FAMILY SECRETS

THE DNA OF COUNTERFEIT CBHS

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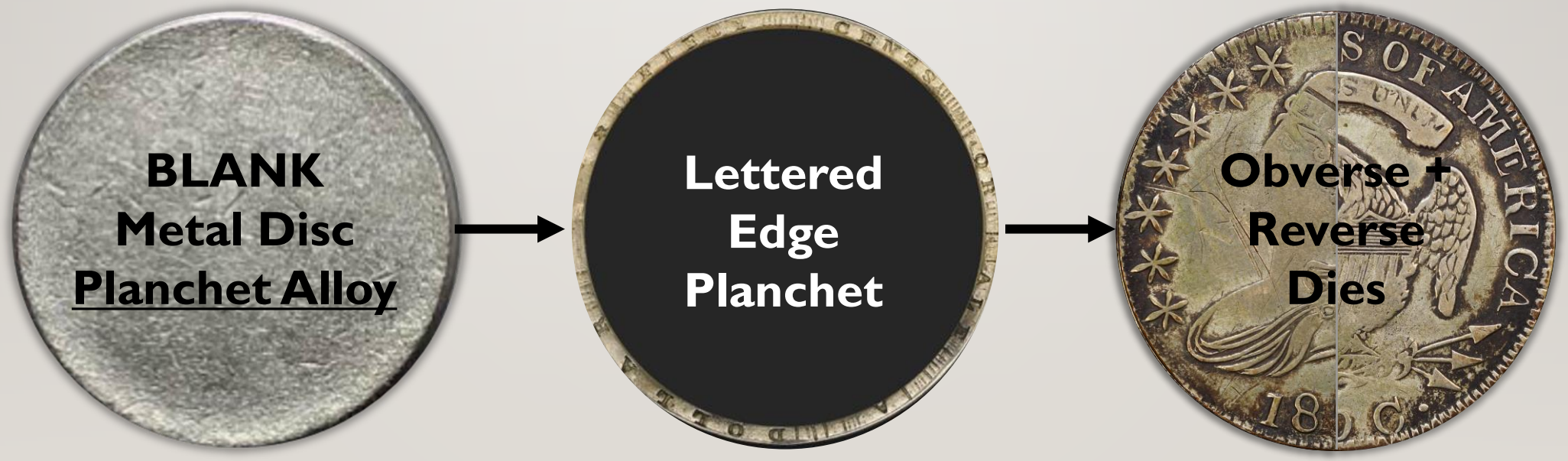
PRESENTATION OVERVIEW

1. **Counterfeit Families** How do we classify these?
2. **XRF Overview** Elemental Analysis 101
3. **XRF Case Studies** 4 Examples
4. **Final Thoughts** Summary & Future Research

HOW DO WE CLASSIFY COUNTERFEIT CBH FAMILIES?

WHAT IS A 'COUNTERFEIT FAMILY'?

"A group of 2 or more die struck counterfeit varieties whose dies were made by the same die sinker. This may include overlapping die use, shared device punches, and/or showing close stylistic or artistic similarities." (Bad Metal 2019, 2022)



Die Marriage Attributions, Die Family Associations, Estimated Emission Order

ATTRIBUTING DIES

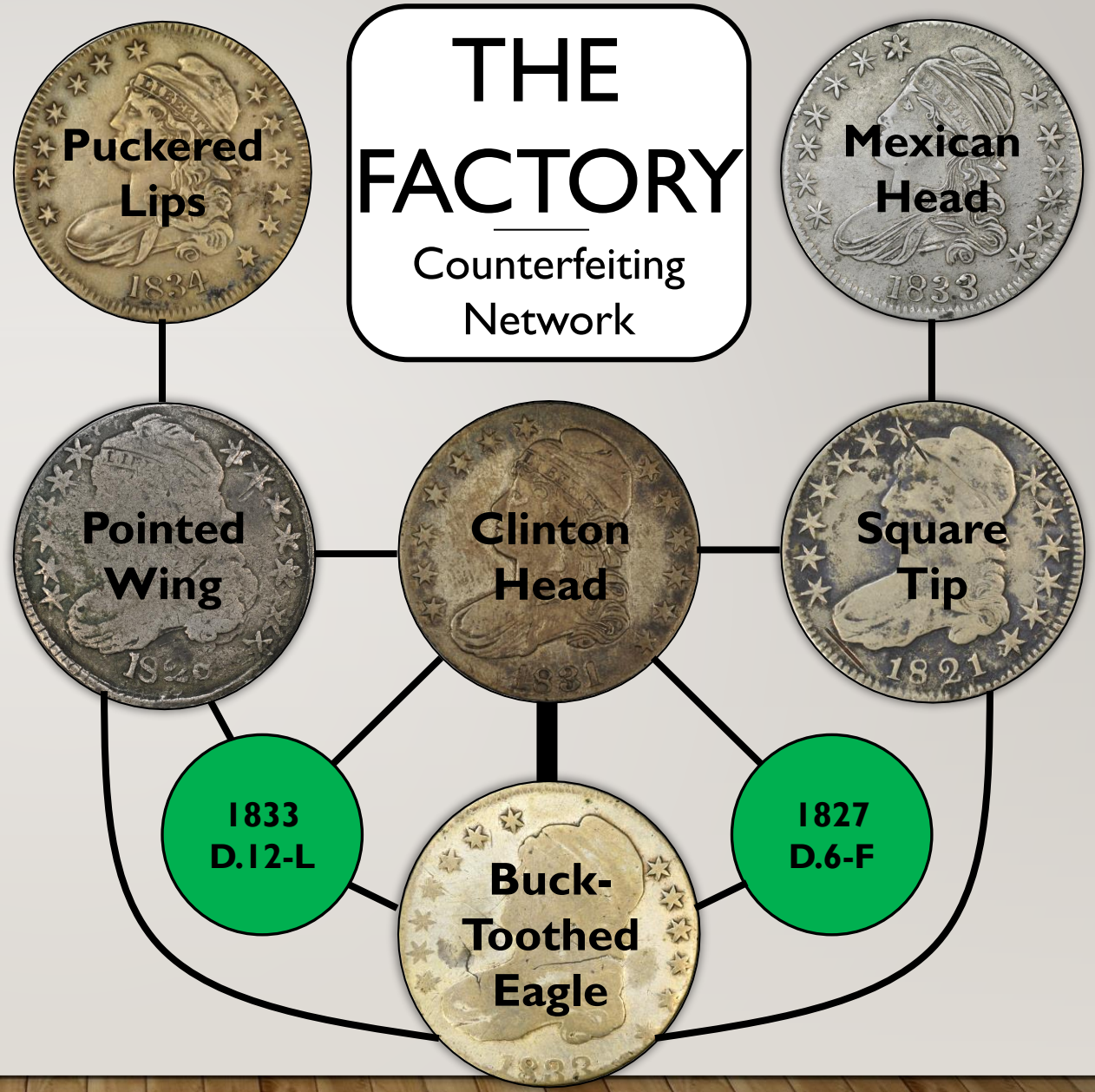
- Obverse
- Reverse
- Lettered Edge

30+ Families Total

- 249 of 324 DMs (77%)
- 75 Singletons

THE FACTORY

- 112 of the 324 DMs (35%)



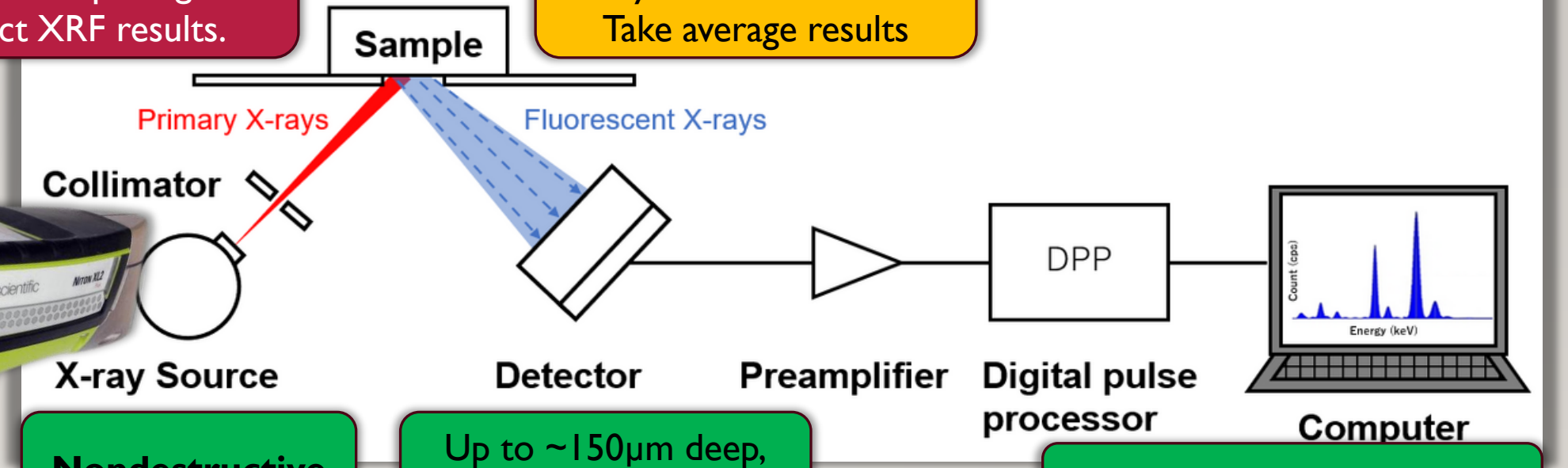
Circles = Obv.-Rev. Family or a Singleton;
Black lines = Lettered edge DM connections

X-RAY FLUORESCENCE (XRF) FOR BEGINNERS

VISUALLY. We cannot always confidently know what the planchet metal or alloy is on a counterfeit CBH.
XRF is a tool to help us identify those planchet compositions.

External Factors
Corrosion, plating can affect XRF results.

Test Both Sides
Alloy variation can exist
Take average results



Nondestructive

Up to ~150µm deep,
20-30 elements

Elemental Composition

False-Positives
Identify these and you may need to adjust your results.

XRF RESEARCH:
COUNTERFEIT CBHS

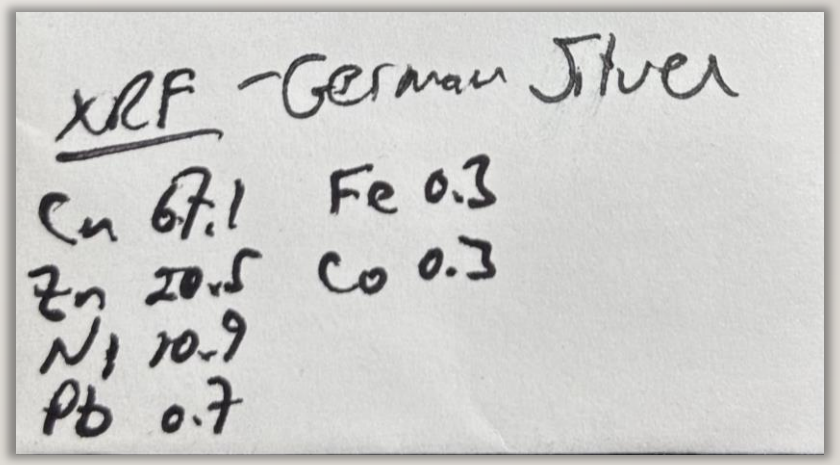
QUALITATIVE

Metals and Alloys

QUANTITATIVE

% of Each Element

- Copper
- Brass (all types)
- Brass-Silver
- Bronze
- Sterling Silver
- **Billon**
- **German silver**
- GS-Silver
- Tin-Based
- Random/Unclassified



COUNTERFEIT CBH FAMILIES: BLANK PLANCHET

Can we identify unique clusters of **alloy batches** between two or more die struck counterfeits?

Unique alloy recipes, possibly changing slightly from 1 batch to the next.

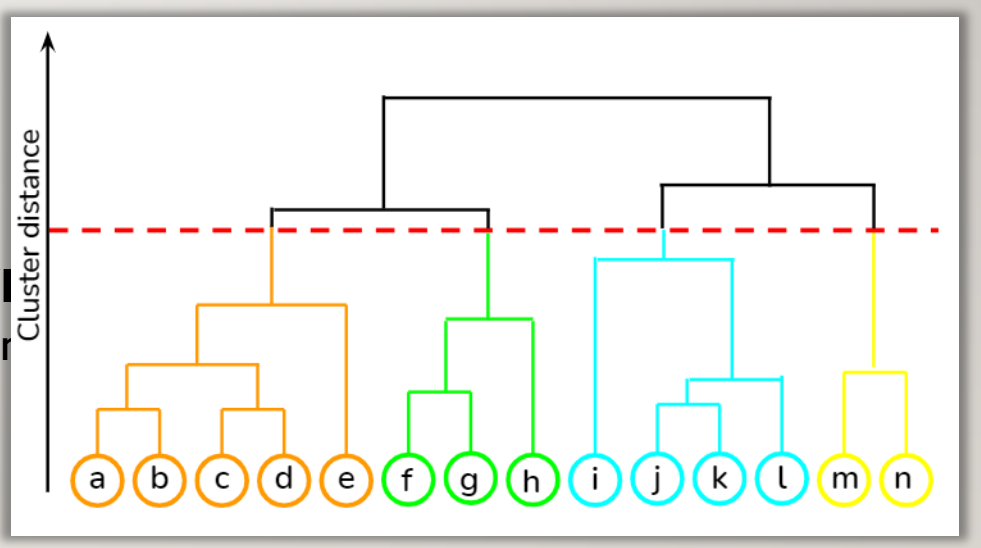
Can the **planchet alloy** be a factor for evaluating **Family relatedness**?

4 XRF CASE STUDIES

Each case study has a different set of factors and research themes

STATISTICAL + ANALYTICAL METHODOLOGY
CONSISTENT FOR EACH CASE STUDY

Statistical Method	**K-Means Cluster Analysis**. Each observation belongs to the cluster with the nearest mean.
# of Clusters	**Explained Variance Ratio (EVI** (i.e., level of strength/confidence ir
Sample Size	5 – 19 examples (small case studies for viability)
Elements Analyzed	5 – 8 elements (i.e., Cu, Ni, Zn, Fe, Co, Bi, Pb, Sn)



1 Metal, 1 Variety

1821 D.3-D
Ski Nose
5 examples
Copper

1 Alloy, 1 Variety

1833 D.2-B
Mexican Head
12 examples
German silver

1 2
3 4

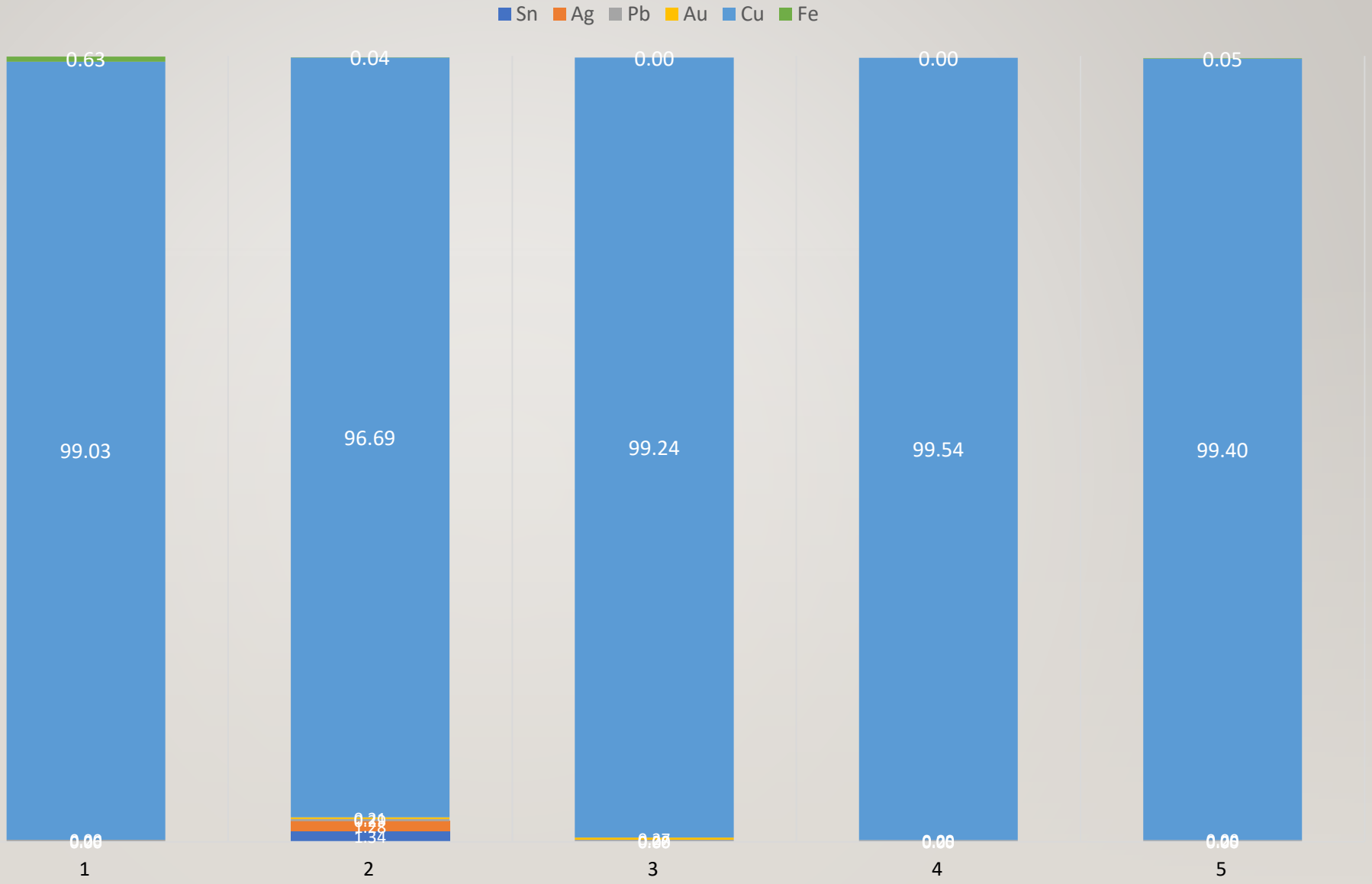
1 Alloy, 1 Family

5 Varieties
Too Legit to Quit
19 examples
German silver

1 Alloy, All Varieties

4 Varieties
3 Families
6 examples
Tin-Based

1821 D.3-D
Ski Nose
Copper planchet



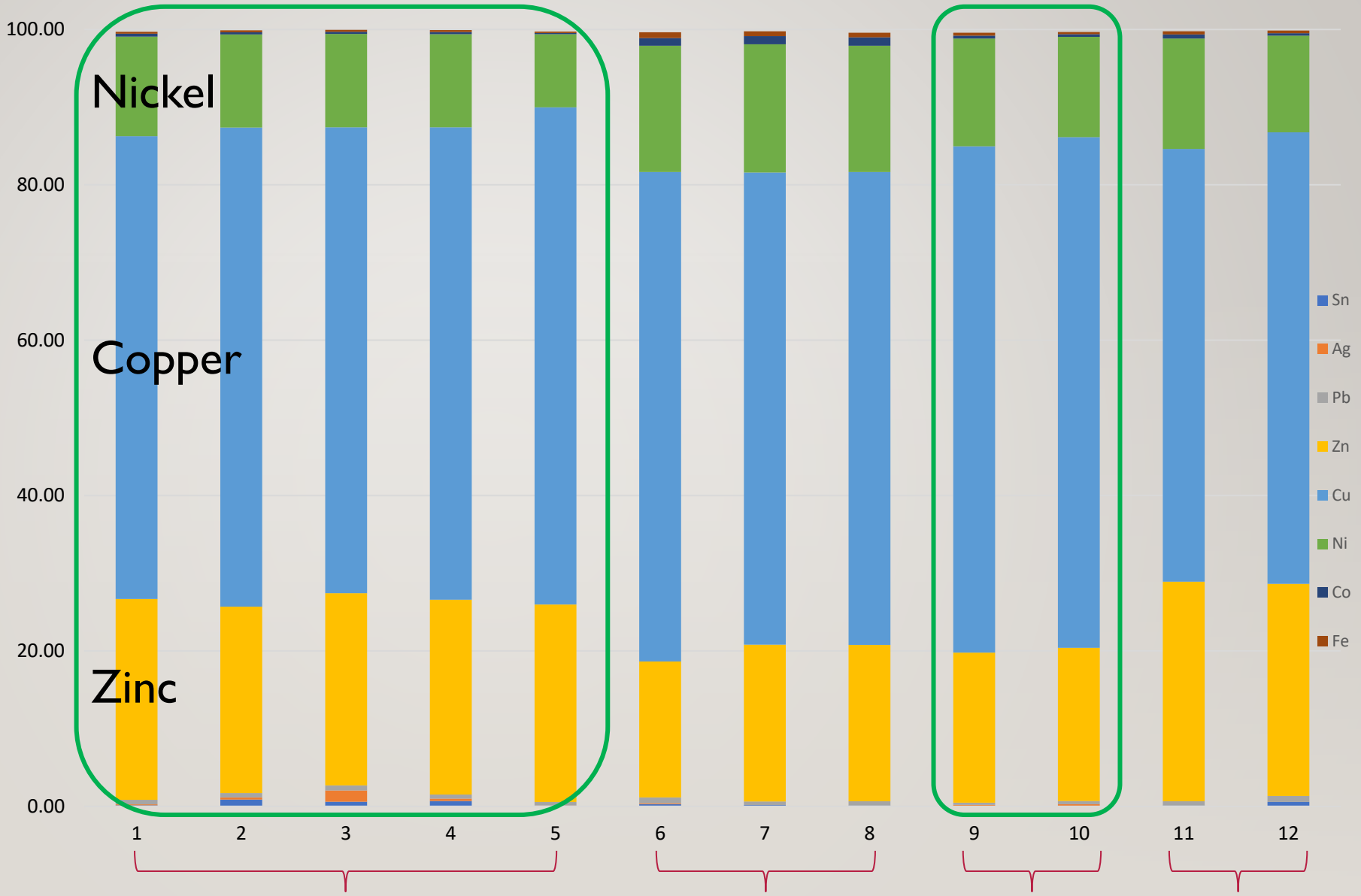
1. **1821 D.3-D. *SKI NOSE*. COPPER** RESULTS

Q: Did we detect different planchet **batches** for this 1 die marriage from a **single metal planchet**?

A: No, at least not from this small sample size. >90% explained variance ratio (EVR) was achieved with one cluster.

O: There is not enough metallic diversity within primarily a **single metal planchet** for this statistical analysis to differentiate planchet **metal** batches.

1833 D.2-B
Mexican Head
GS planchet



Cluster 1 Cluster 2 Cluster 3 Cluster 4

2. 1833 D.2-B. *MEXICAN HEAD*. GERMAN SILVER RESULTS

Q: Did we detect different planchet alloy batches for this 1 die marriage from a **German Silver alloyed** planchet?

A: YES – This sample study found, at 92.5% EVR, 4 distinct clusters, which likely represents different GS planchet alloy batches for this 1 die marriage.

O1: For a 3-metal alloy like GS, there is enough metallic diversity for this analytical method to work.

O2: I need to analyze more *Mexican Head* **family** varieties **as a whole** against each other to see how all the German silver planchets compare. **ON THAT NOTE…**

All 5 Varieties
Too Legit to Quit
GS planchet

Nickel
Copper
Zinc

1833 D.1-A
1838 D.3-E
1833 D.1-A
1836 D.5-E
1837 D.2-B
1838 D.3-C
1833 D.1-A
1838 D.3-E
1838 D.3-C
D.3-E

100.00
80.00
60.00
40.00
20.00
0.00

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

Sn Ag Pb Zn Cu Ni Co Fe

Clusters 1 + 2 C.3 C.4 C.5 C.6 C.7 C.8

3. *TOO LEGIT TO QUIT* RESULTS

Q: Do the alloy clusters correlate to **individual** O-R DMs, or are the results more **random** within the *TLTQ* family? (Minting sequence and XRF accuracy, reliability)

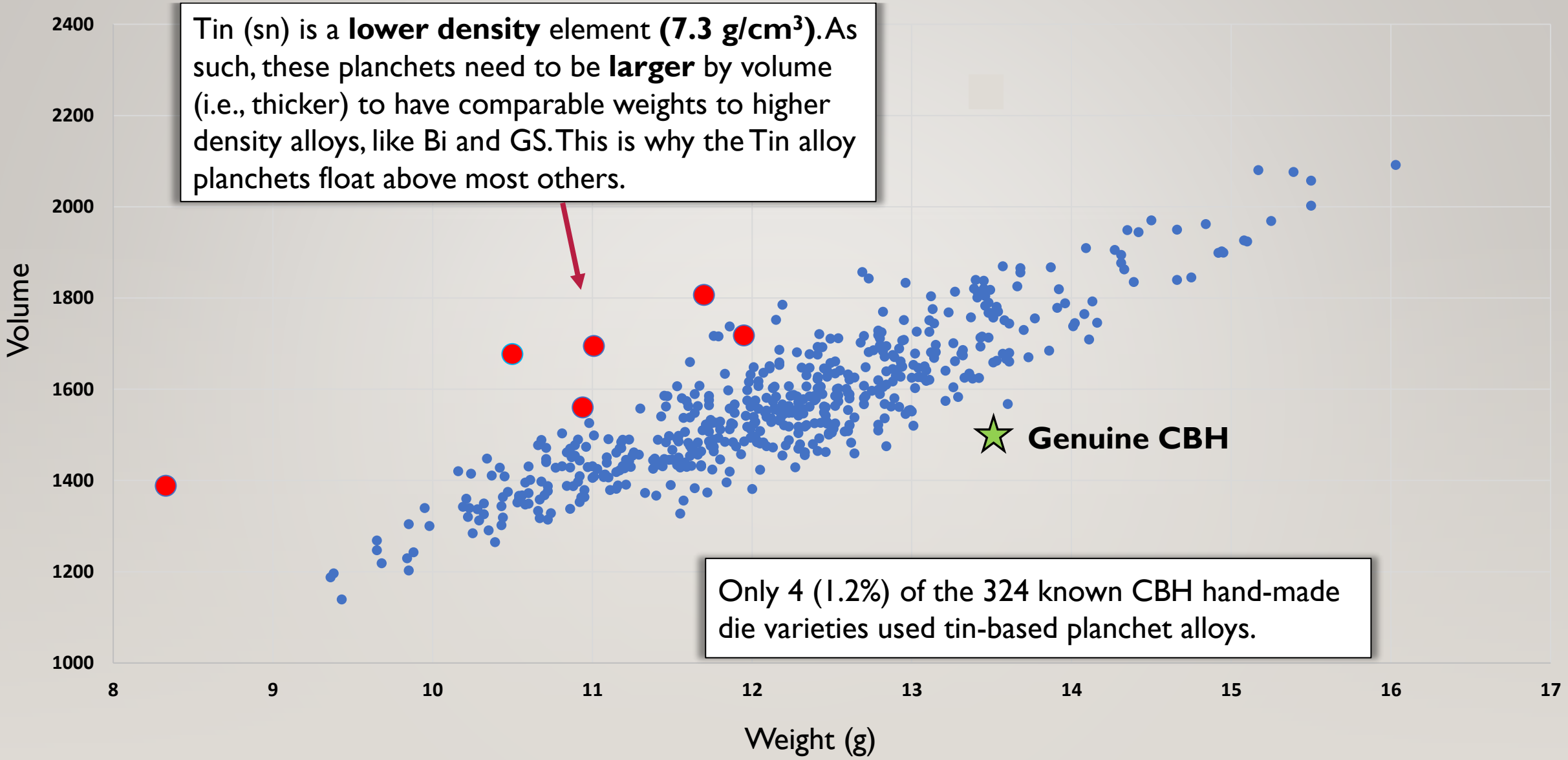
A: Each of the 7 clusters (93.1% EVR), after C.6 is removed as possibly being altered surfaces, correlates to 1 or 2 varieties. **Preliminarily**, this suggests a **methodical** counterfeiting operation, and **supports** reliable XRF results.

Context: This counterfeiting operation likely produced 10,000s of pieces (est. 2-3k survive). As such, it is certain that **many** GS planchet **alloy batches** were produced over the course of their production, and those batches may have changed slightly.

O1: These results may allow us to better understand emission order.

O2: We need a larger sample size, at least 100 examples (20 per variety), for stronger interpretive results.

4. TIN-BASED PLANCHETS


Tin (sn) is a **lower density** element **(7.3 g/cm³)**. As such, these planchets need to be **larger** by volume (i.e., thicker) to have comparable weights to higher density alloys, like Bi and GS. This is why the Tin alloy planchets float above most others.
Genuine CBH
Only 4 (1.2%) of the 324 known CBH hand-made die varieties used tin-based planchet alloys.
Volume
2400
2200
2000
1800
1600
1400
1200
1000
8
9
10
11
12
13
14
15
16
17
Weight (g)

1828 D.17-R/Z.13-BV

1831 D.1-A/Z.4-P

1831 D.1-A/Z.4-P

1831 D.1-A/Z.4-P

1831 D.unl/Z.21-P

1833 D.unl/Z.42-IN

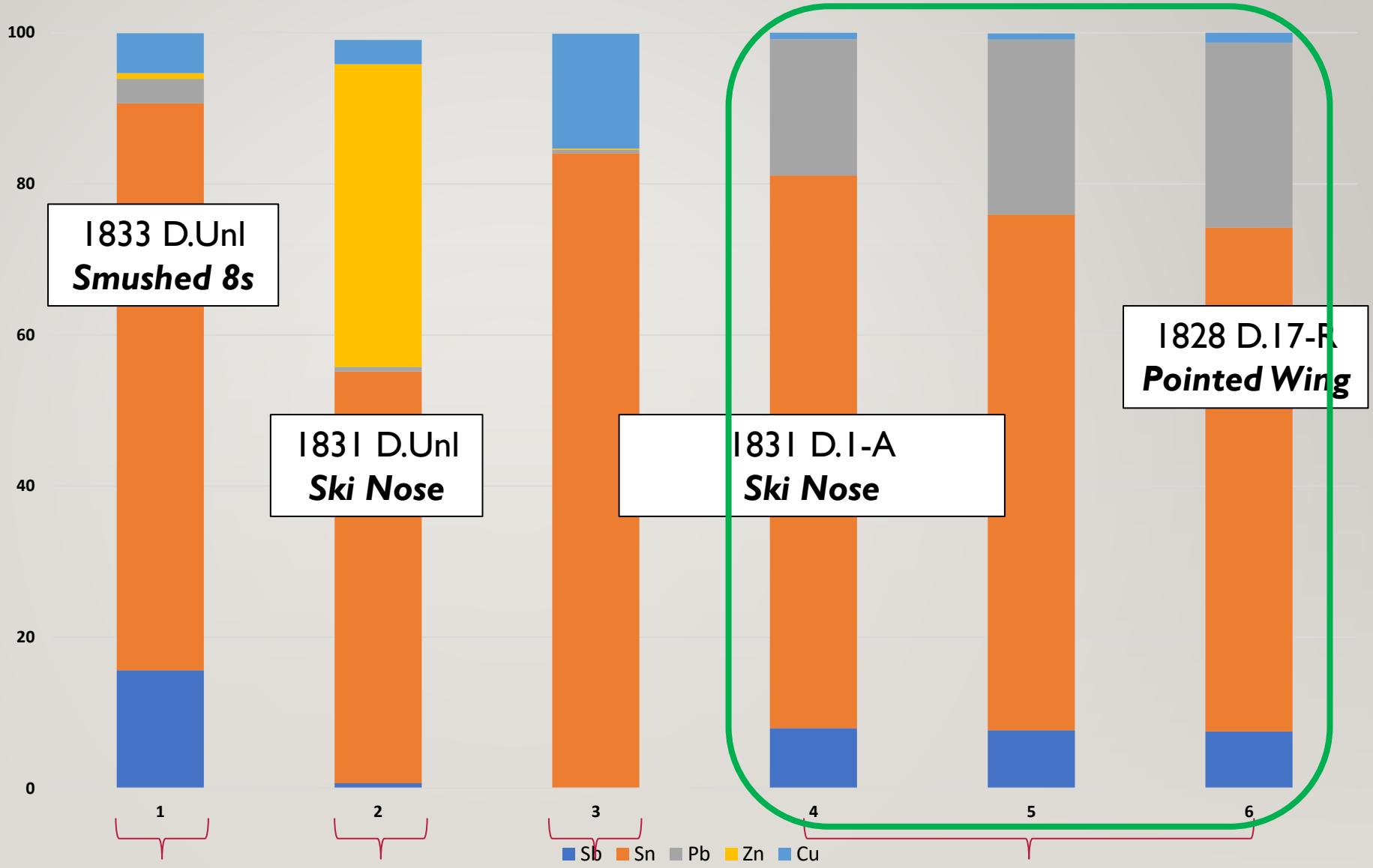
TIN EXAMPLES ANALYZED

Year	Variety	Family	Weight (g)	Volume
1828	D.17-R (Z.13-BV)	*Pointed Wing*	8.33	1,388
1831	D.1-A (Z.4-P)	*Ski Nose*	10.50	1,677
1831	D.1-A (Z.4-P)	*Ski Nose*	11.01	1,694
1831	D.1-A (Z.4-P)	*Ski Nose*	10.94	1,560
1831	D.Unl (Z.21-P)	*Ski Nose*	11.95	1,718
1833	D.Unl (Z.42-IN)	*Smushed 8s*	11.70	1,806

Tin-Based
4 Varieties
3 Clusters
(90.6% EVR)

Both 1831 D.1-A and 1828 D.17-R found to be **closely related**.

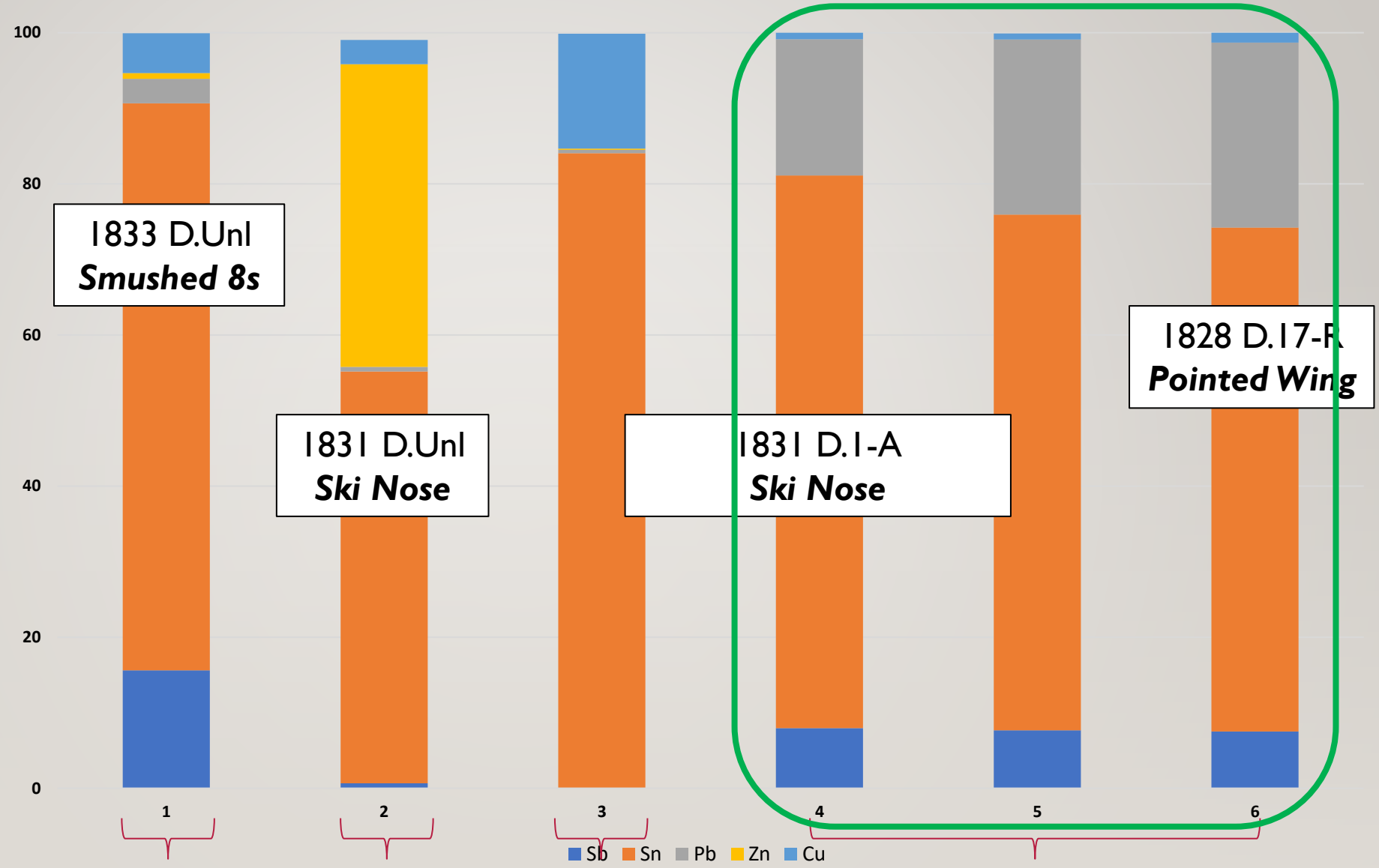
Samples 1 and 3 **forced** to be the next most closely related but they are truly different.



Tin-Based
4 Varieties
4 Clusters
(98.4% EVR)

Samples 4, 5, 6 still found to be **closely related**.

Samples 1, 2, and 3 shown to be distinctly different (no surprise).

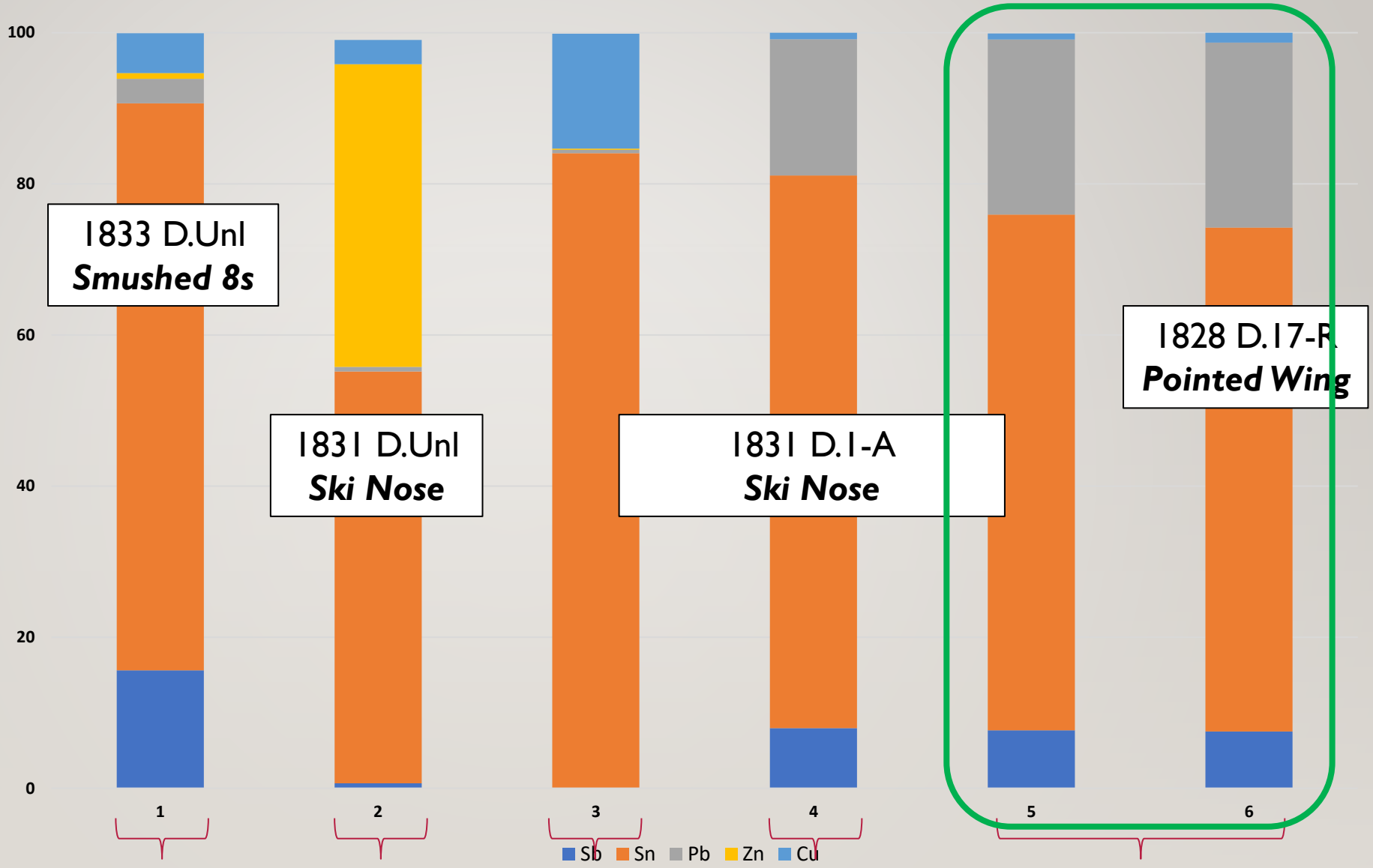


C.3 C.1 C.4 C.2

Tin-Based
4 Varieties
5 Clusters
(99.9% EVR)

I tested 5 clusters to force and see which of the two samples from 4, 5, and 6 were most similar.

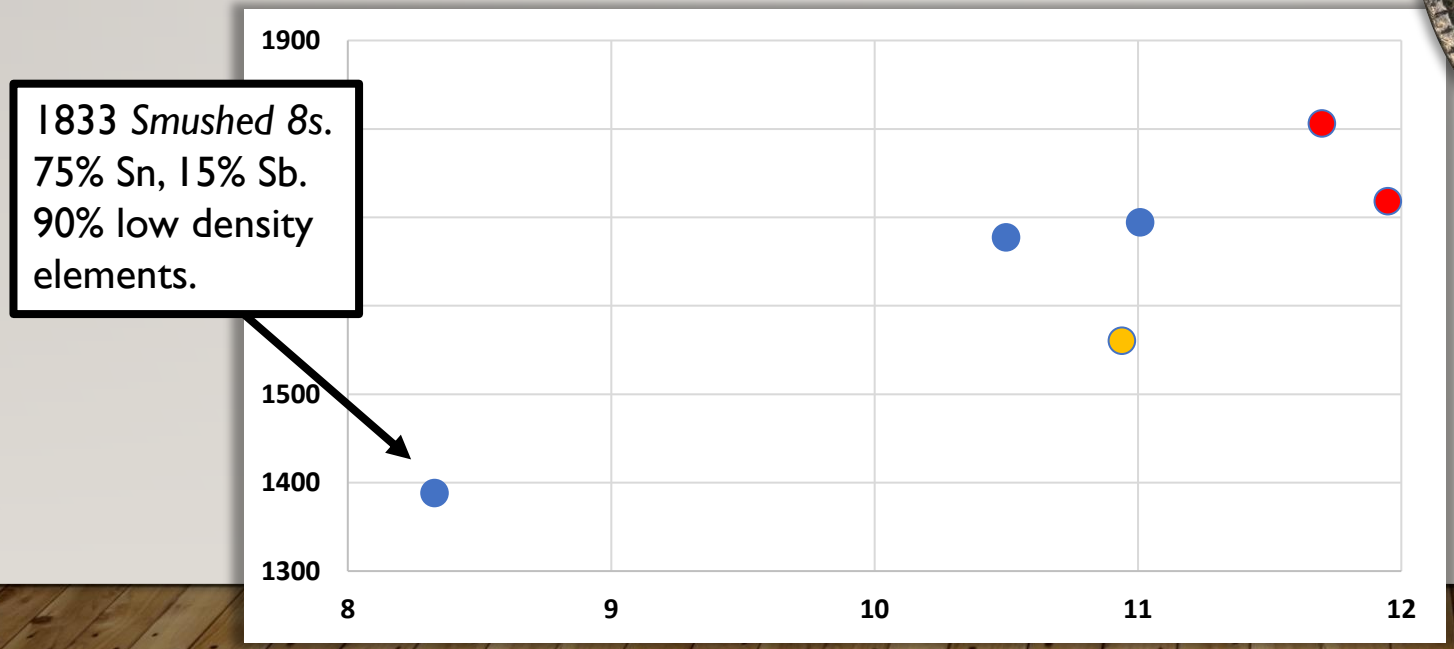
Excitedly, 1831 D.1-A and 1828 D.17-R were found to be more similar than the two 1831 D.1-As (4 and 5), but all 3 are still likely related.



C.5 C.2 C.1 C.3 C.4

TIN-BASED PLANCHETS: **RESULTS**

- 1831 D.1-A (***Ski Nose***) and 1828 D.17-R (***Pointed Wing***) have very similar weights and volumes (red).



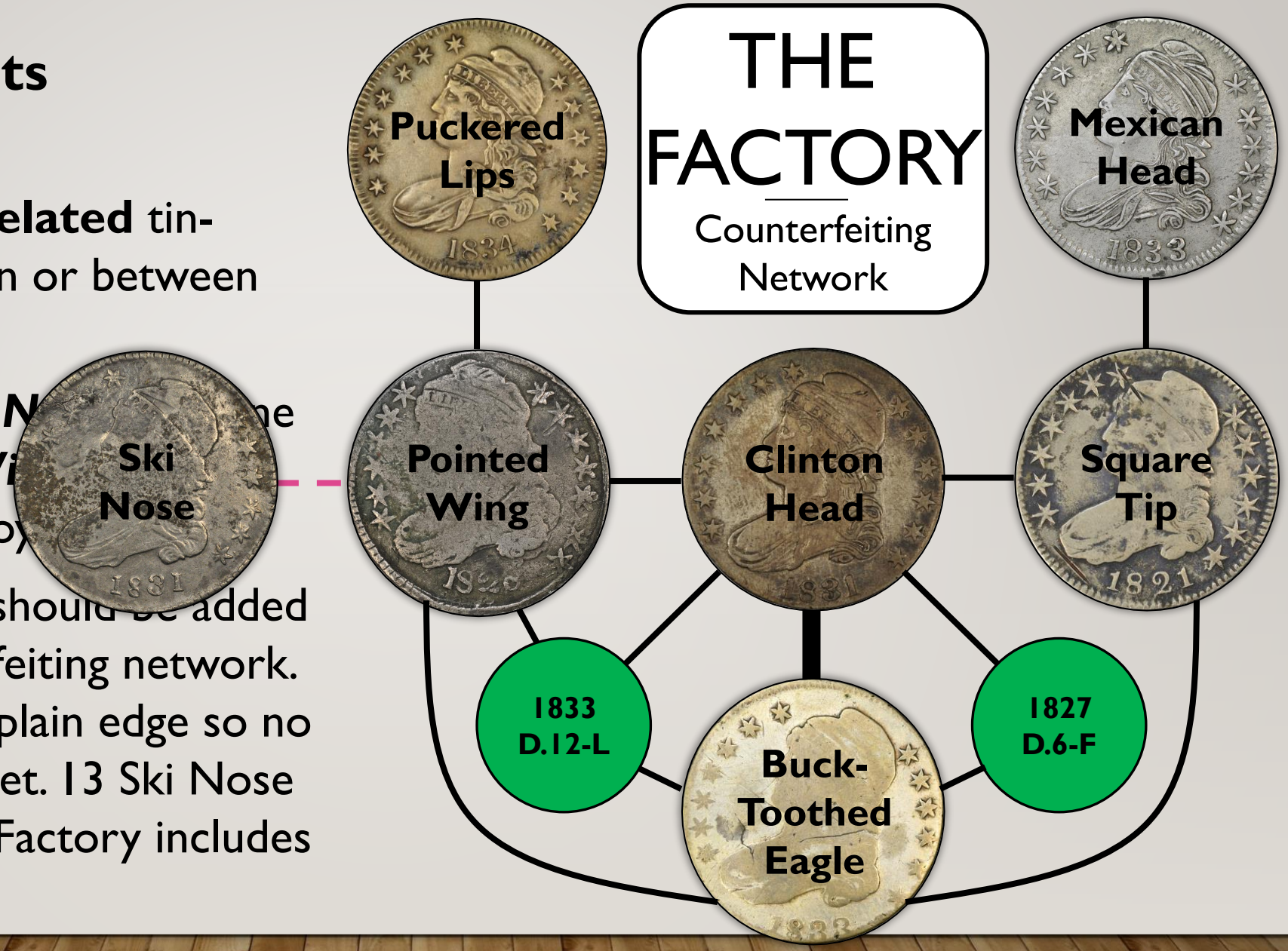
Tin-Based Planchets

Results

Q: Can we identify any **related** tin-based planchet alloys w/in or between individual O-R varieties?

A: Yes. 1831 D.1-A (***Ski N*** ne 1828 D.17-R (***Pointed Wi*** same unique planchet allo

O: The ***Ski Nose*** family should be added to ***The Factory*** counterfeiting network. 1828 D.17-R (*PW*) has a plain edge so no physical die connection yet. 13 Ski Nose varieties added, and The Factory includes 125 of 324 DMs (39%).



Black lines = Lettered edge DM connections
Red line = Planchet alloy match

4. TIN-BASED PLANCHETS
RESULTS

Q: Why did CBH counterfeiters choose tin-based planchet alloys?

H: Since so few varieties (n=4) are known with these alloys, I'm guessing these were largely ***experimental***, **lower cost** planchet alloys (relative to Bi and GS). These alloys are compositionally similar to **white/pot metal cast** counterfeit CBHs (typically tin-based with lead, antimony, or zinc as the 2nd most common element).

4. TIN-BASED PLANCHETS
RESULTS

Q: Did CBH counterfeiters use standard tin-based alloys like **Pewter** or **Solder**?

A: No. Pewter (85-99% Sn, 5-10% Sb, 2% Cu) and Solder (63% Sn, 37% Pb) both have **noticeably different alloys** than the 6 examples analyzed. In most cases it seems that counterfeiters intentionally added higher proportions of higher density elements, like lead and copper, to increase planchet density and weight to be more similar to genuine CBHs.

4

FINAL THOUGHTS

SHOULD MY DEFINITION OF 'COUNTERFEIT FAMILY' CHANGE?

"A group of 2 or more die struck counterfeit varieties whose dies were made by the same die sinker. This may include overlapping die use, shared device punches, and/or showing close stylistic or artistic similarities." (Bad Metal 2019, 2022)

- Should I add planchet **alloy matches** to this definition?
- If so, I should include '**rules**' to what constitutes an 'alloy match'? For example, if I studied 150 DMs all struck on German silver planchets, there will be some coincidental alloy matches that are probably not meaningfully related.

SUMMARY

Research Methodology

- **It works**! XRF & cluster analysis is a **viable** analytical method for distinguishing alloy batches.

Sample Size

- Initial results not likely coincidental.
- **FUTURE. Larger sample sizes** between **all case study types** (individual varieties, other families, etc.). This should further strengthen future results.

Alloys

- This research works **best with alloys**, **not individual metal** planchets.
- **FUTURE**. More Alloy studies needed (billon, brass, etc.).

THE END

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XRF Lab: $3-5/coin

References:

LE/LRE CBHs. https://www.badmetalcoin.com/half-dollars

Cluster Stats. https://www.statskingdom.com/cluster-analysis.html