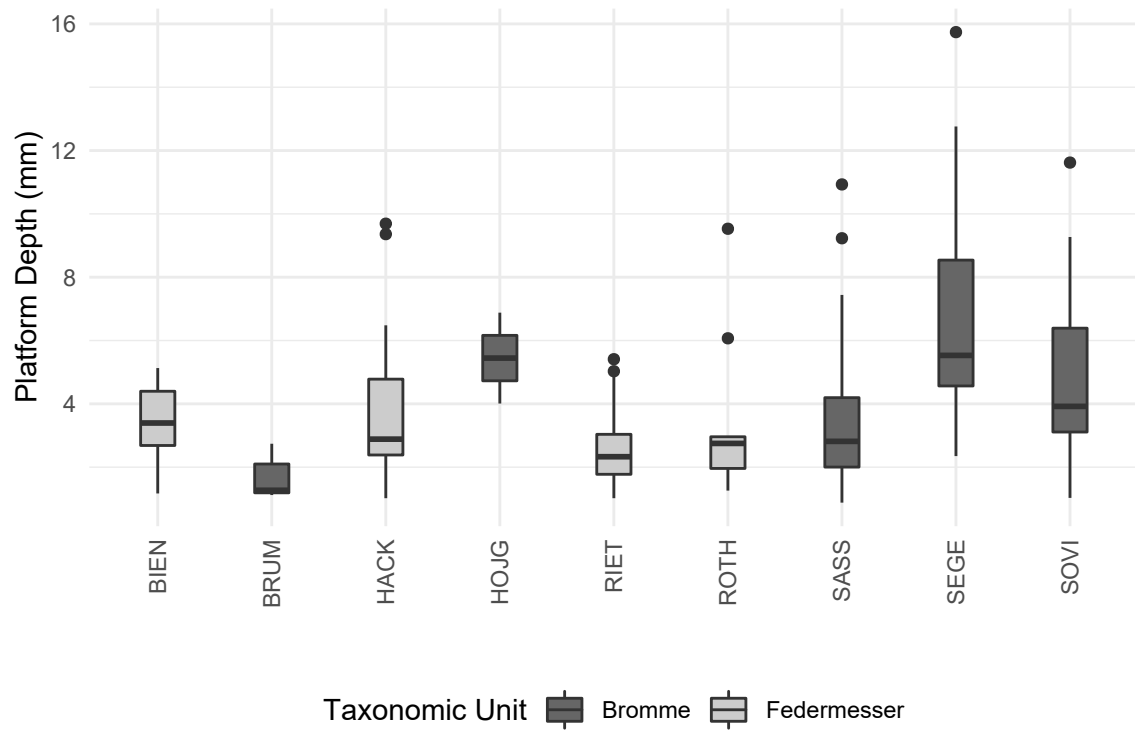
CONTEXT	n_obs	min	max	mean	med	sd	var
Bienenbüttel (FStNr. 15)	12	1.17	5.13	3.37	3.40	1.32	1.75
Brümmerhof (FStNr. 16)	5	1.12	2.74	1.68	1.27	0.71	0.51
Häcklingen (FStNr. 19)	34	1.02	9.69	3.61	2.88	2.14	4.57
Højgård	2	4.01	6.88	5.44	5.44	2.03	4.12

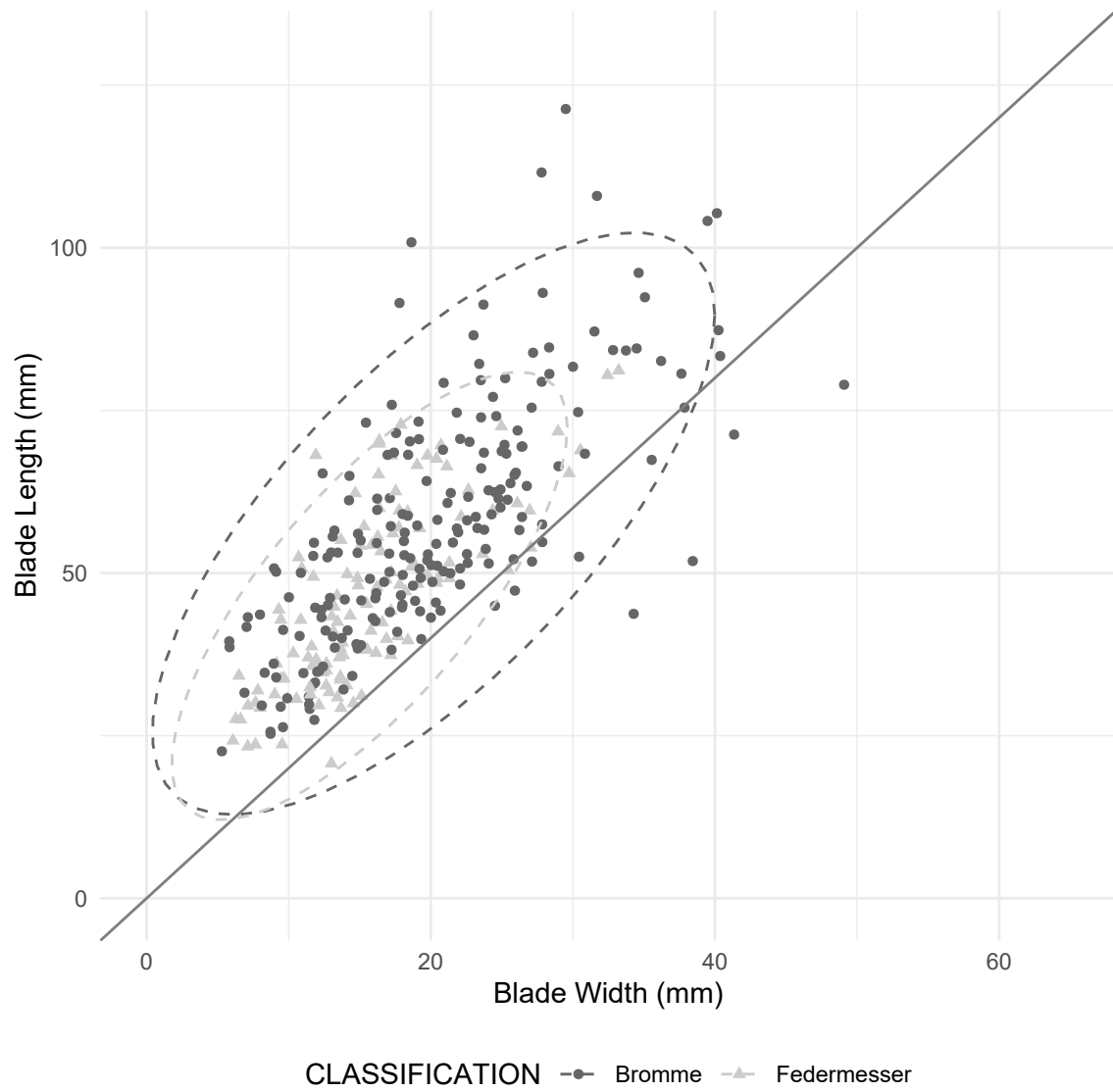
Rietberg (1)	46	1.02	4.93	2.45	2.32	0.98	0.96
Rietberg (2)	7	1.51	5.41	2.91	2.24	1.30	1.69
Rietberg (5)	11	1.25	5.03	2.31	2.11	1.10	1.21
Rietberg (Other)	2	3.15	3.24	3.20	3.20	0.06	0.00
Rothenkirchen	9	1.26	9.53	3.44	2.75	2.70	7.27
Sassenholz (FStNr. 78)	86	0.88	10.93	3.37	2.88	1.91	3.65
Sassenholz (FStNr. 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

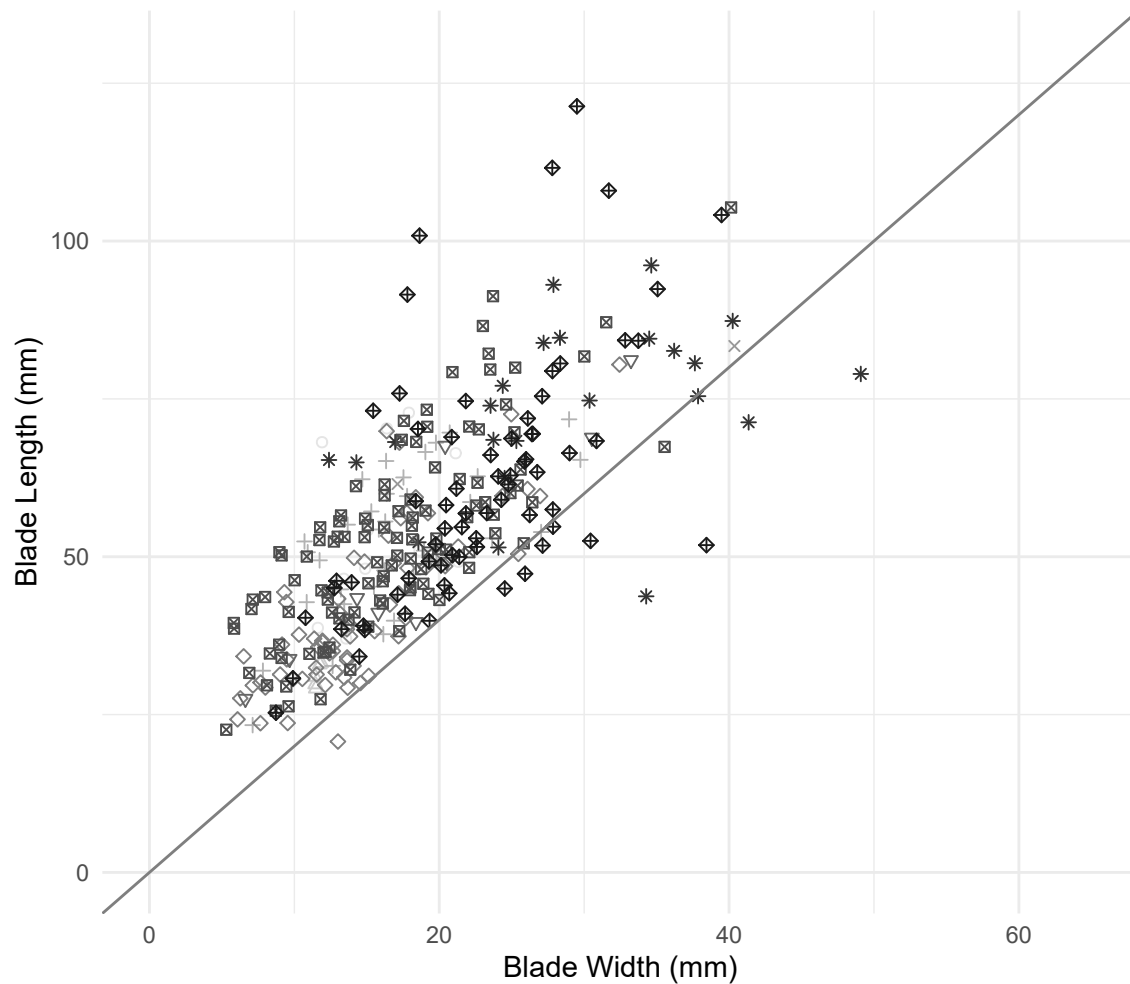












CODE ○ BIEN + HACK ◇ RIET ■ SASS ◆ SOVI
 △ BRUM × HOJG ▼ ROTH * SEGE

```
##
## 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

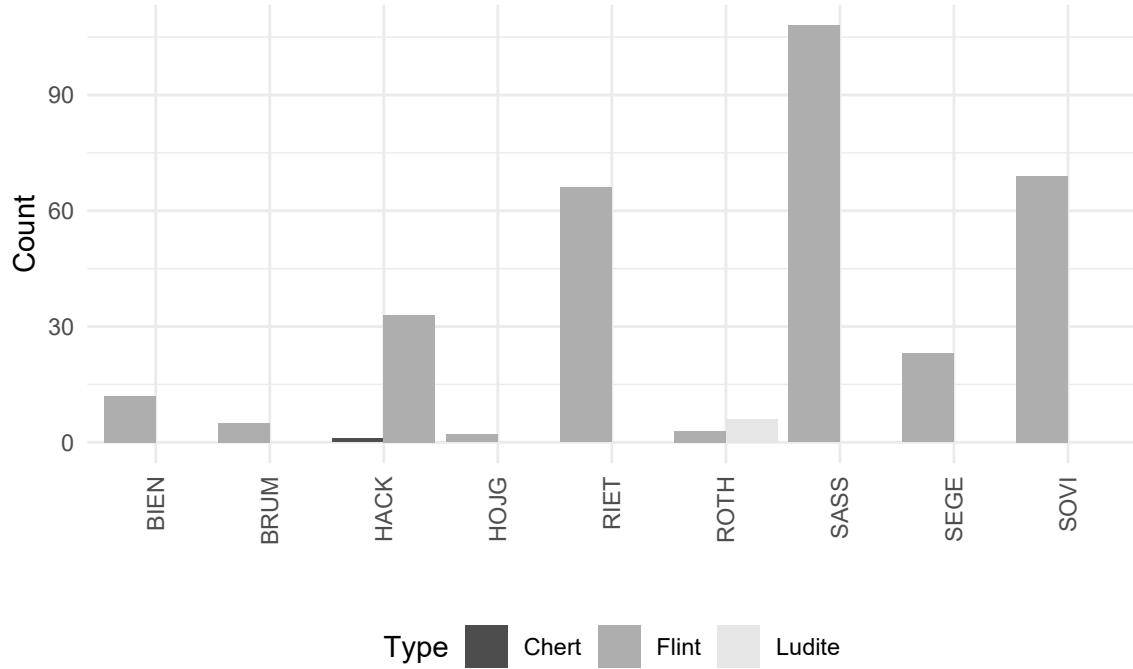
```

```

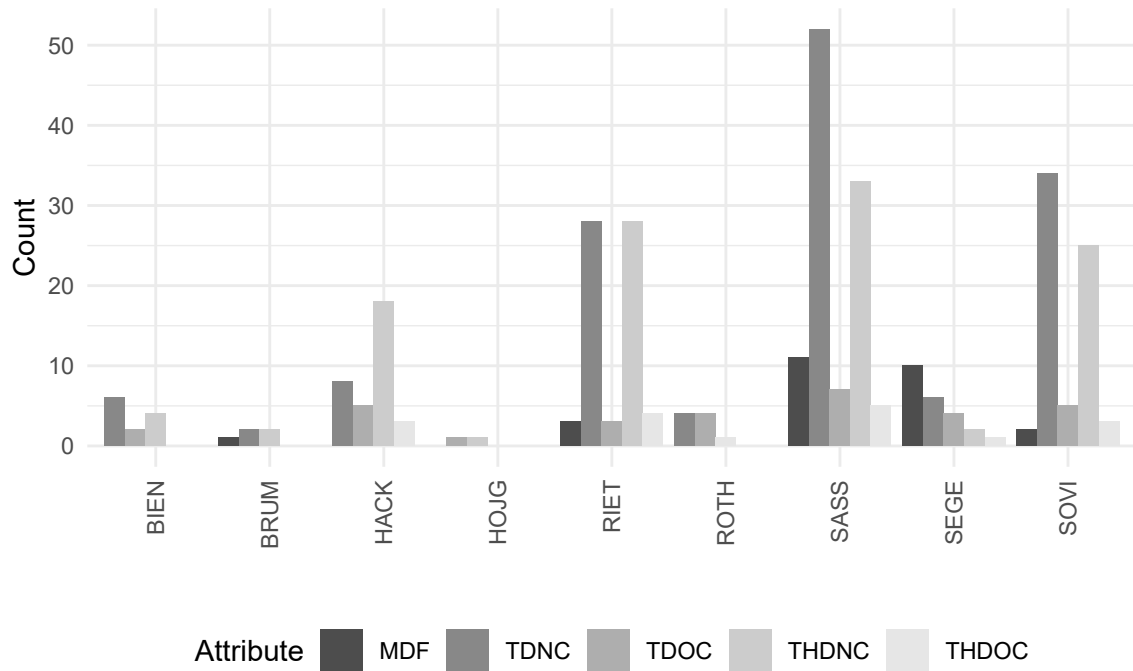
##
## P value adjustment method: bonferroni
##
## Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data: blade_data_clean$ELONGATION and blade_data_clean$CLASSIFICATION
##
## Bromme
## Federmesser 0.35
##
## P value adjustment method: bonferroni
##
## Pairwise comparisons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

```

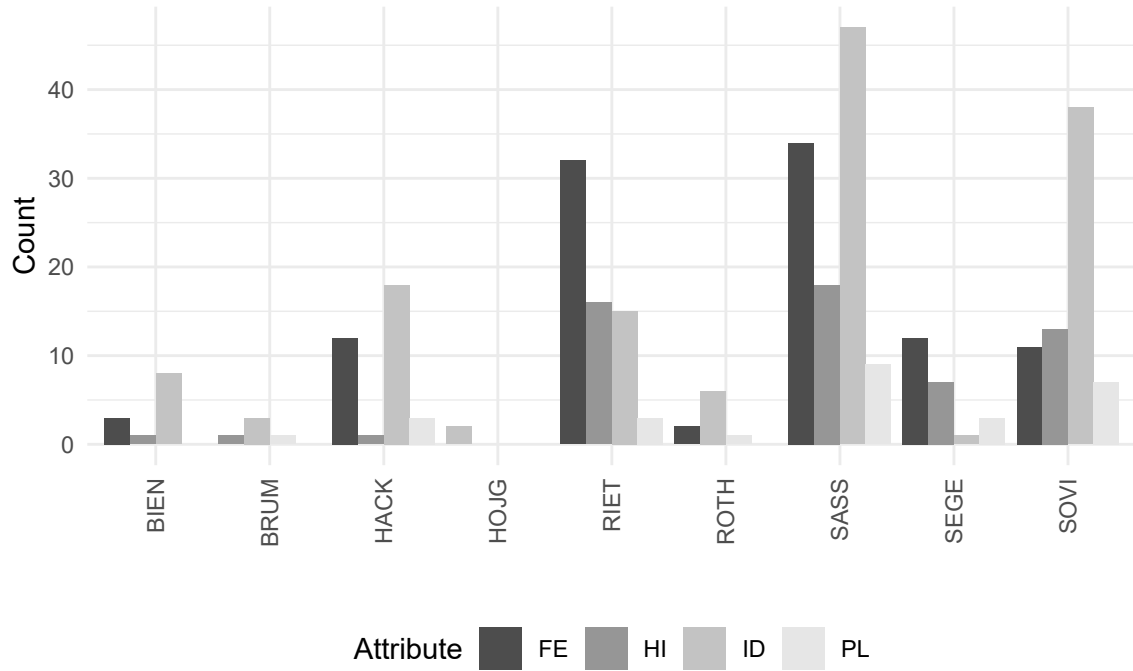

Raw Material



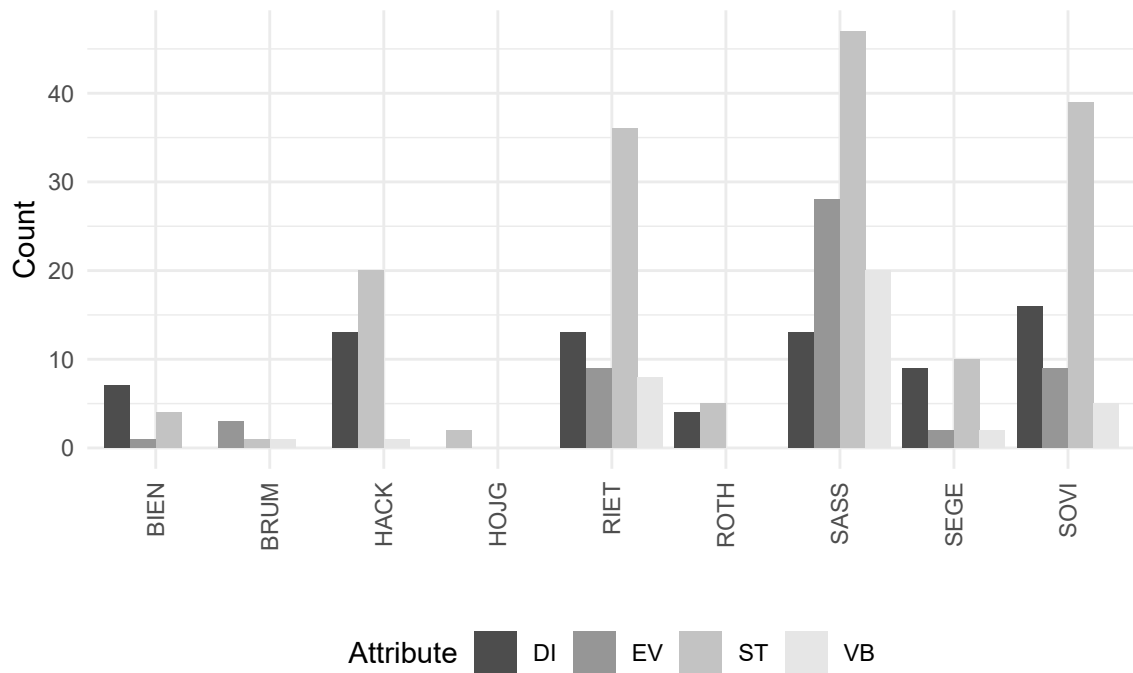
Dorsal Blade Profile



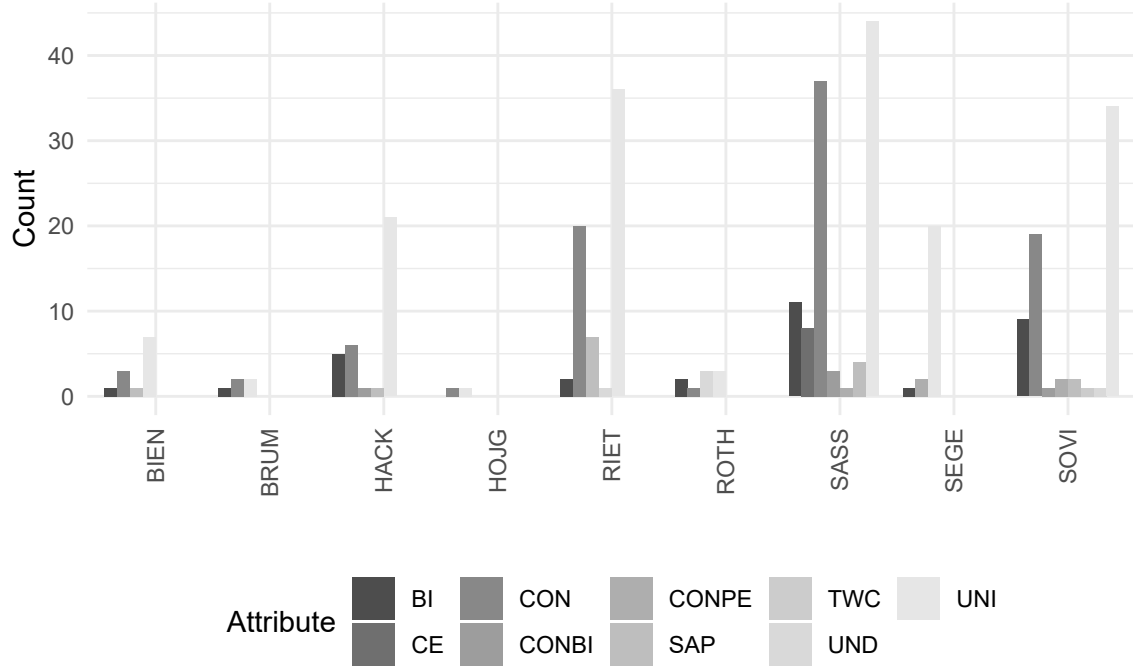
Blade Determination Profile



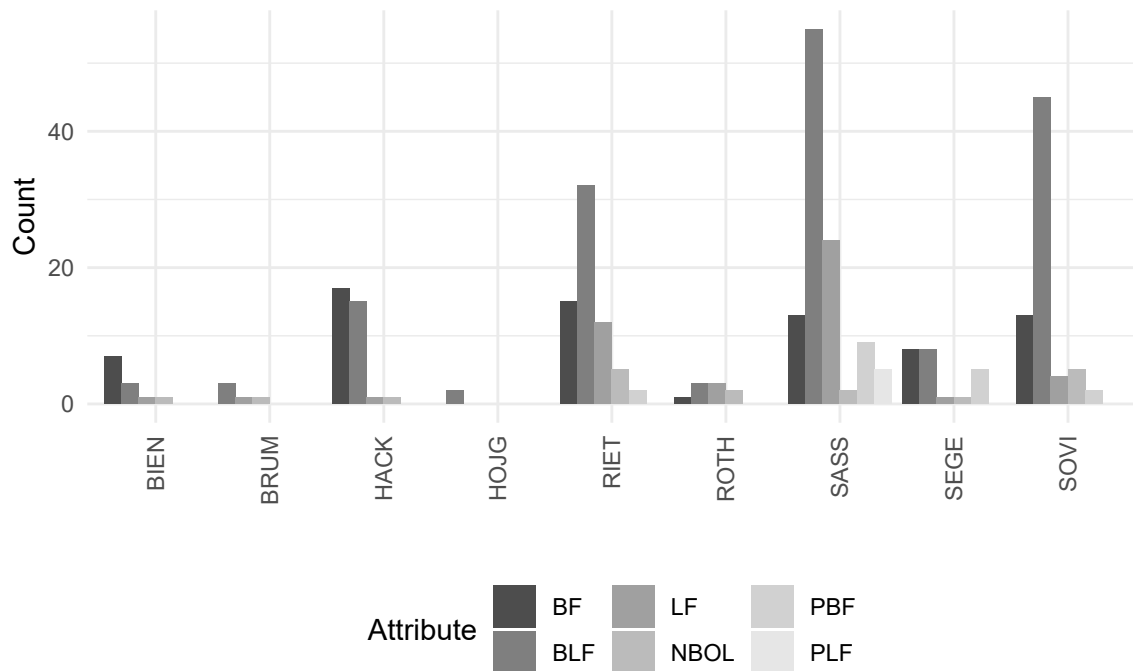
Blade Curvature



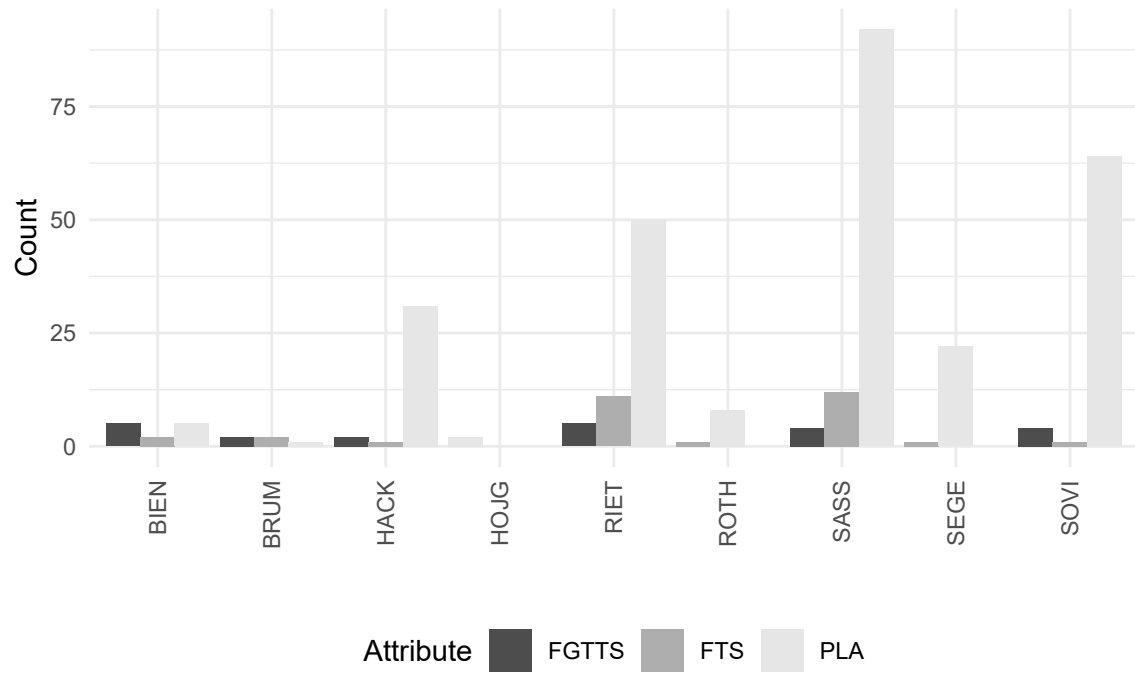
Dorsal Pattern Profile



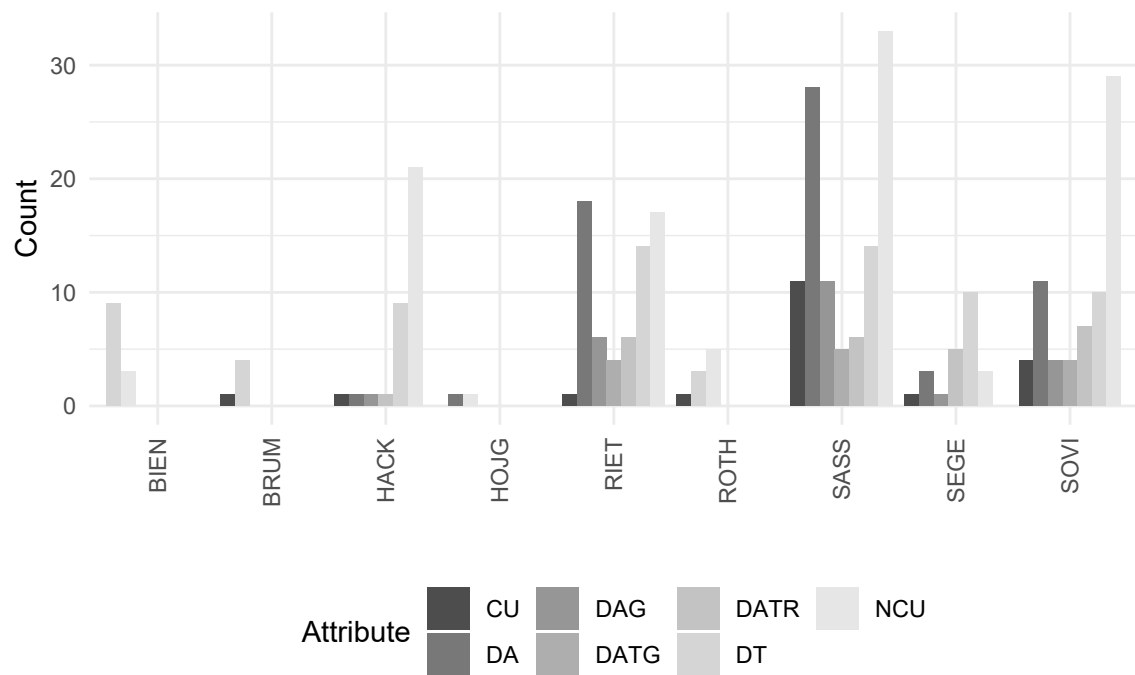
Bulb Morphology



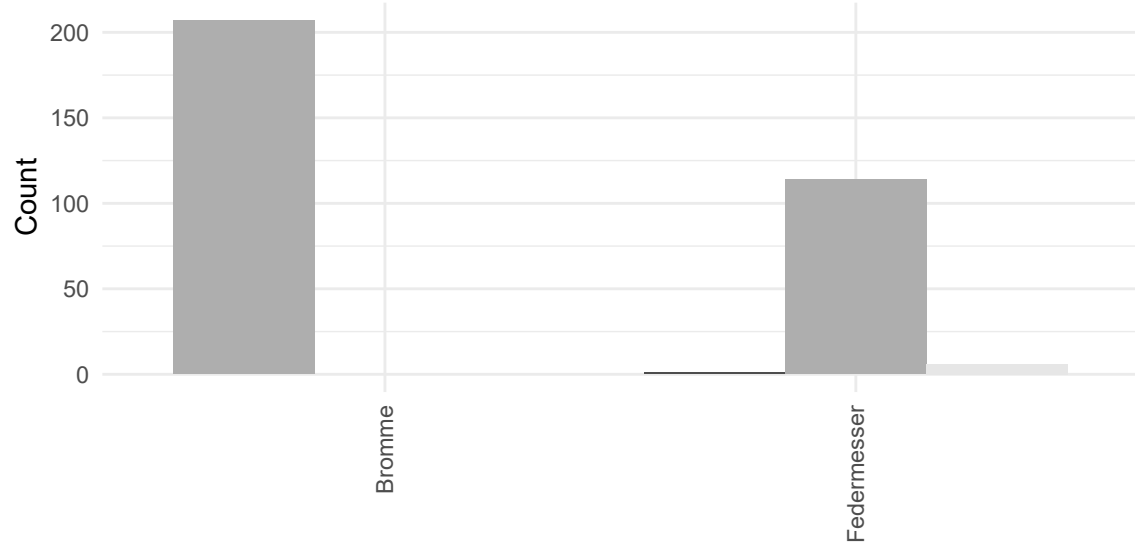
Butt Preparation Method #1



Butt Preparation Method #2

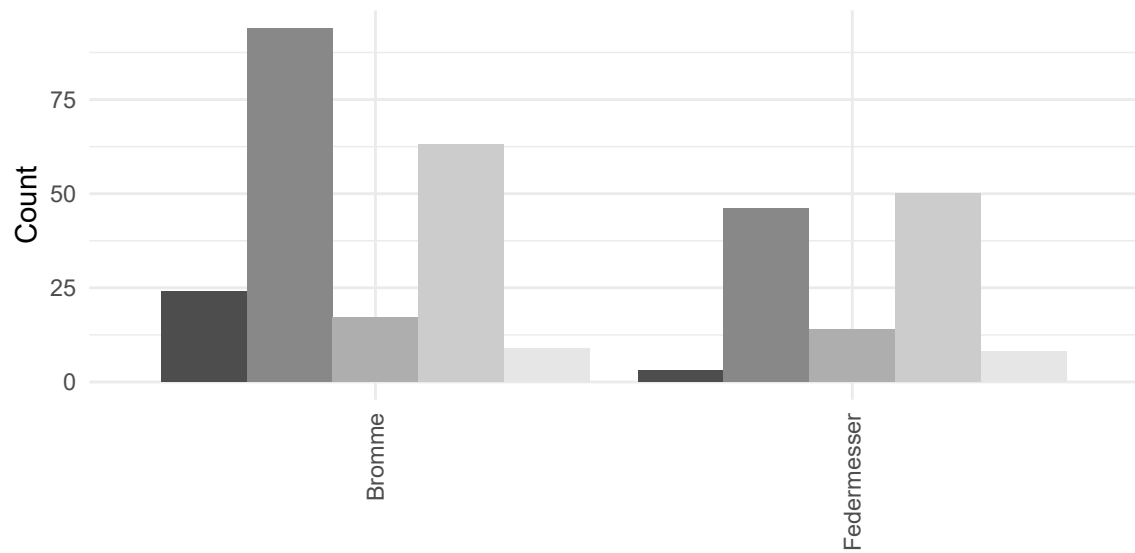


Raw Material



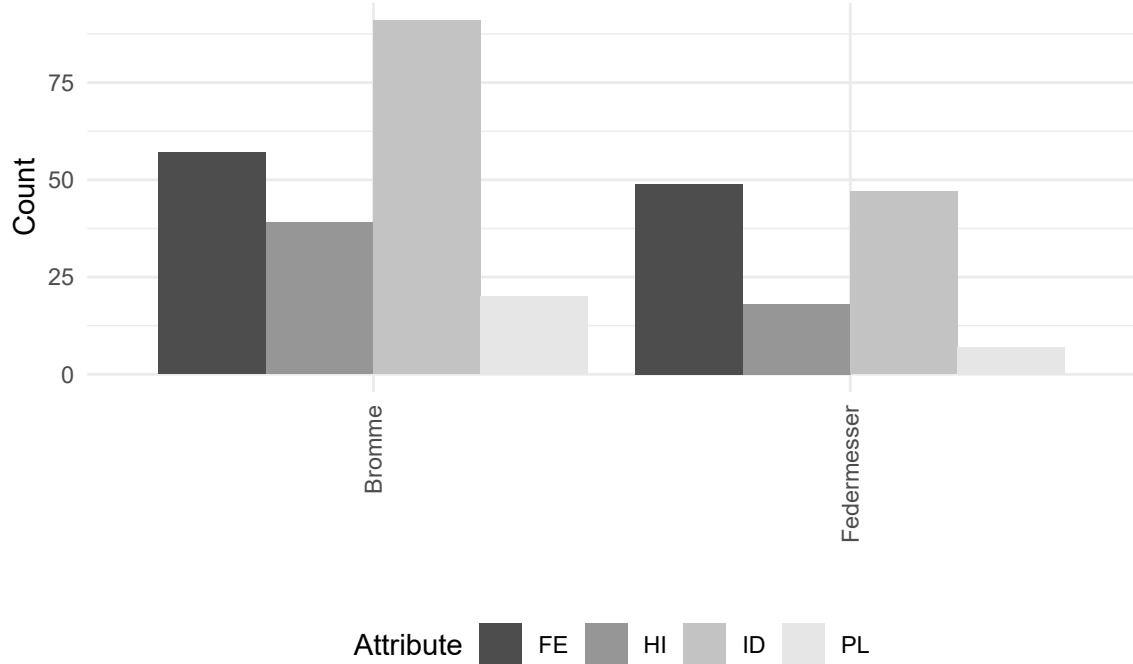
Type Chert Flint Ludite

Dorsal Blade Profile

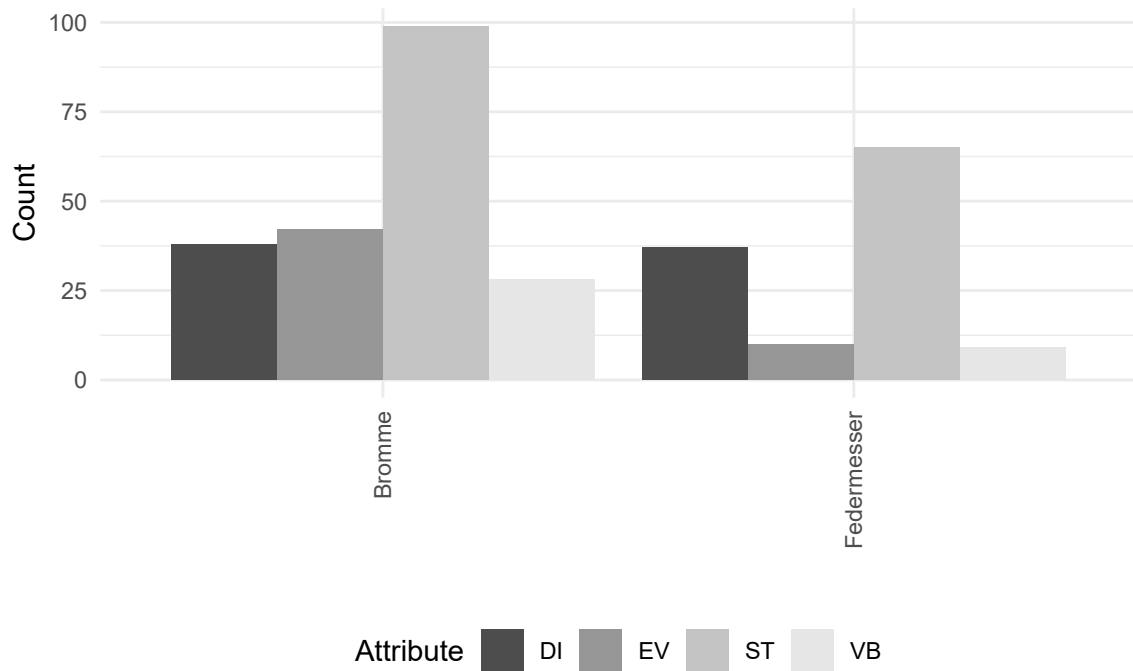


Attribute MDF TDNC TDOC THDNC THDOC

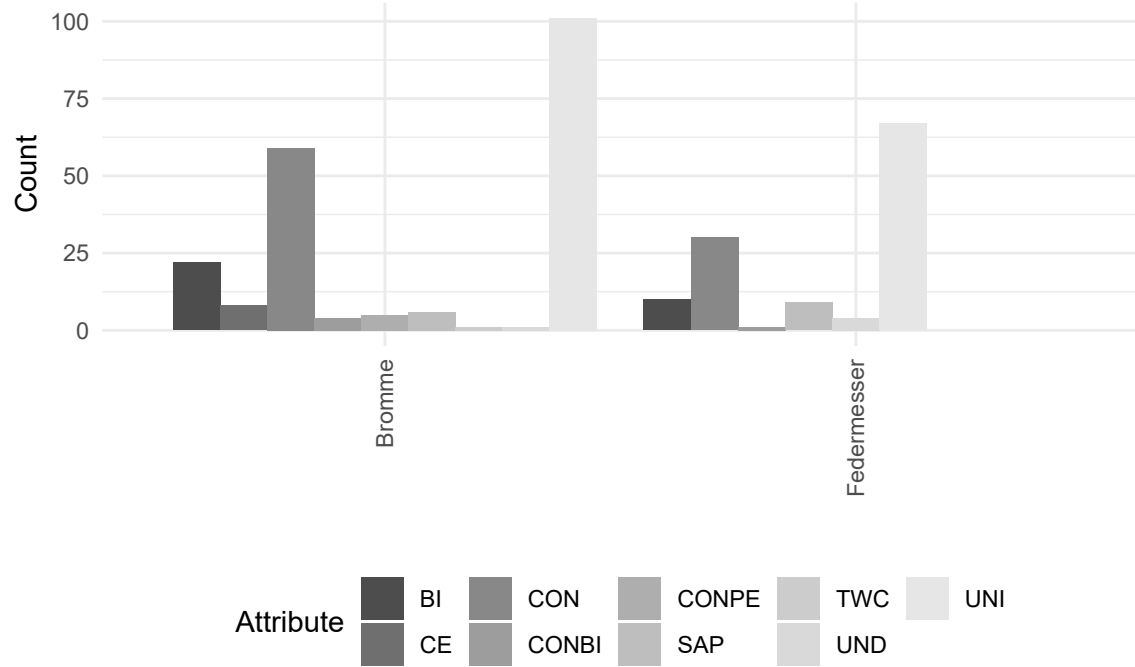
Blade Determination Profile



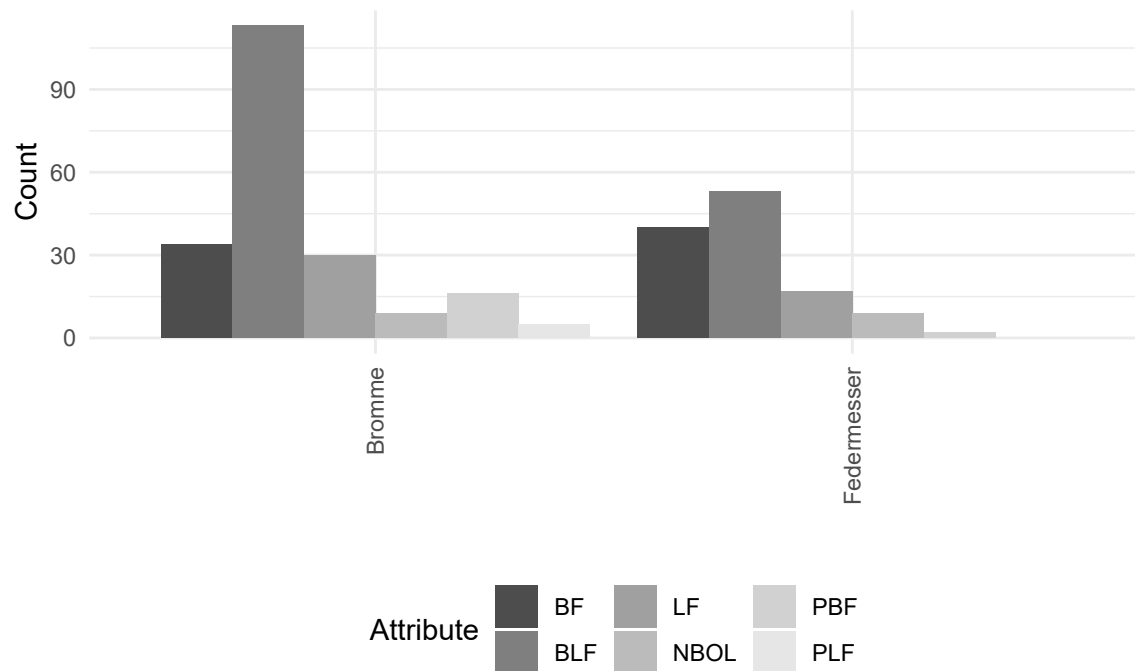
Blade Curvature



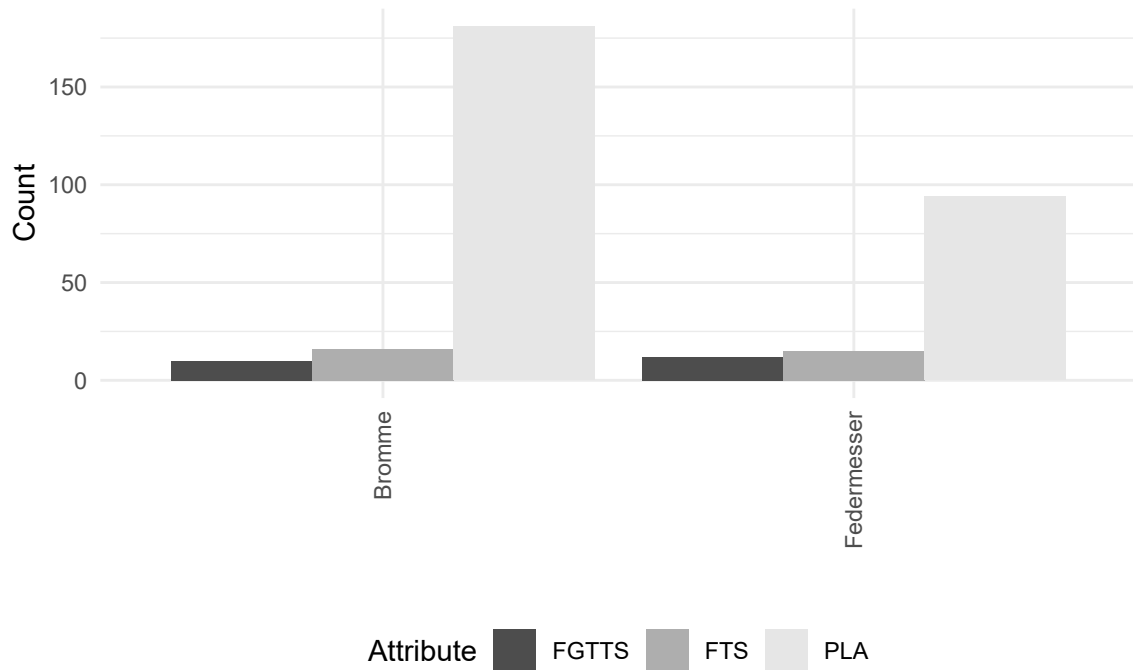
Dorsal Pattern Profile



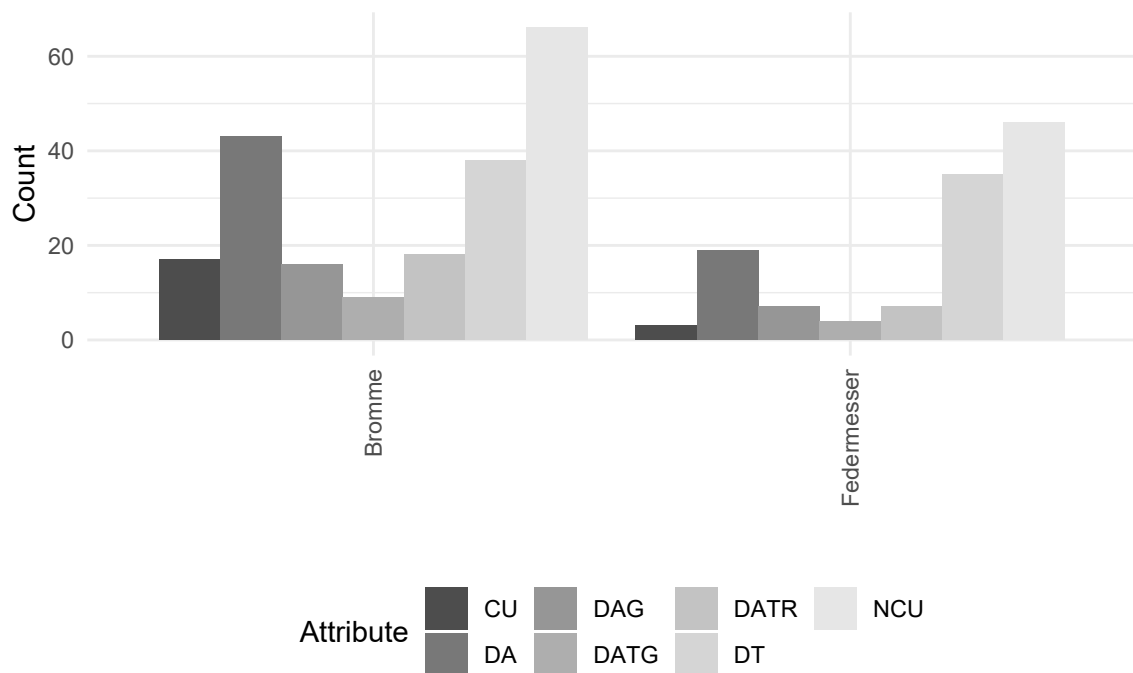
Bulb Morphology



Butt Preparation Method #1

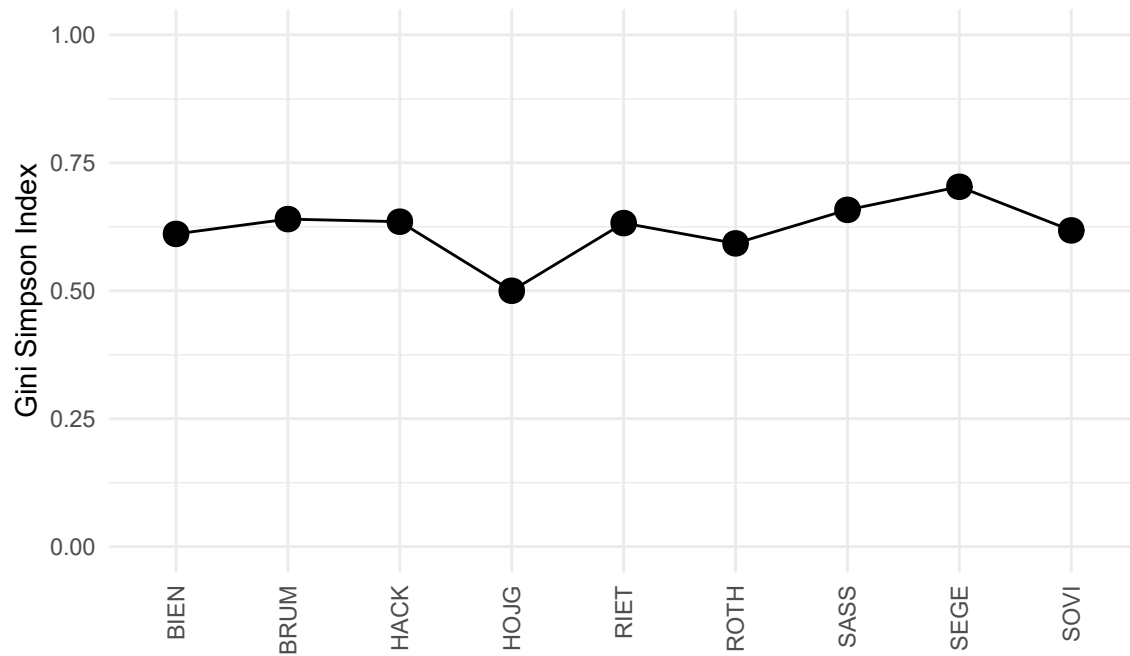


Butt Preparation Method #2

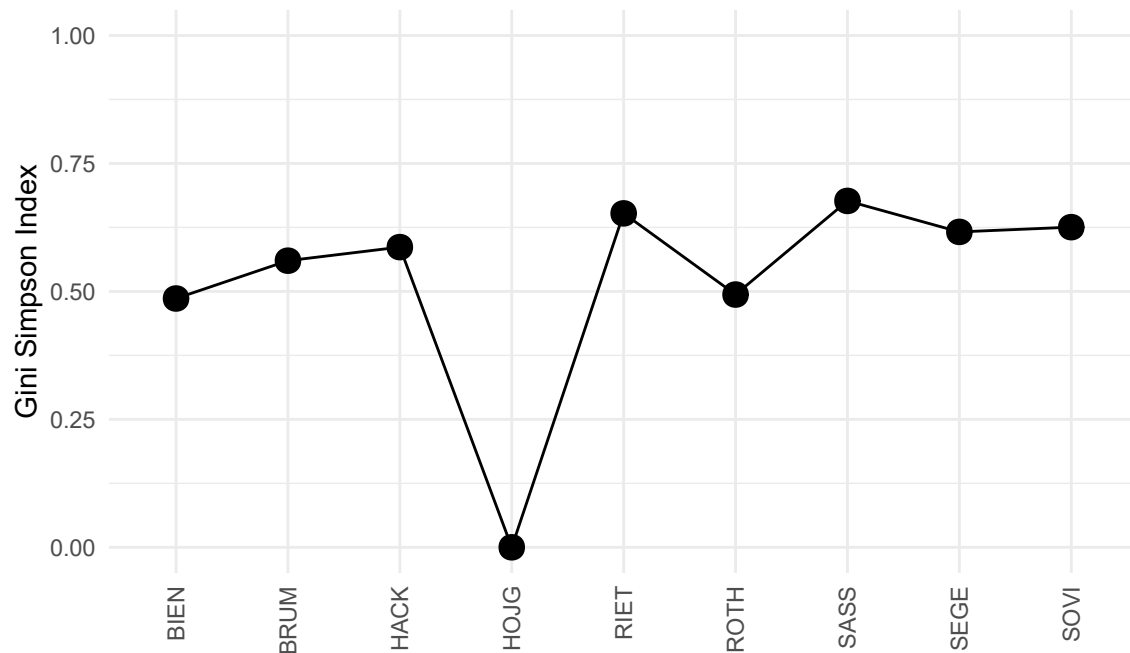


Gini-Simpson and Morisita-Horn diversity indices

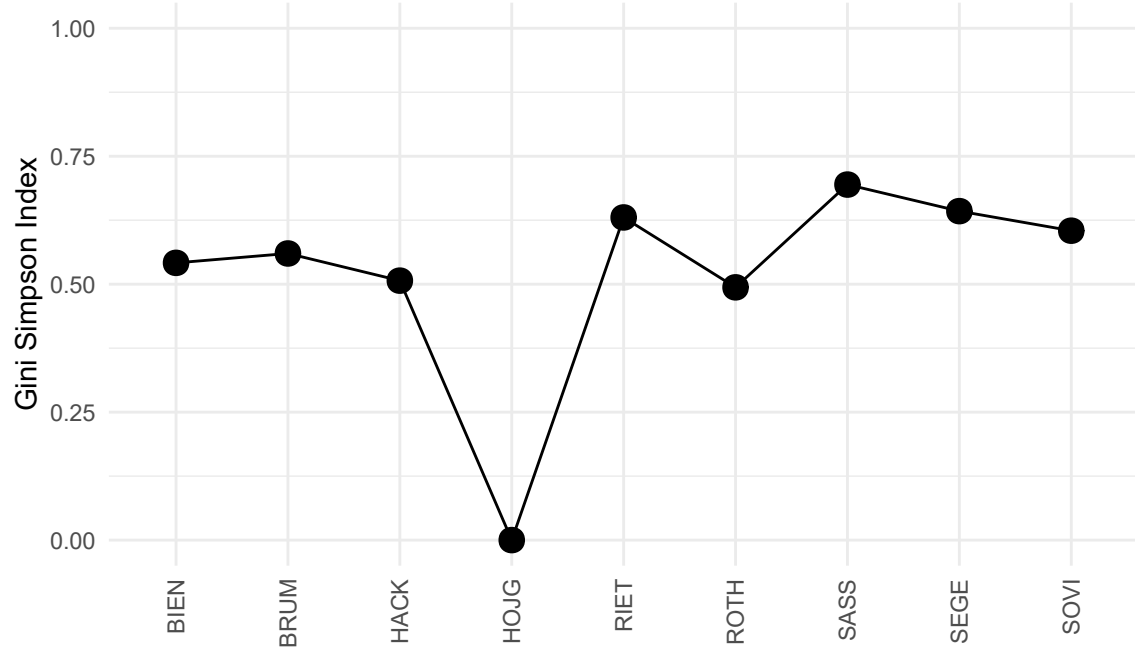
Dorsal Profile



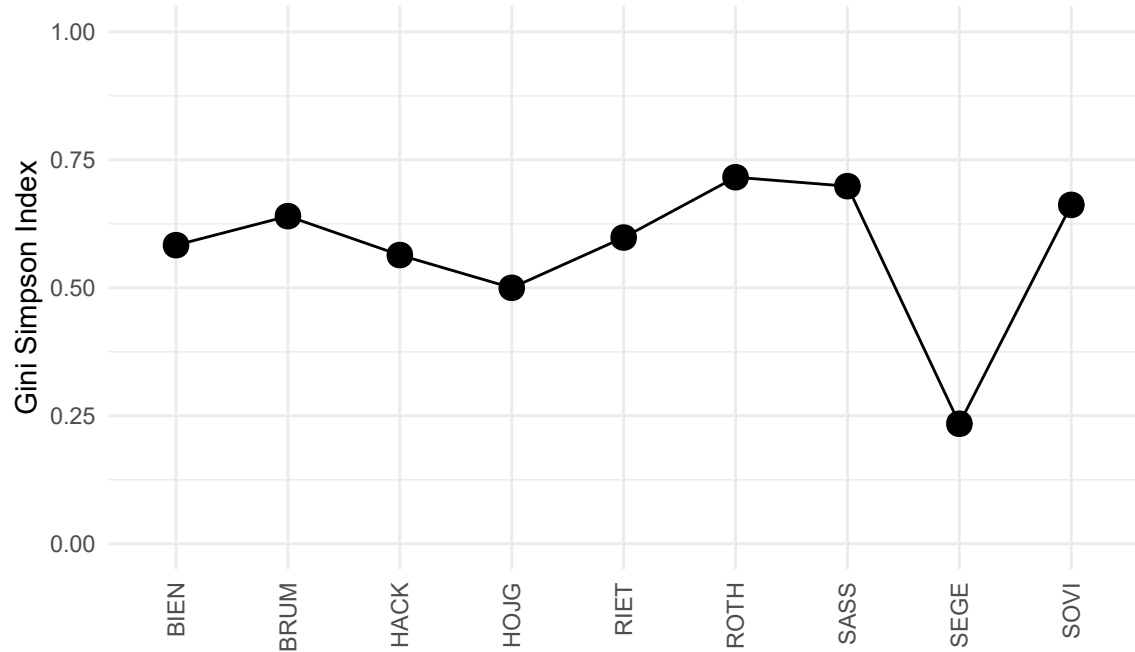
Blade Determination Profile



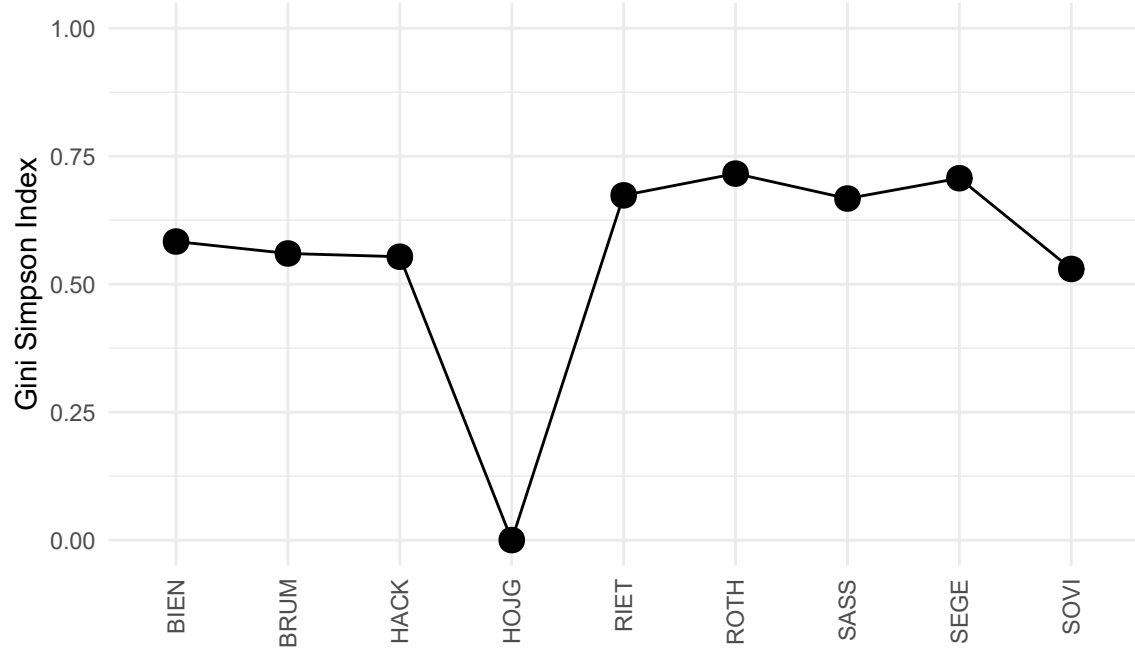
Blade Curvature



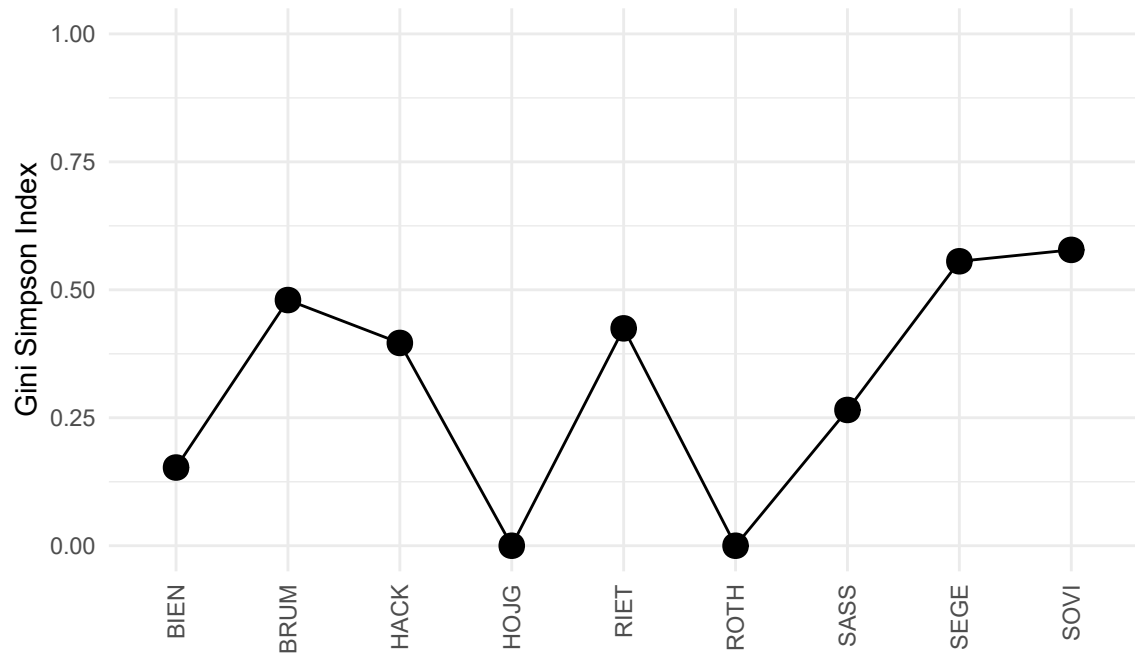
Dorsal Pattern



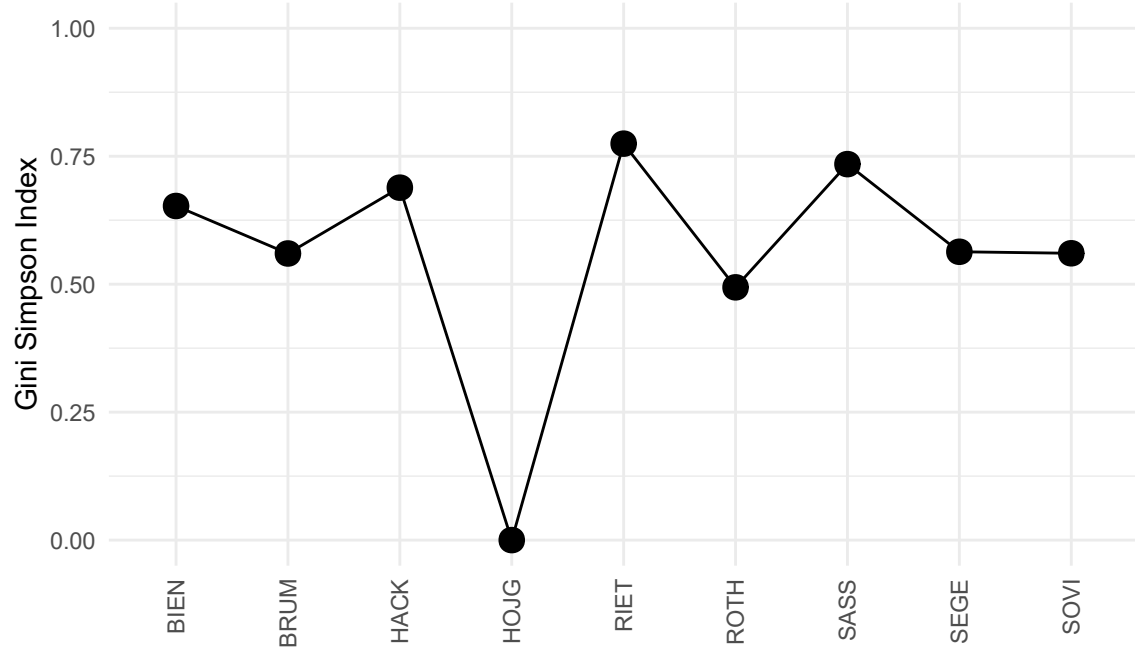
Bulb Morphology



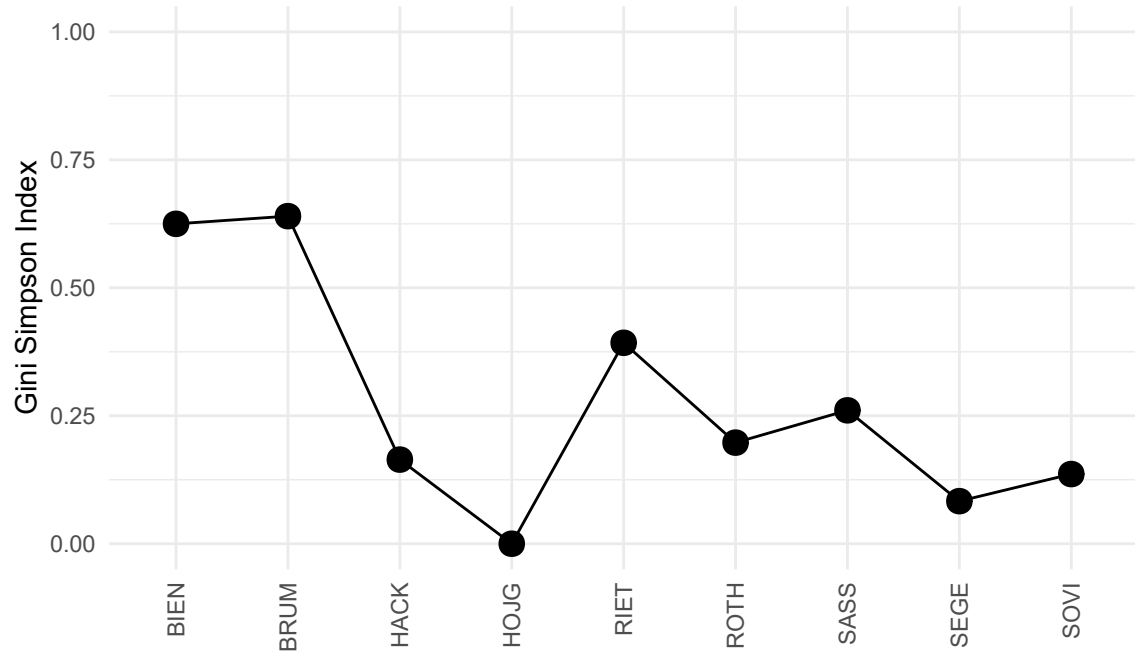
Conus Formation



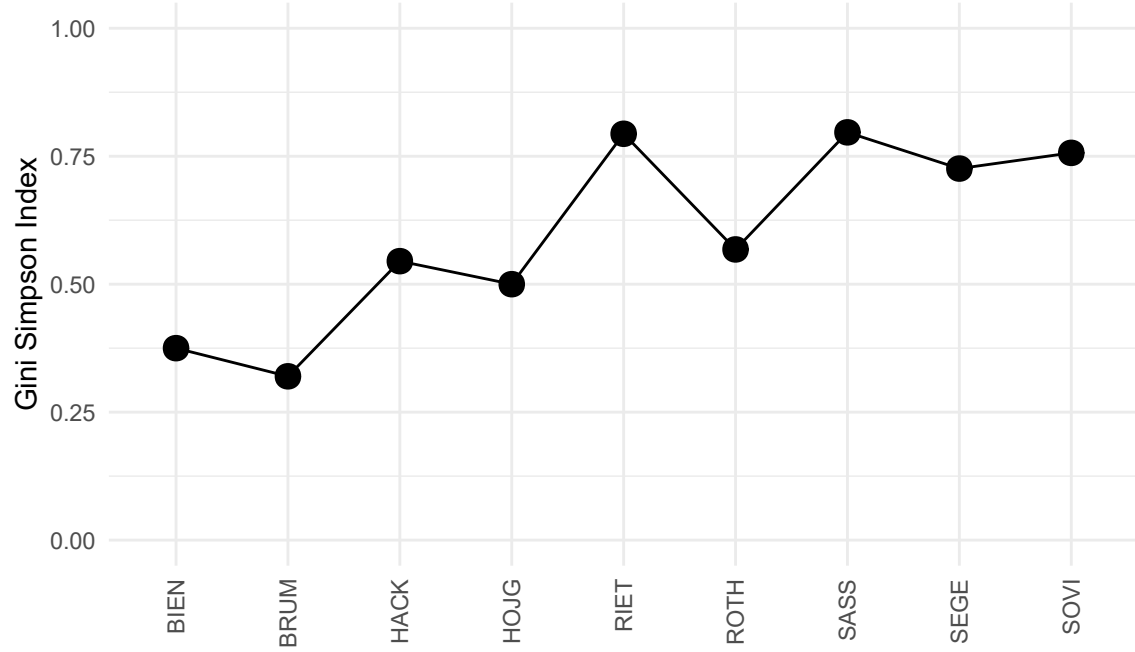
Butt Morphology



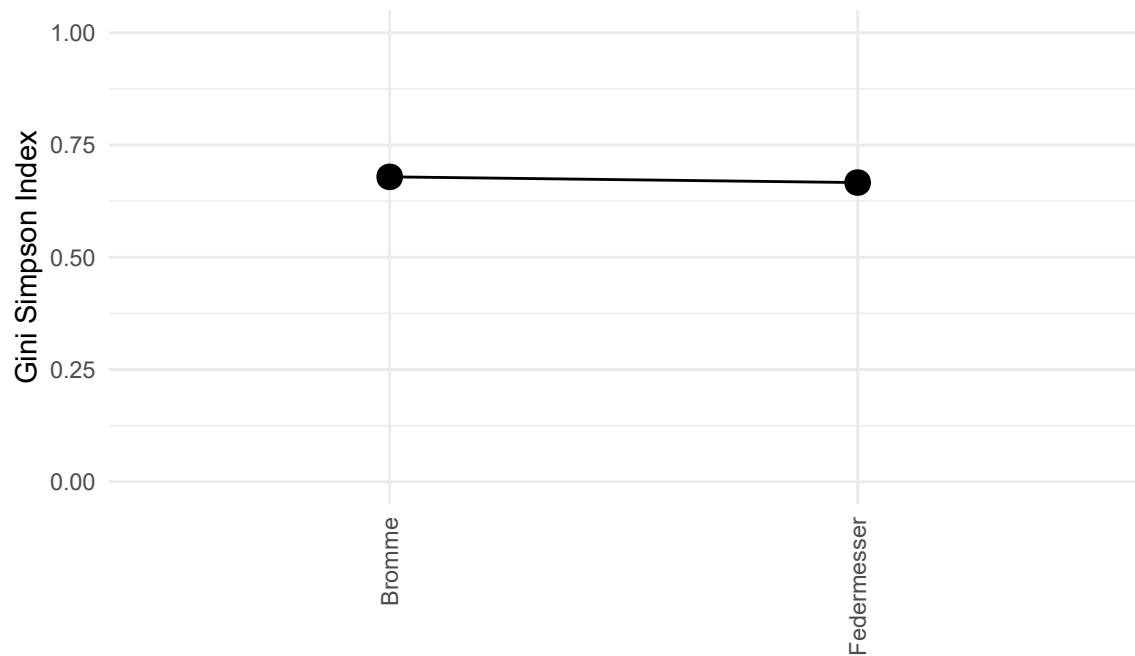
Butt Preparation #1



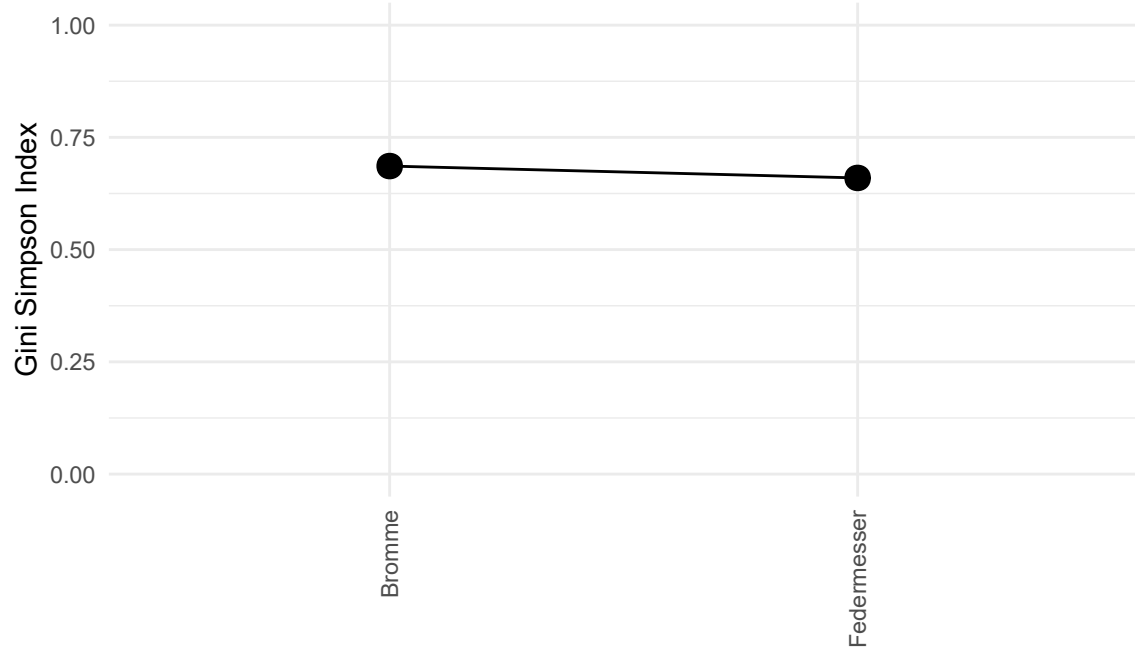
Butt Preparation #2



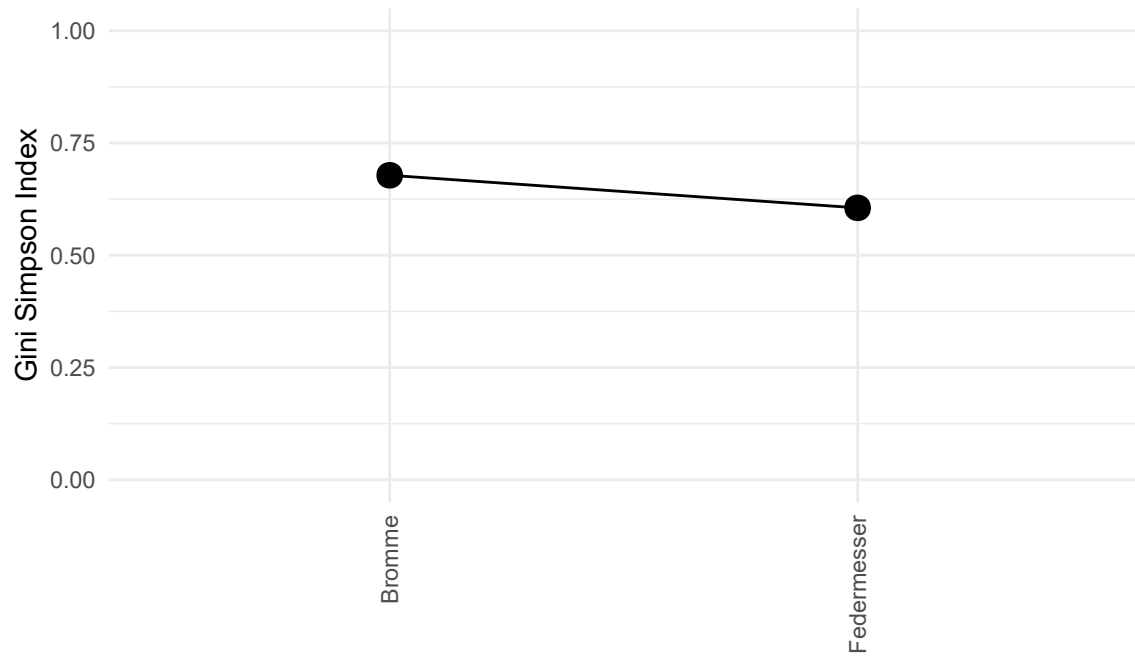
Dorsal Profile



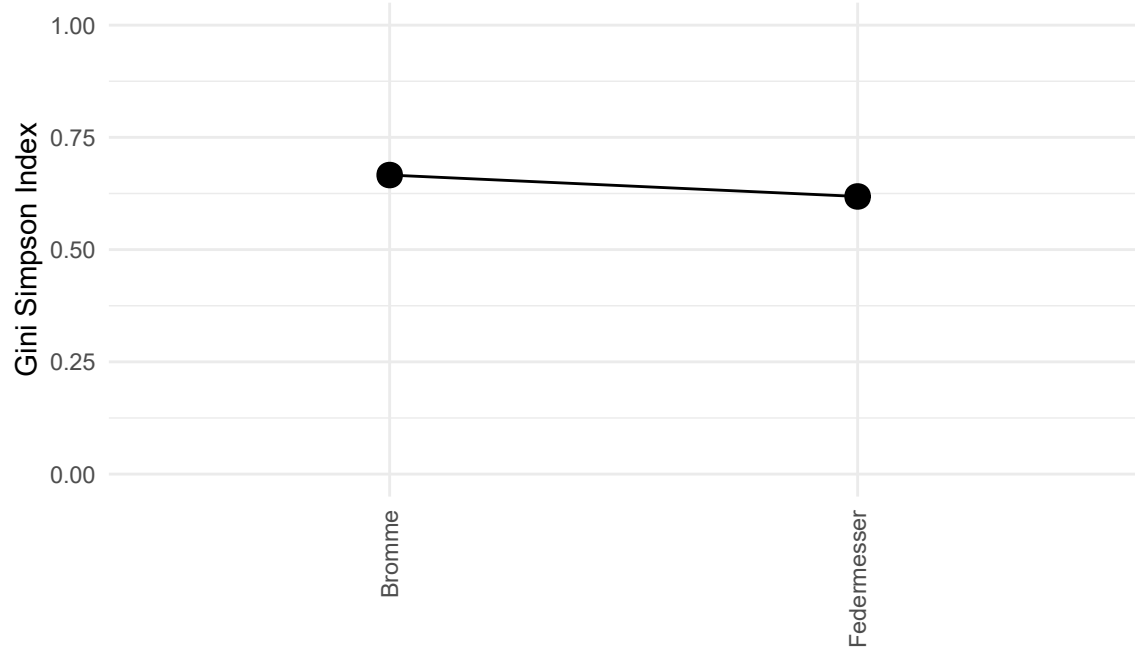
Blade Determination Profile



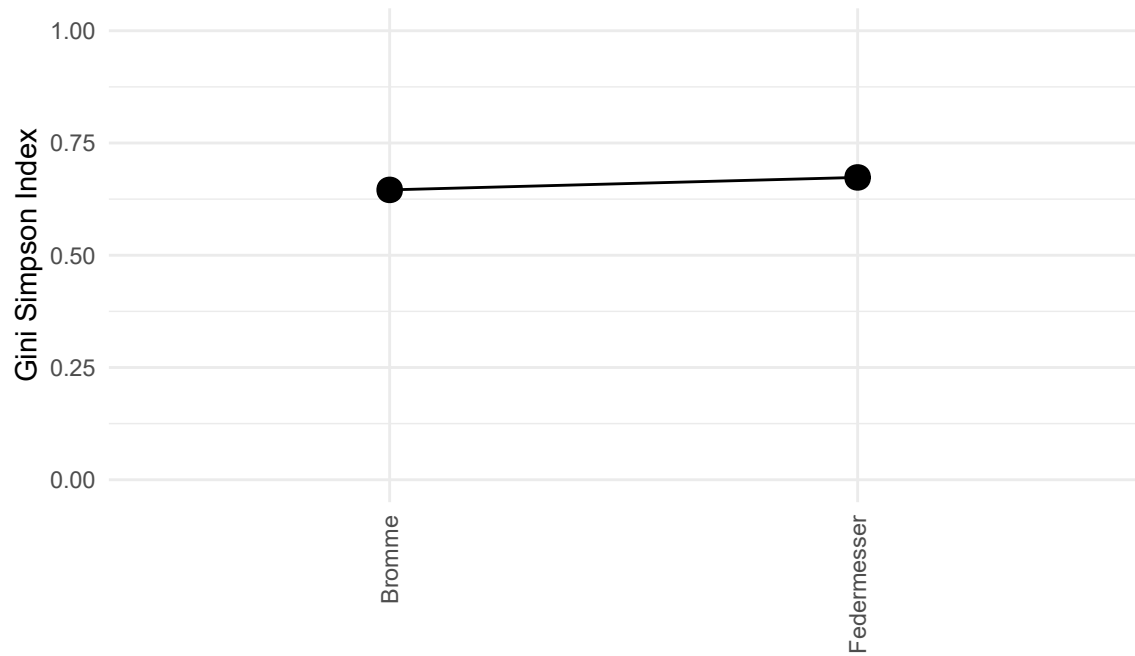
Blade Curvature



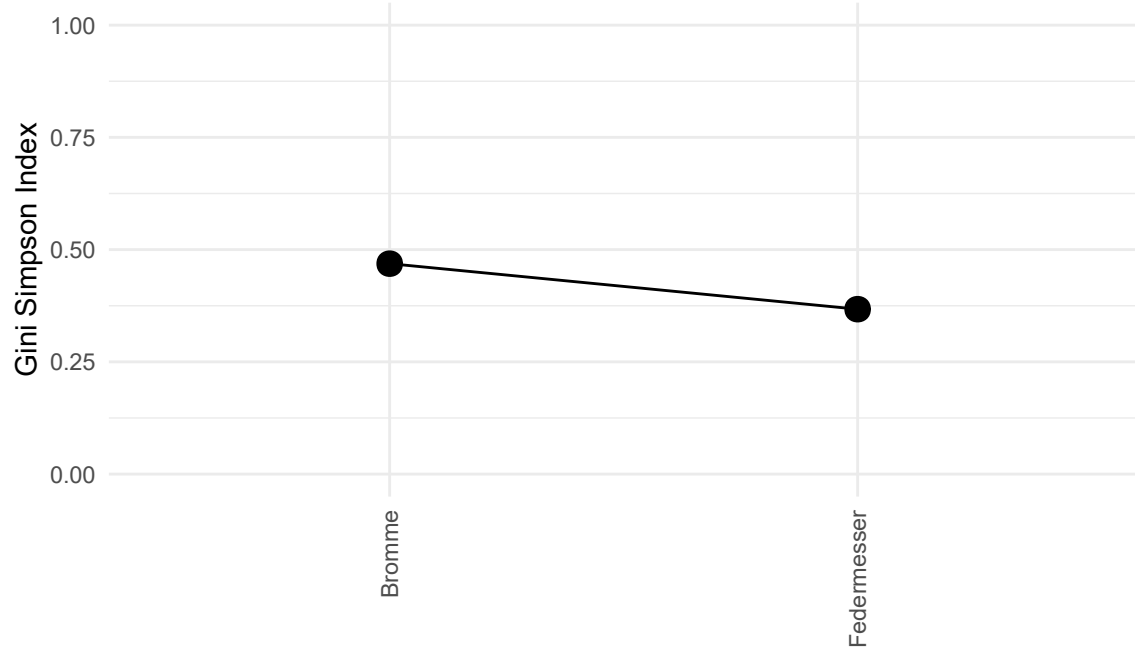
Dorsal Pattern



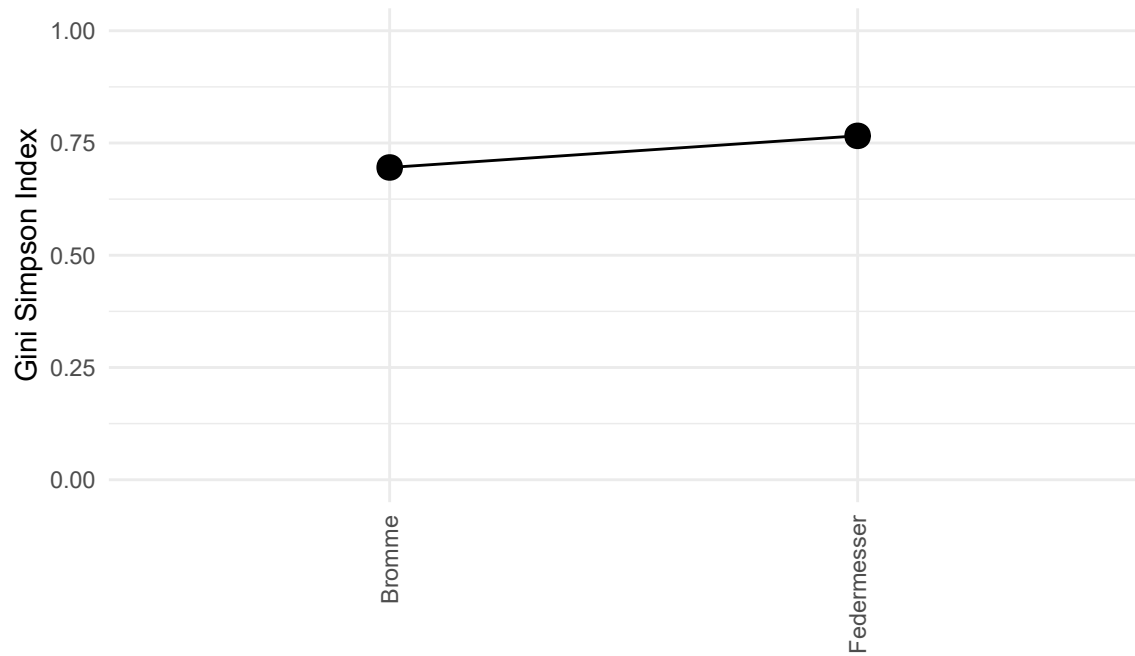
Bulb Morphology



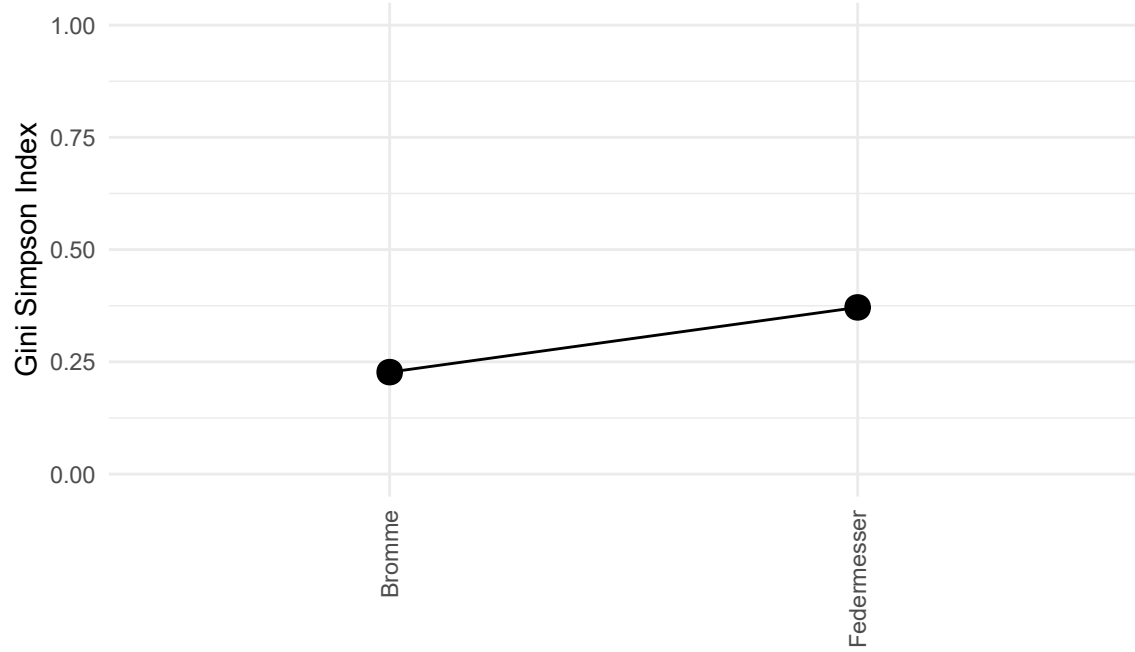
Conus Formation



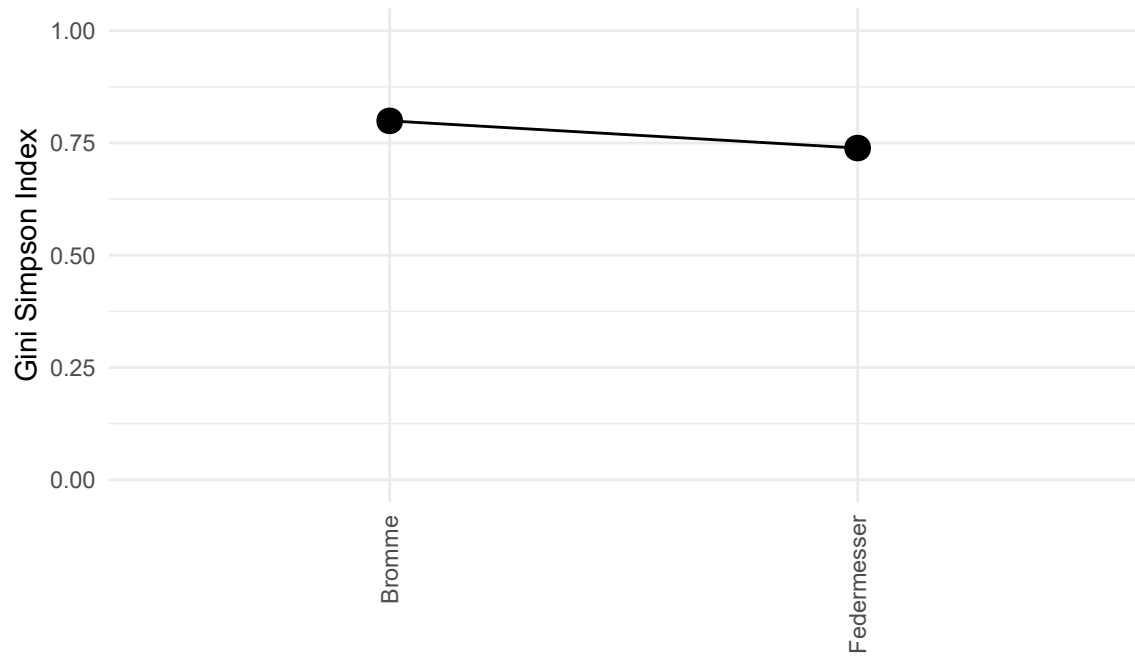
Butt Morphology



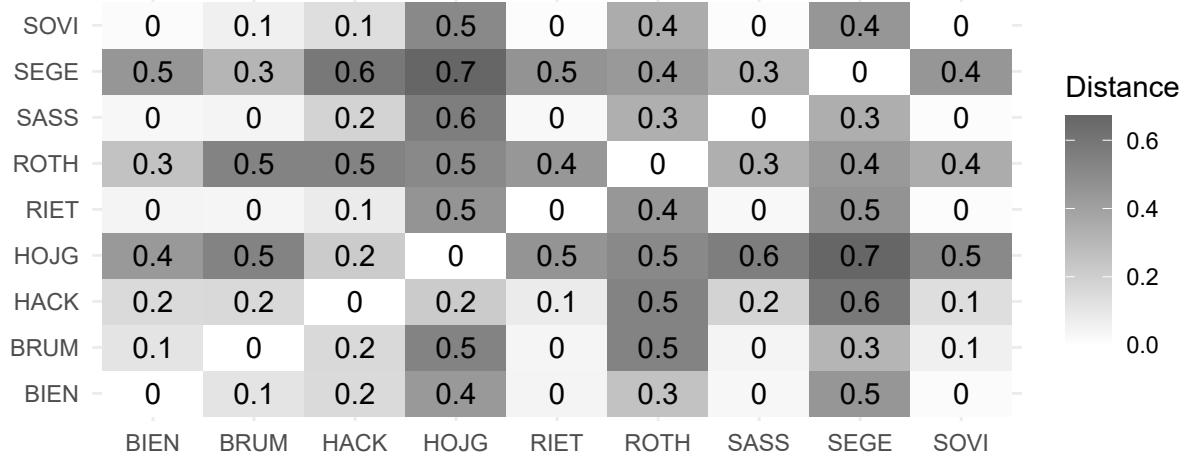
Butt Preparation #1



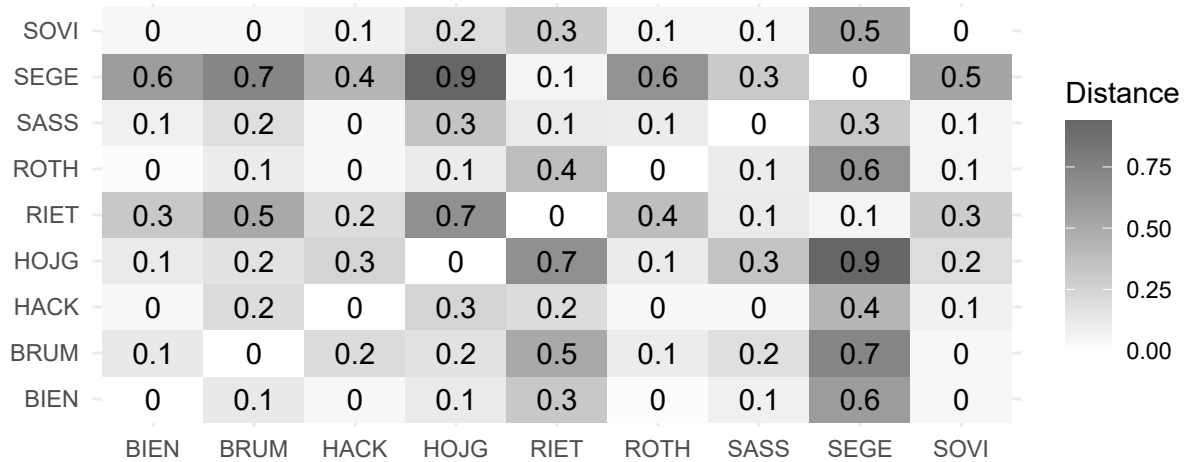
Butt Preparation #2



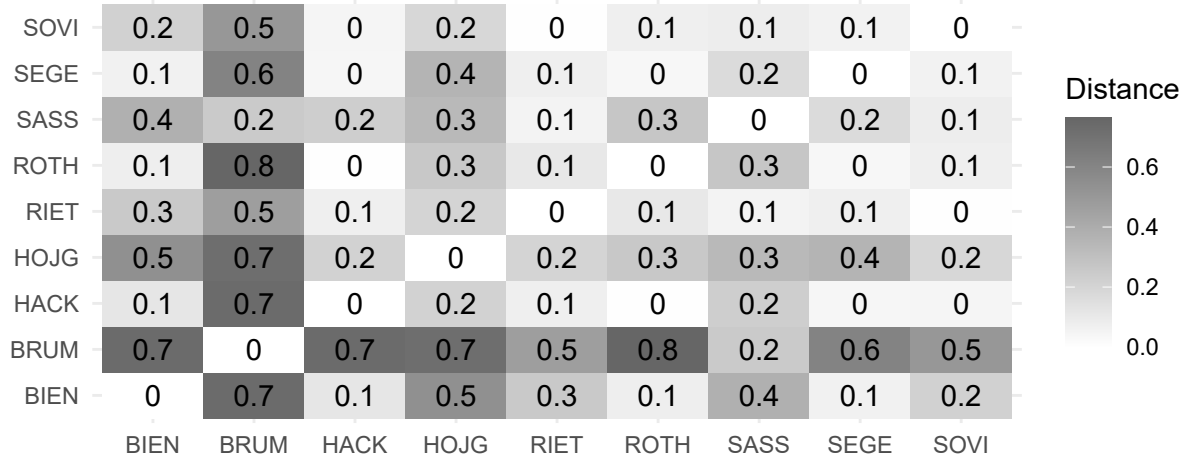
Dorsal Profile: Morisita-Horn Index



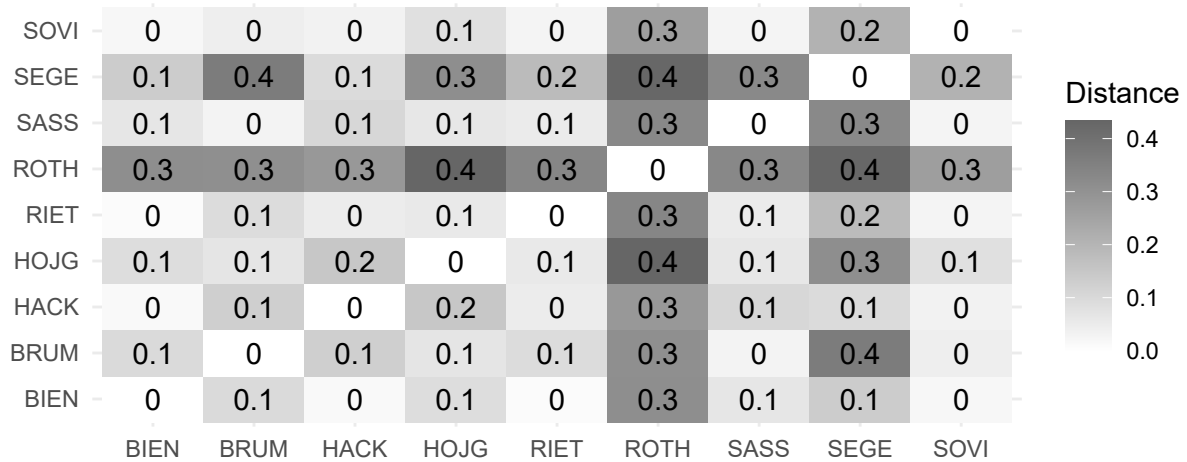
Blade Determination Profile: Morisita-Horn Index



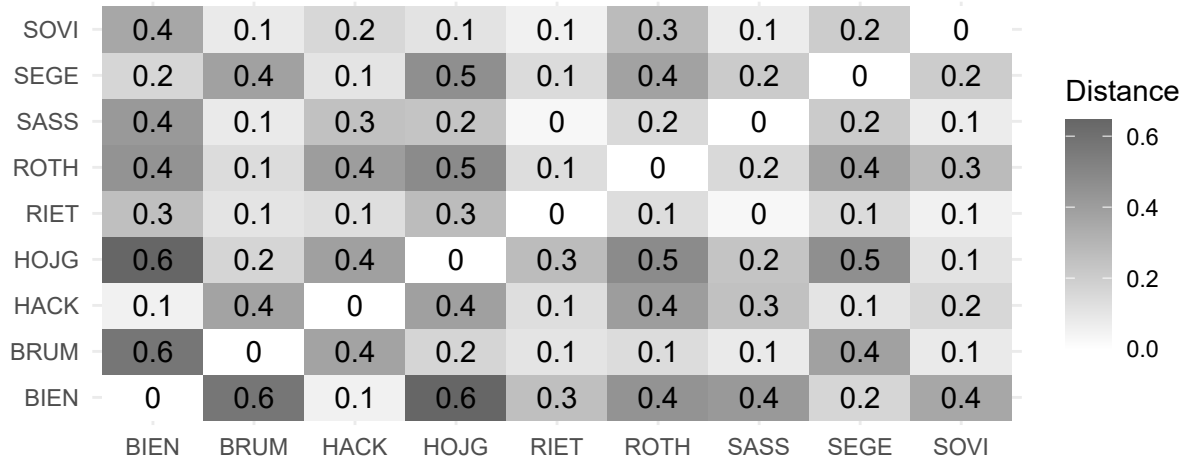
Blade Curvature: Morisita-Horn Index



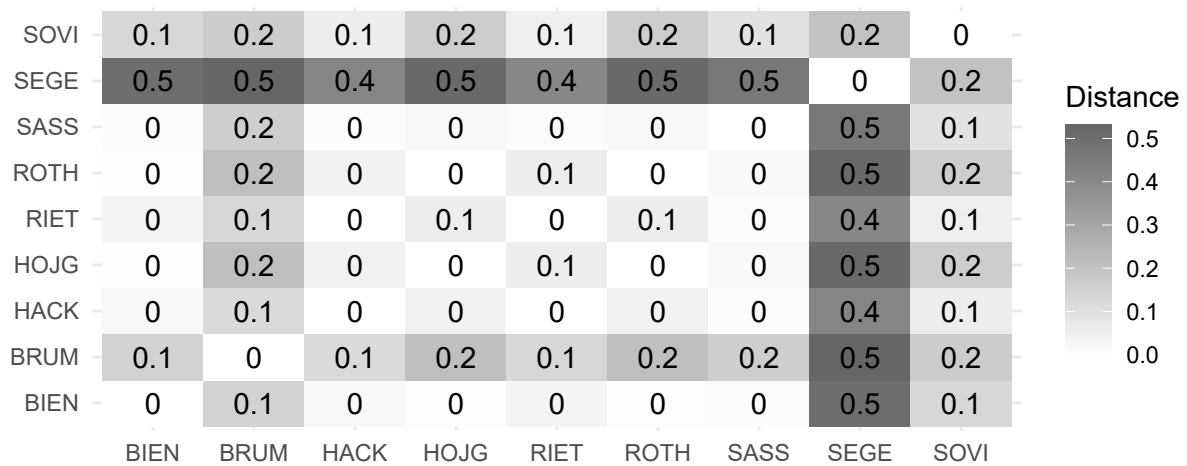
Dorsal Pattern: Morisita-Horn Index



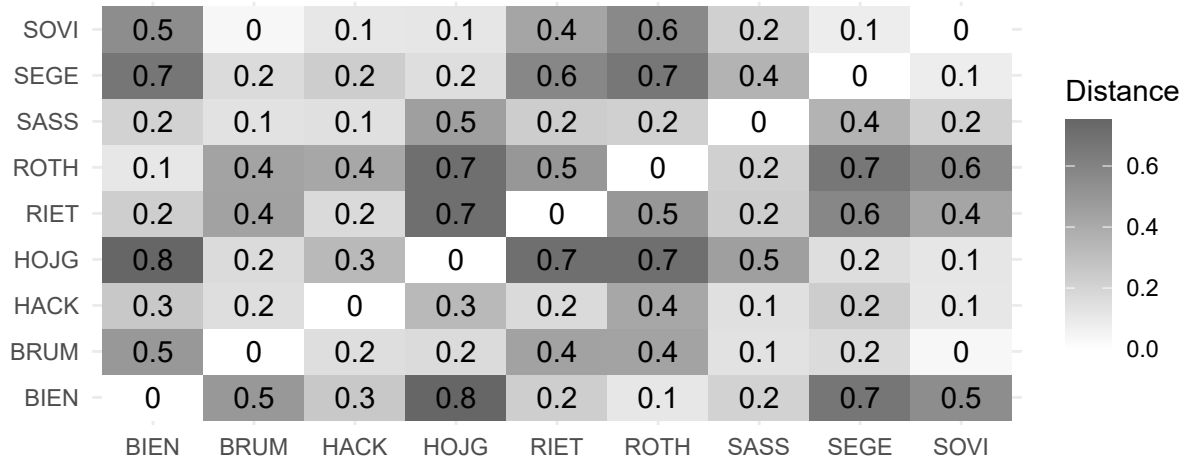
Bulb Morphology: Morisita-Horn Index



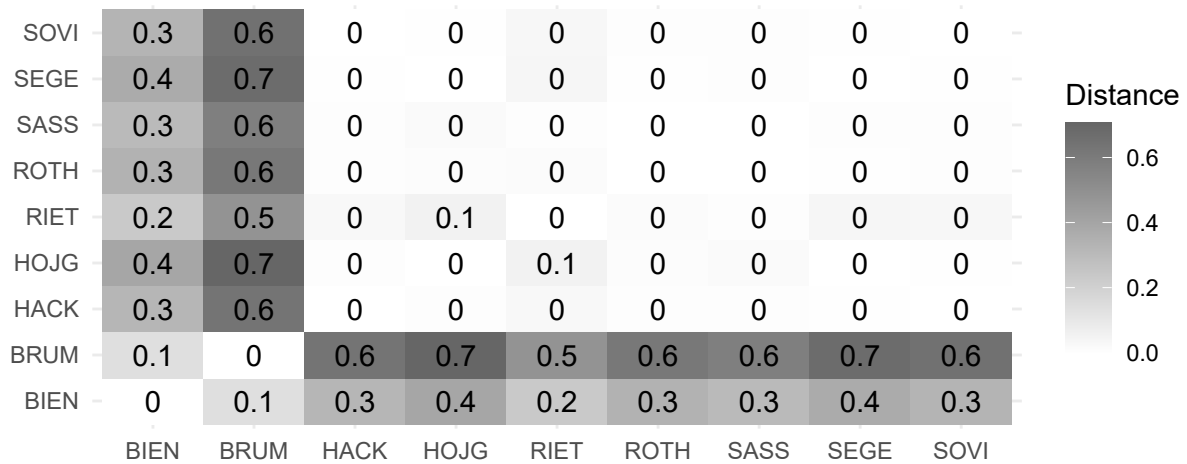
Conus Formation: Morisita-Horn Index



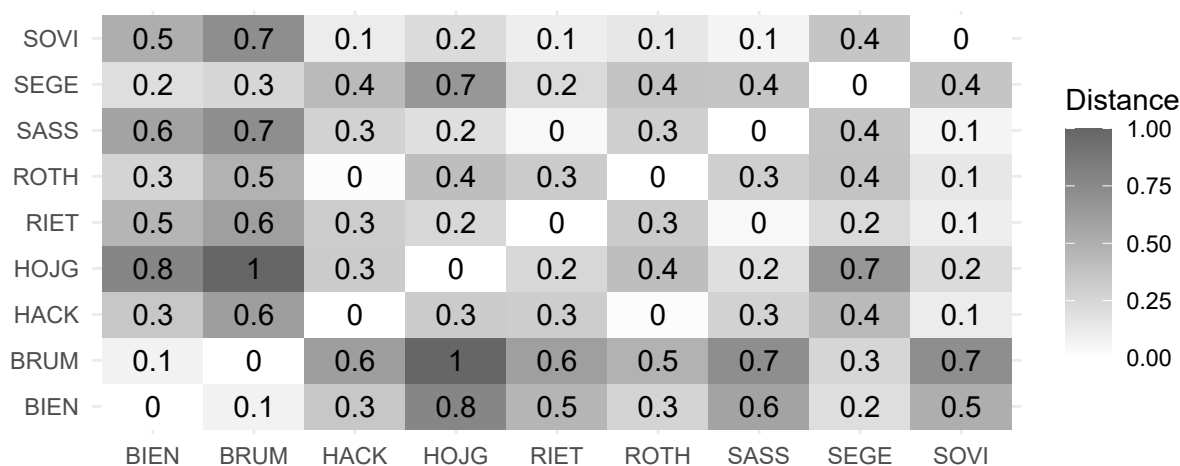
Butt Morphology: Morisita-Horn Index



Butt Preparation #1: Morisita-Horn Index



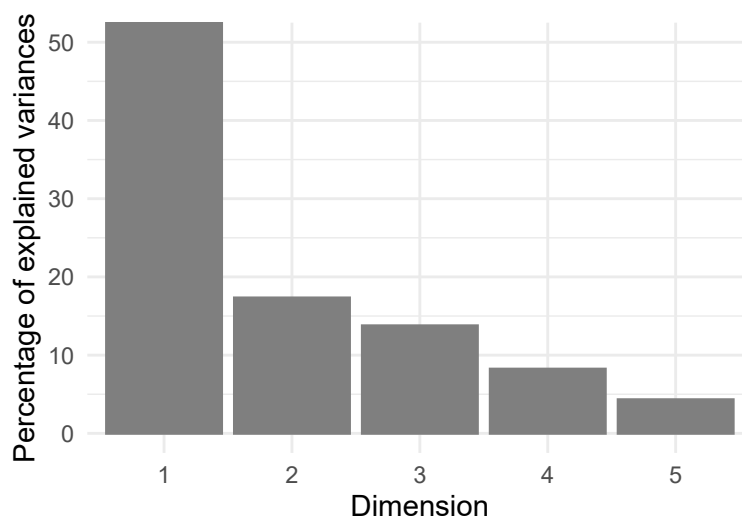
Butt Preparation #2: Morisita-Horn Index



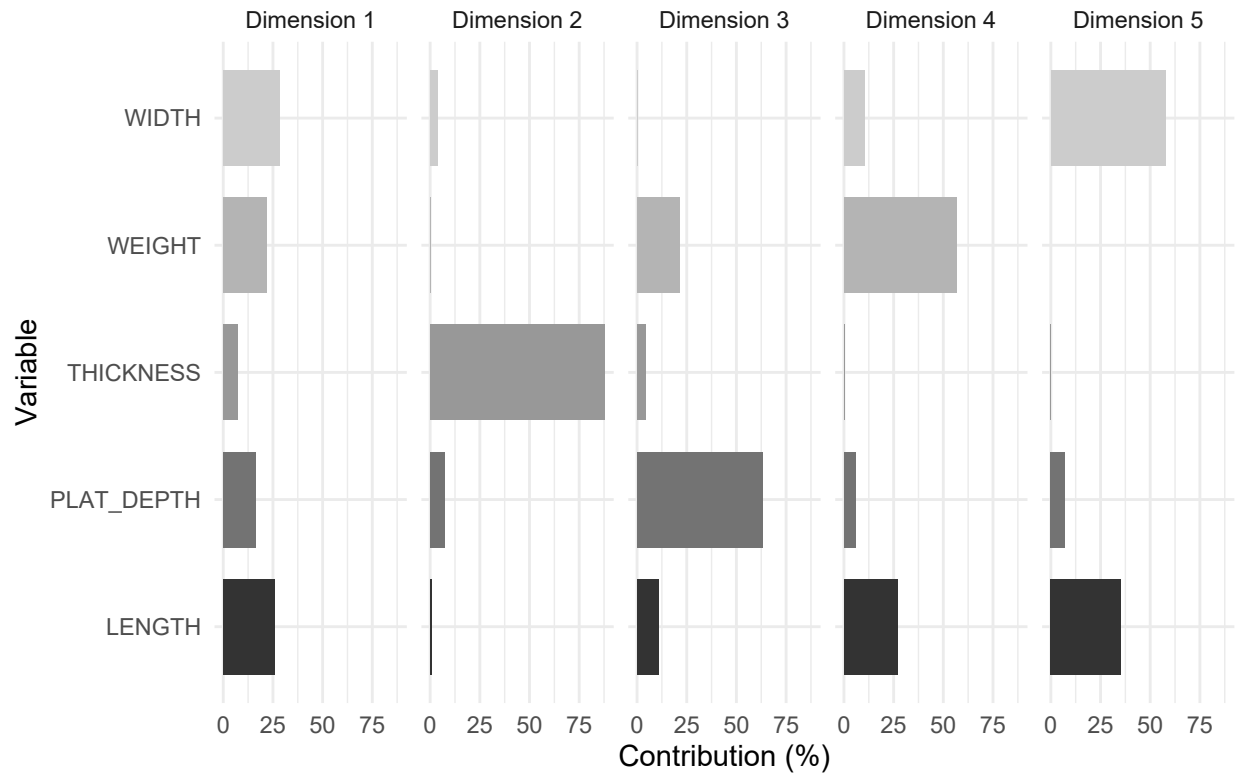
Principal Component Analysis (PCA)

Note: Elongation is omitted from this analysis as it is a combination of two pre-existing variables. Crested blades and broken/indistinguishable butts and bulbs are also omitted from this analysis.

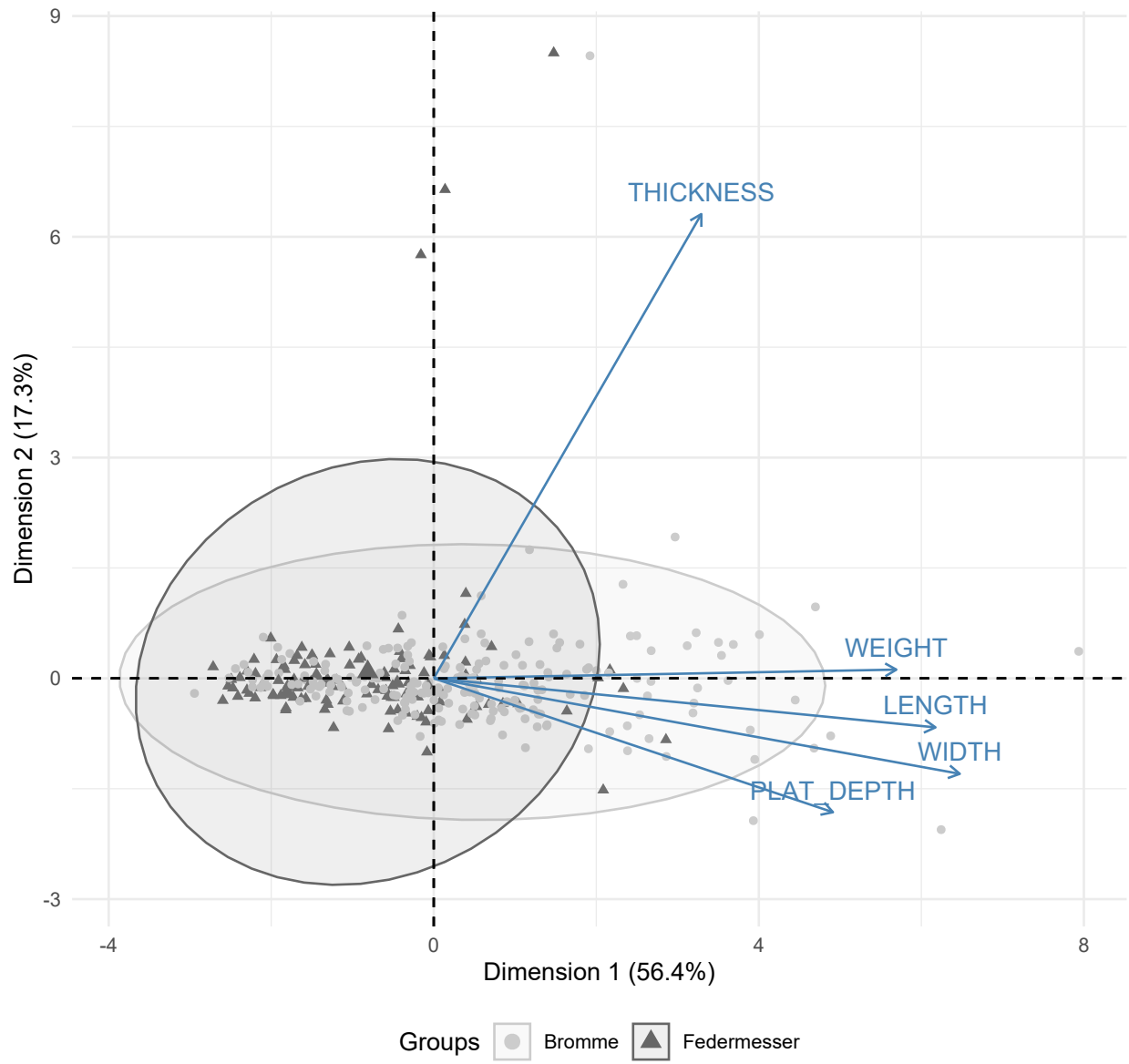
```
## # A tibble: 5 x 4
##   rowname eigenvalue variance cumulative
##   <chr>      <dbl>    <dbl>      <dbl>
## 1 Dim.1      2.82     56.4       56.4
## 2 Dim.2      0.866    17.3       73.7
## 3 Dim.3      0.688    13.8       87.5
## 4 Dim.4      0.411     8.22      95.7
## 5 Dim.5      0.215     4.31     100
```



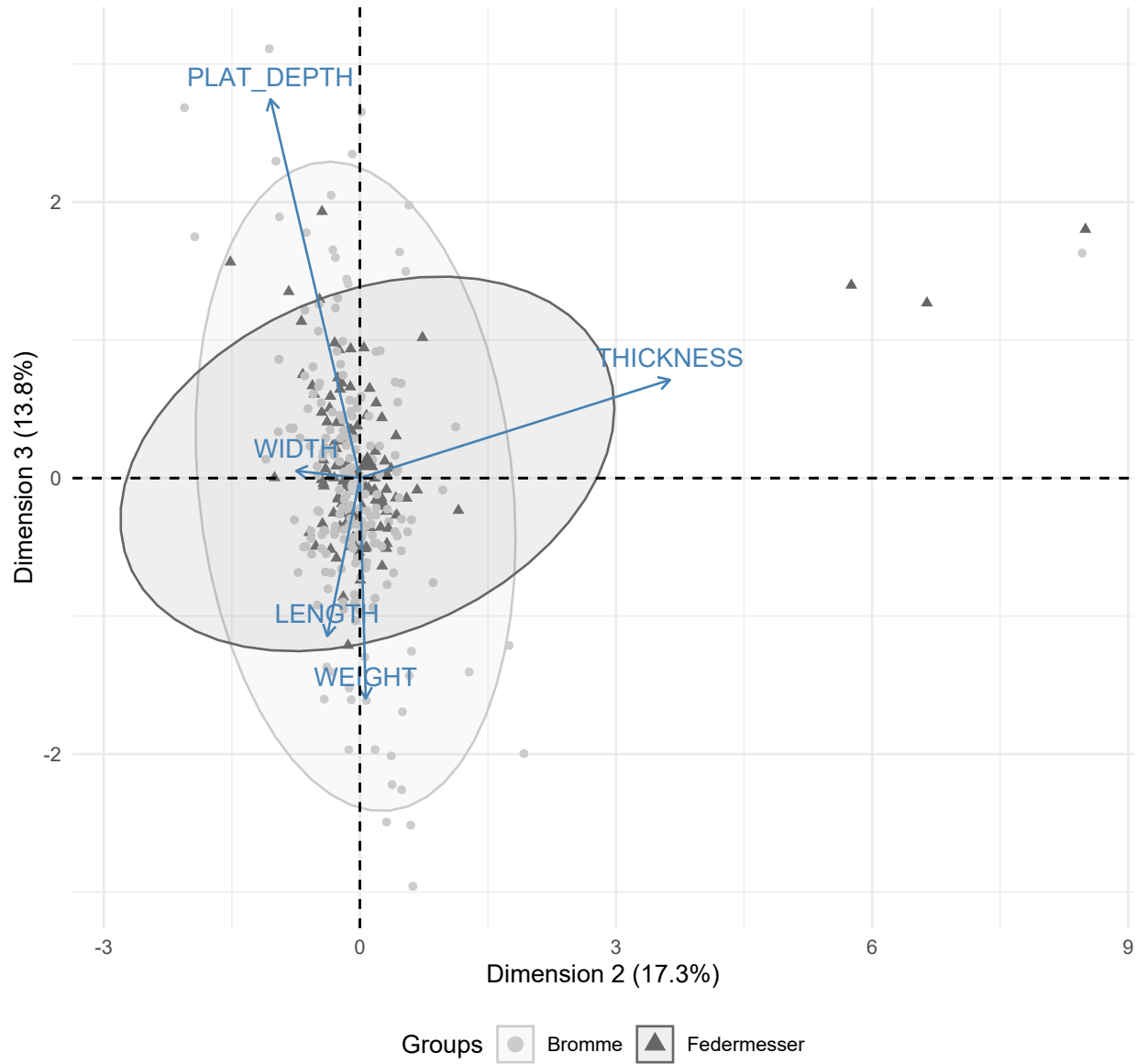
Contribution of Variables



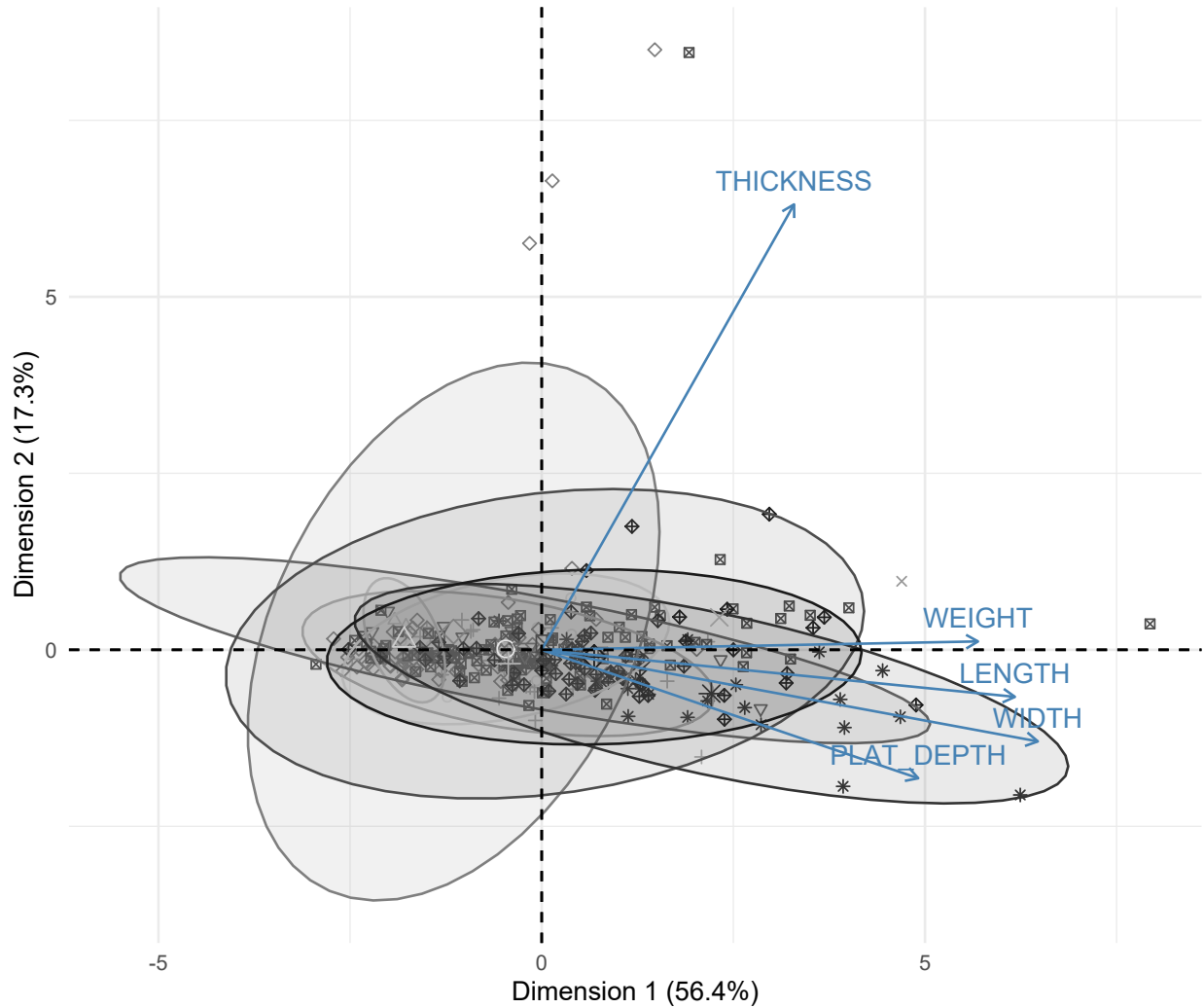
PCA 1 vs. PCA 2 (Classification)



PCA 2 vs. PCA 3 (Classification)

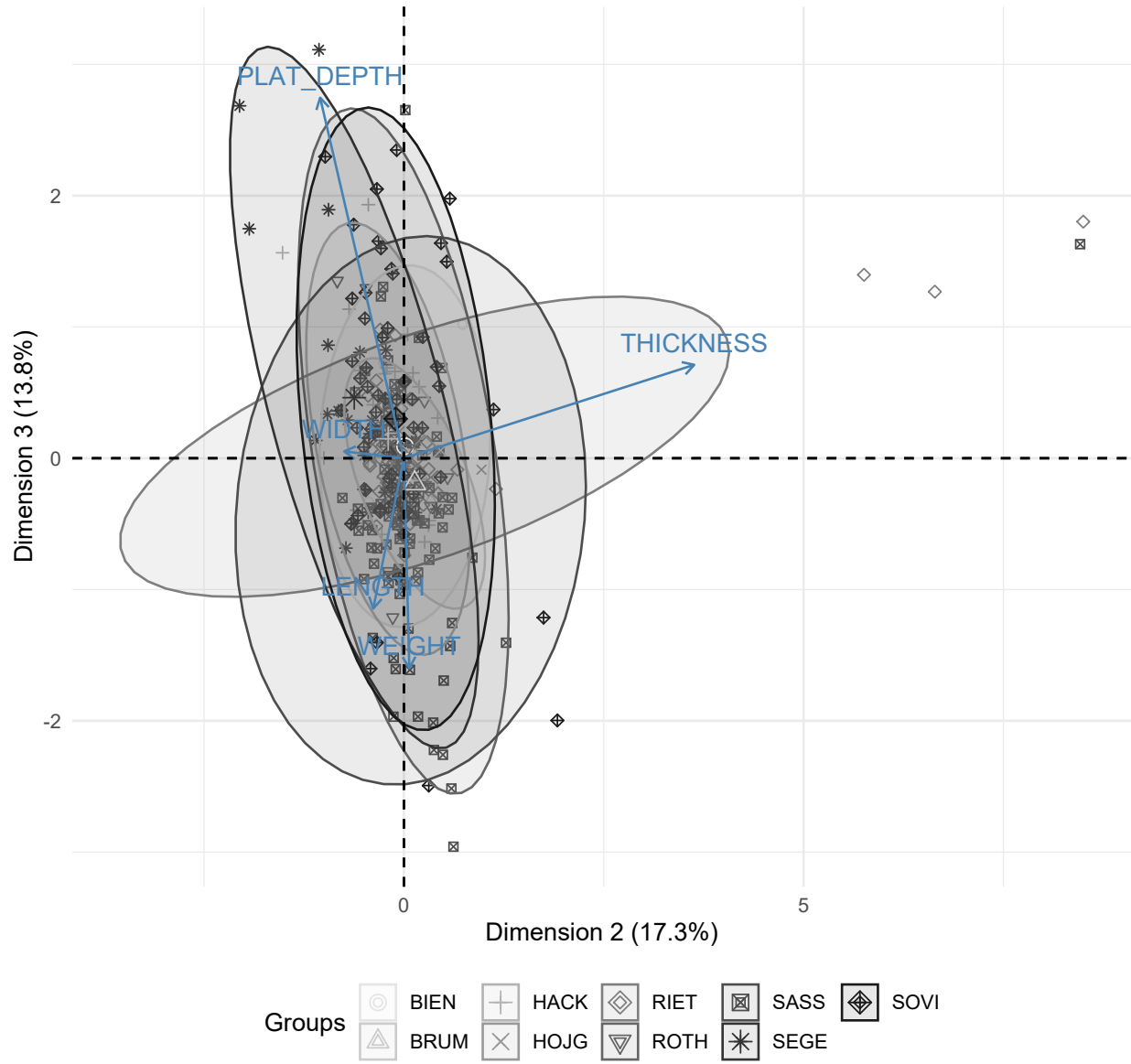


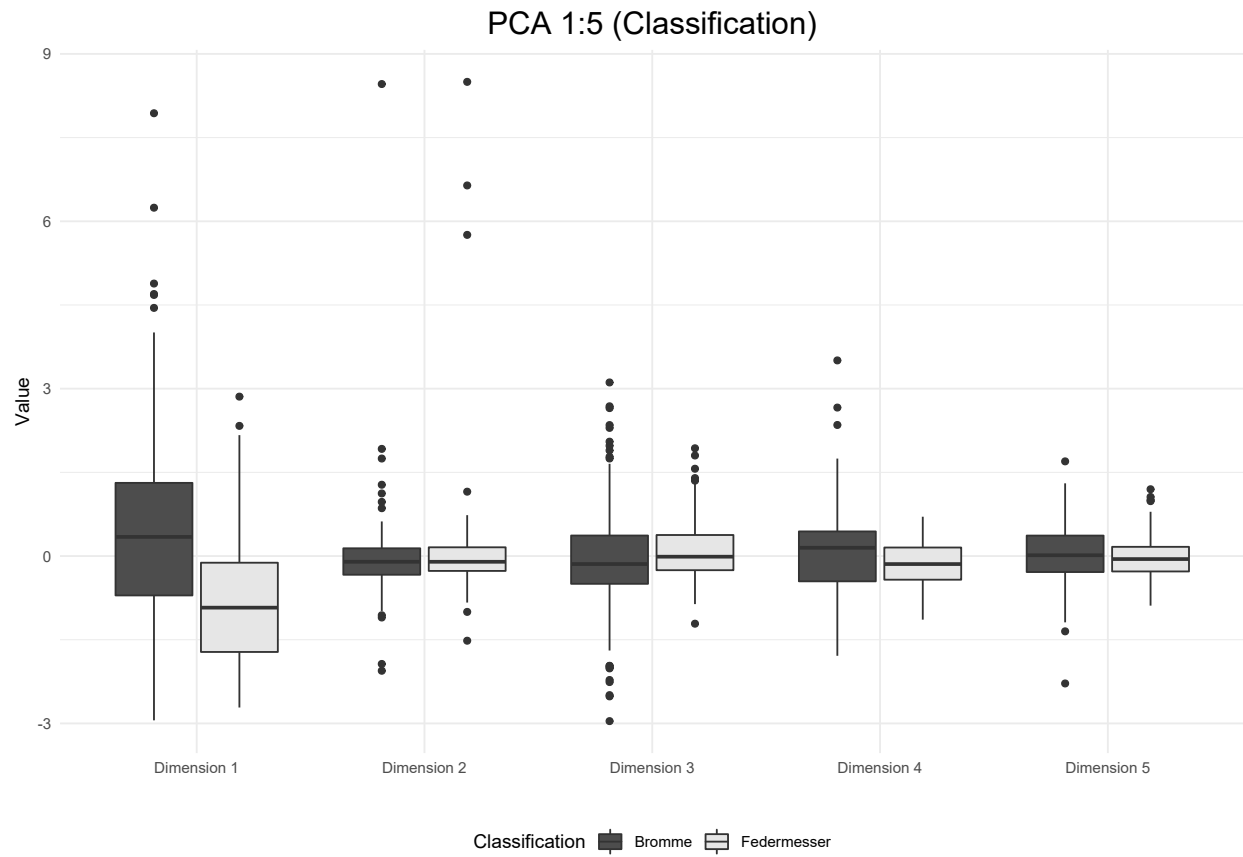
PCA 1 vs. PCA 2 (Context)

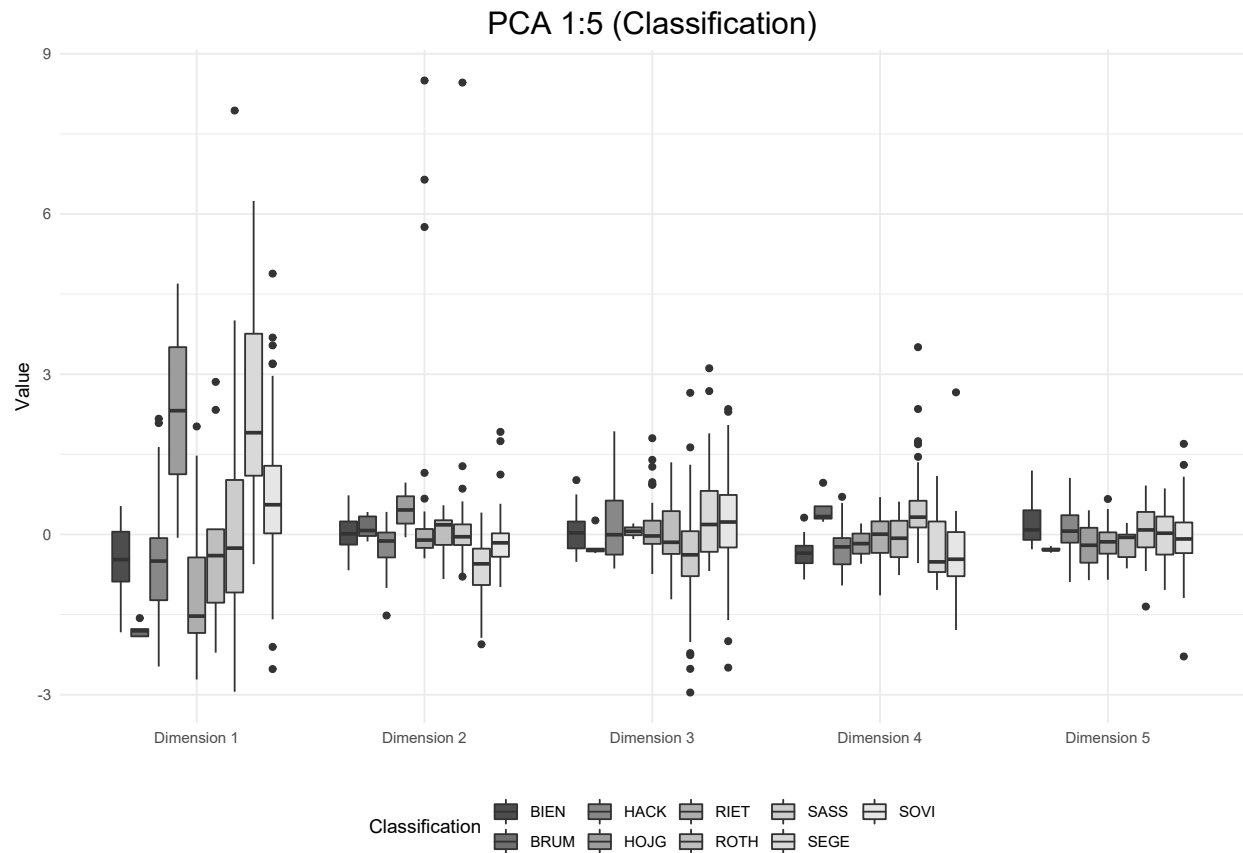


- Groups
- | | | | | |
|------|------|------|------|------|
| BIEN | HACK | RIET | SASS | SOVI |
| BRUM | HOJG | ROTH | SEGE | |

PCA 2 vs. PCA 3 (Classification)



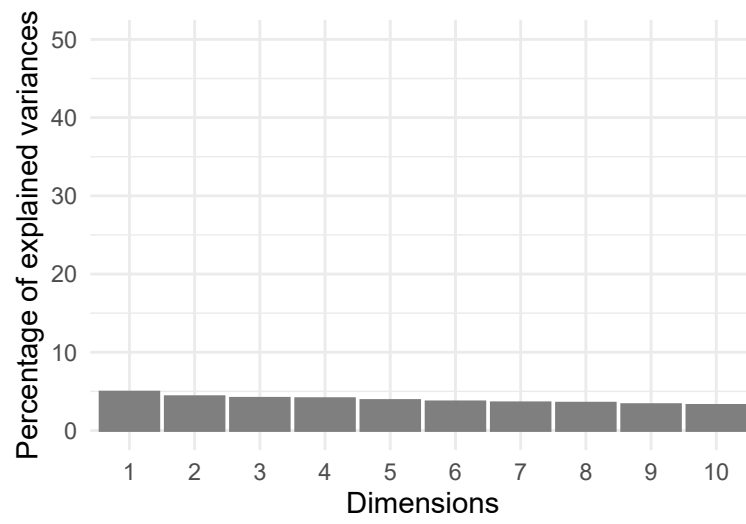




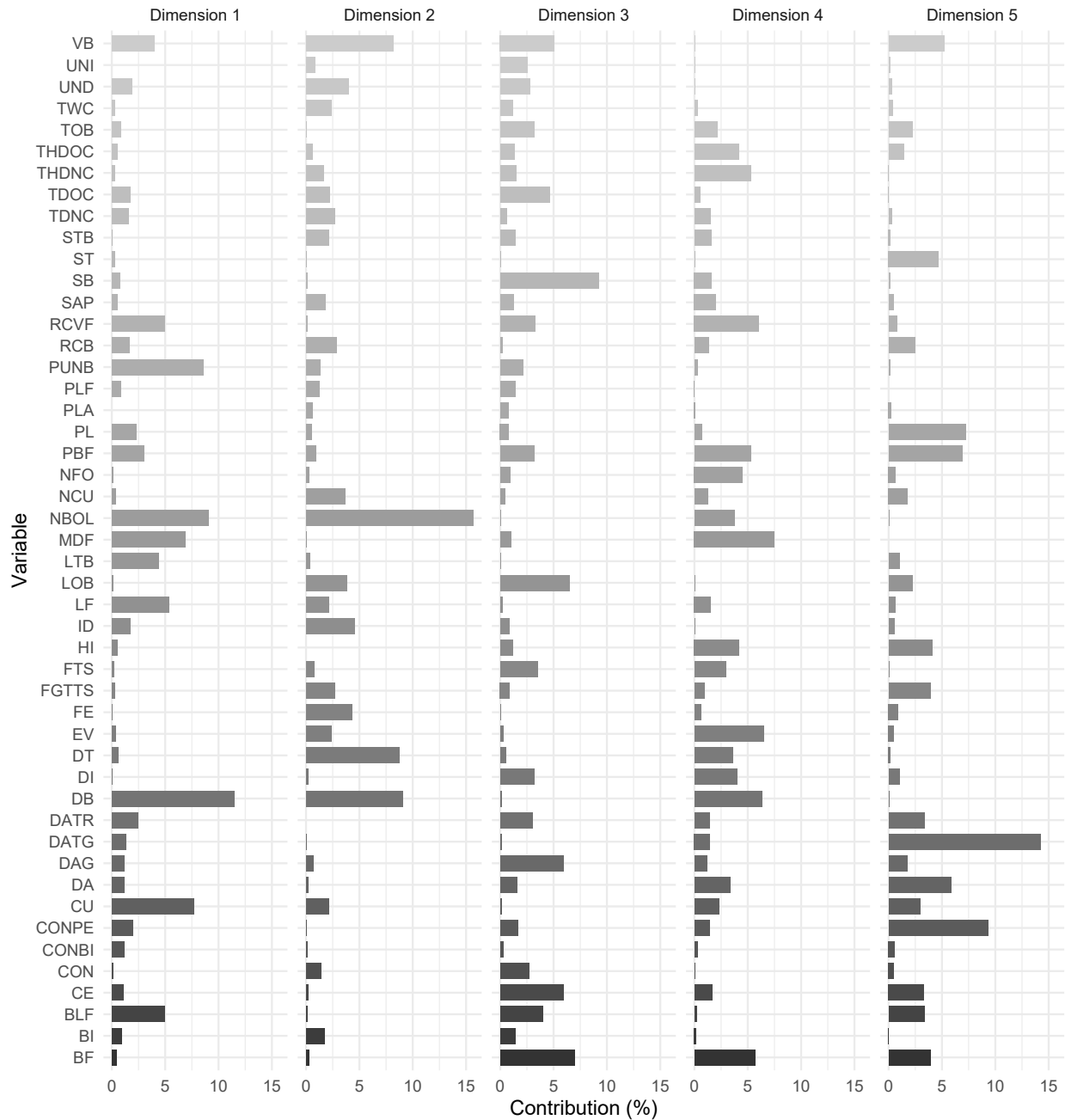
Multiple Correspondence Analysis (MCA)

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



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**)

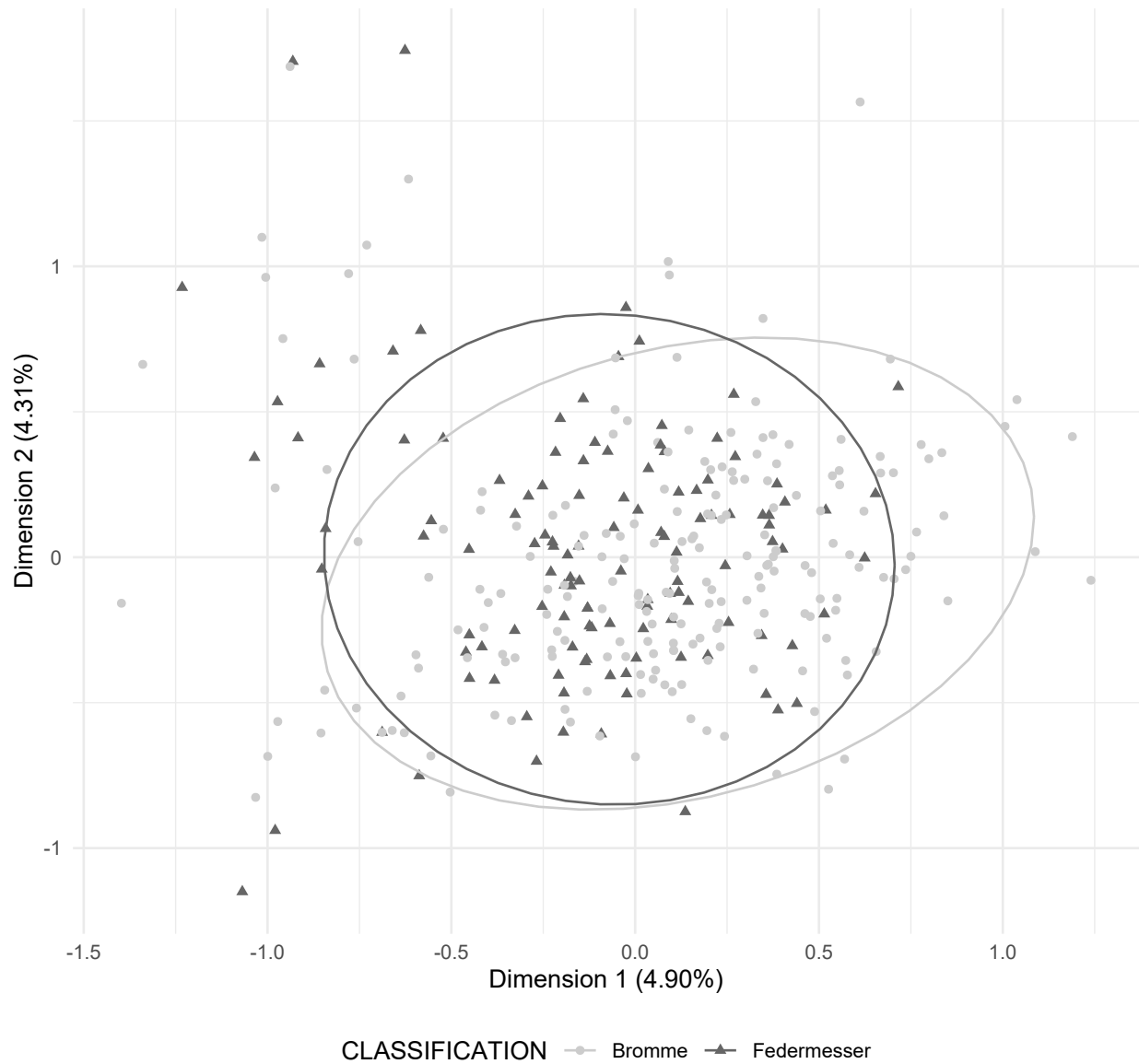
MDF: Multiple dorsal faces (**Dorsal Blade Prof**)

Key acronyms for responses in *Axis 2*:

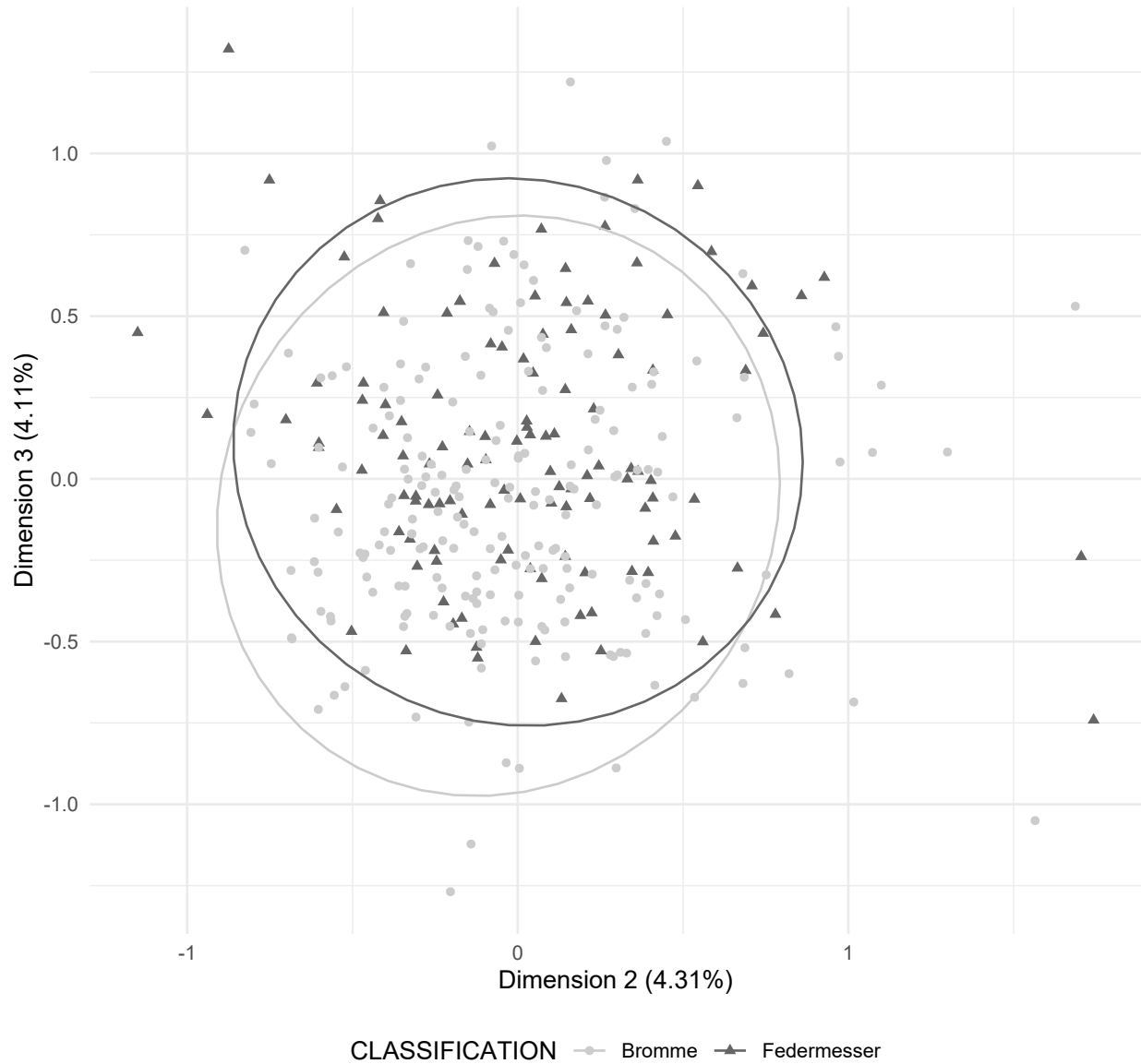
NBOL: No bulb or lip (**Bulb Morph**)

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)

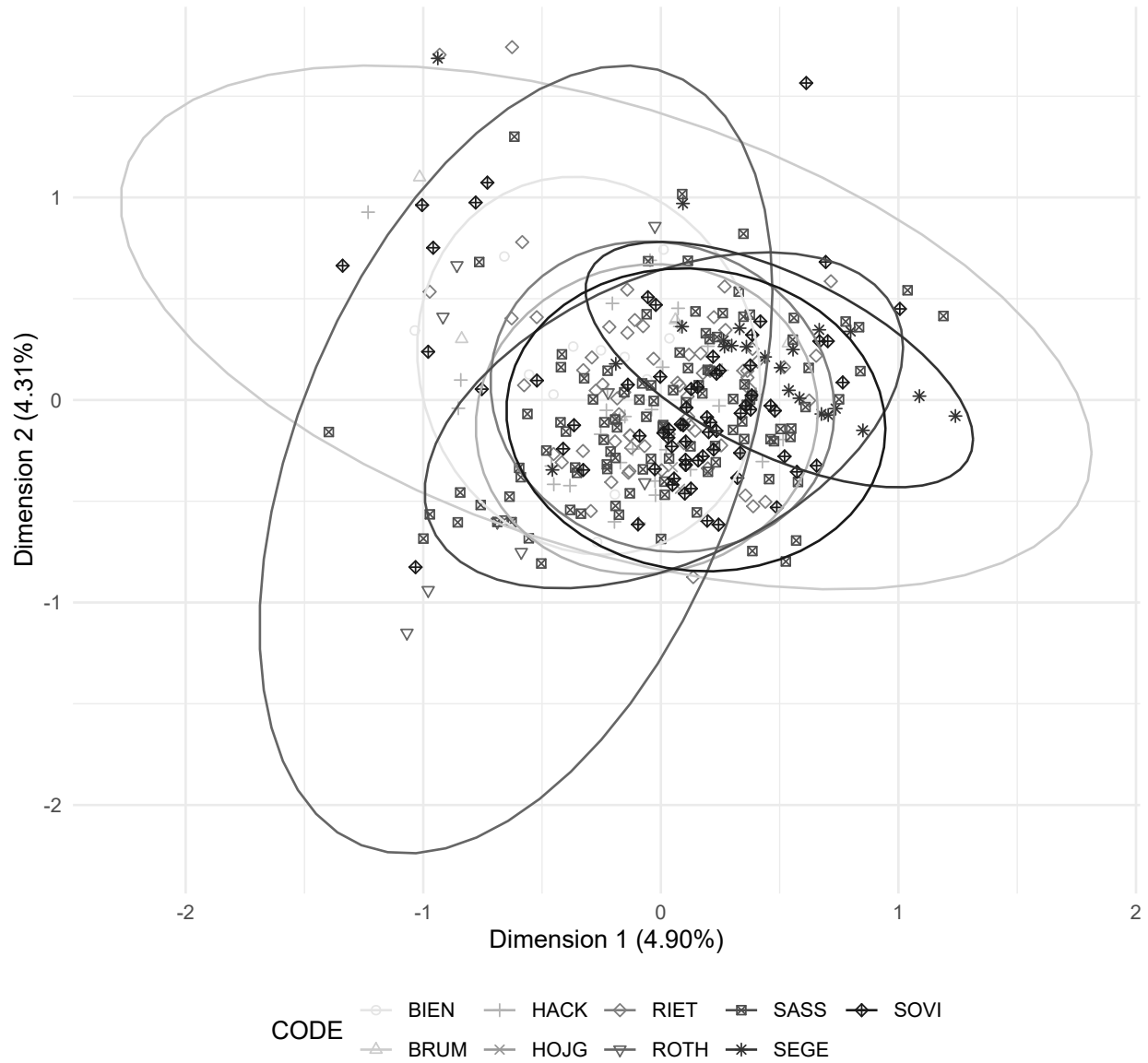


MCA 2 vs. MCA 3 (Classification)



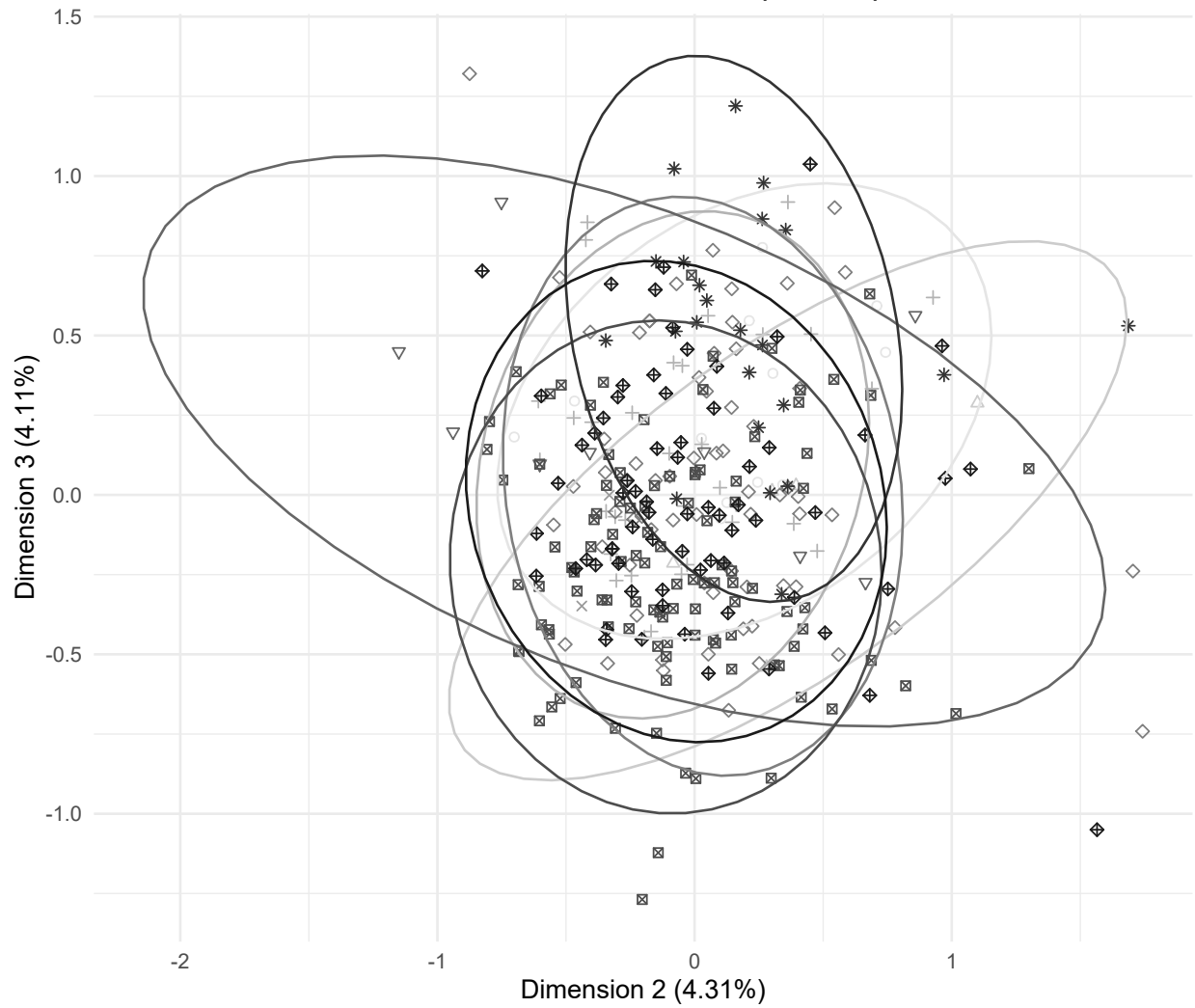
Warning: Removed 1 row(s) containing missing values (geom_path).

MCA 1 vs. MCA 2 (Code)



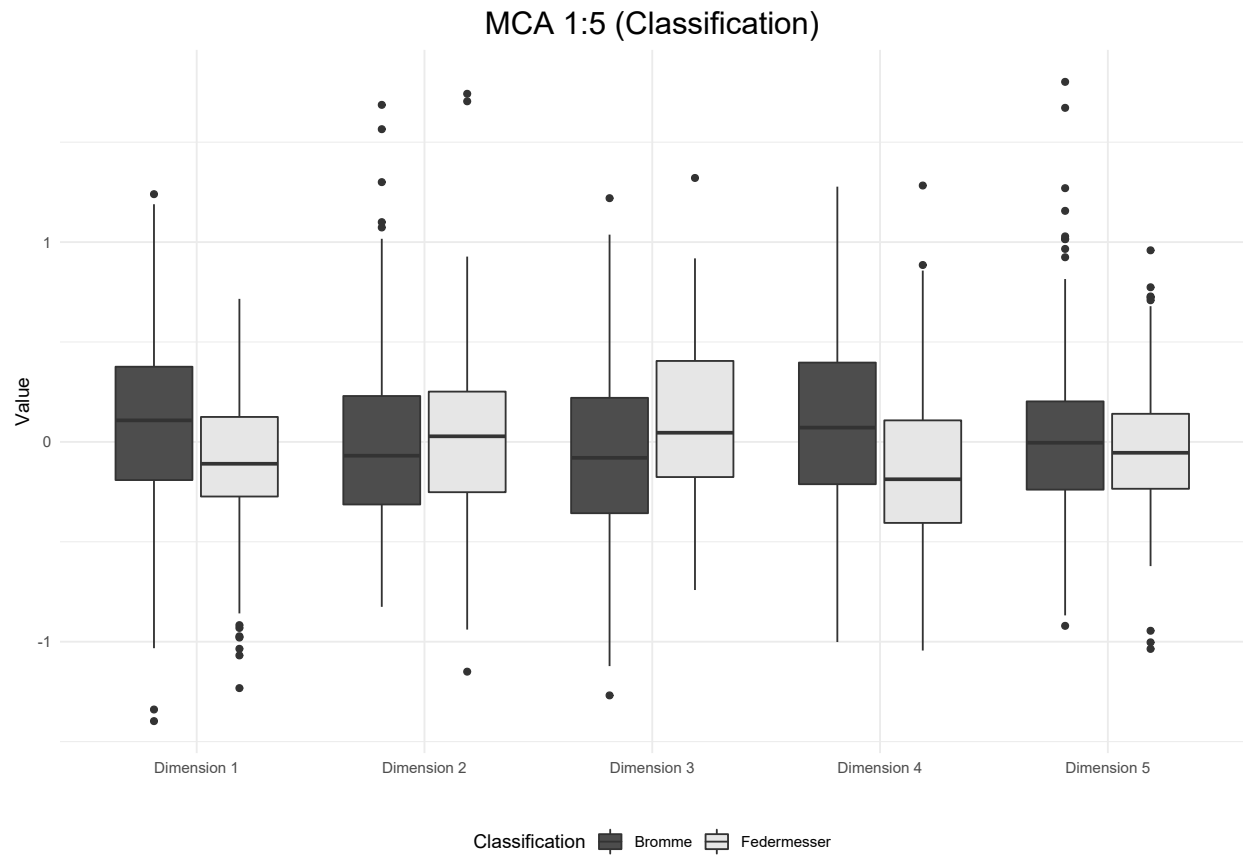
Warning: Removed 1 row(s) containing missing values (geom_path).

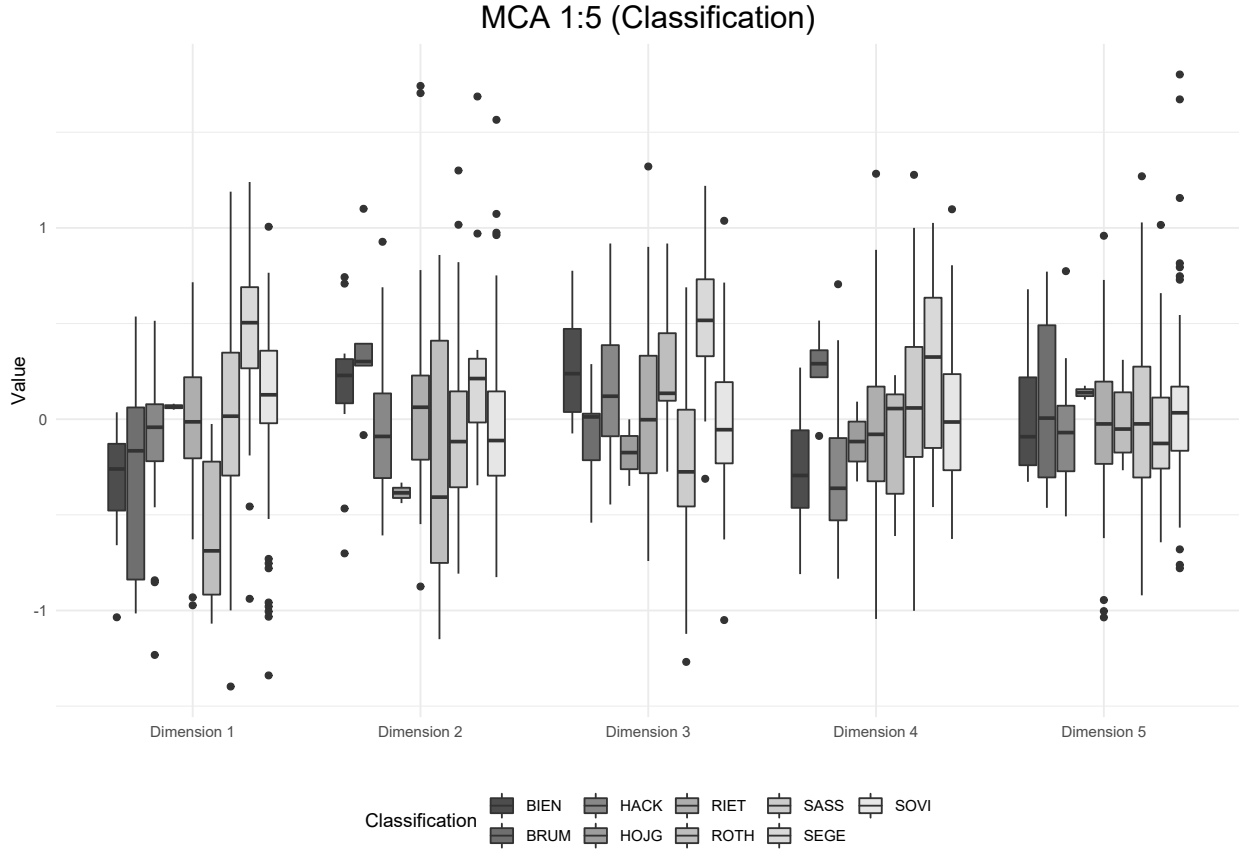
MCA 2 vs. MCA 3 (Code)



CODE

BIEN	HACK	RIET	SASS	SOVI
BRUM	HOJG	ROTH	SEGE	





Analysis: Cores

Visual and Descriptive Summaries of Data

Table 9. 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 10. 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 11. 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

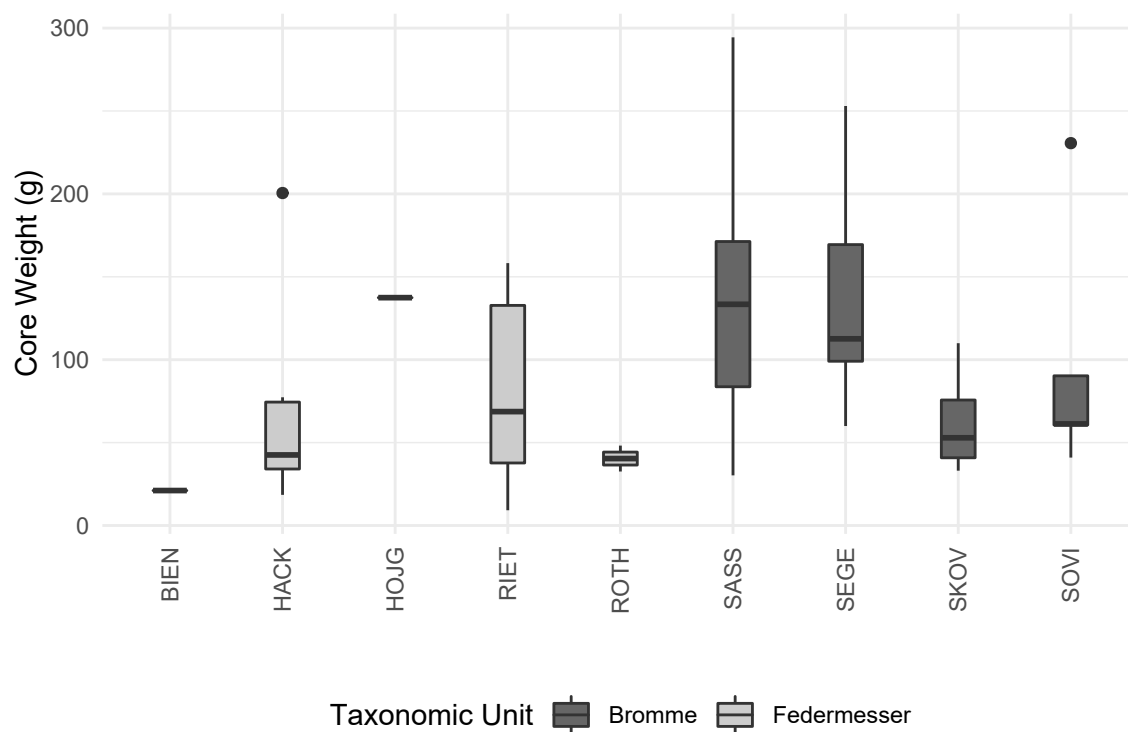
Table 12. Descriptive Statistics: Blade Core Breadth (mm)

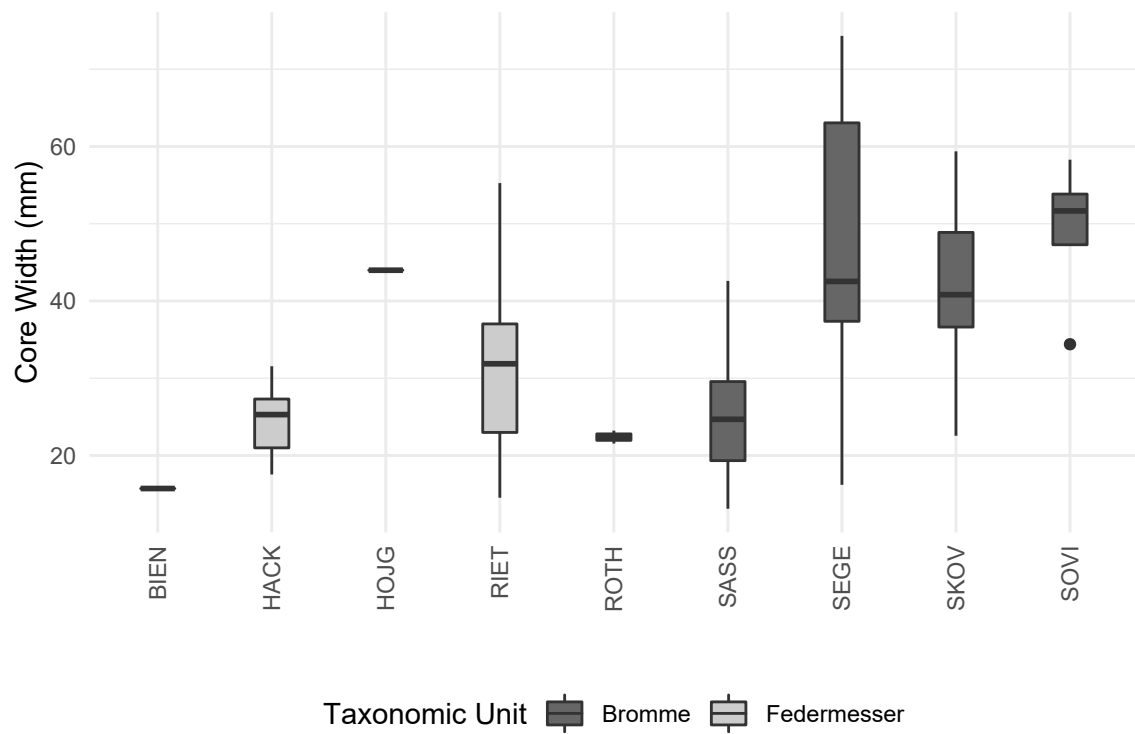
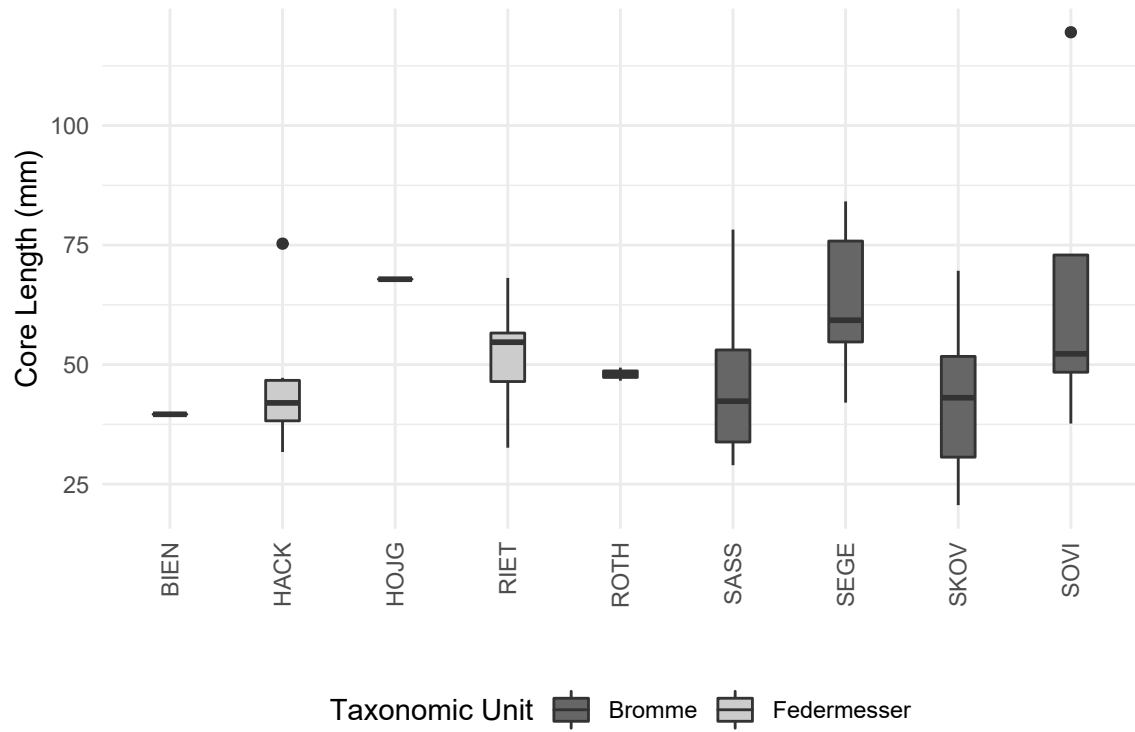
CONTEXT	n_obs	min	max	mean	med	sd	var
Bienenbüttel (FStNr. 15)	1	19.41	19.41	19.41	19.41	NA	NA
Häcklingen (FStNr. 19)	8	17.54	31.22	23.22	21.78	4.67	21.79
Højgård	1	51.50	51.50	51.50	51.50	NA	NA
Rietberg (1)	5	33.79	54.66	40.89	36.31	9.08	82.38
Rietberg (5)	2	36.45	39.80	38.12	38.12	2.37	5.61
Rietberg (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

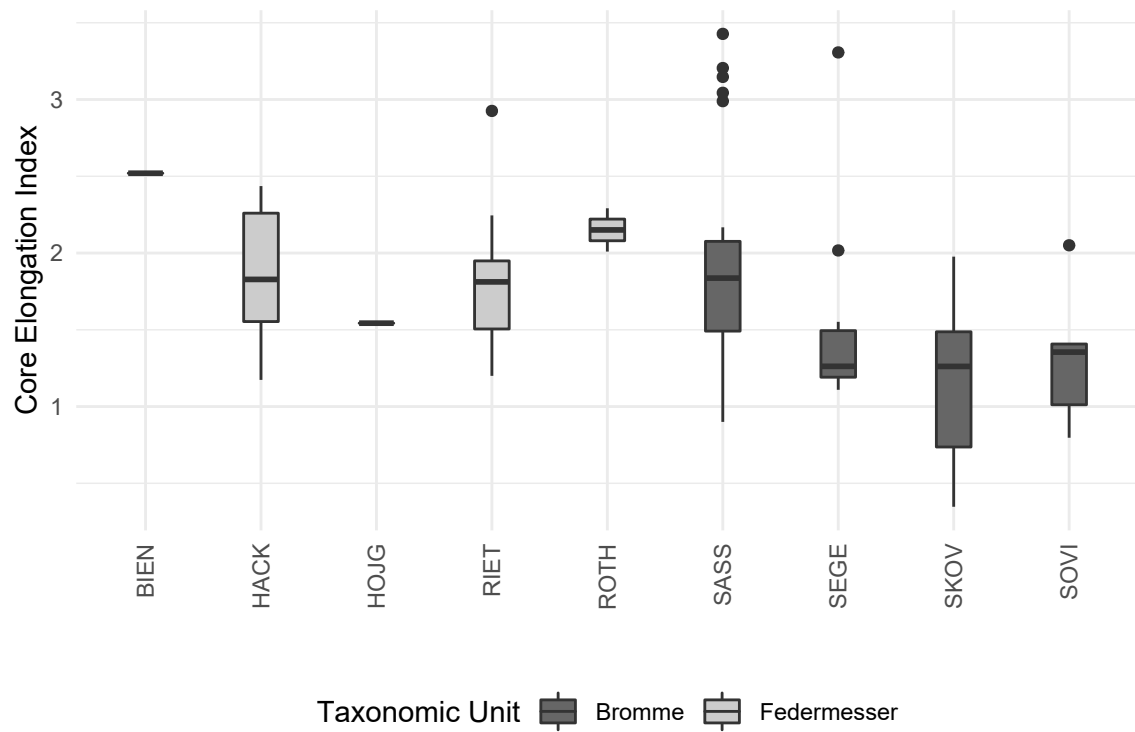
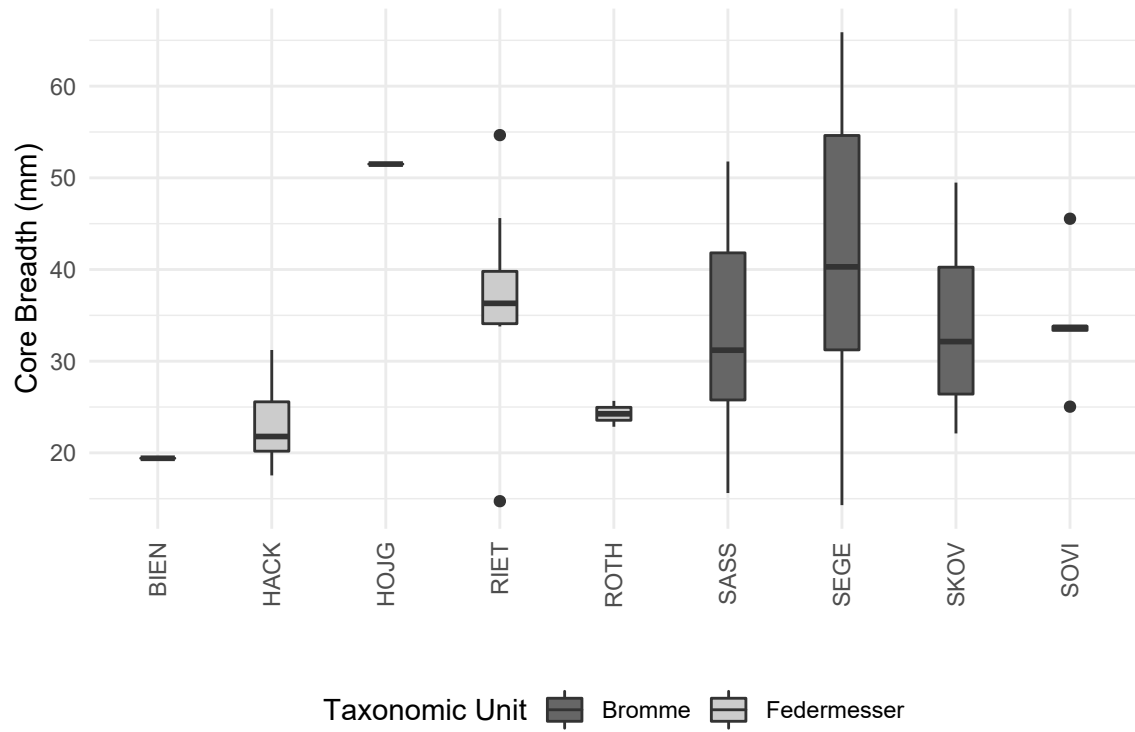
Table 13. Descriptive Statistics: Blade Core Elongation (L/W)

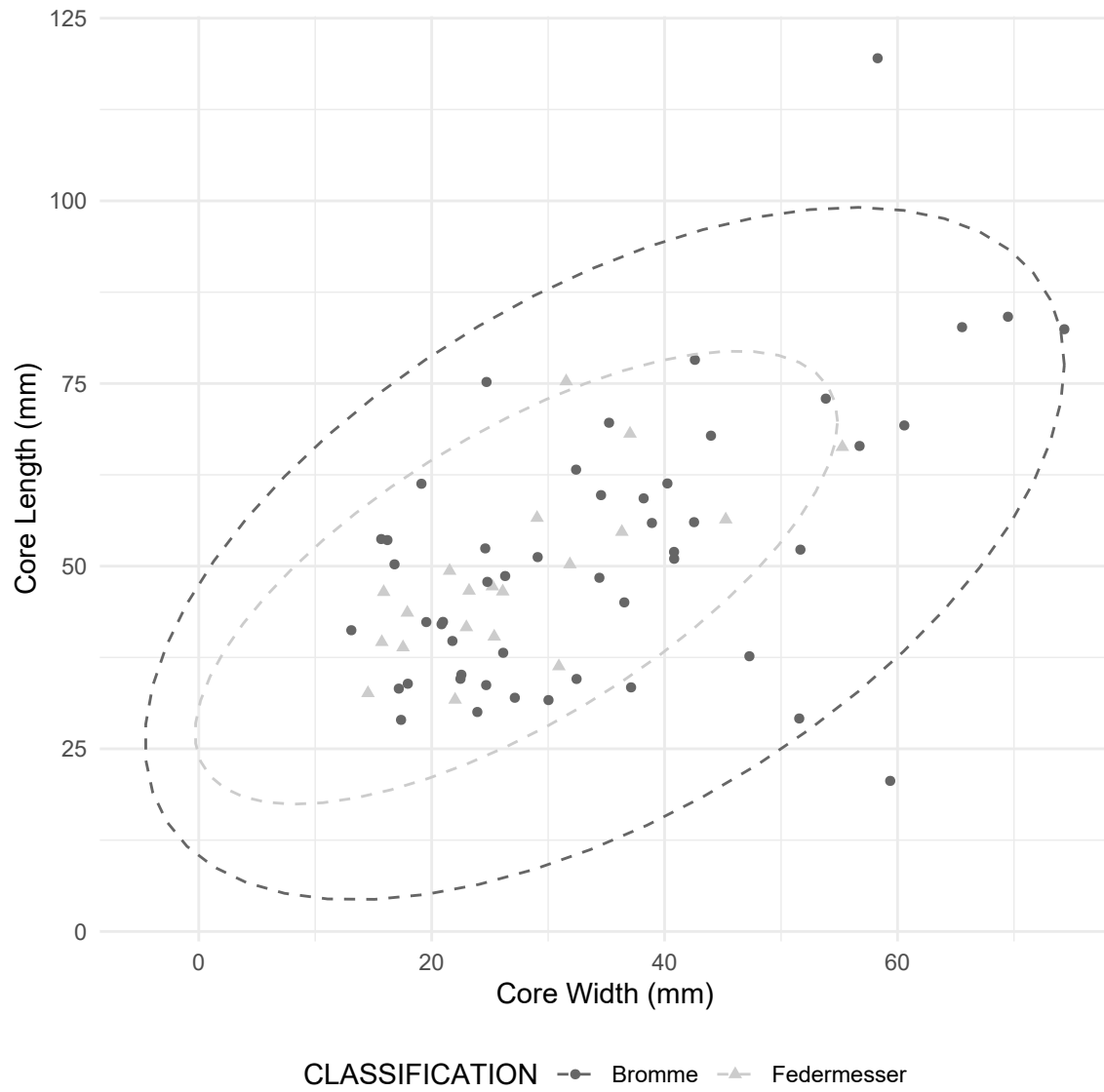
CONTEXT	n_obs	min	max	mean	med	sd	var
Bienenbüttel (FStNr. 15)	1	2.52	2.52	2.52	2.52	NA	NA

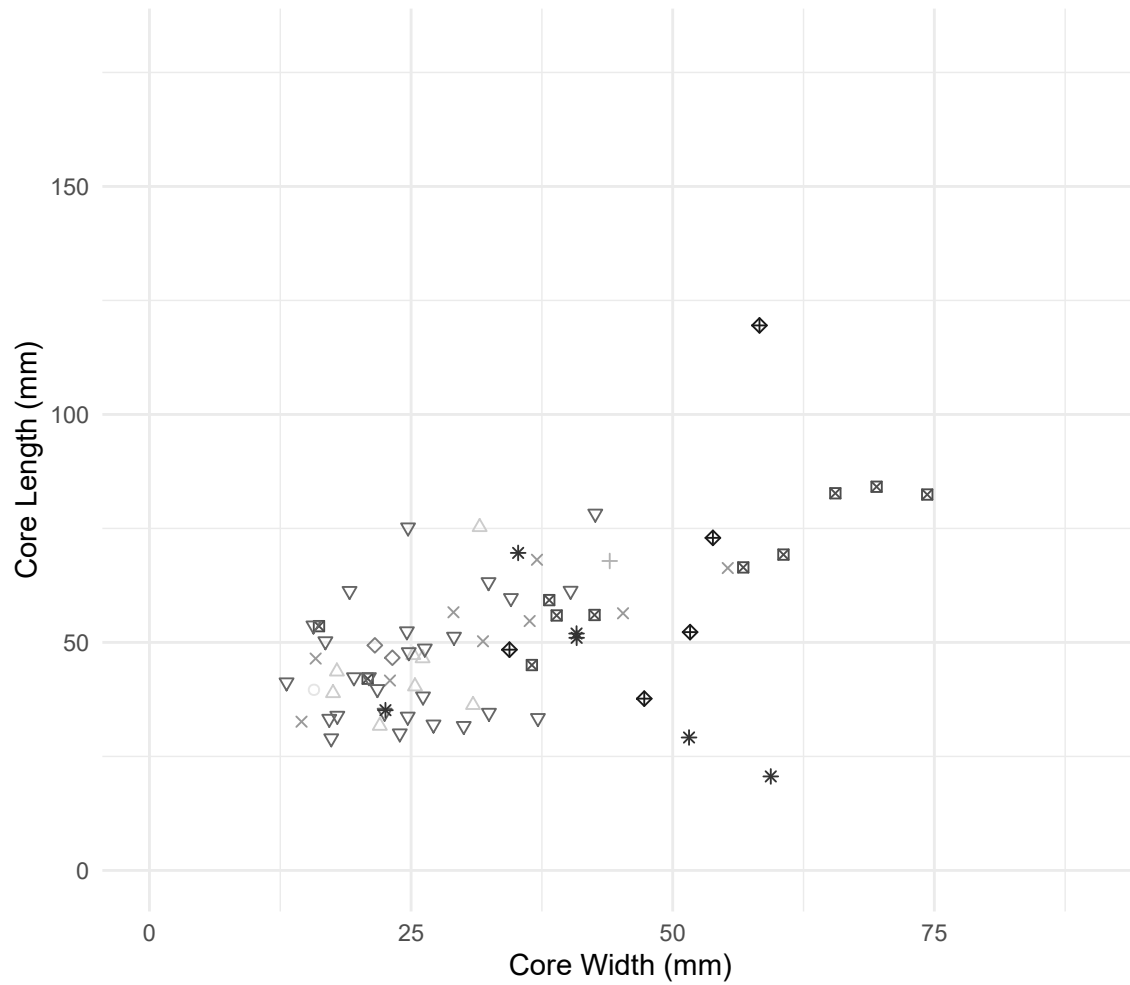
Häcklingen (FStNr. 19)	8	1.17	2.44	1.86	1.83	0.46	0.21
Højgård	1	1.54	1.54	1.54	1.54	NA	NA
Rietberg (1)	5	1.25	2.93	1.88	1.81	0.63	0.40
Rietberg (5)	2	1.20	1.95	1.57	1.57	0.53	0.28
Rietberg (Spoil)	2	1.51	2.25	1.88	1.88	0.52	0.27
Rothenkirchen	2	2.01	2.29	2.15	2.15	0.20	0.04
Sassenholz (FStNr. 78)	22	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











CODE ○ BIEN + HOJG ◇ ROTH ■ SEGE ◆ SOVI
 △ HACK × RIET ▼ SASS * SKOV

```
##
## 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
##

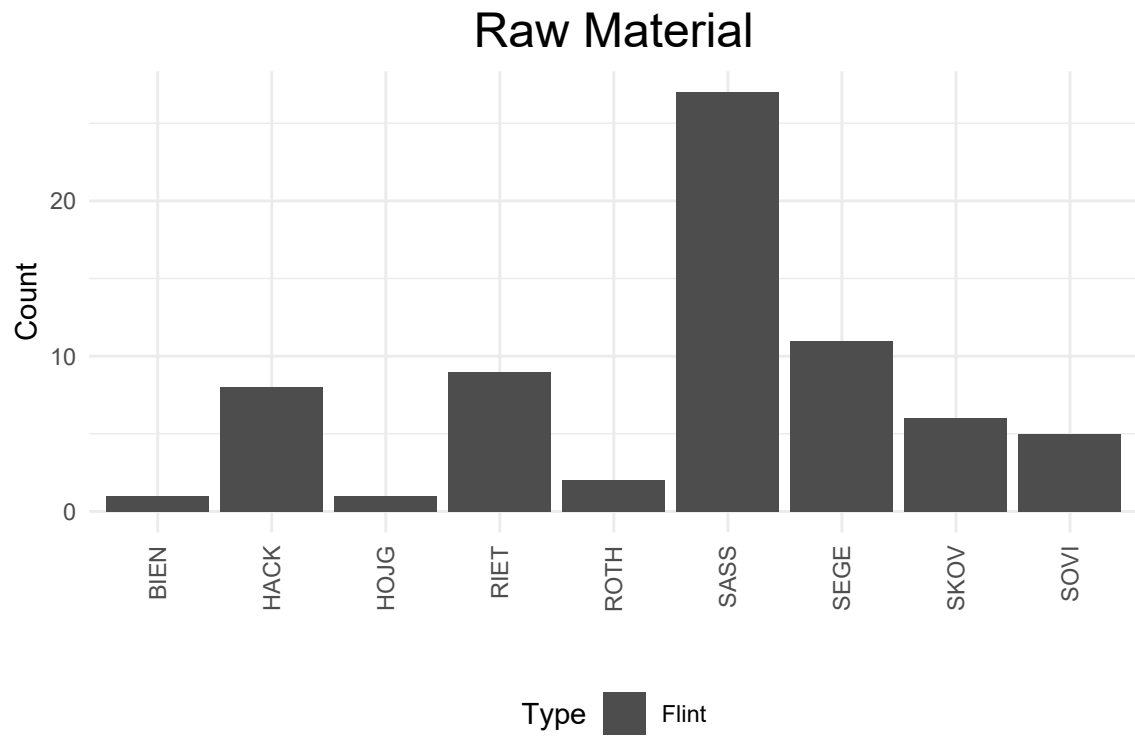
```

```

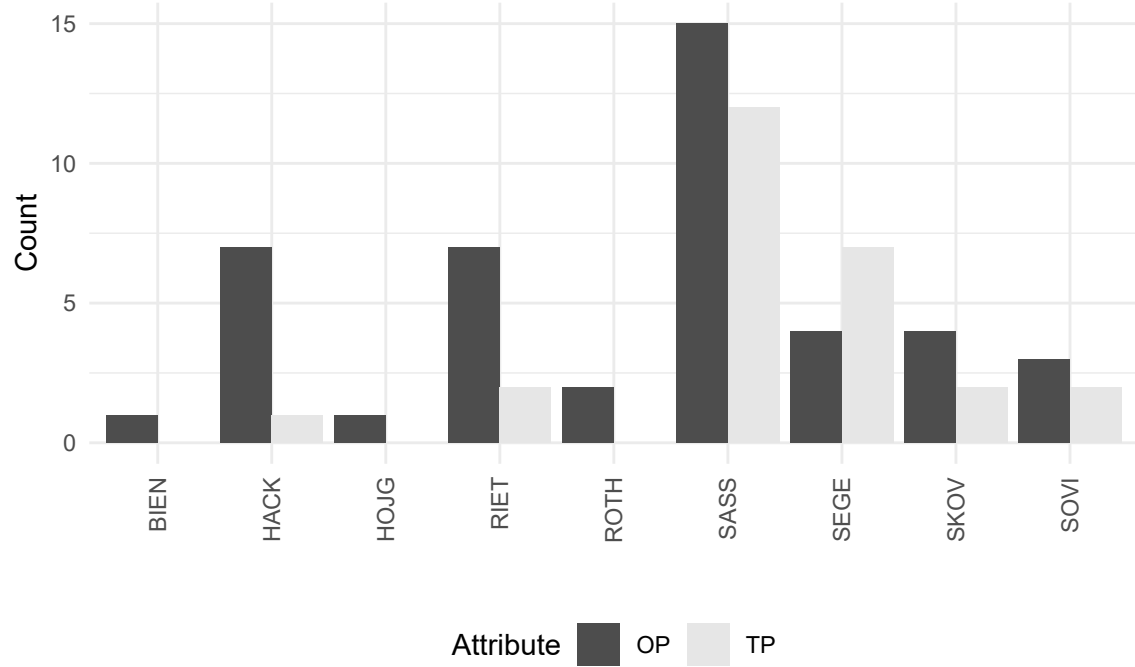
##      BIEN HACK HOJG RIET ROTH SASS SEGE SKOV
## HACK 1  -  -  -  -  -  -  -
## HOJG 1  1  -  -  -  -  -  -
## RIET 1  1  1  -  -  -  -  -
## ROTH 1  1  1  1  -  -  -  -
## SASS 1  1  1  1  1  -  -  -
## SEGE 1  1  1  1  1  1  -  -
## SKOV 1  1  1  1  1  1  1  -
## SOVI 1  1  1  1  1  1  1  1
##
##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

```

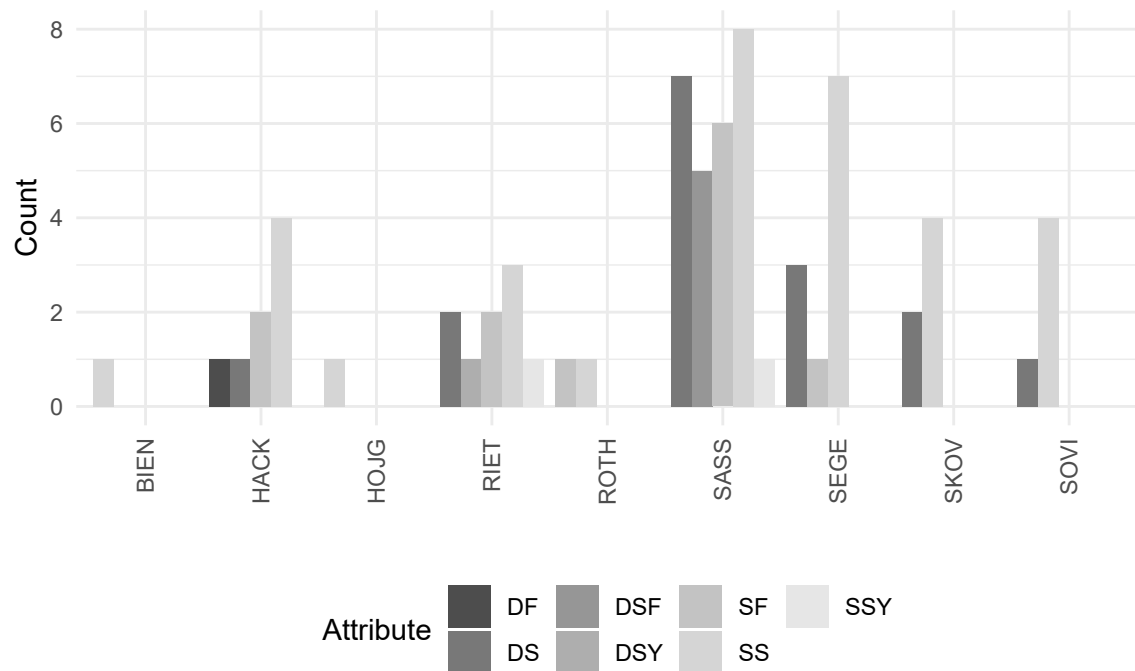
```
##  
##           Bromme  
## Federmesser 0.055  
##  
## P value adjustment method: bonferroni
```



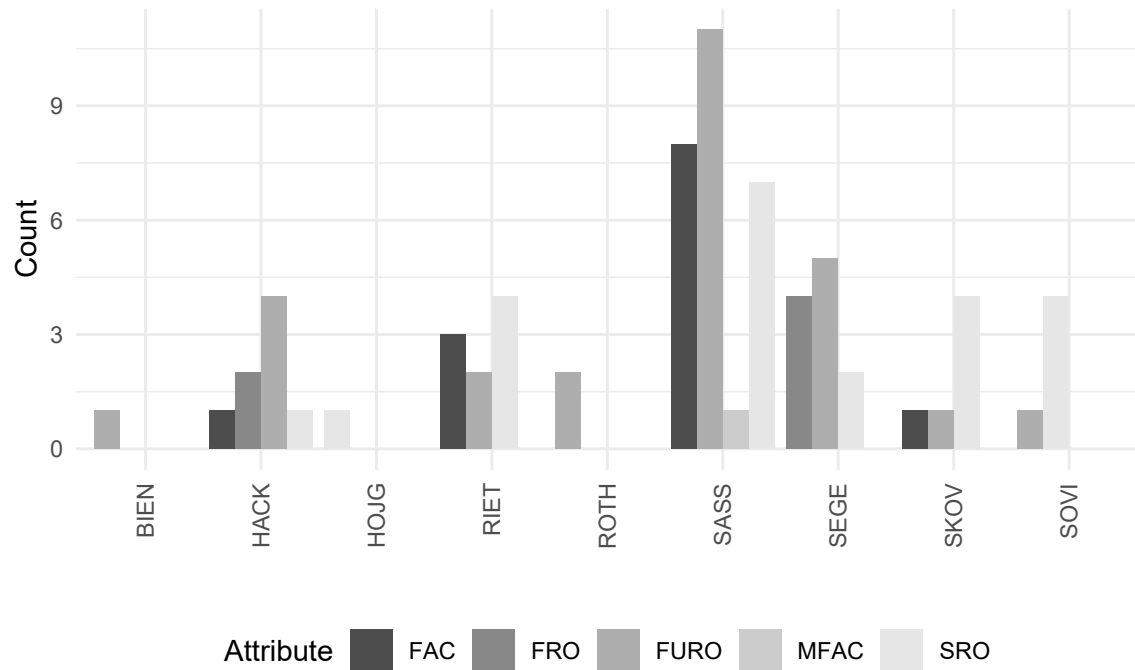
Core Morphology



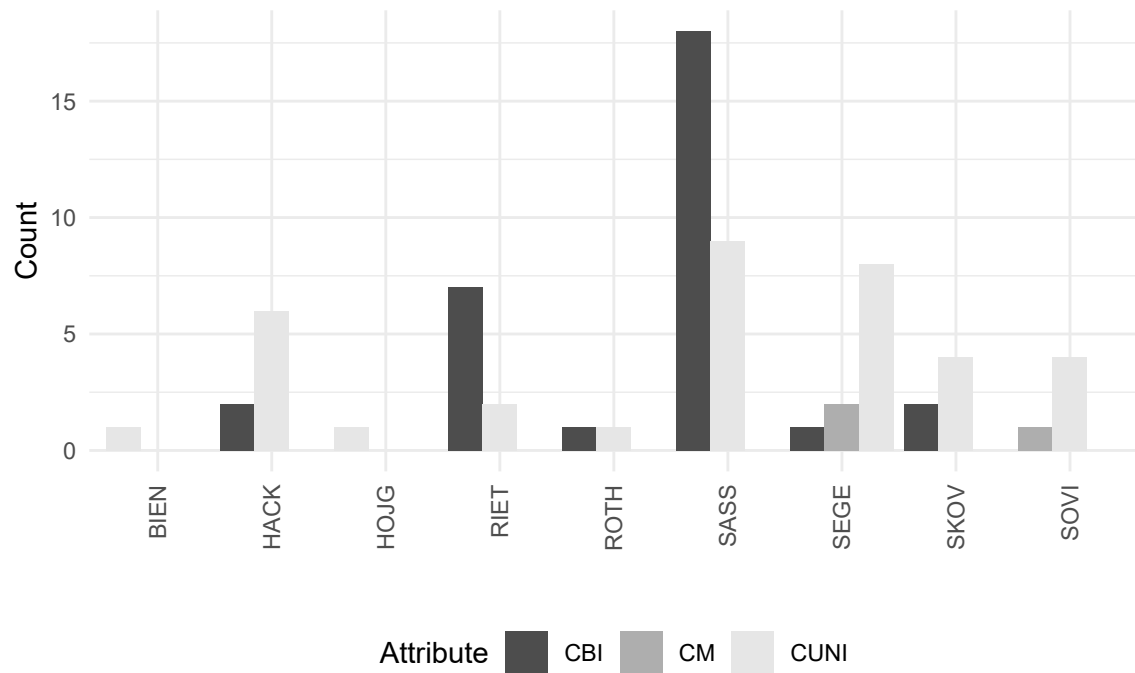
Platform Profile



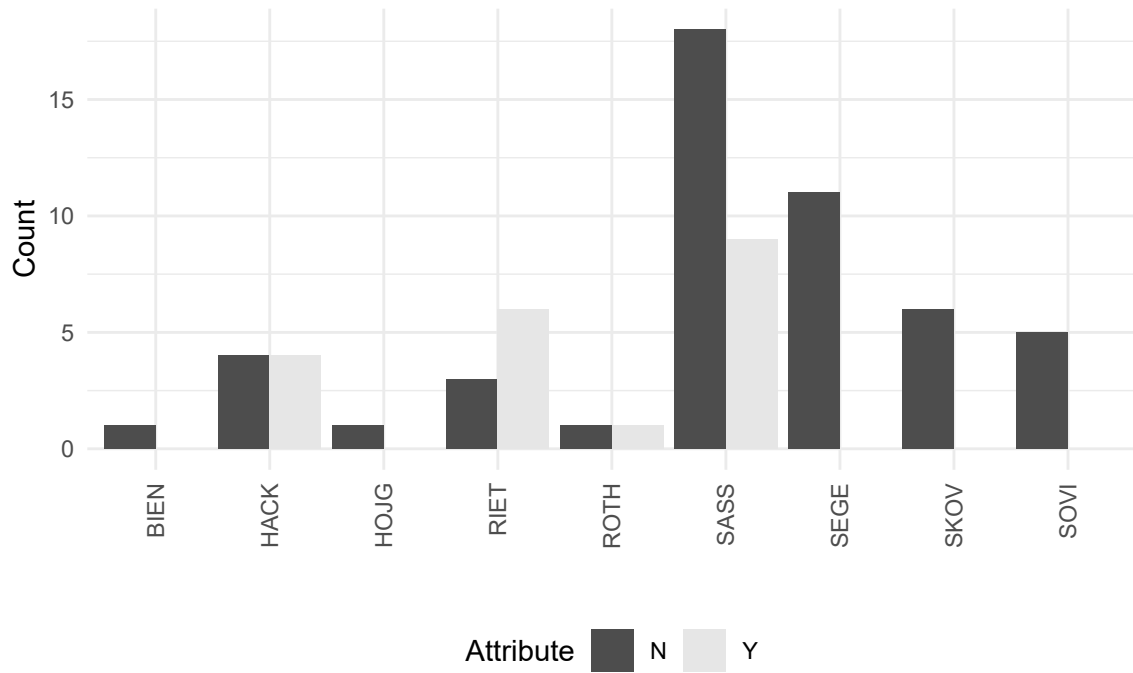
Core Reduction Strategy



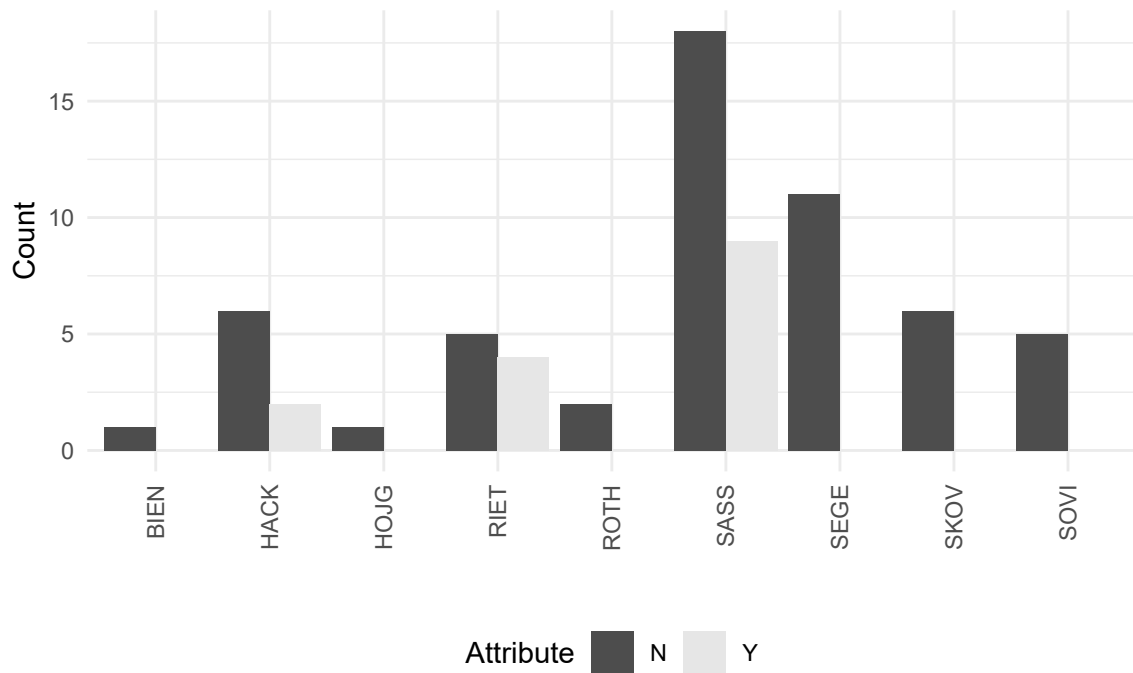
Core Directionality



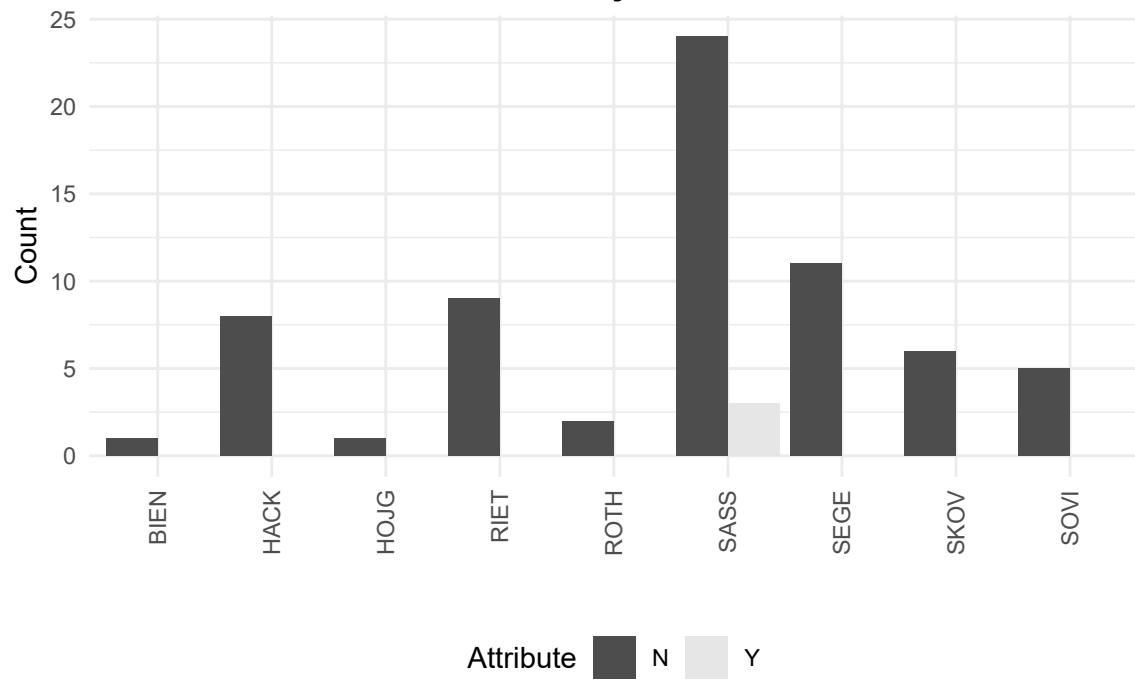
Core Tablet Rejuvenation



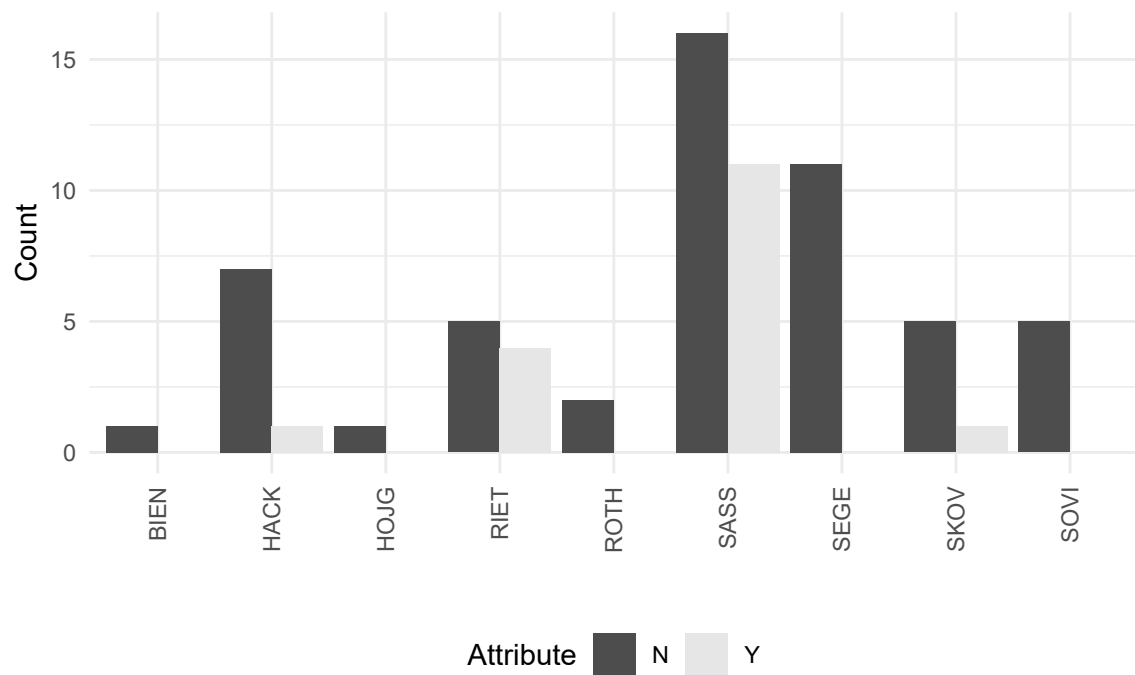
Preparatory Flake Rejuvenation



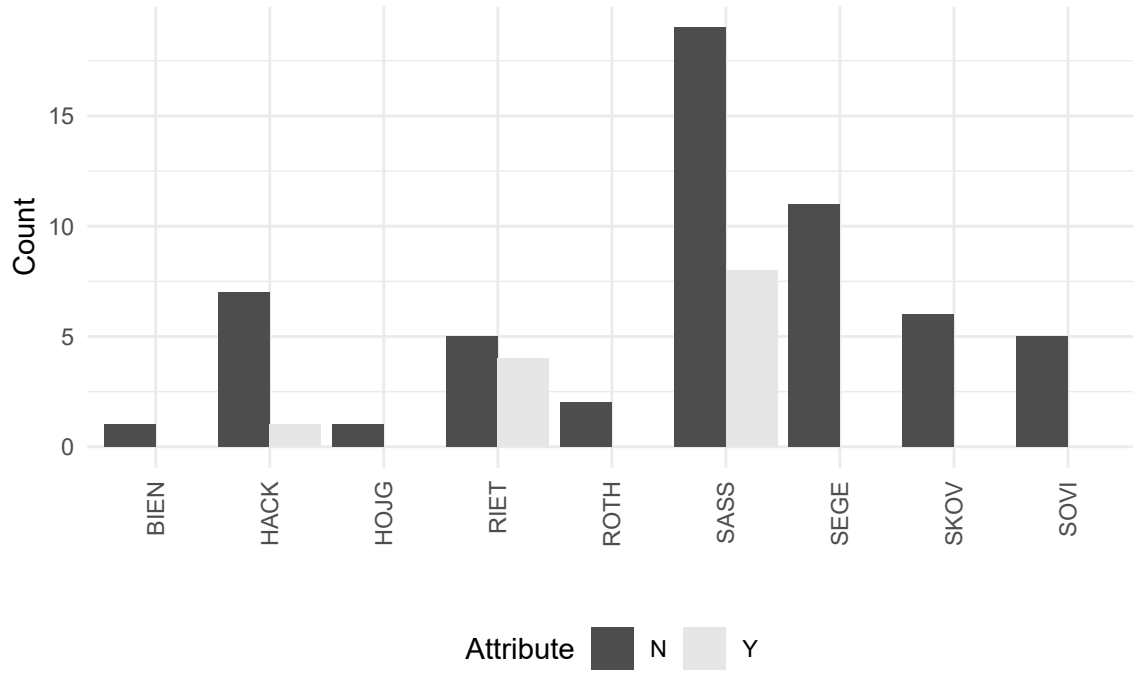
Frontal Rejuvenation



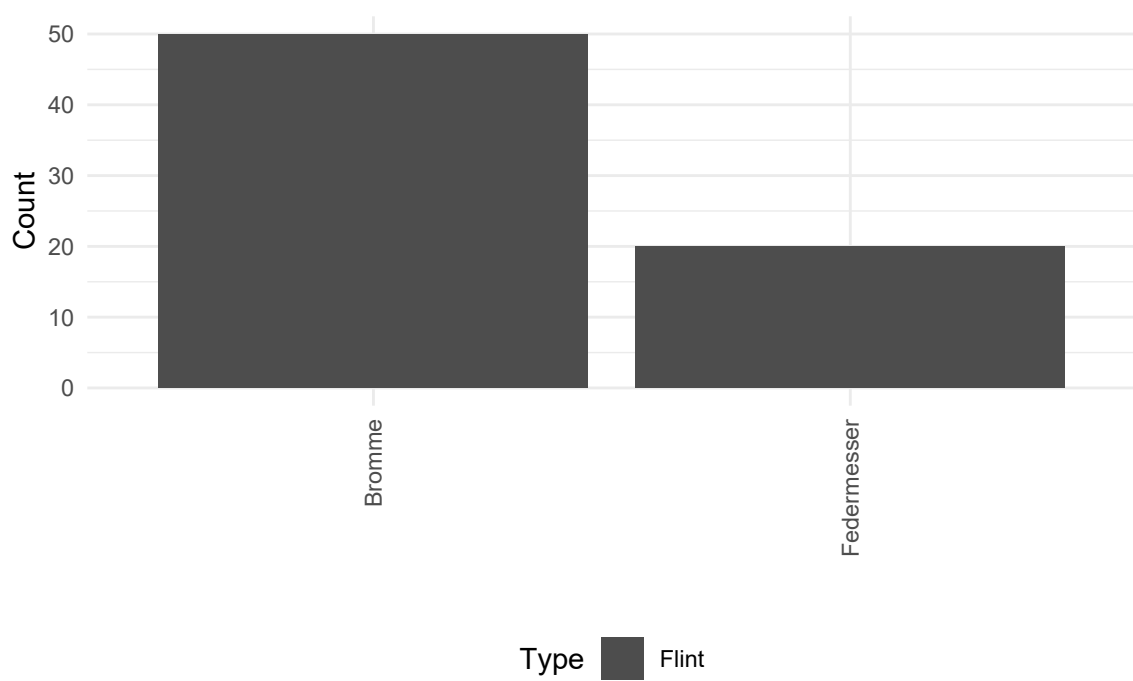
Distal Rejuvenation



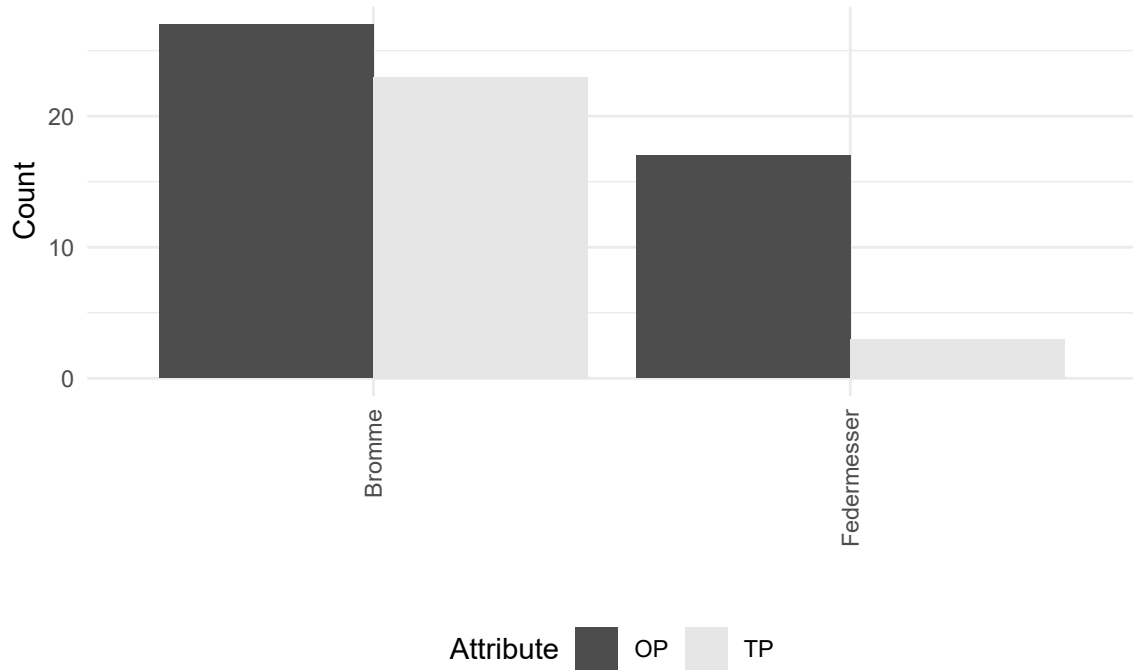
Lateral Rejuvenation



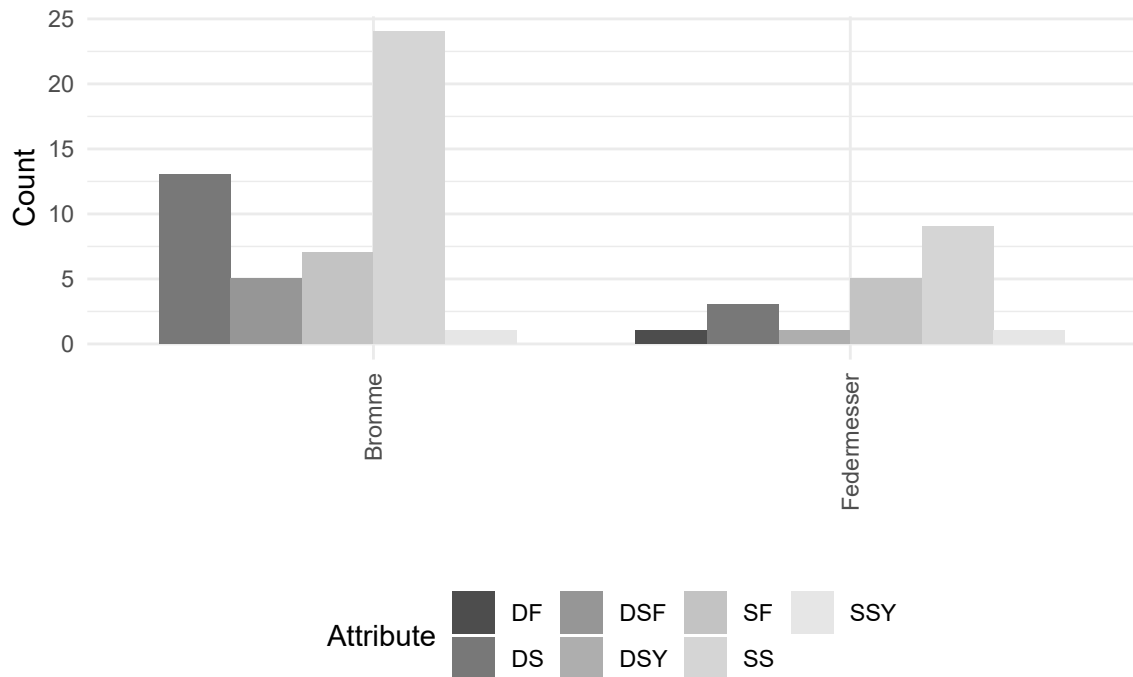
Raw Material

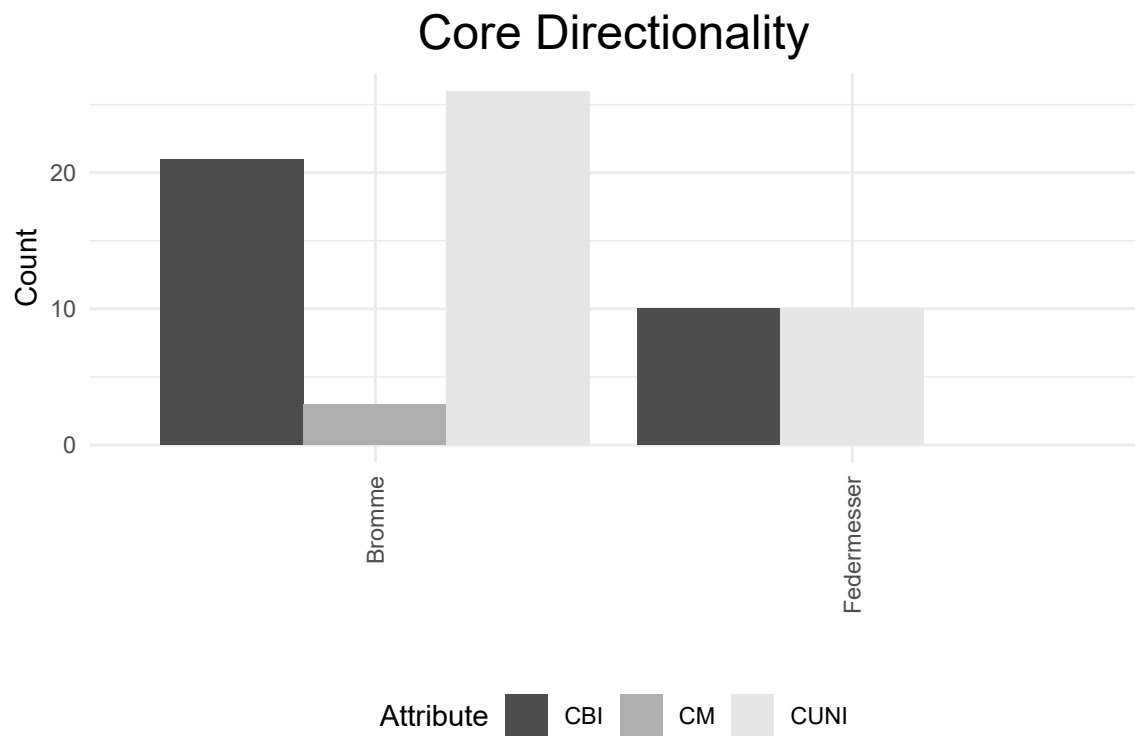
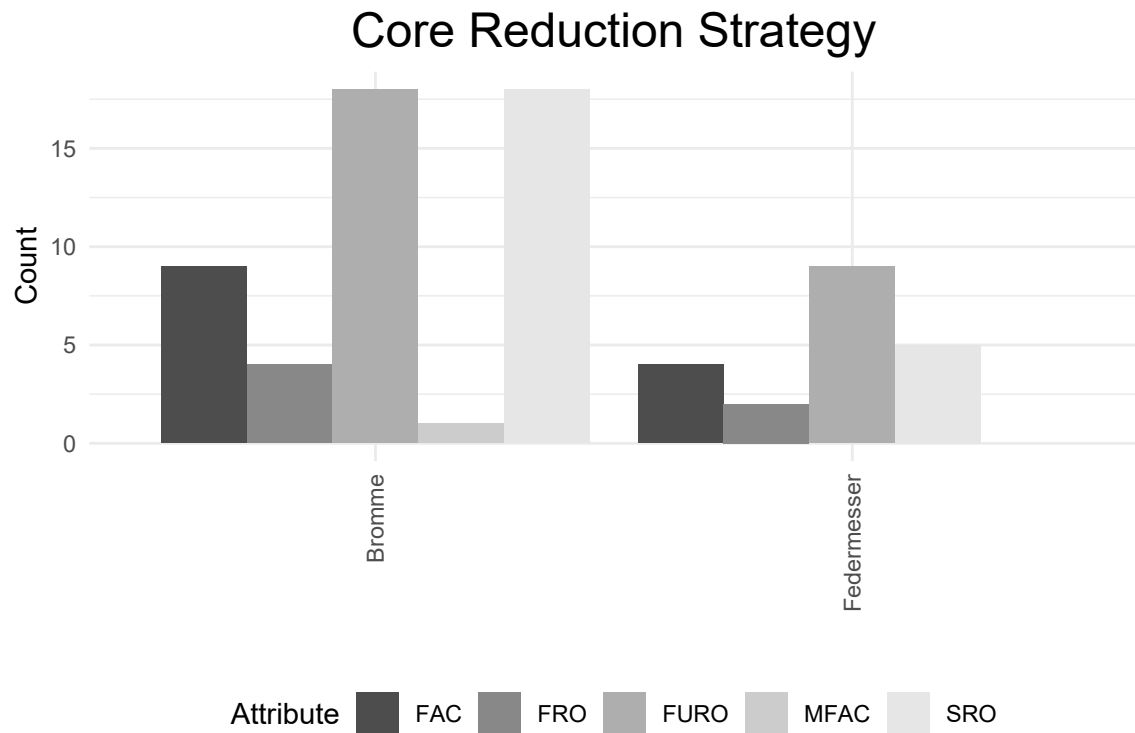


Core Morphology

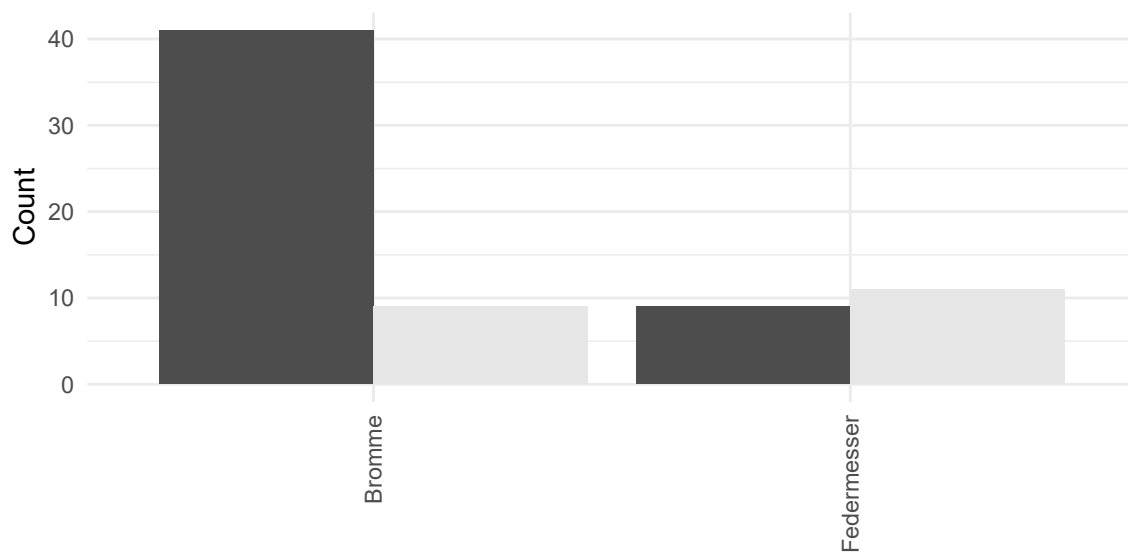


Core Platform Profile



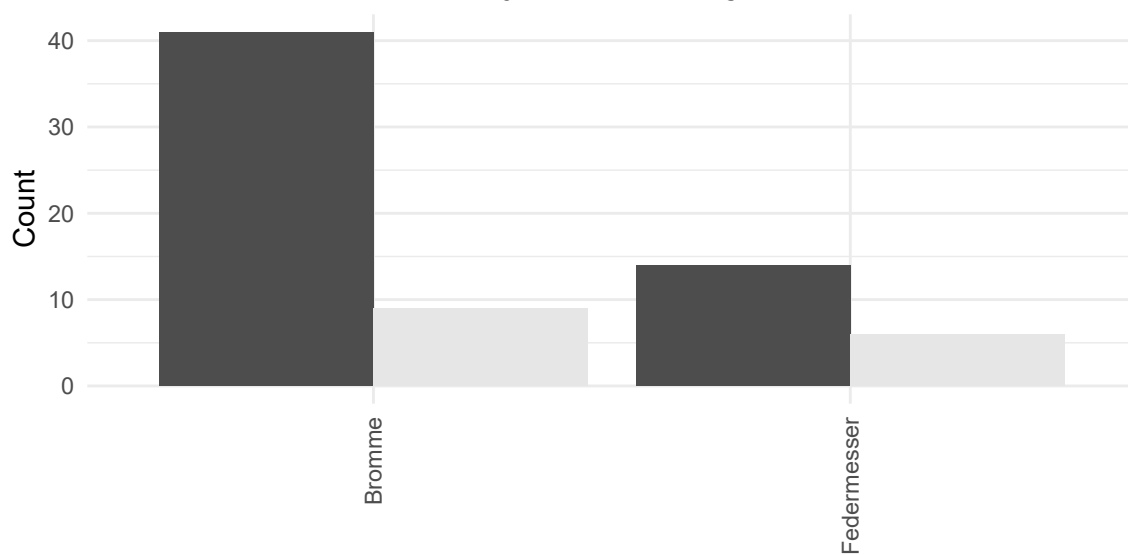


Core Tablet Rejuvenation

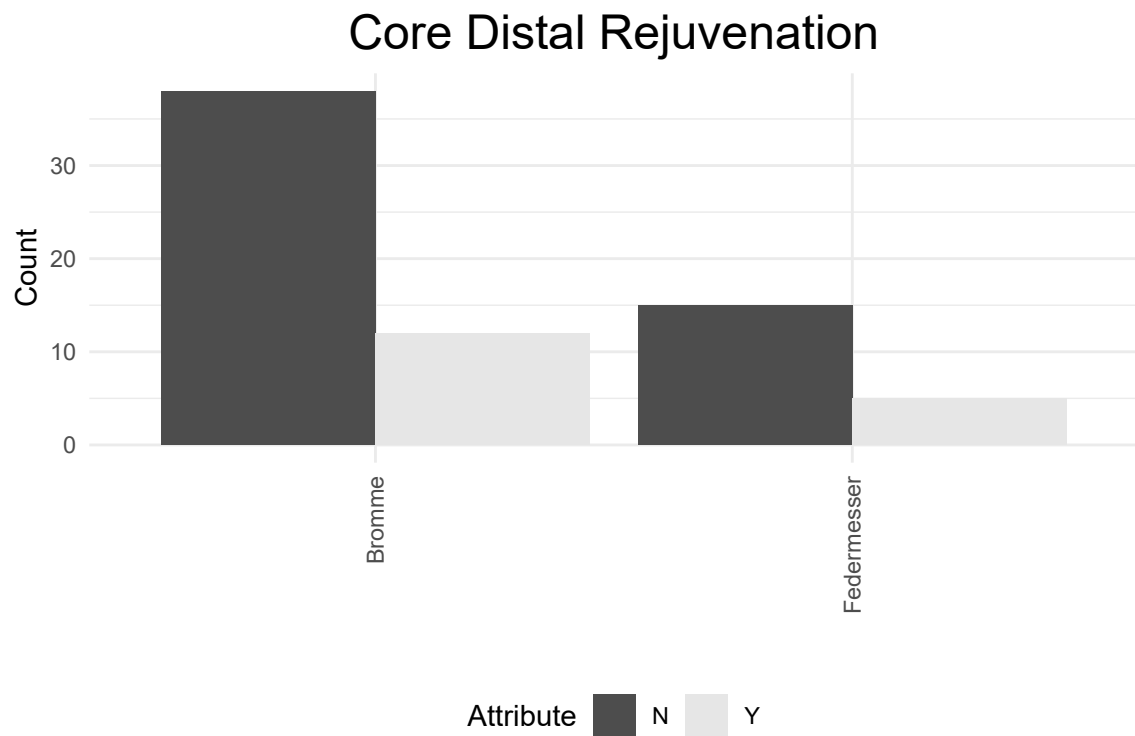
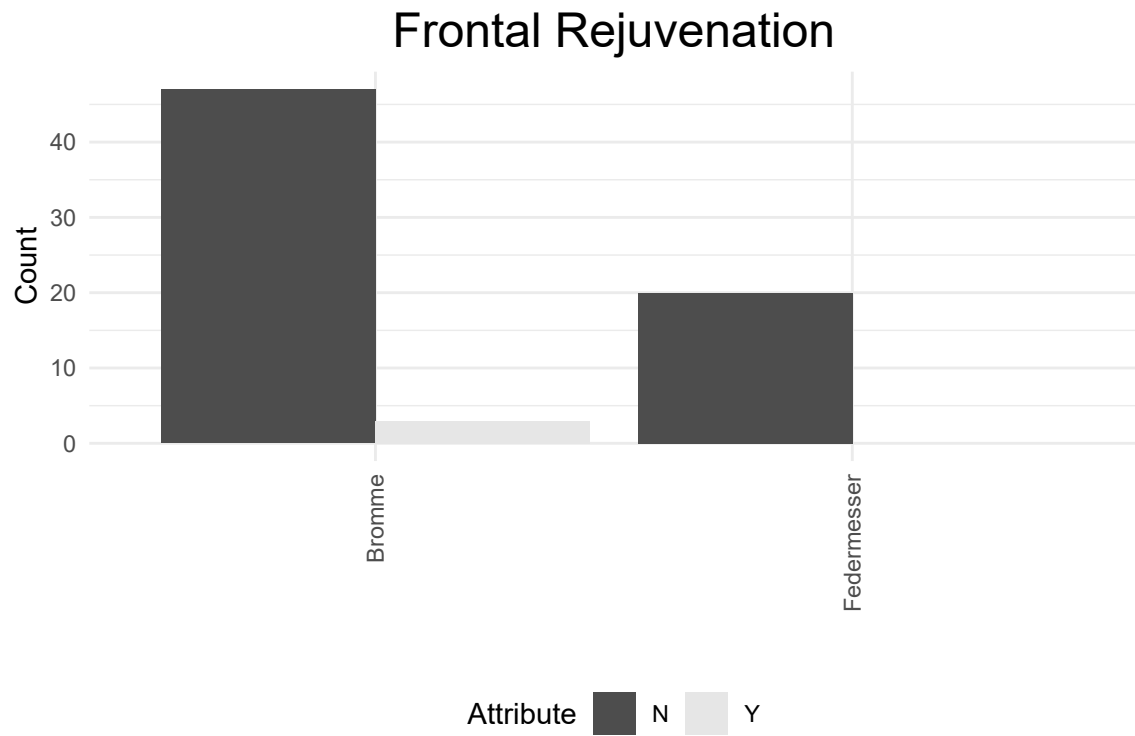


Attribute N Y

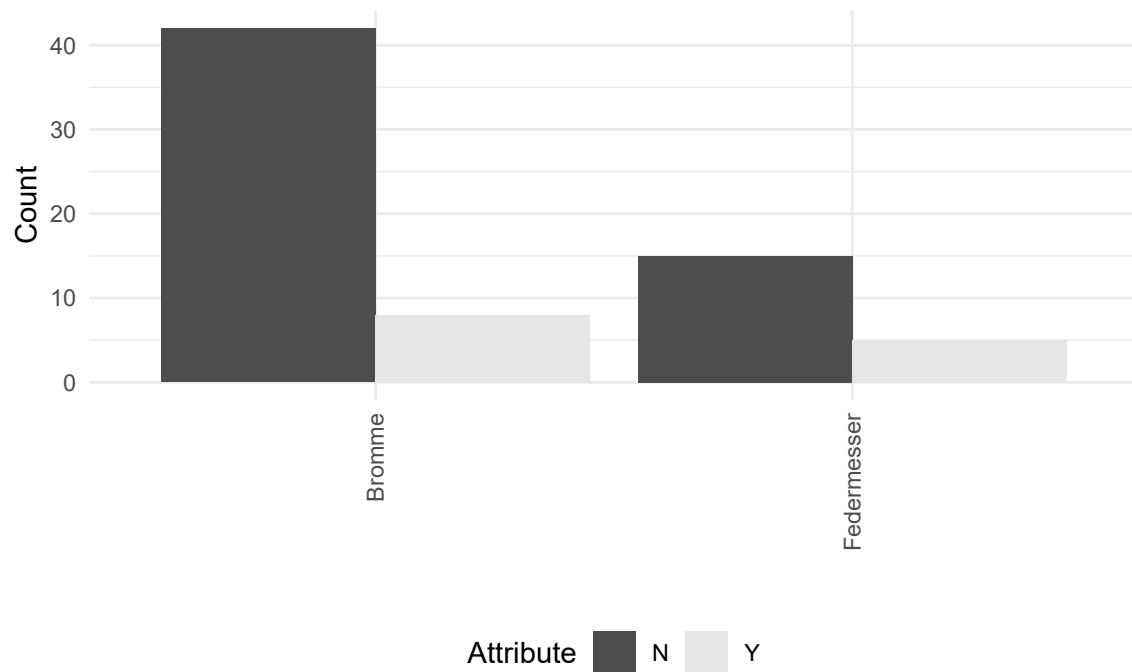
Preparatory Flake Rejuvenation



Attribute N Y

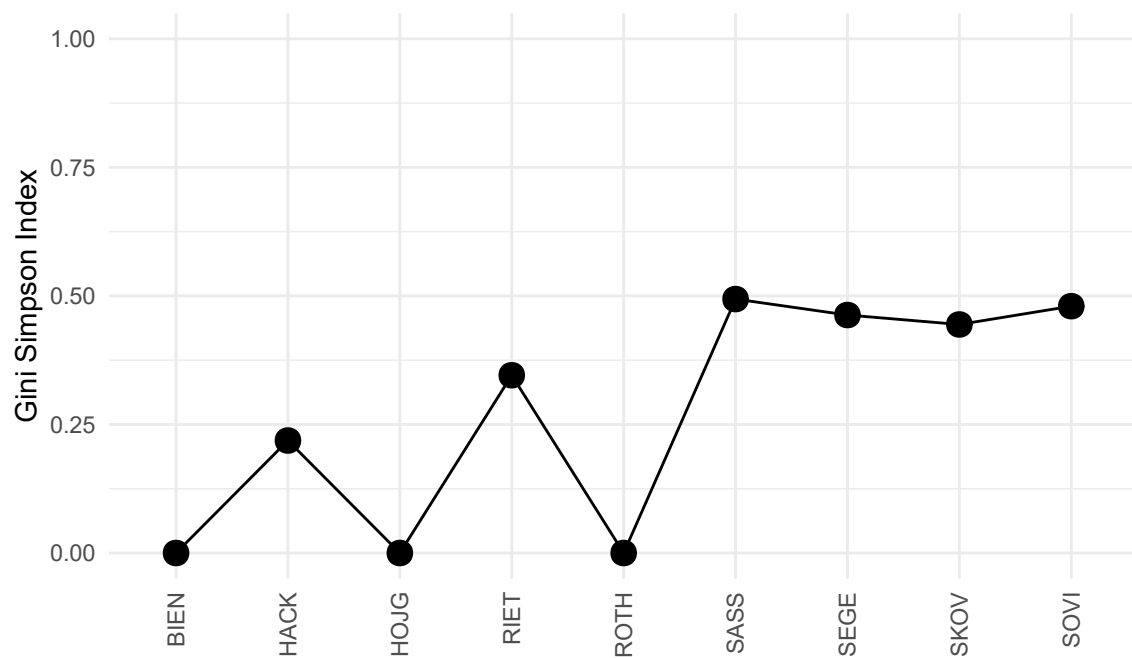


Core Lateral Rejuvenation

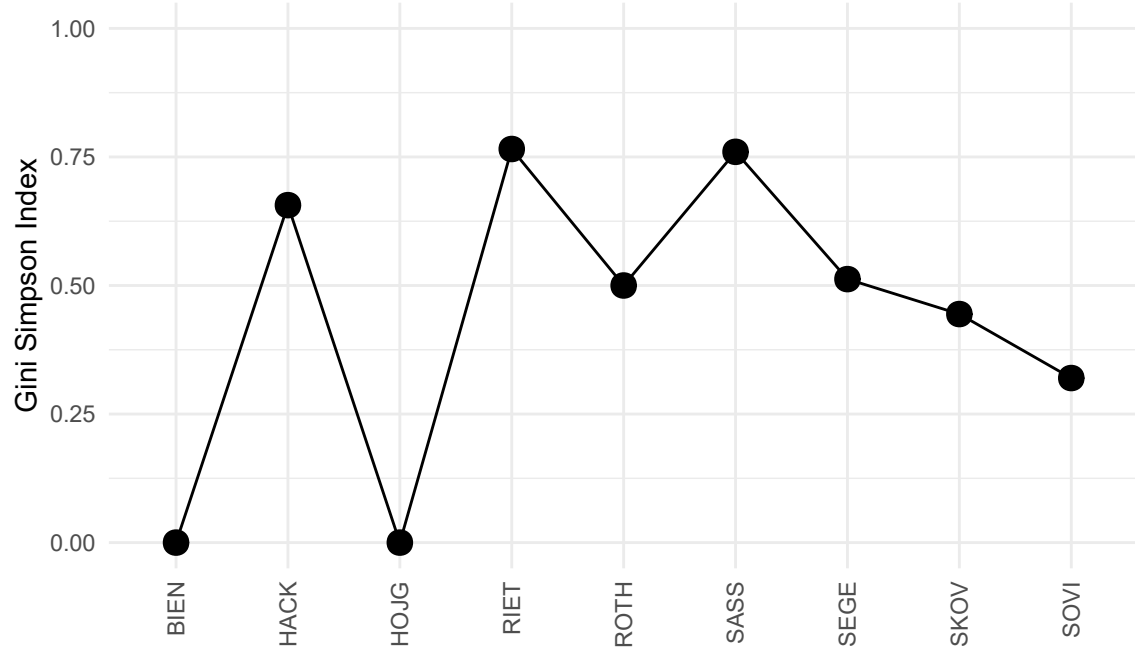


Gini-Simpson and Morisita-Horn diversity indices

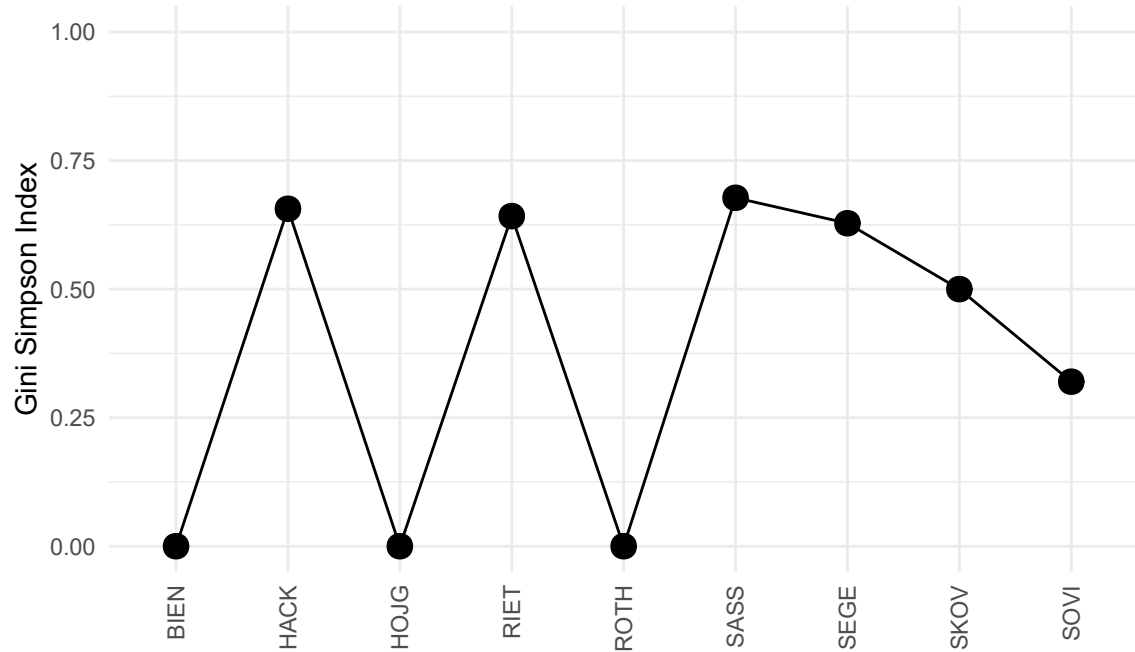
Core Morphology



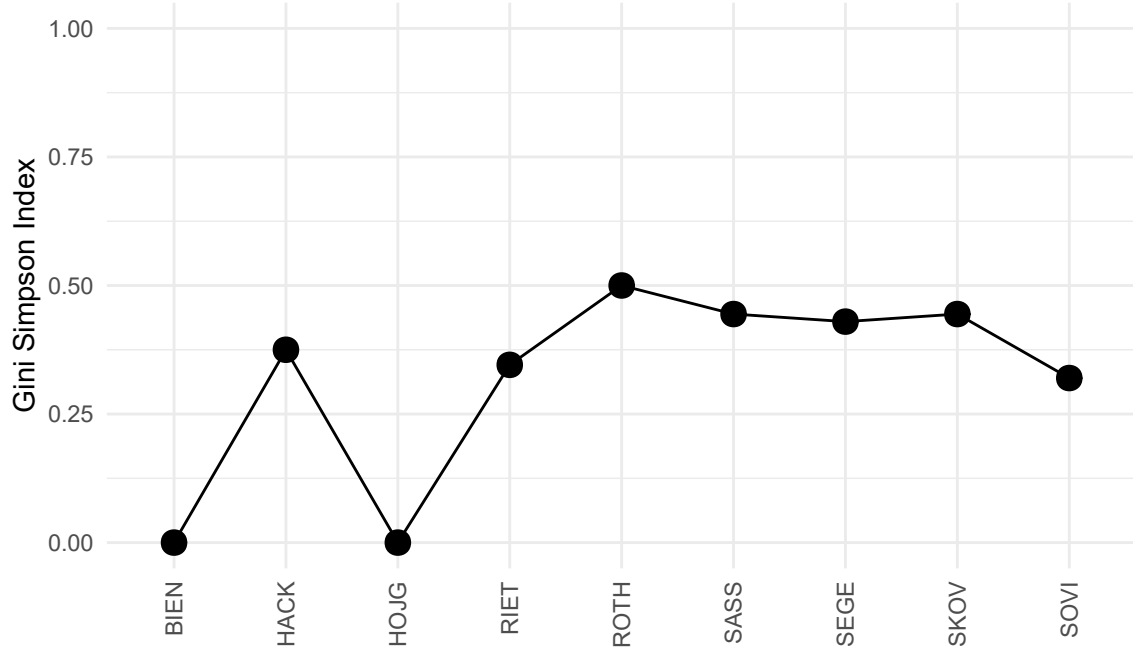
Core Platform Profile



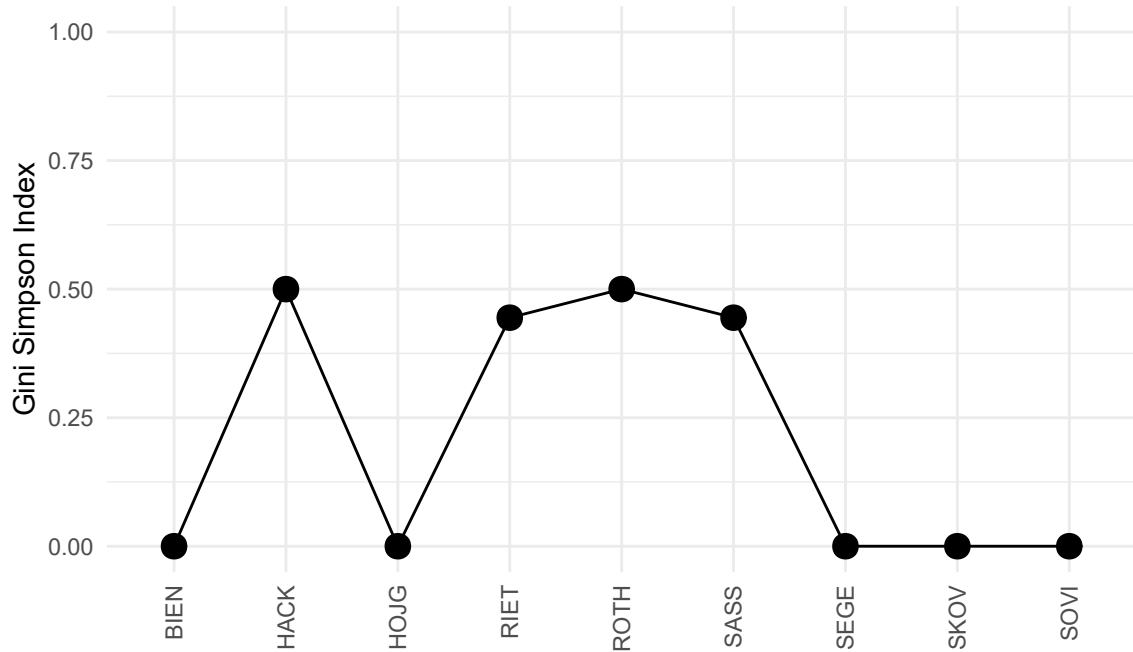
Core Reduction Strategy



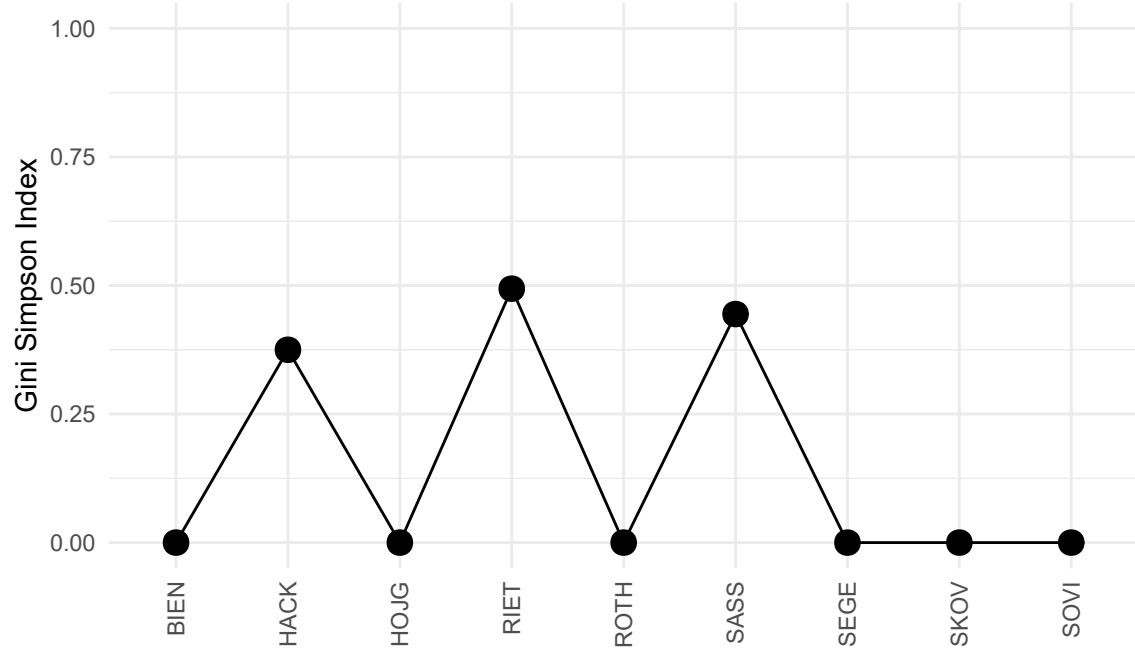
Core Directionality



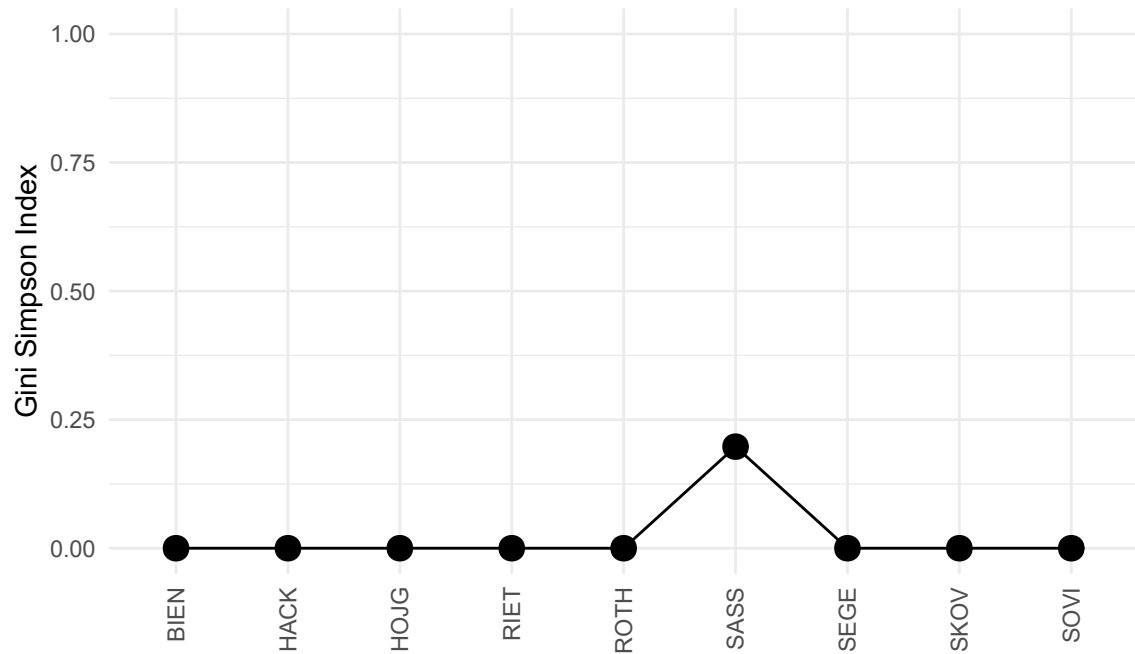
Core Tablet Rejuvenation



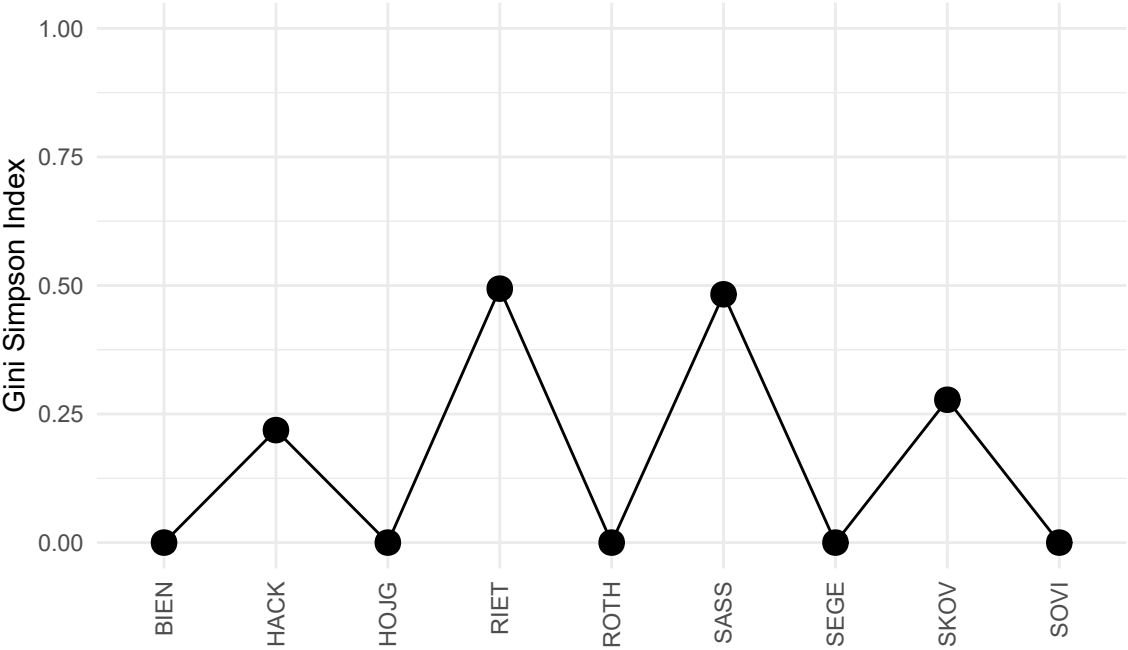
Preparatory Flake Rejuvenation



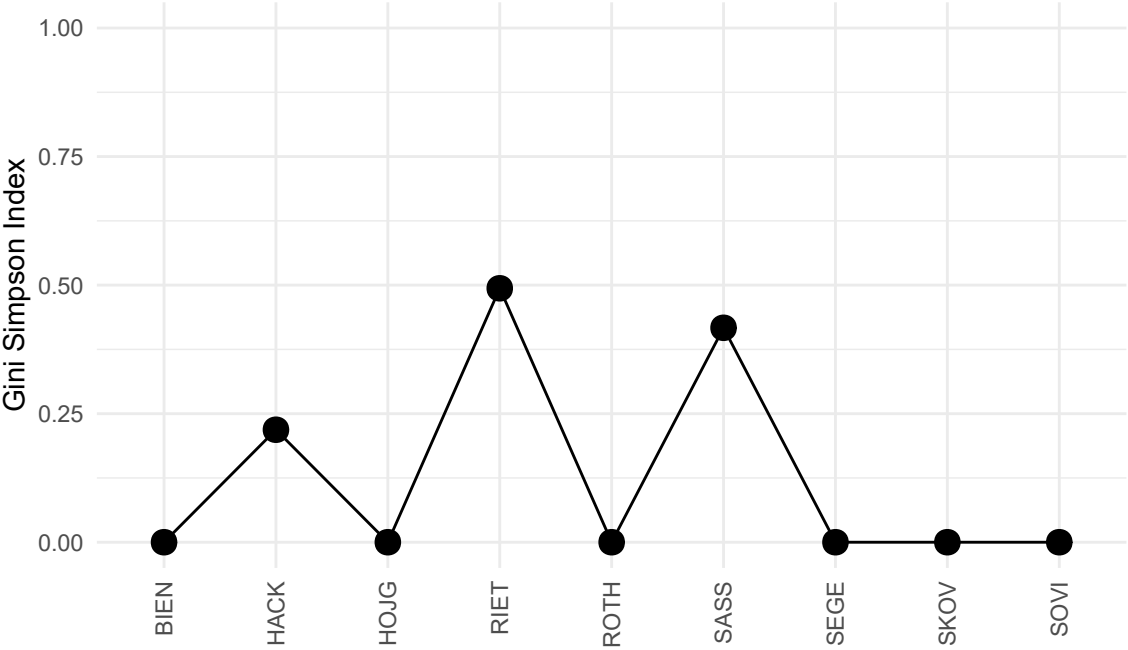
Frontal Rejuvenation



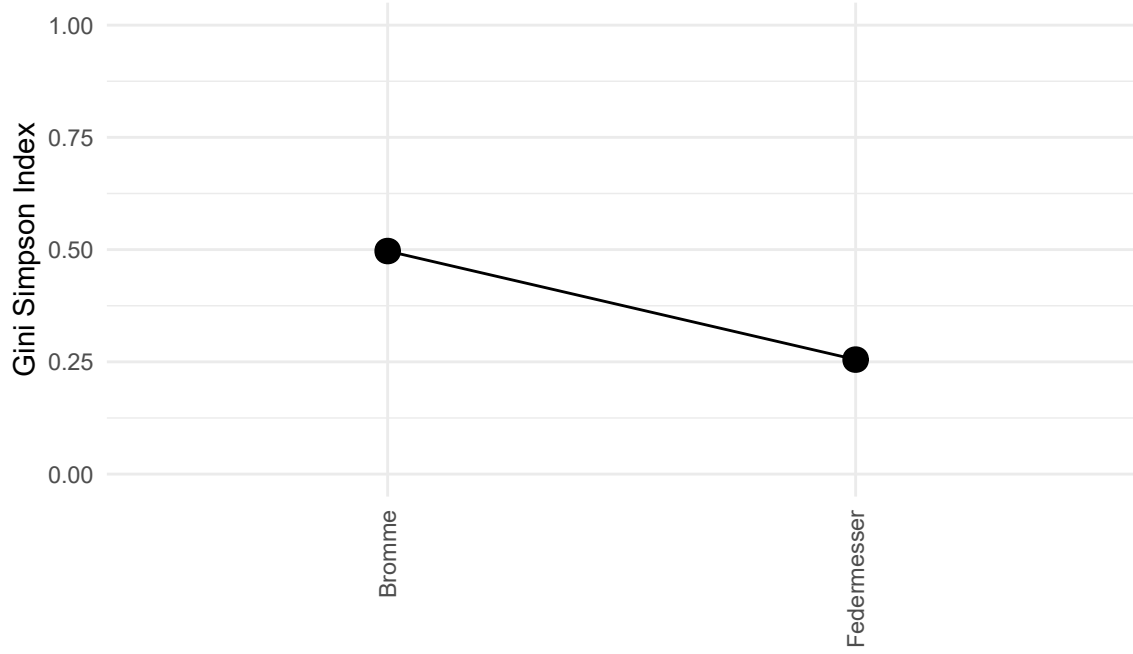
Core Distal Rejuvenation



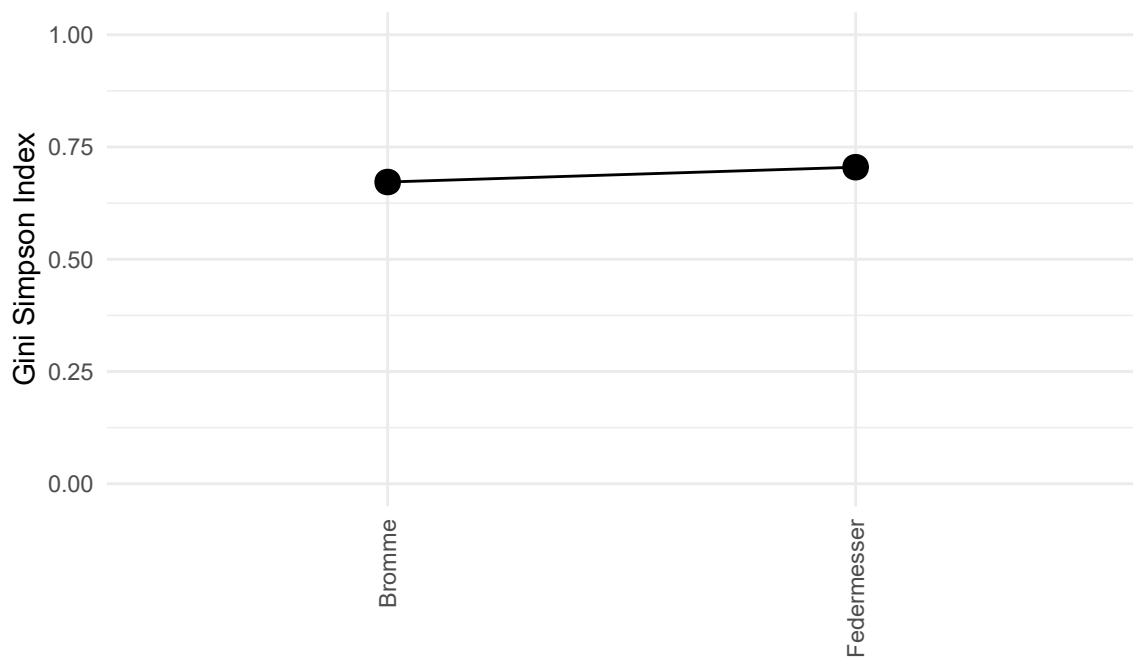
Core Lateral Rejuvenation



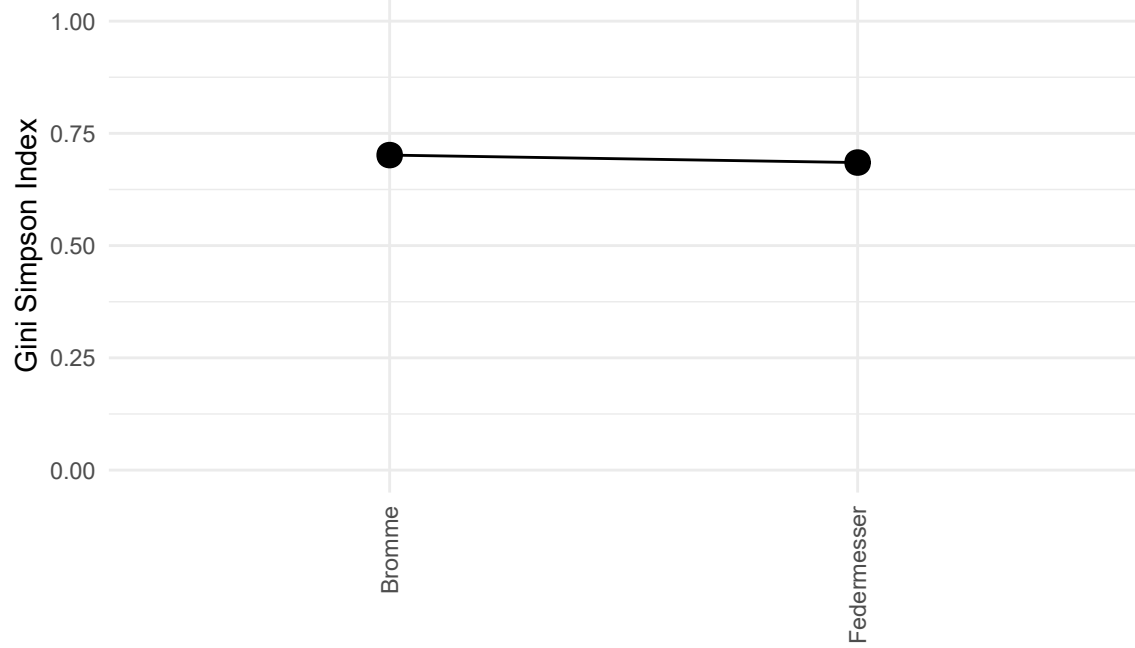
Core Morphology



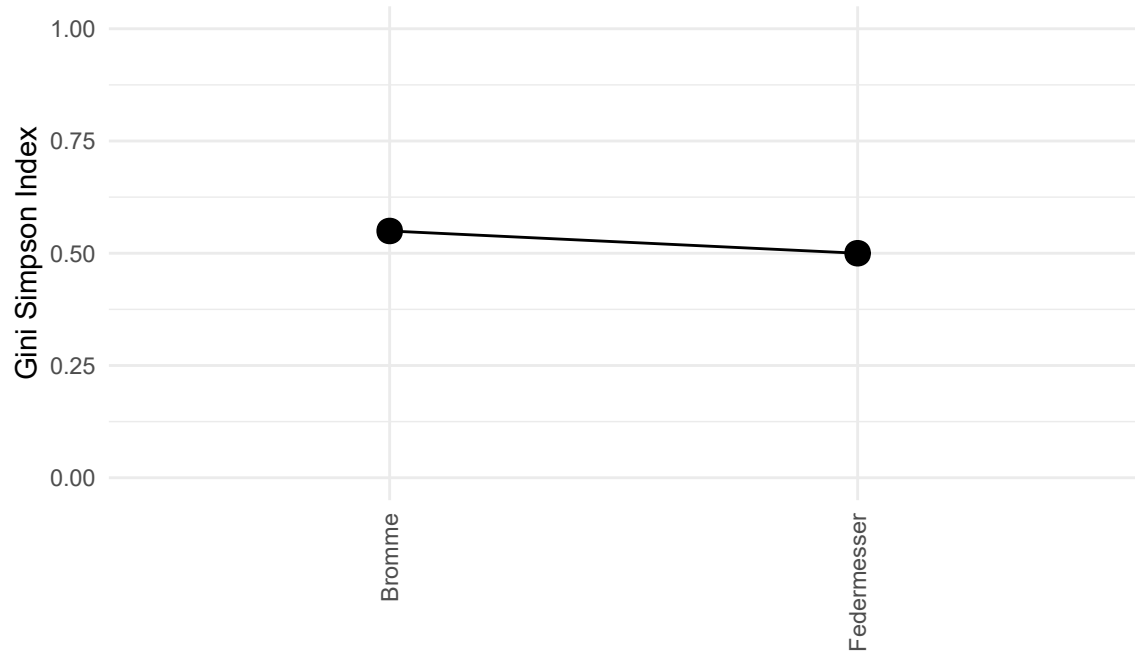
Core Platform Profile



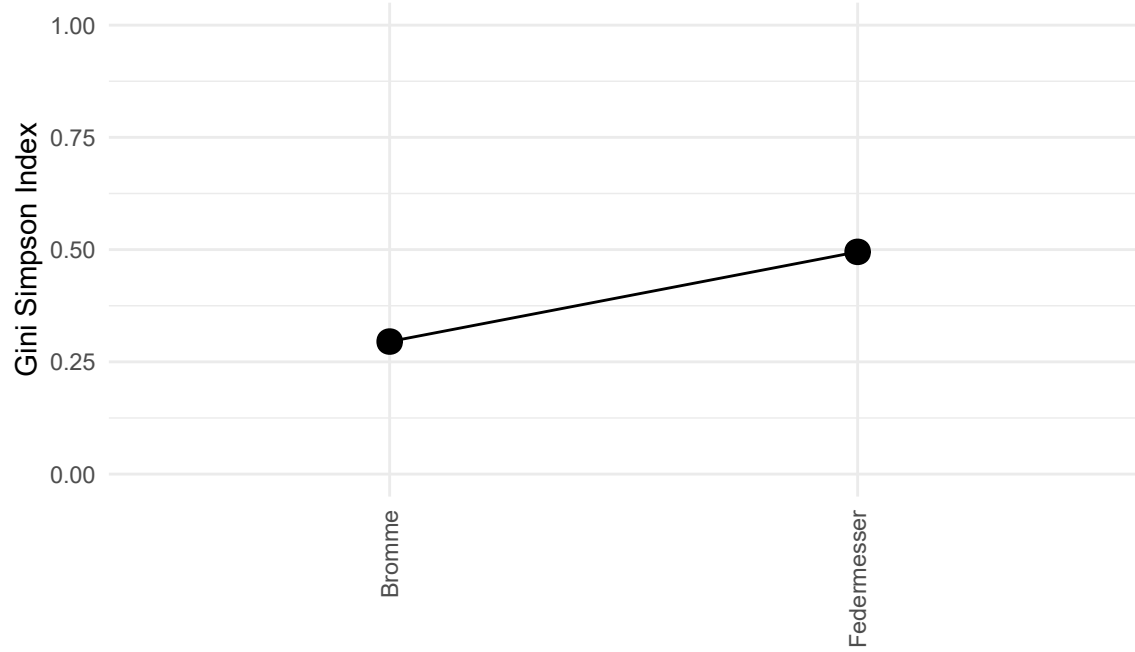
Core Reduction Strategy



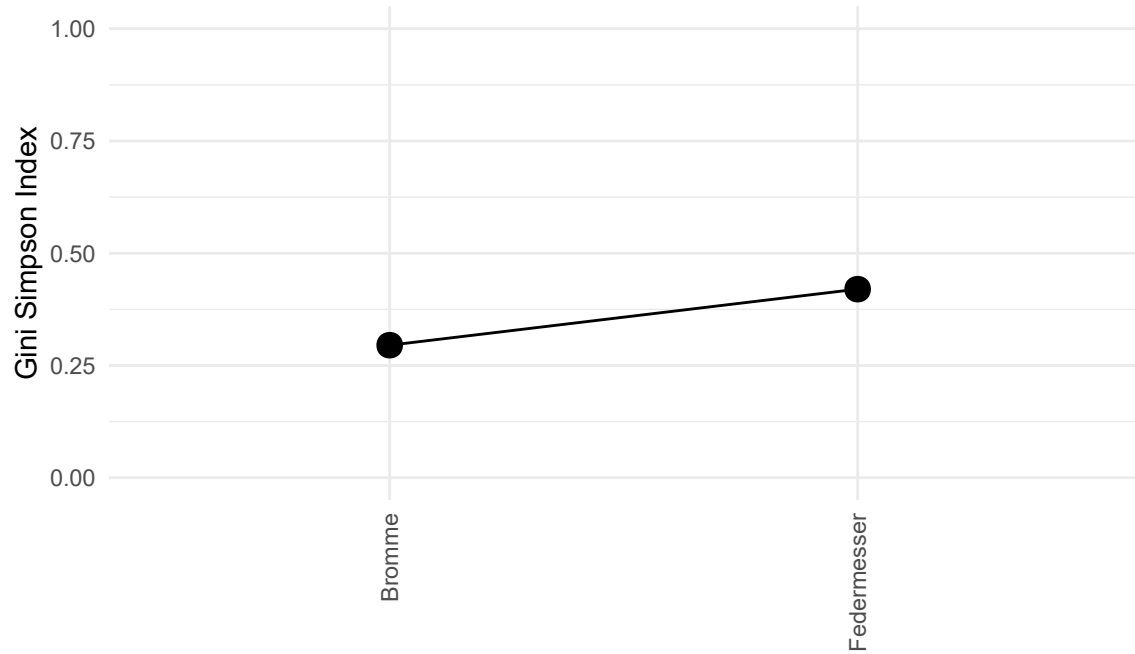
Core Directionality



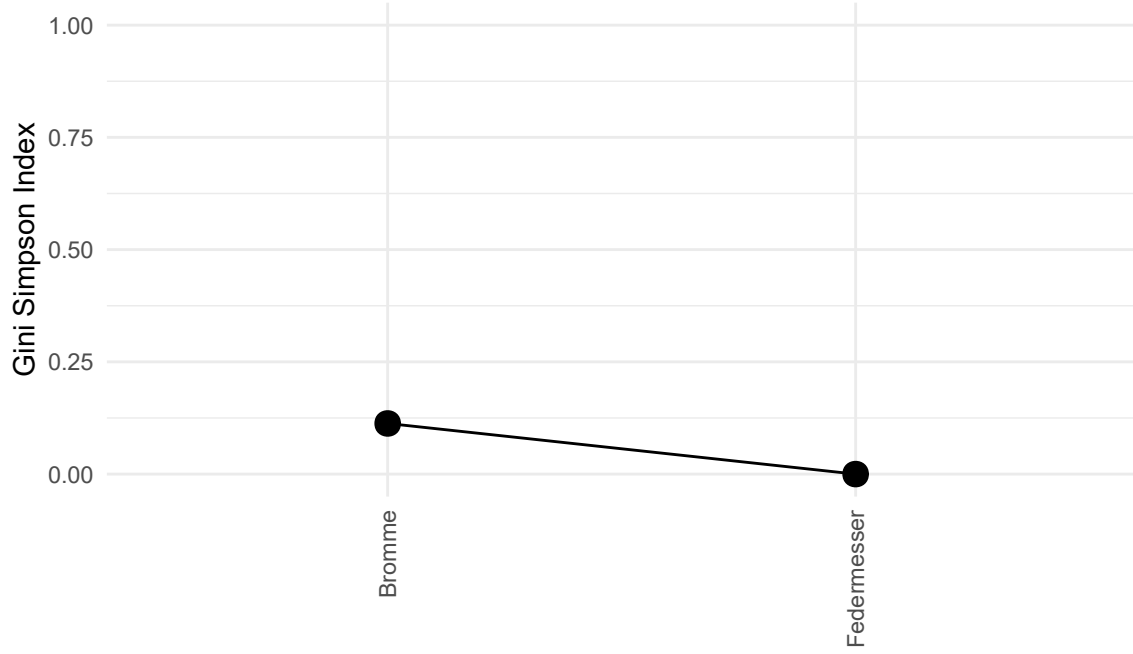
Core Tablet Rejuvenation



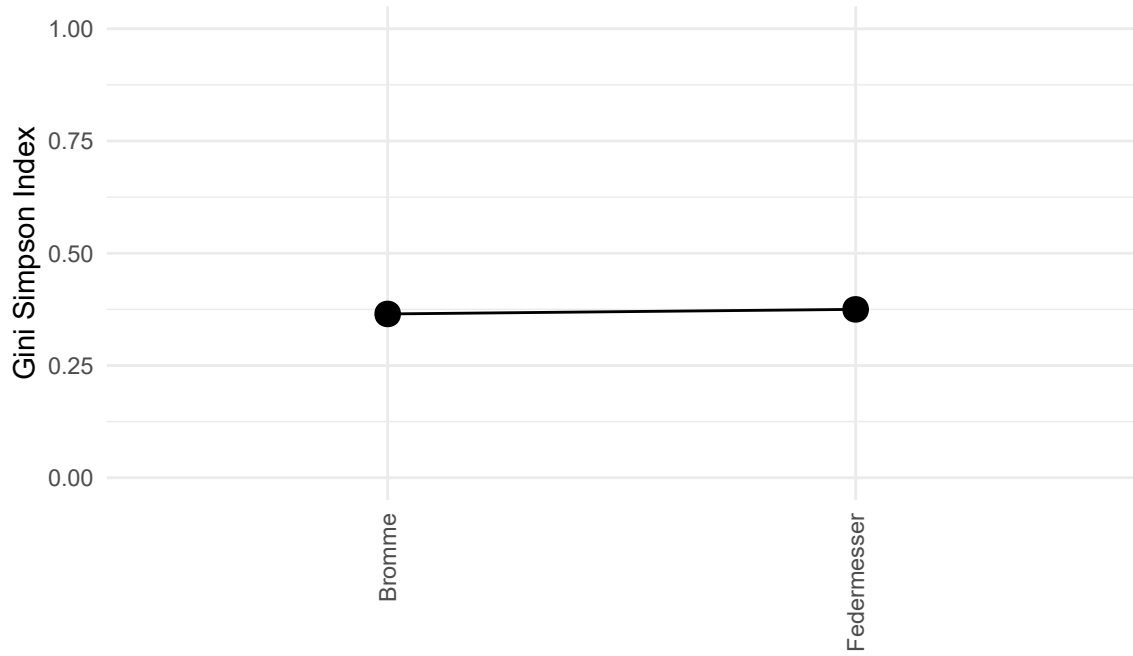
Preparatory Rejuvenation



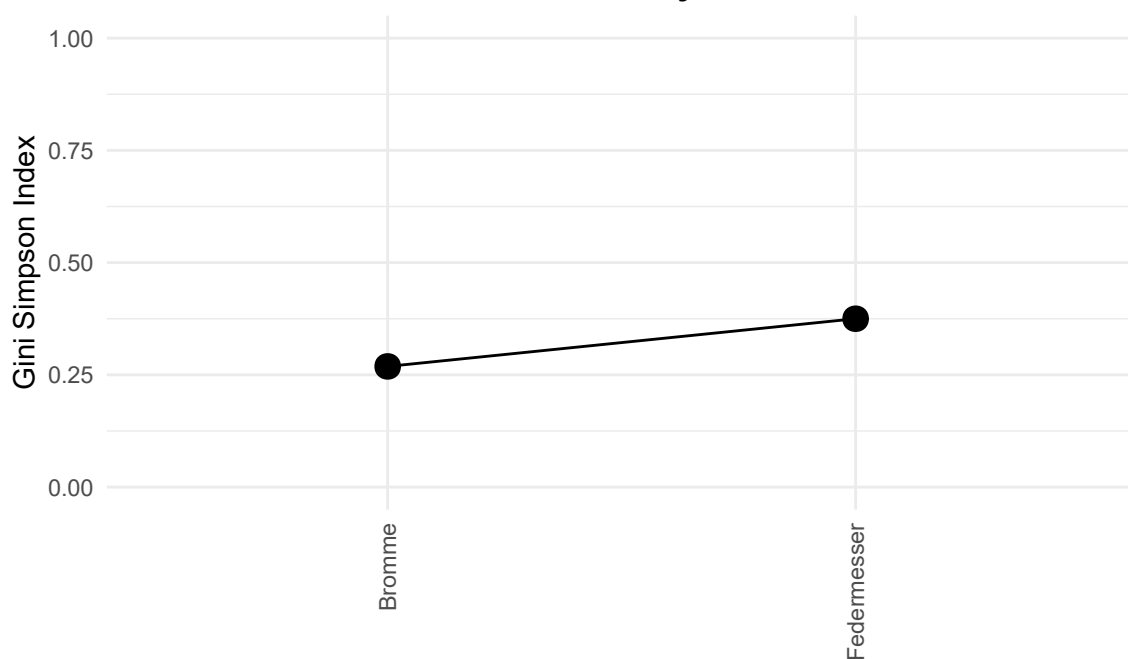
Frontal Rejuvenation



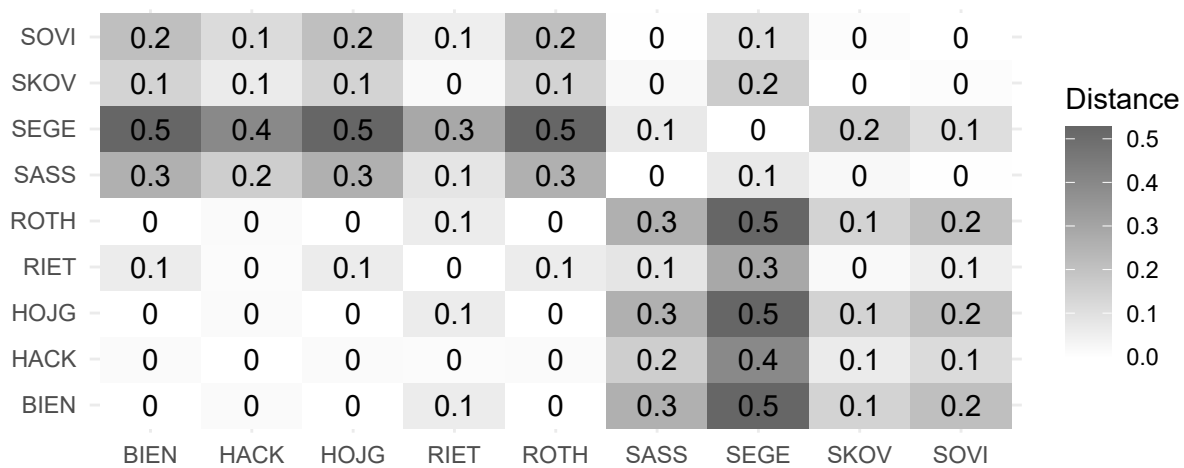
Core Distal Rejuvenation



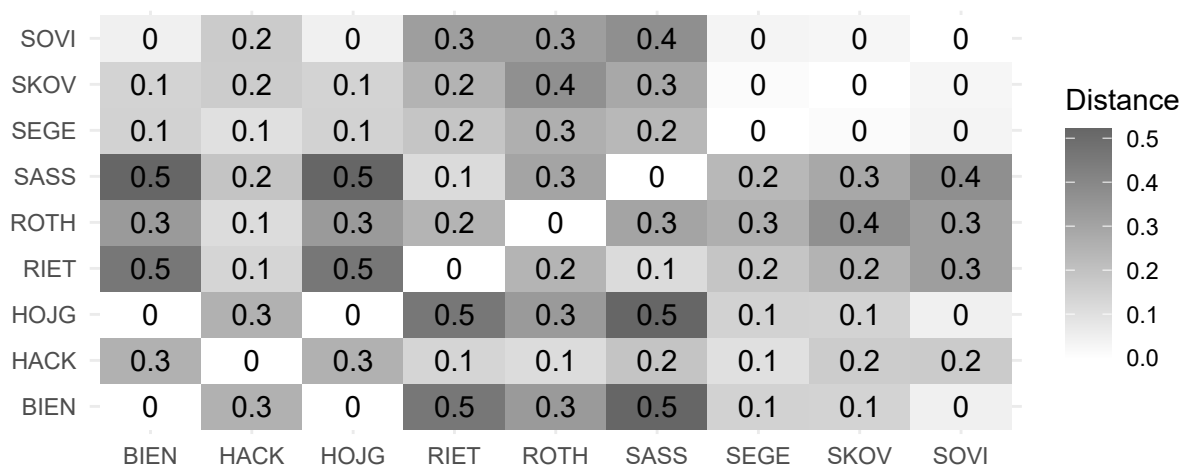
Core Lateral Rejuvenation



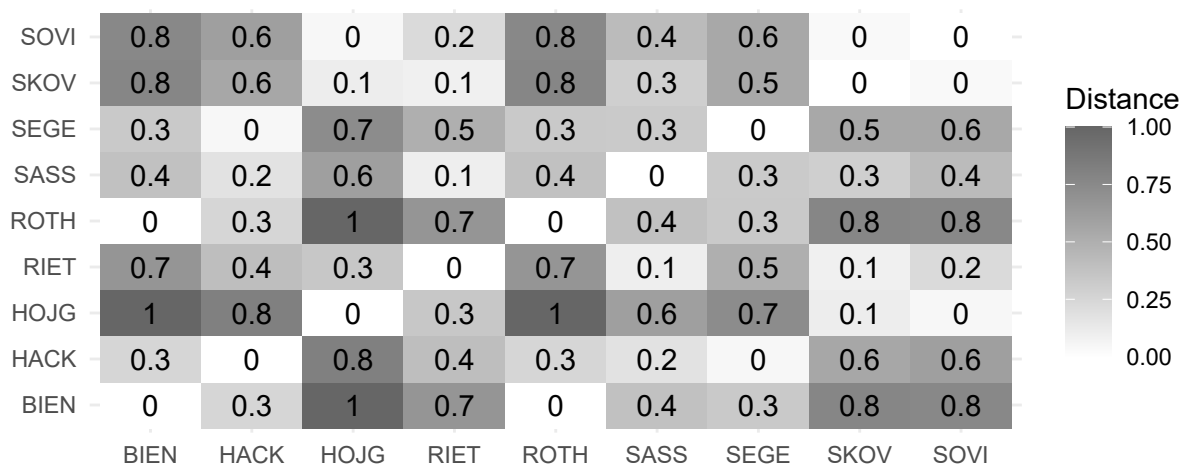
Core Morphology: Morisita-Horn Index



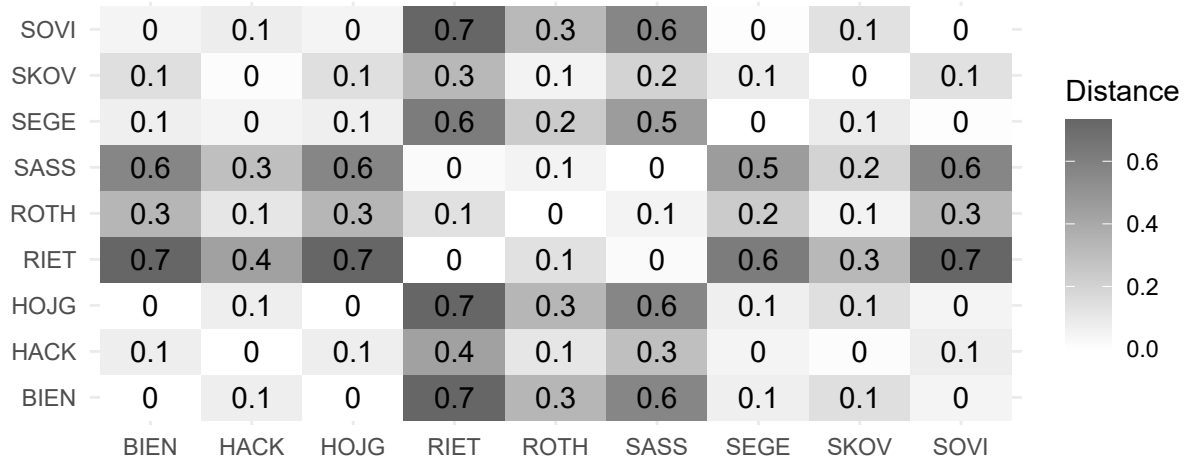
Core Platform Profile: Morisita-Horn Index



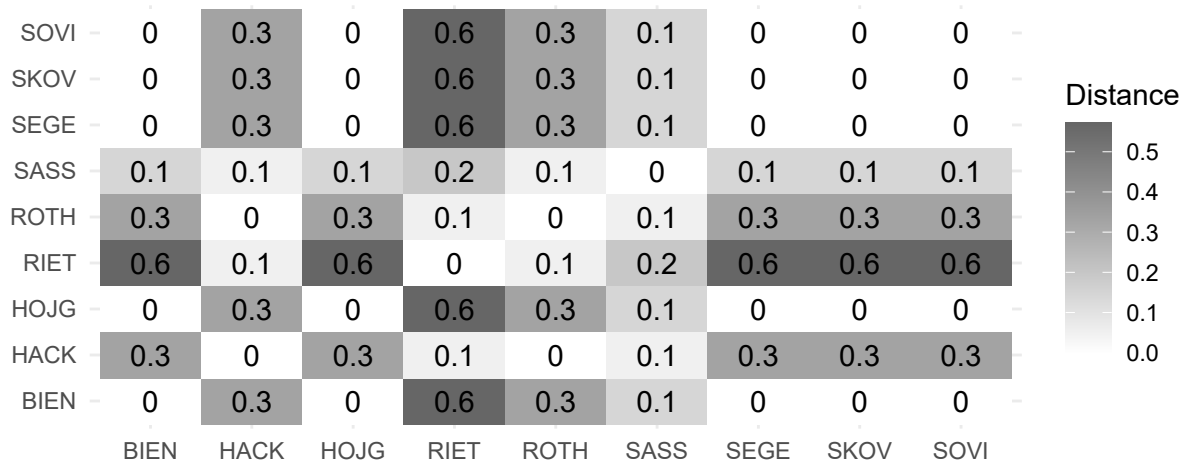
Core Reduction Strategy: Morisita-Horn Index



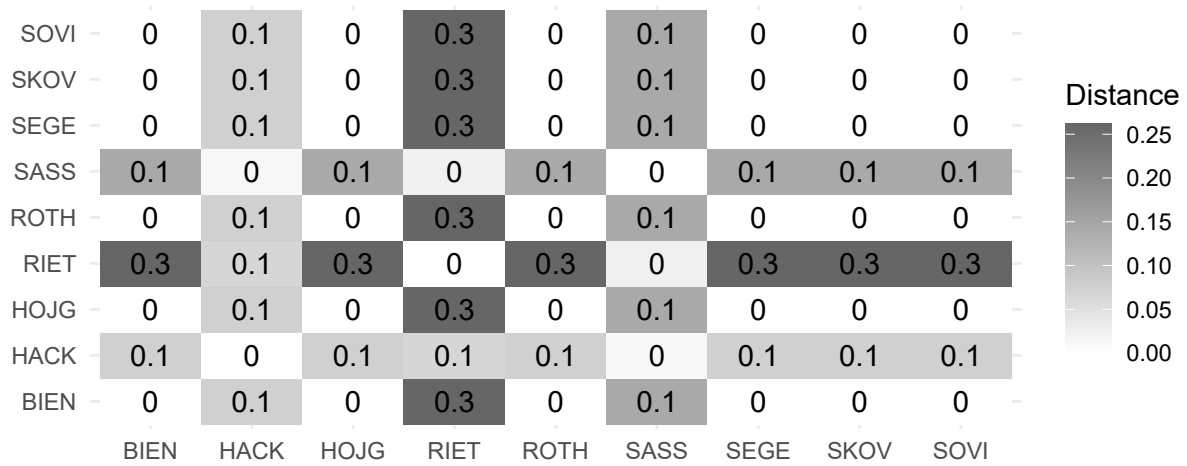
Core Directionality: Morisita-Horn Index



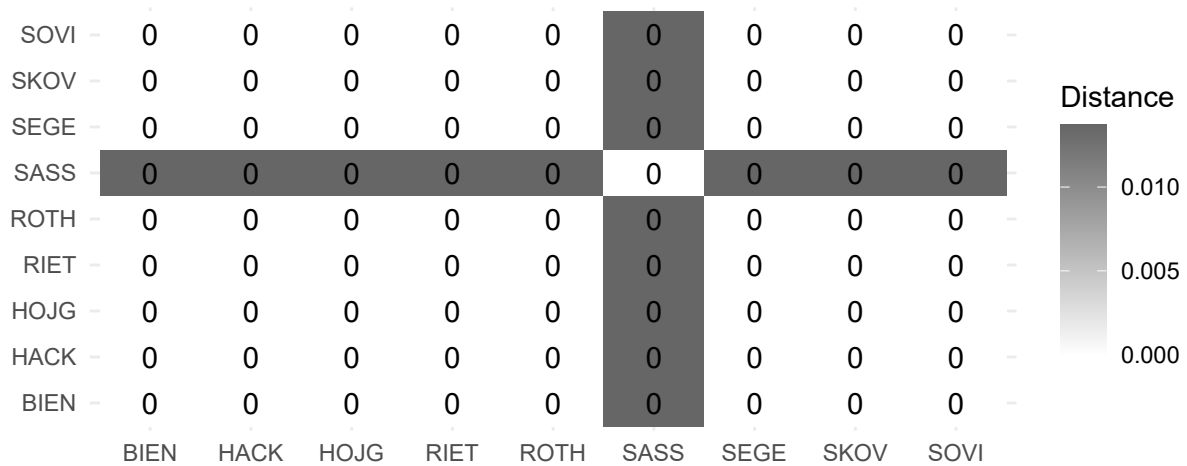
Core Tablet Rejuvenation: Morisita-Horn Index



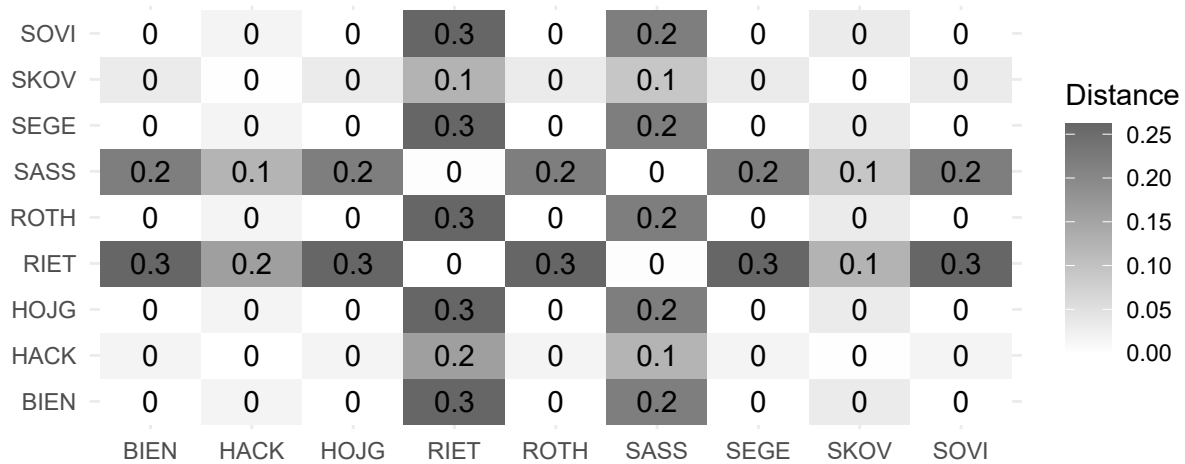
Preparatory Flake Rejuvenation: Morisita-Horn Index



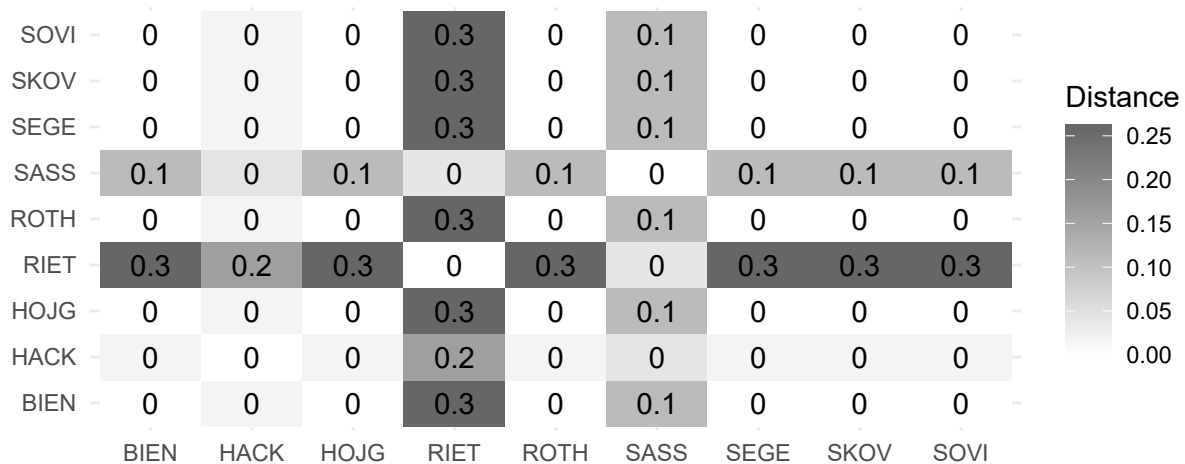
Frontal Rejuvenation: Morisita-Horn Index



Core Distal Rejuvenation: Morisita-Horn Index



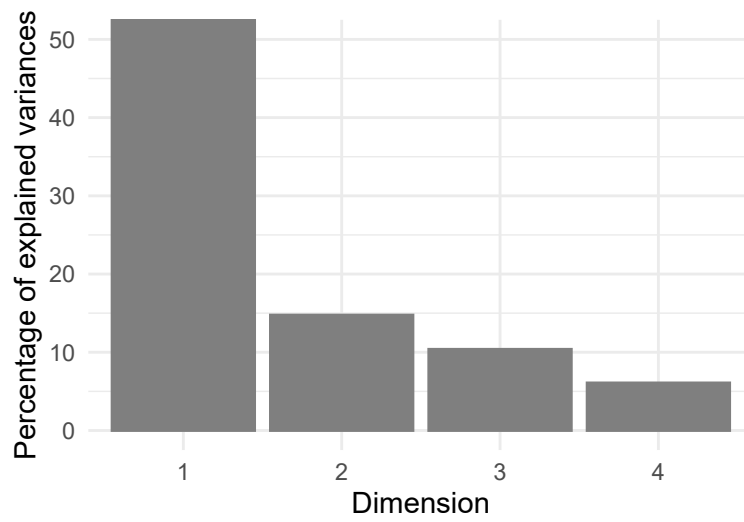
Core Lateral Rejuvenation: Morisita-Horn Index



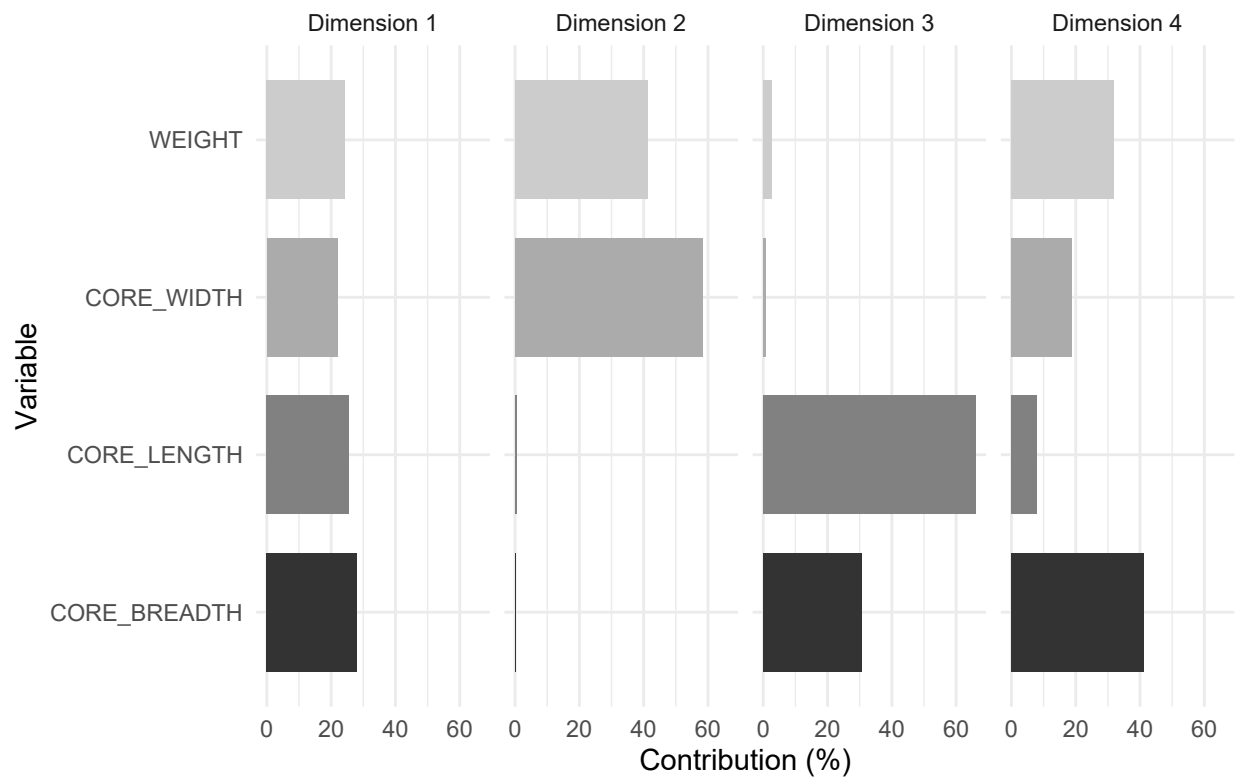
Principal Component Analysis (PCA)

Note: Elongation is omitted from this analysis as it is a combination of two pre-existing variables.

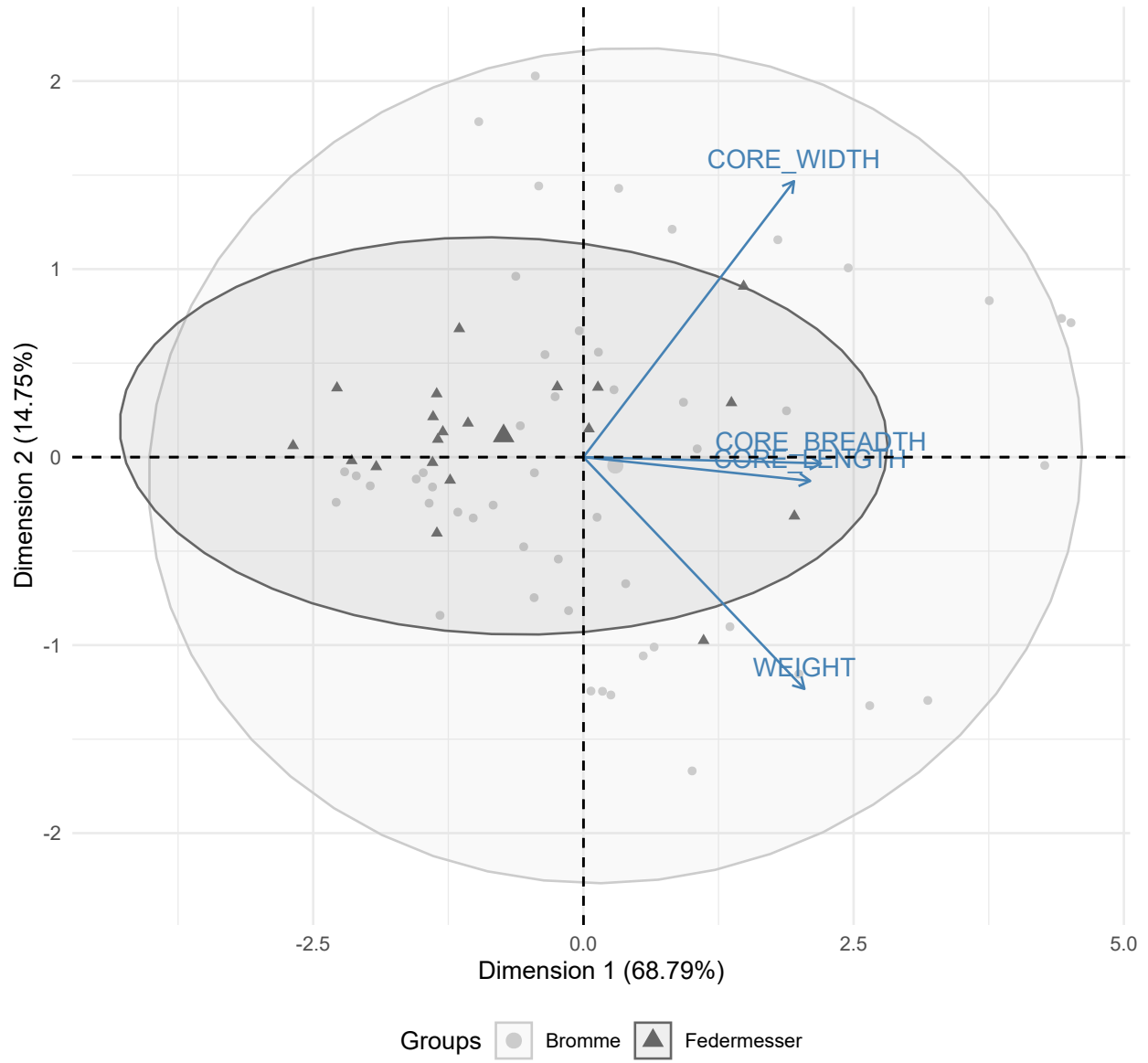
```
## # A tibble: 4 x 4
##   rowname eigenvalue variance cumulative
##   <chr>      <dbl>    <dbl>      <dbl>
## 1 Dim.1      2.75     68.8       68.8
## 2 Dim.2      0.590    14.8       83.5
## 3 Dim.3      0.415    10.4       93.9
## 4 Dim.4      0.243     6.08      100
```



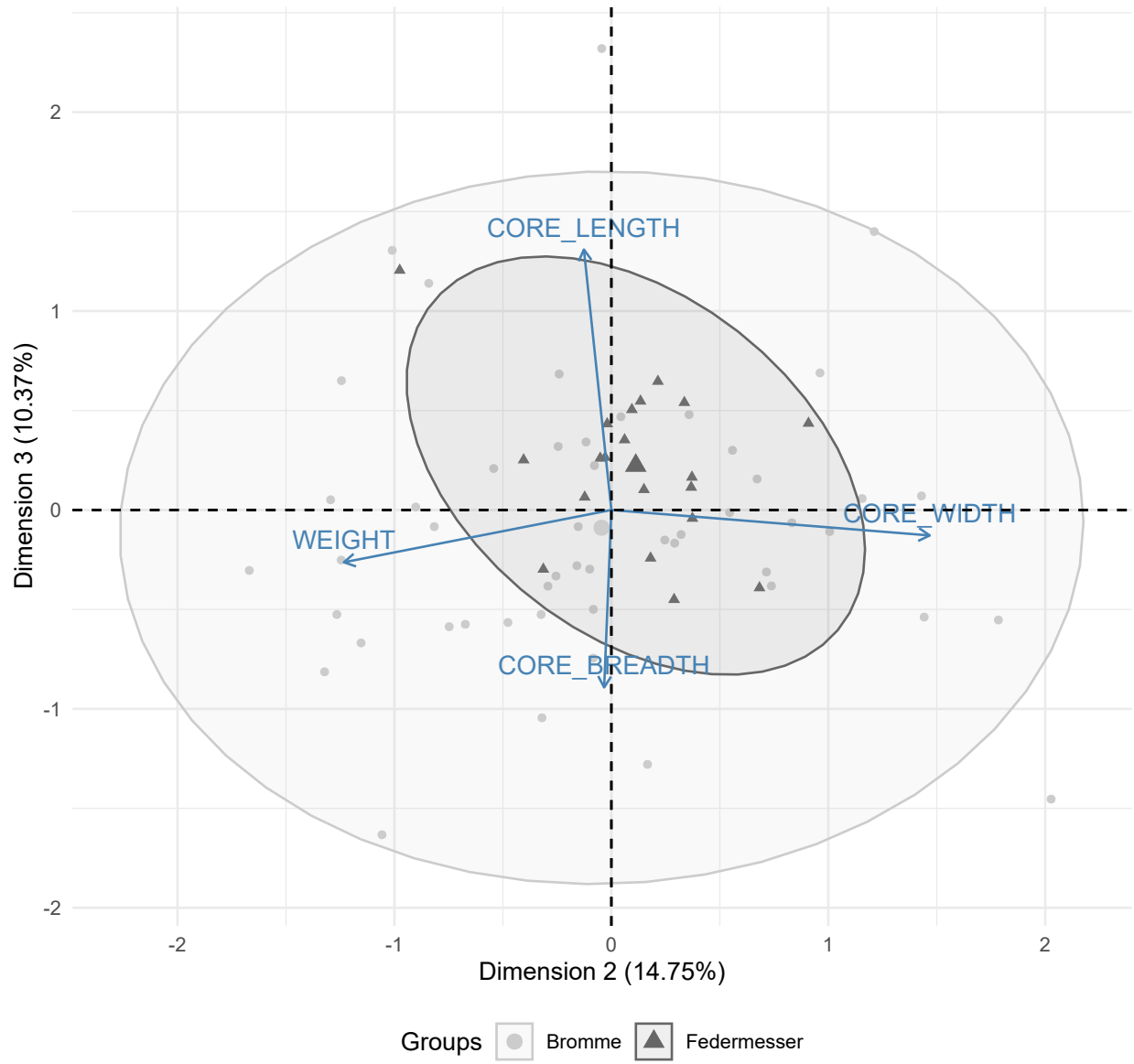
Contribution of Variables



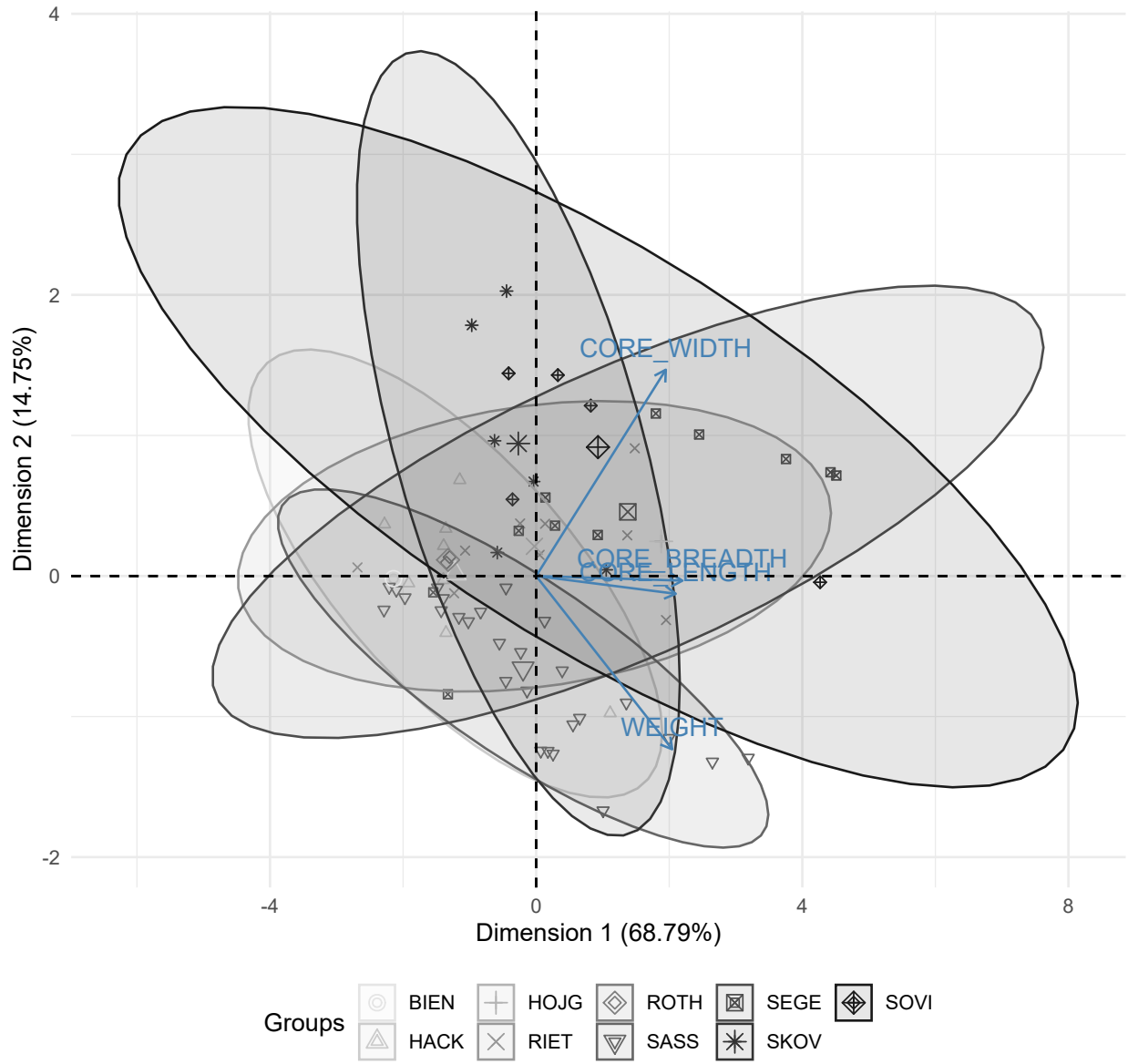
PCA 1 vs. PCA 2 (Classification)



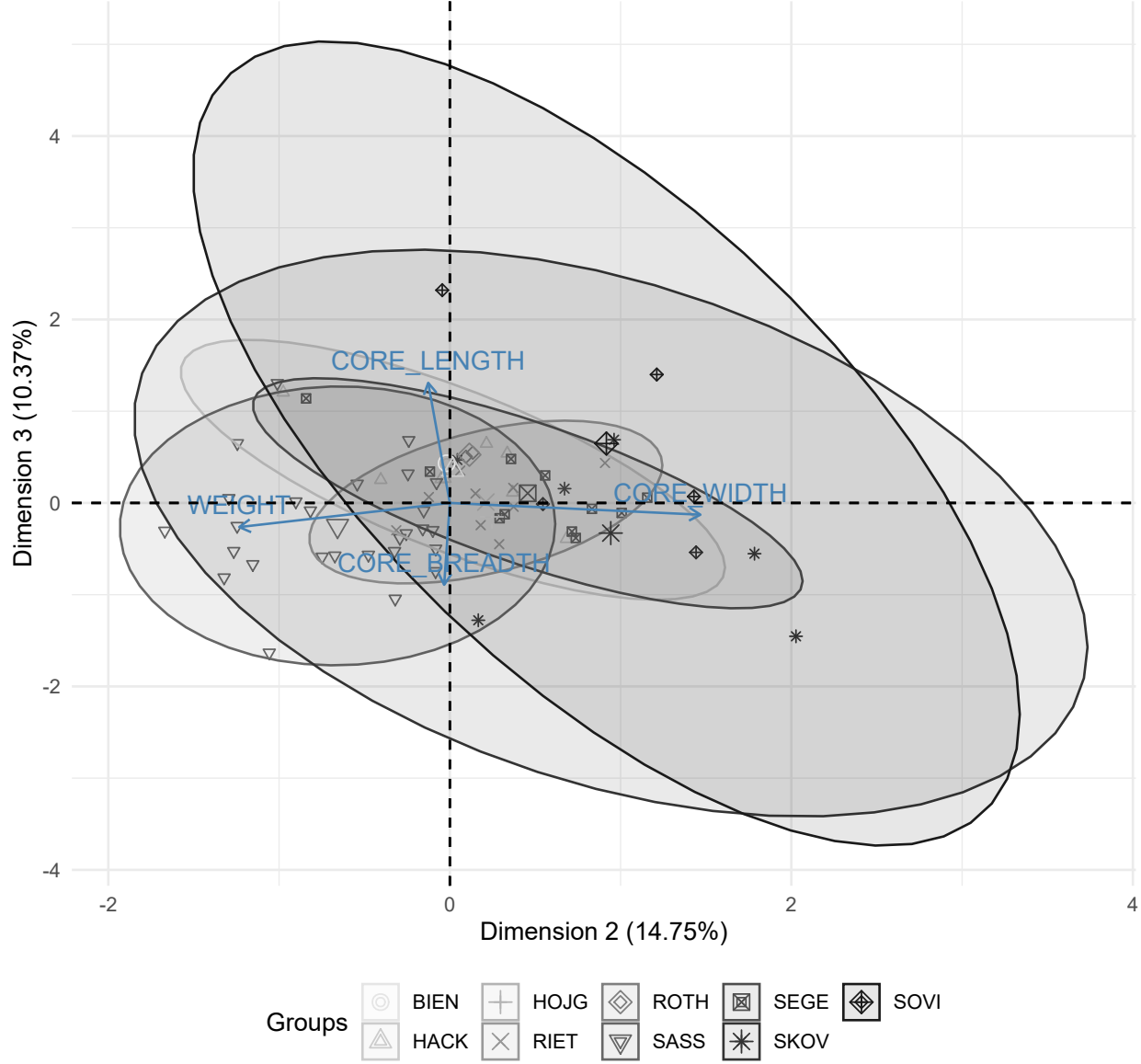
PCA 2 vs. PCA 3 (Classification)

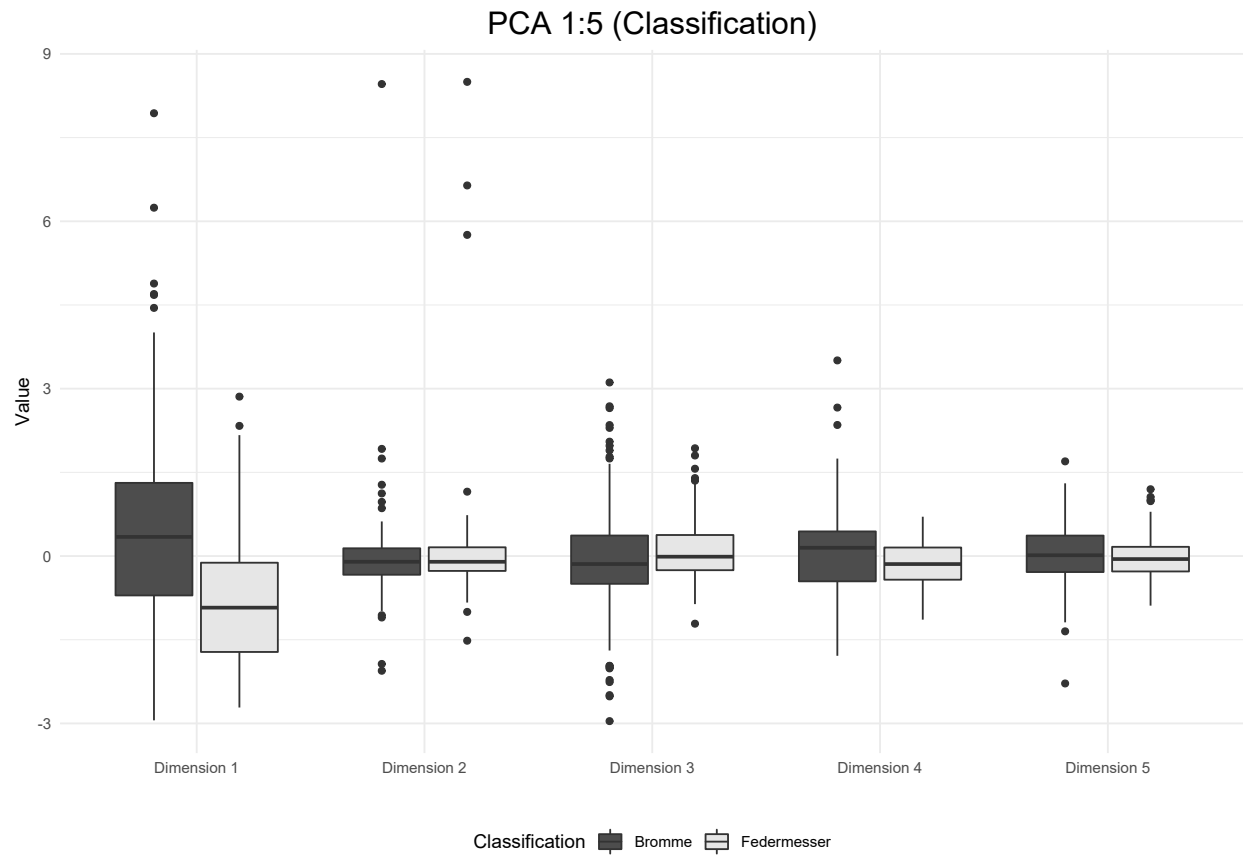


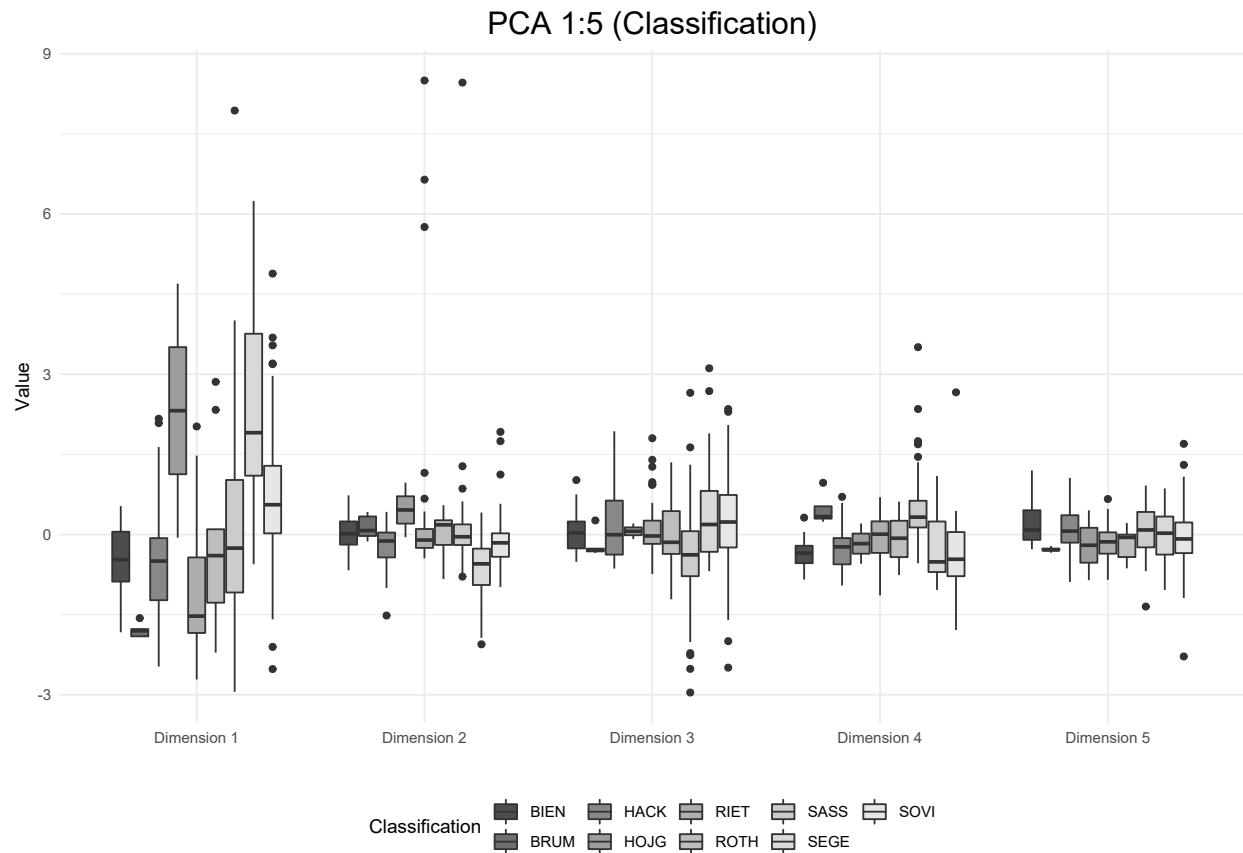
PCA 1 vs. PCA 2 (Context)



PCA 2 vs. PCA 3 (Context)

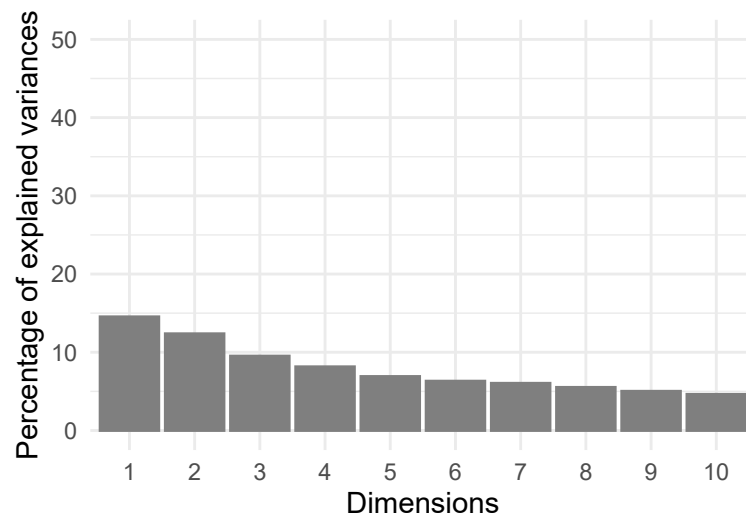


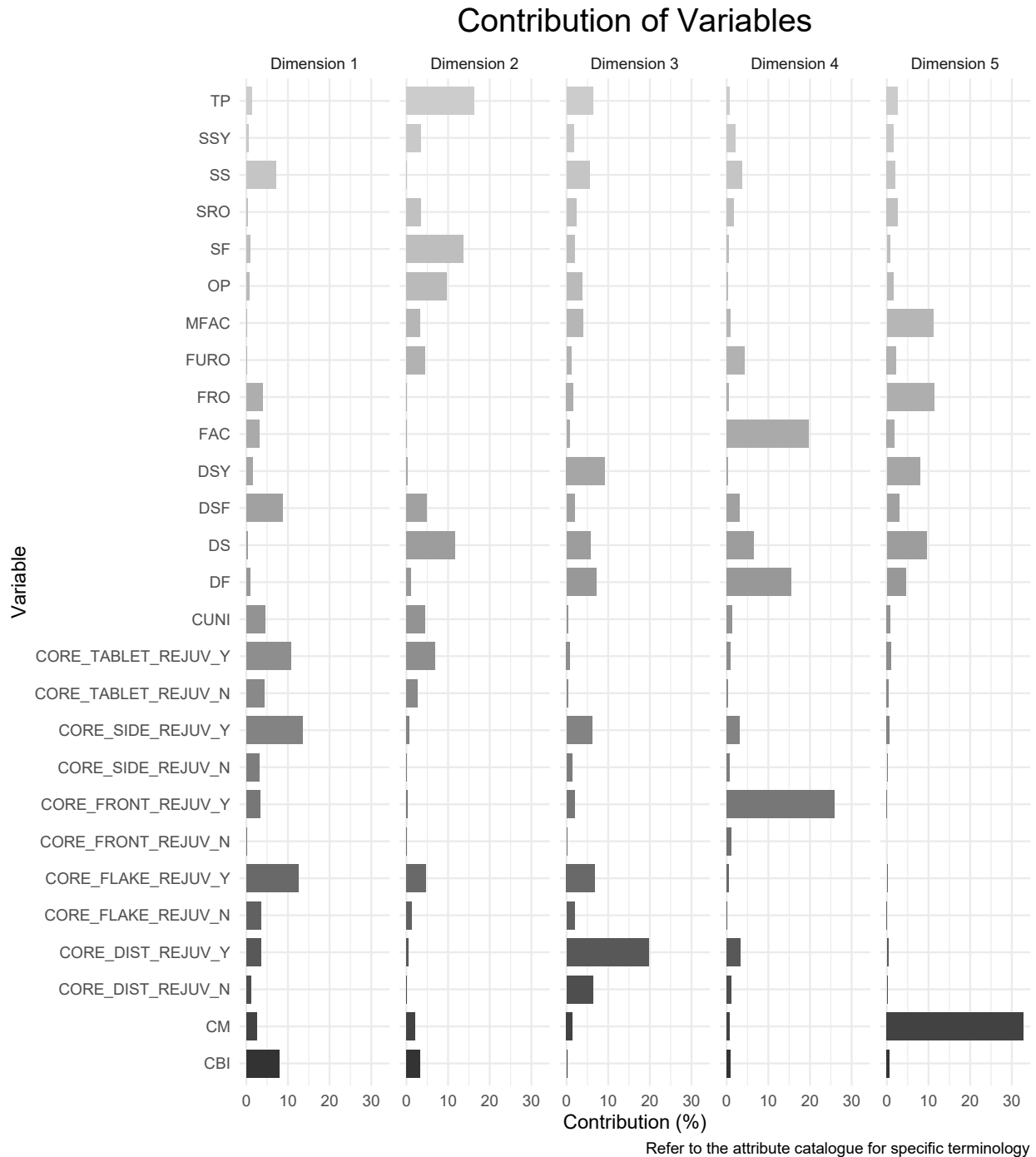




Multiple Correspondence Analysis (MCA)

```
## # 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
```





Key acronyms for responses in *Axis 1*:

CORE_FLAKE_REJUV_Y: Preparatory flake rejuvenation: positive response (**Core Flake Rejuv**)

CORE_SIDE_REJUV_Y: Lateral rejuvenation: positive response (**Core Side Rejuv**)

CORE_TABLET_REJUV_Y: Core tabletting: positive response (**Core Tablet Rejuv**)

DSF: Double smooth and facetted core platforms (**Plat Rejuv**)

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

Key acronyms for responses in *Axis 2*:

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

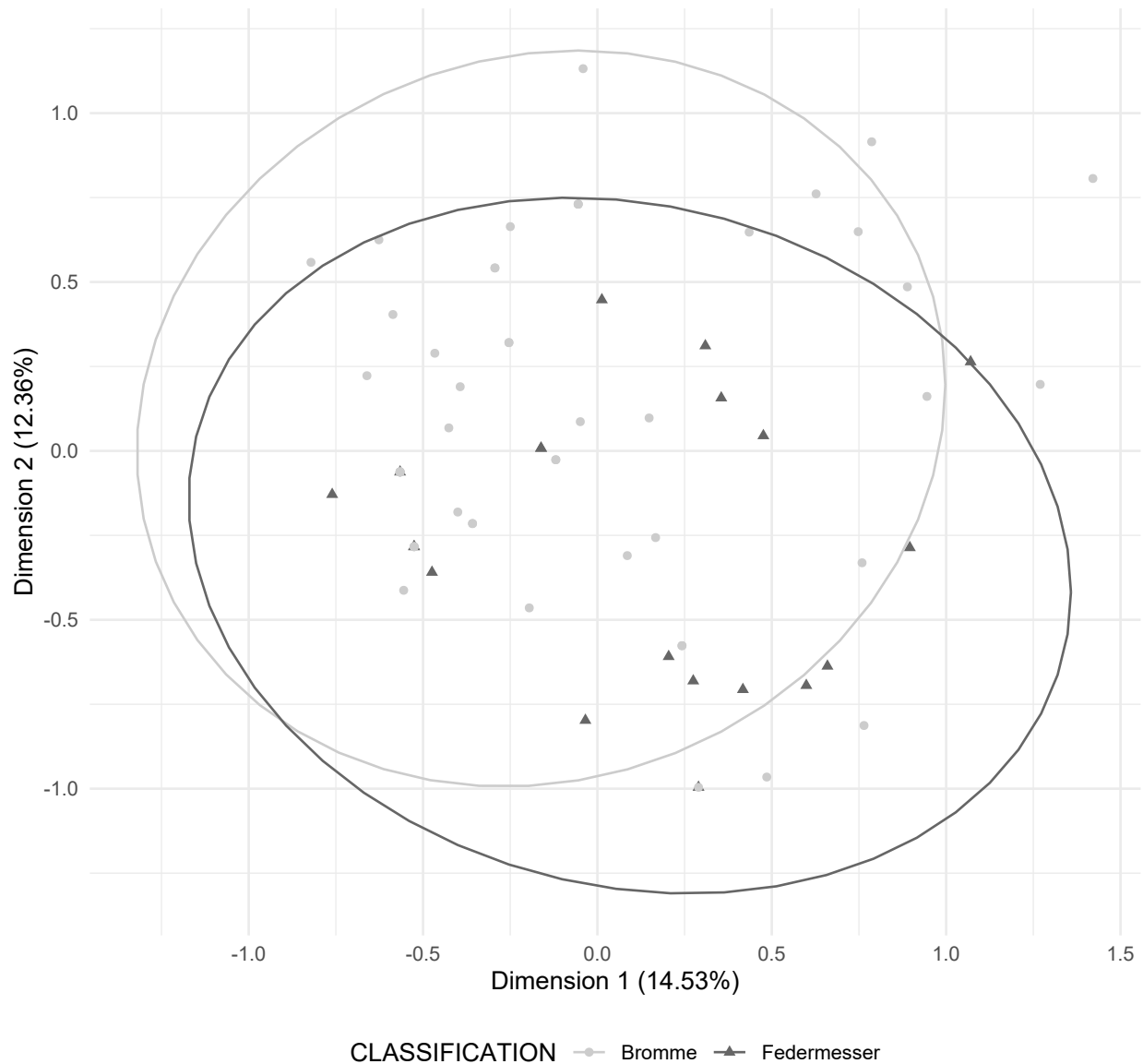
SF: Single facetted and/or flaked platforms (**Plat Rejuv**)

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

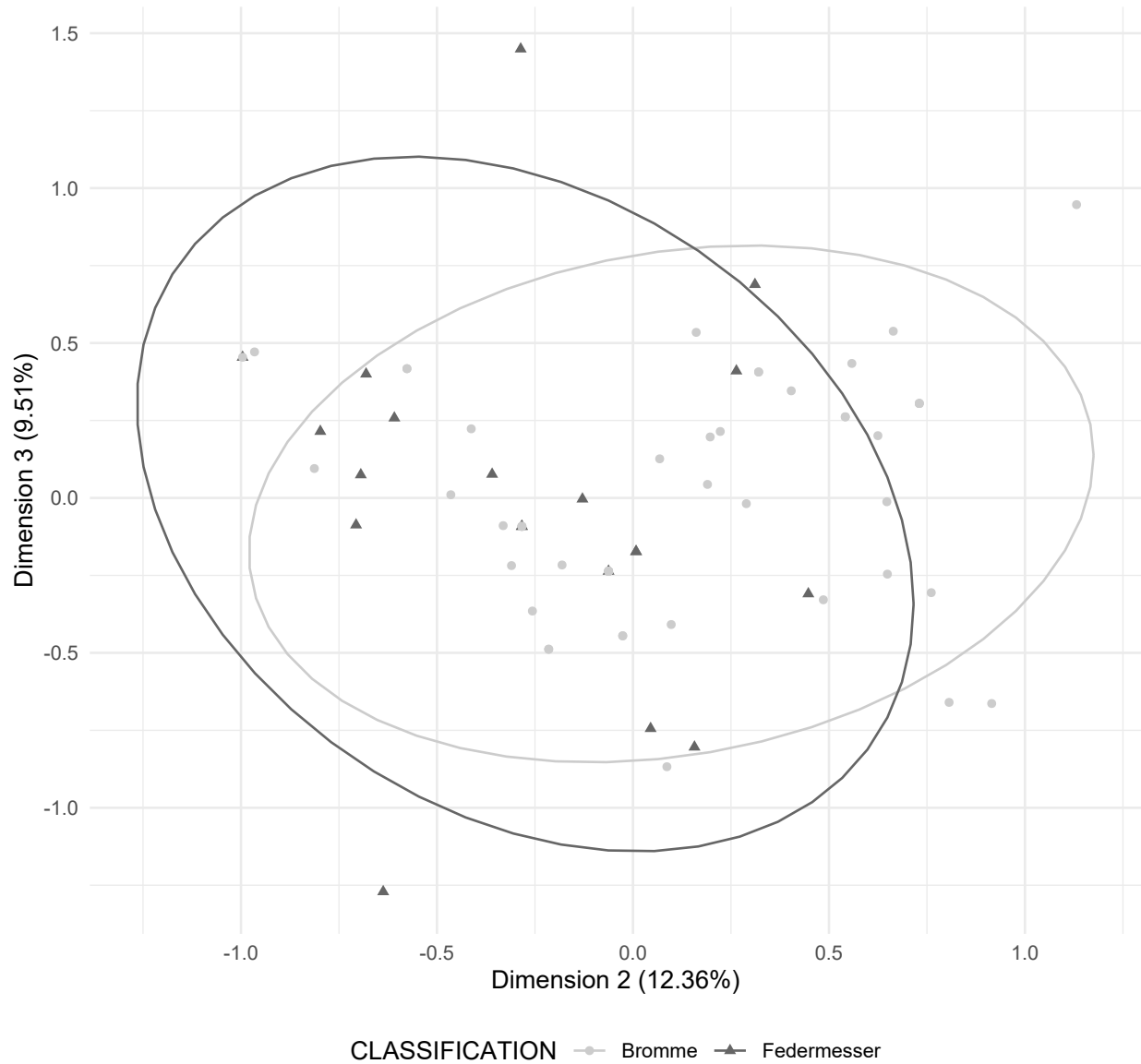
OP: One platform (**Core Morph**)

CORE_TABLET_REJUV_Y: Core tabletting: positive response(**Core Tablet Rejuv**)

MCA 1 vs. MCA 2 (Classification)

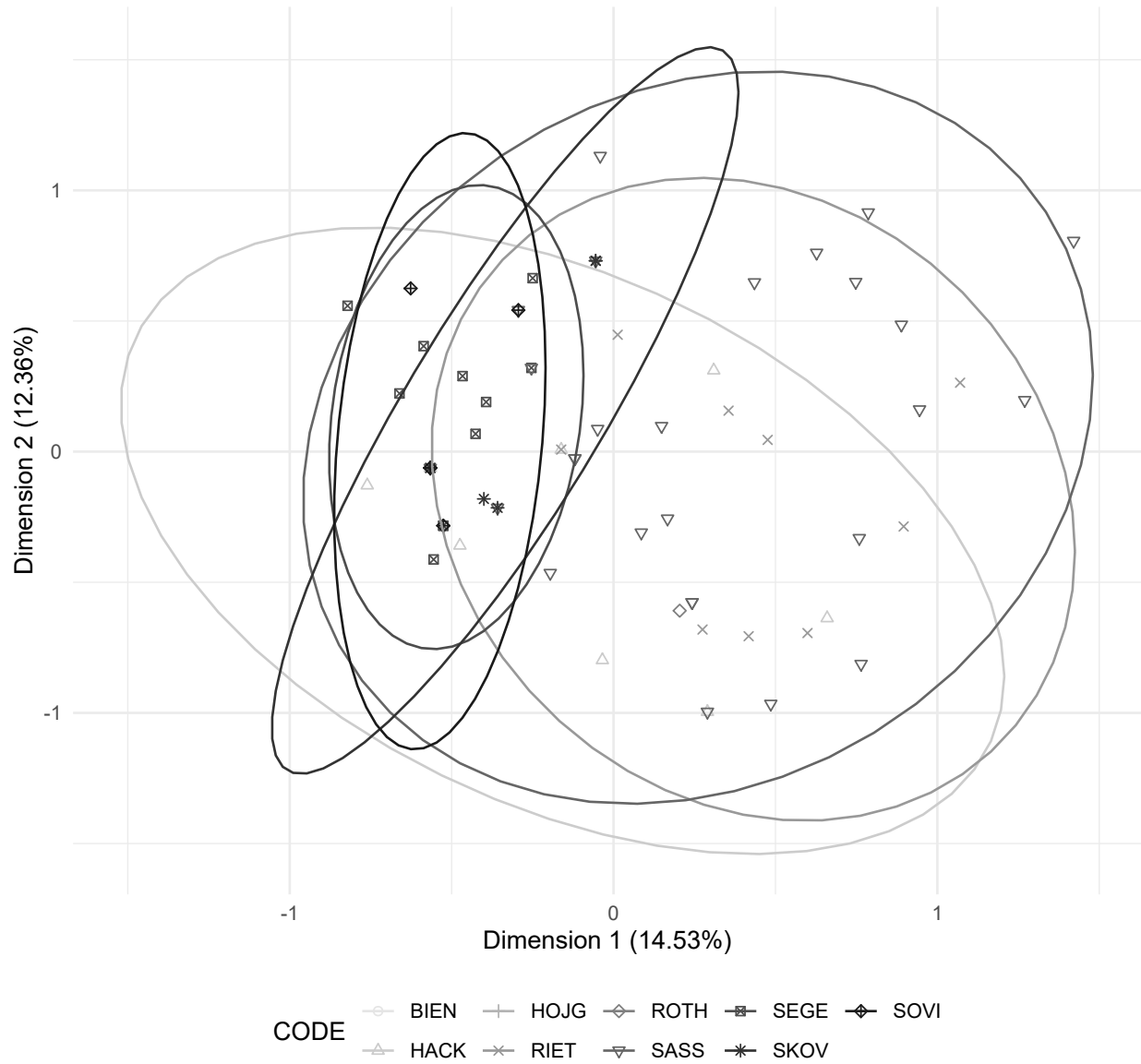


MCA 2 vs. MCA 3 (Classification)



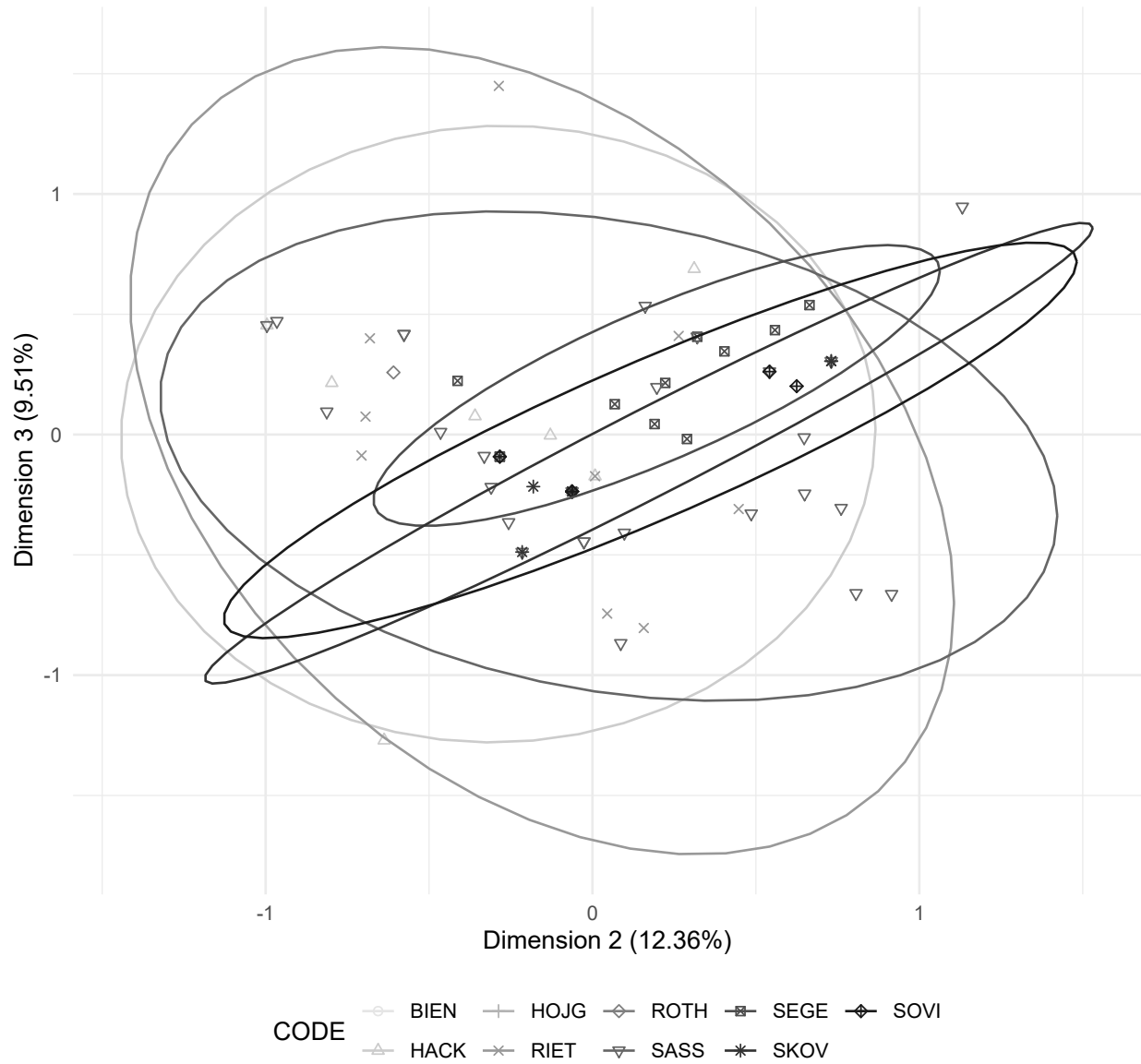
Warning: Removed 3 row(s) containing missing values (geom_path).

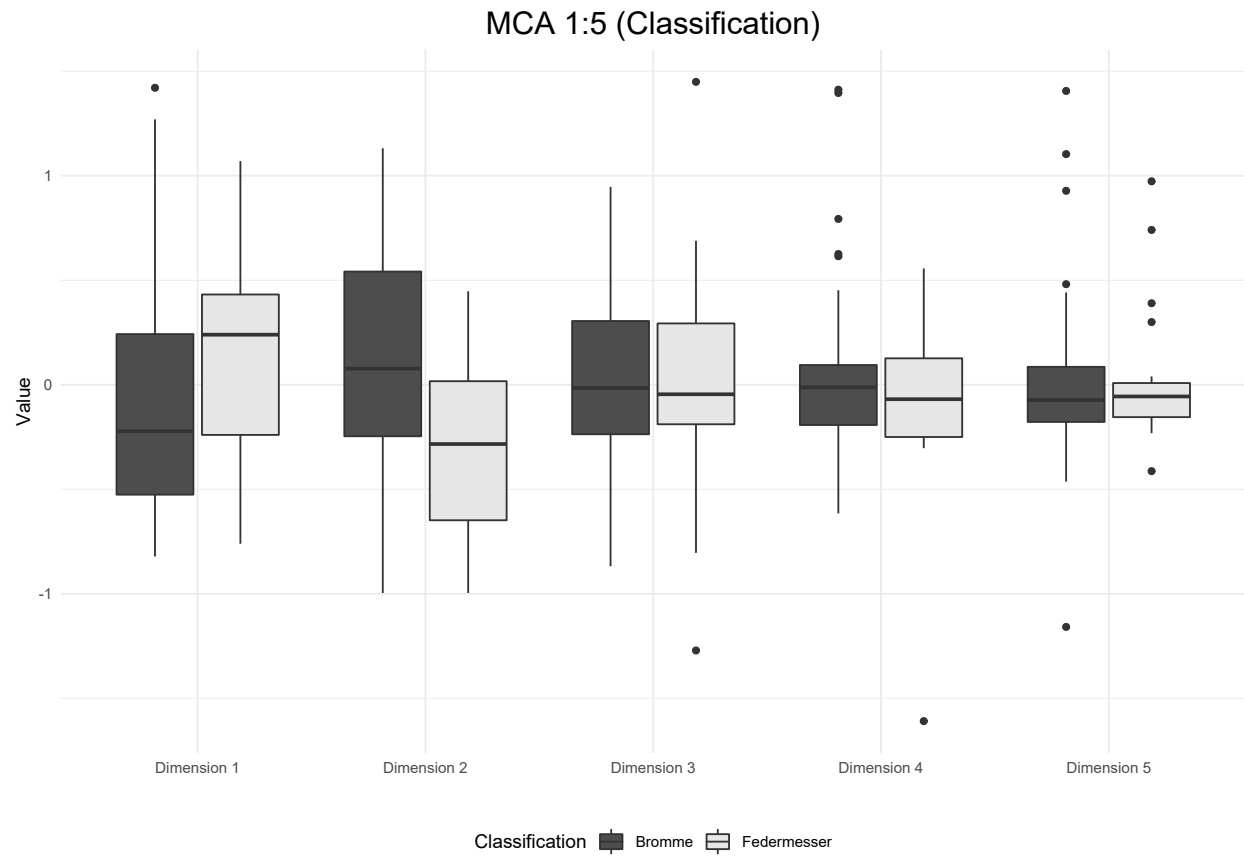
MCA 1 vs. MCA 2 (Code)

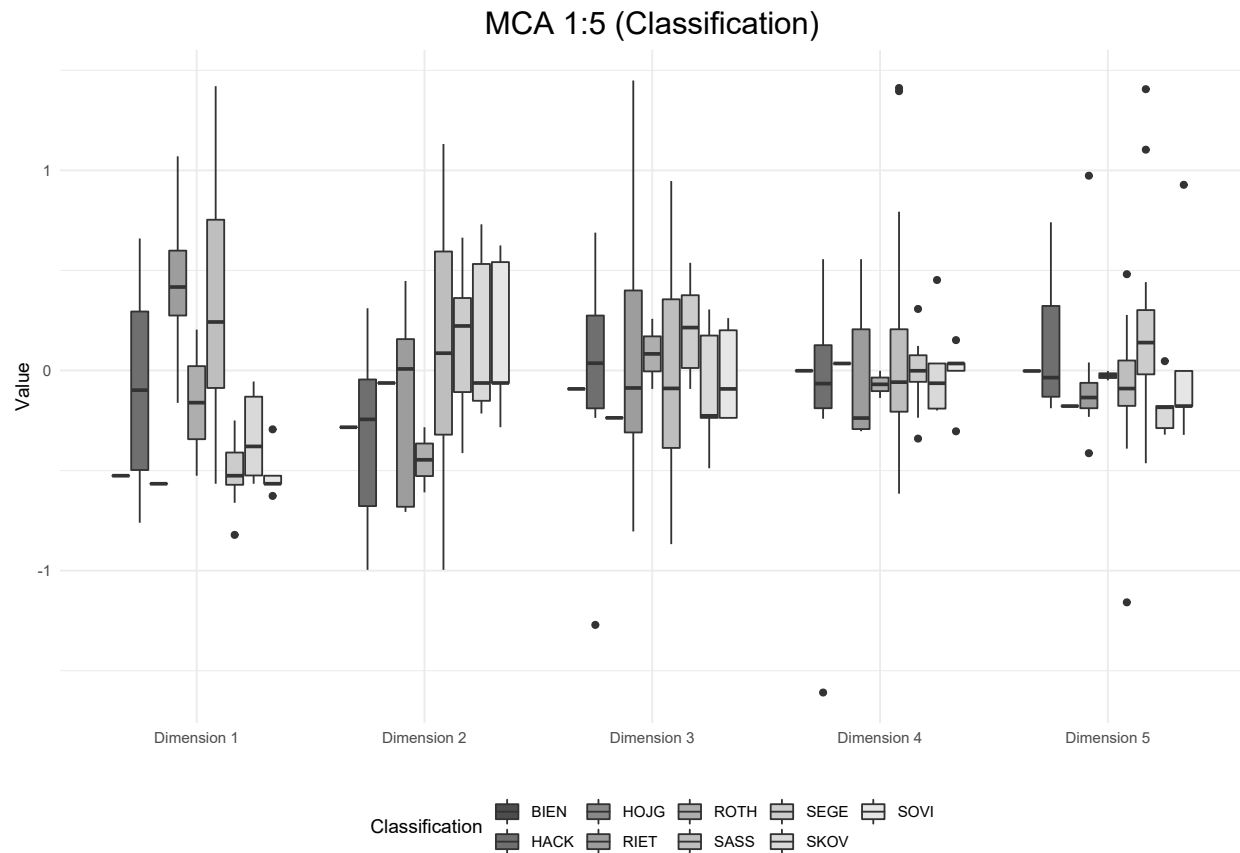


Warning: Removed 3 row(s) containing missing values (geom_path).

MCA 2 vs. MCA 3 (Code)







Analysis: Backed Points (exc. burinated pieces)

Visual and Descriptive Summaries of Data

Principal Component Analysis (PCA)

Analysis: Backed Points (inc. burinated pieces)

Visual and Descriptive Summaries of Data

Principal Component Analysis (PCA)

Analysis: Tanged Points (exc. burinated pieces)

Visual and Descriptive Summaries of Data

Principal Component Analysis (PCA)

Analysis: Tanged Points (inc. burinated pieces)

Visual and Descriptive Summaries of Data

Principal Component Analysis (PCA)