

Macromorphoscopy Software

Version 1.61

User Manual

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1.0 Introduction

Ancestry estimation is an integral part of establishing a biological profile on unknown human skeletal remains. Ancestry estimation is accomplished through multiple methods including macromorphoscopic trait analysis (Hefner, 2009; Plemons and Hefner, 2016). Macromorphoscopic traits are *quasicontinuous* morphological traits of the cranium, which Brues (1958) describes as reflective of soft-tissue differences in the living. Macromorphoscopic traits are divided into five classes of observations: 1) assessing bone shape; 2) bony feature morphology; 3) suture shape; 4) presence or absence of a feature; and lastly, 5) feature prominence or protrusion (Hefner, 2009).

Traditionally, these traits were used in a trait list approach (Rhine, 1990) in which ancestry was assigned to a cranium through an ad-hoc assessment and comparison to an arbitrary type specimen supposedly reflective of certain ancestral groups. A statistical approach to macromorphoscopic trait data (Hefner, 2009) allows for assessment against all human variation captured within a given population. Further, this approach allows for consistency and objectivity in assessing macromorphoscopic traits across different users.

To complement Hefner's (2009) method, the MMS data collection program allows the user to assess and collect macromorphoscopic data from various specimens. This system is designed to reduce observer error and increase objectivity through standardized descriptions of traits and scoring procedures. Further, the data is designed to be exported and used in different programs, including an analytical tool, for future research into ancestry estimation and macromorphoscopic trait variation across populations.

2.0 Set-up

2.1 *Creating a sample*

To create a new sample, open the MMS program and click the 'NEW' button under the 'TABLE' box. This will allow the user to create a new advantage data table for the purpose of organizing samples or projects. A table will house a series of individuals associated with the indicated skeletal collection.

2.2 Adding an individual

To add an individual, first enter the recorder initials in the 'Initials' box. Hit the Tab key to move to the next entry box labeled 'Catalog Key'. Type the number assigned to the specimen (e.g. a case ID or individual ID for a collection) in the 'Catalog Key' box. This box should *never* be empty as it is the identifier information for the Macromorphoscopic Databank. If there are more than one individual associated with the catalog key, then an individual identifier should be entered into the box labeled as 'Individual'. For example, if there were two individuals in a single internment, the burial number would be provided as the 'Catalog Key' (e.g. B32) and the individual number would be provided as the 'Individual' (e.g. 1 or 2). The final box, labeled 'Tracking No.' is used when a single individual is scored multiple times, such as observer error studies, for example. The number of each observation should be entered as the tracking number with the first observation being 0; however, the first observation should be left blank so that all tracking numbers begin with '1' for the second observation and so on.

Once all necessary information is entered into the appropriate text boxes, press the green 'SEARCH' button (Figure 2.1). If no record exists for the qualifying information, a dialogue box will appear that states: "No match found. Would you like to enter a new record?" Select 'Yes'. Once a new case is created, the MMS interface window will appear which signals that the program is ready to receive macromorphoscopic trait data.

If you would like to return to an existing entry, insert the qualifying information in the four text boxes and press the 'Search' button. The entry will appear in the table below the search button. You may double click on row of interest in the table to open the MMS interface with previously scored traits.

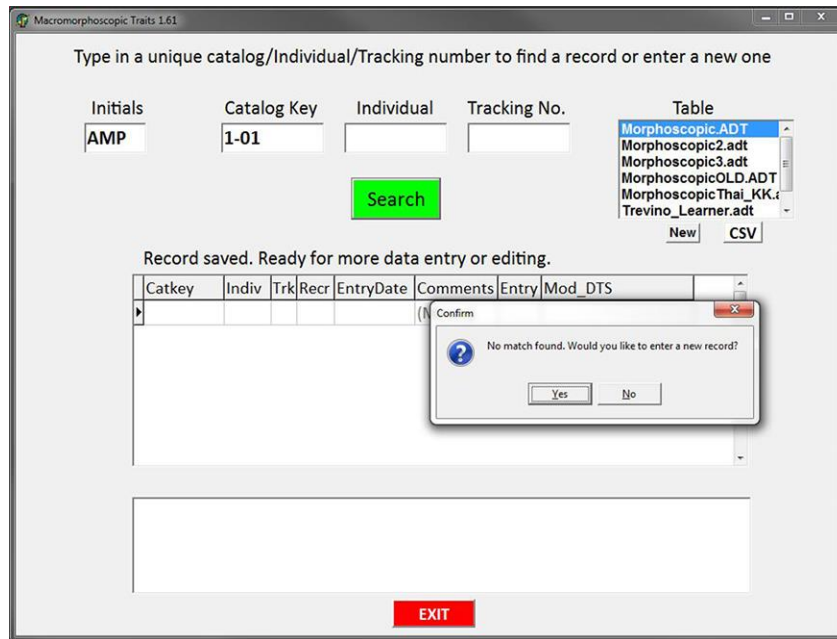


Figure 2.1. Entering a new case in the data entry window.

2.3 Recommended Tools

We recommend two tools to aid in the collection of macromorphoscopic trait data: a clear ruler and a contour gauge. Contour gauges can be purchased at most hardware stores (refer to Figure 5.9 to view a contour gauge).

The clear rule can be used to assess two traits, Malar Tubercle (MT) (Section 5.4) and Posterior Zygomatic Tubercle (PZT) (Section 5.13). These traits focus on the degree of expression of bony projections. The ruler is used to create a horizontal line at the root of the projections to aid in examination. The ruler need not exceed 6 inches in length.

A contour gauge is primarily used to assess Nasal Bone Contour (NBC) (Section 5.7), but can also be used for Postbregmatic Depression (PBD) (Section 5.12). This tool is useful to examine curvature of bony features that may be difficult to detect with the naked eye.

3.0 MMS data entry:

3.1 MMS Interface window

The MMS program allows for the scoring of up to 17 macromorphoscopic traits on an individual cranium. The MMS interface window is composed of various sections (Figure 3.1). The name of the trait appears in the center of the screen, highlighted in blue. A radio button box, called the 'Trait List', on the right side of the screen lists all macromorphoscopic traits, with the current trait being evaluated highlighted as a dark, filled-in circle. The definition of the trait is provided in the 'Trait

Definition Box' in the lower right portion of the screen. This definition describes the trait and any special requirements, such as tools or comments useful for assessment. The largest box, in the center left of the screen, the 'Selected Trait Box', shows an image of the cranium with the trait of focus denoted. Below, in a smaller box, 'The Character State Box', the character state, shown in the above image, is described.

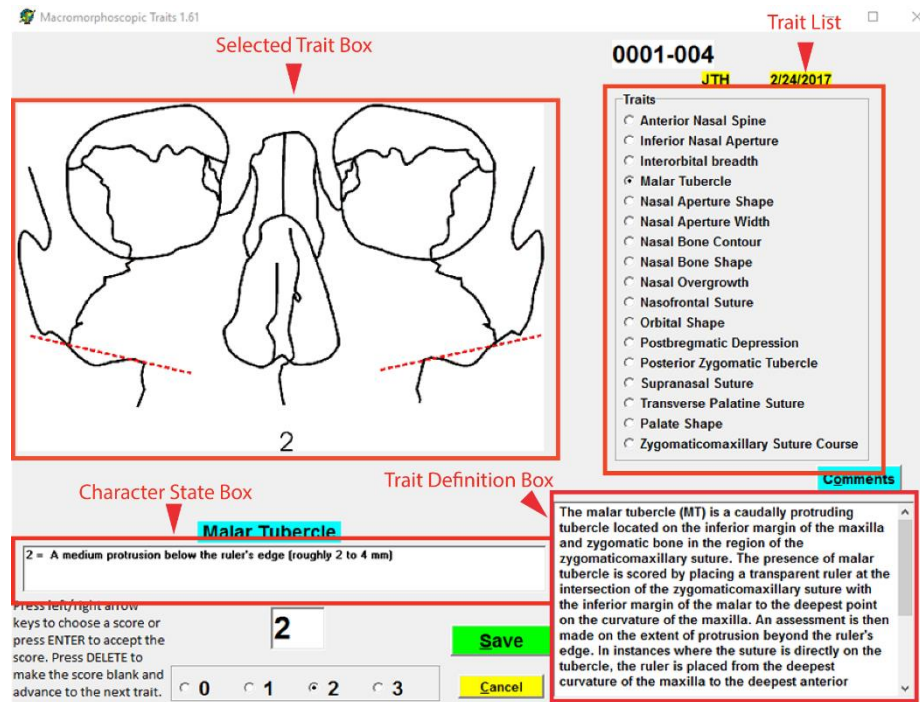


Figure 3.1. MMS interface labeled.

3.2 Moving through the list and collecting trait data:

The user can move through the 'Trait List' in two ways; (1) moving the cursor and selecting the radio buttons with the computer mouse, or (2) using the computer keyboard shortcut <ENTER>. Below the 'Character State Box', the user can select the character state observed for a trait by selecting the corresponding numerical denotation for the character state with the mouse, or by using the right and left arrow keys on the keyboard. As a note, the computer shortcut is helpful for moving back and forth to consider the full range of variability for each trait. Once the observed character state is selected, the user can press ENTER on the keyboard to record the trait and advance to the next screen.

If the trait in question is unobservable or obliterated or the cranium is damaged or pathological, it is best practice to leave the data box BLANK and add a note can in the comments box.

3.3 *Deleting a character state entry:*

To delete a trait, as in when a trait is accidentally recorded when it's actually unobservable, reselect the trait in the 'Trait Score Box' and press the DELETE key. This will leave the score blank and automatically advance to the next trait.

4.0 **Macromorphoscopic trait locations:**

4.1 *General macromorphoscopic trait locations*

All traits are pictured in line drawings and described in detail below. Figures 3, 4, and 5 depicts anterior, lateral, and inferior views all traits and their location on the cranium. Figure 4.4 demonstrates location and variations of palate shape as this is the newest addition to the macromorphoscopic trait list. These traits are included as line drawings in the MMS program.

4.2 *Where to make an observation*

Bilateral traits should be observed and recorded from the left side of the cranium with the exceptions of PZT and MT. These two exceptions should be recorded for greatest expression of the trait between the two sides. If remaining traits are unobservable on the left portion of the cranium due to postmortem damage or pathology, the right side should be scored. When neither side can be observed, the 'Trait Score Box' should remain blank, then the user can progress to the next trait.

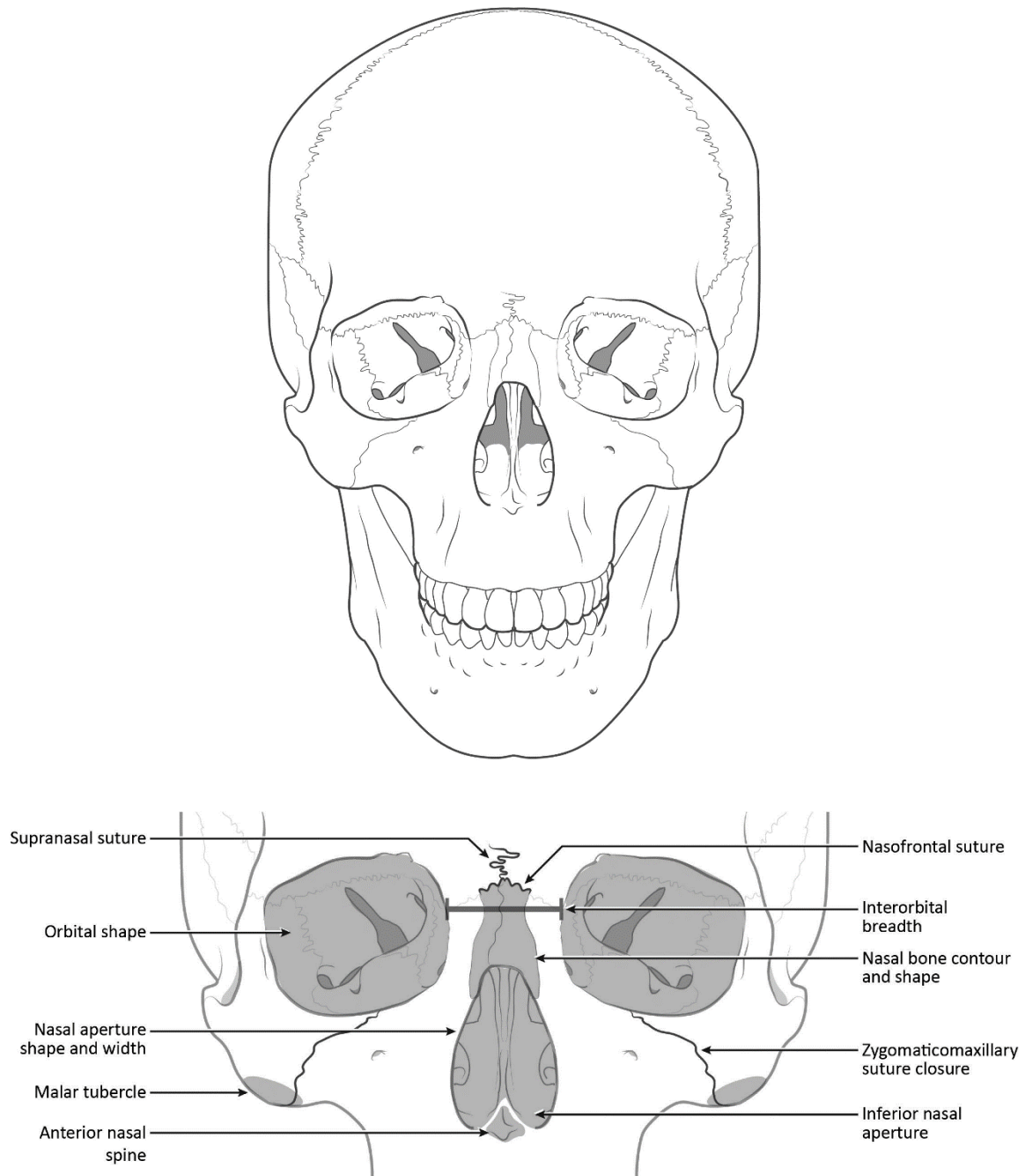


Figure 4.1. Anterior views of a cranium to demonstrate approximate location of macroscopic traits (Image taken from Plemons and Hefner, 2016).

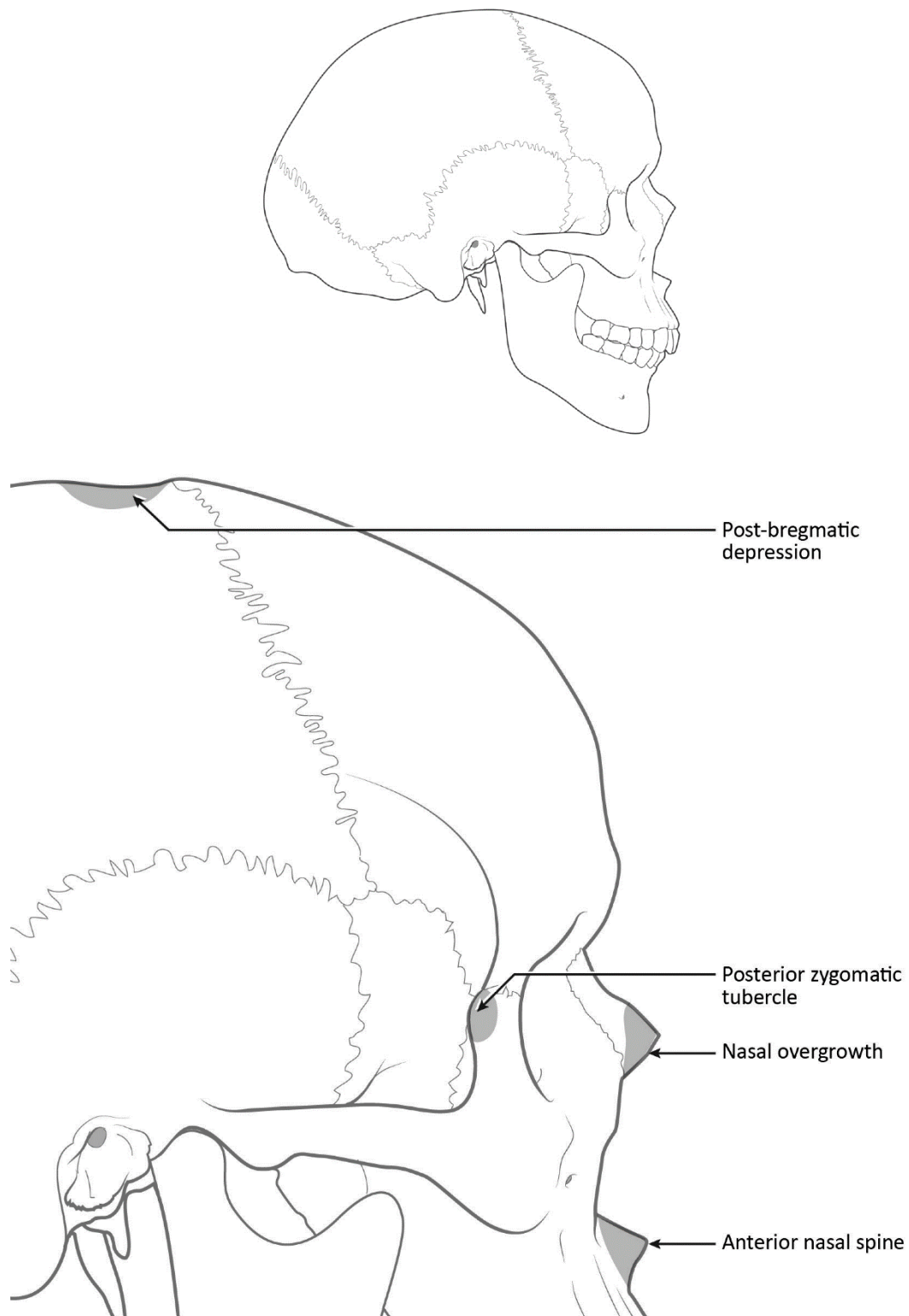


Figure 4.2. Lateral views of a cranium to demonstrate approximate location of macroscopic traits (Image taken from Plemons and Hefner, 2016).

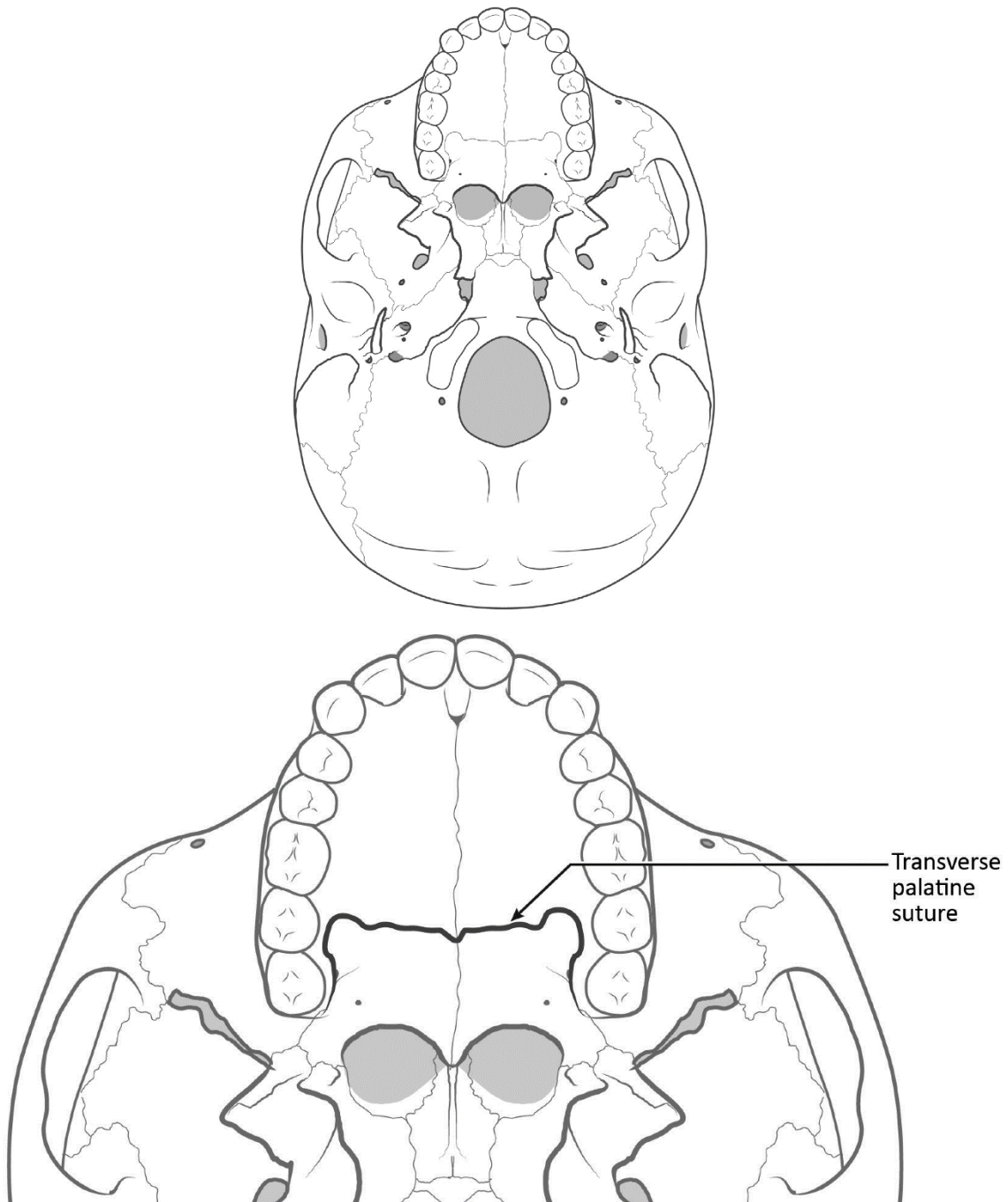


Figure 4.3. Inferior views of a cranium to demonstrate approximate location of macroscopic traits (Image taken from Plemons and Hefner, 2016).

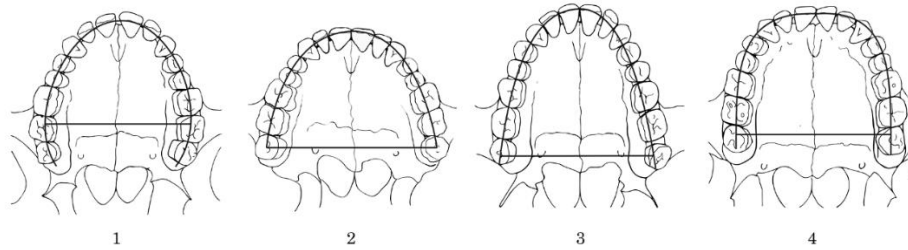


Figure 4.4. Inferior views of a cranium to demonstrate palate shape variations.

5.0 Macromorphoscopic traits and definitions:

5.1 *Anterior nasal spine (ANS):*

Anterior nasal spine is a small bony feature located at the inferior border of the nasal aperture. This trait exhibits the following three character states: slight, intermediate, and marked, with corresponding scores of 1, 2, and 3. Photographs of ANS for each character state and corresponding score are shown in Figure 5.1.

To score this trait, the cranium should be viewed laterally to assess the degree of projection of ANS.

1 = slight; indicates a minimal to no projection of the anterior nasal spine beyond the inferior nasal aperture.

2 = intermediate; indicates a moderate projection of the anterior nasal spine beyond the inferior nasal aperture.

3 = marked; indicates a pronounced projection of the spine beyond the inferior nasal aperture.

****Note:** Do not score if the individual is edentulous.

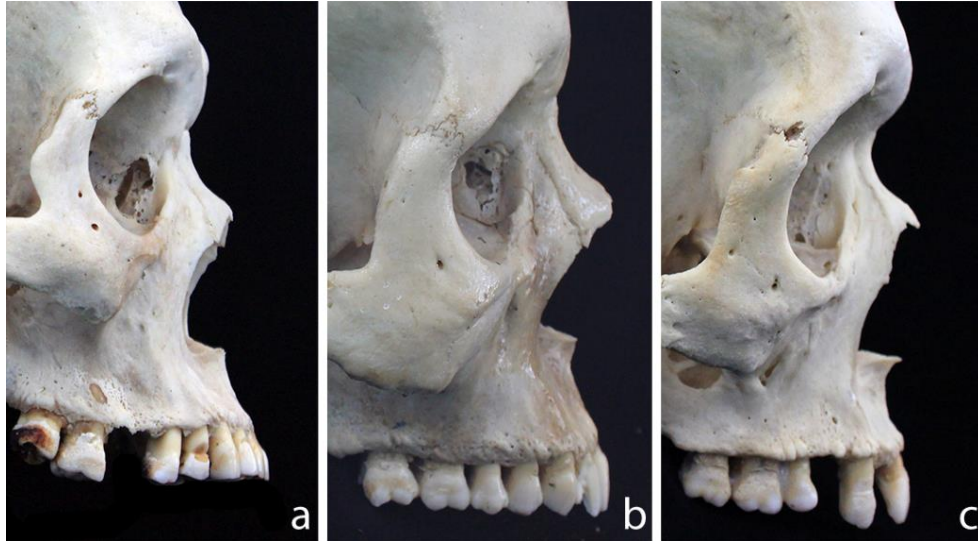


Figure 5.1: Various character states of ANS. Scores: a) 1 = slight; b) 2 = intermediate; c) 3 = marked

5.2 *Inferior nasal aperture (INA):*

Inferior nasal aperture assesses the shape of the inferior border of the nasal aperture. Specifically, this trait aims to assess the transition from the nasal floor to the vertical portion of the maxilla. The left portion of the inferior nasal aperture should be assessed.

This trait exhibits five character states scored as 1, 2, 3, 4, and 5, and ranges in morphology from a gentle slope with no delineation of the inferior border (1) to a sharp, pronounced vertical ridge, commonly referred to as a nasal sill (5). Photographs of INA for each character state and corresponding score are shown in Figure 5.2.

1 = A score of 1 is given to an INA that exhibits a sloping of the nasal floor which starts inside of the nasal cavity and terminates on the vertical surface of the maxilla. This gradual slope is a smooth transition between the two anatomical areas of bone.

2 = With this score, INA again exhibits a slope from the floor of the nasal cavity to the vertical surface of the maxilla. However, to differentiate from the previous state, the slope begins more anteriorly in the nasal aperture and exhibits more angulation at the opening of the nasal aperture.

3 = This state exhibits a steep transition from the nasal floor to the vertical maxilla. There is no slope, however there is no intervening projection or sill. This morphology closely resembles a right angle, although a more blunted form may be present.

4 = A score of 4 is assigned to a character state that shows any superior incline of the anterior nasal floor. This includes leads to the creation of a weak ridge of bone that crosses the anterior nasal floor perpendicularly, resulting in a partial nasal sill.

5 = This score is given to a pronounced ridge, or nasal sill, that obstructs the nasal floor to maxilla transition.

****Note:** When scoring INA, ignore subnasal grooves in the nasal floor. These grooves are indentations made by vessels in the area and are not reflective of the start of the nasal floor (Figure 5.3).

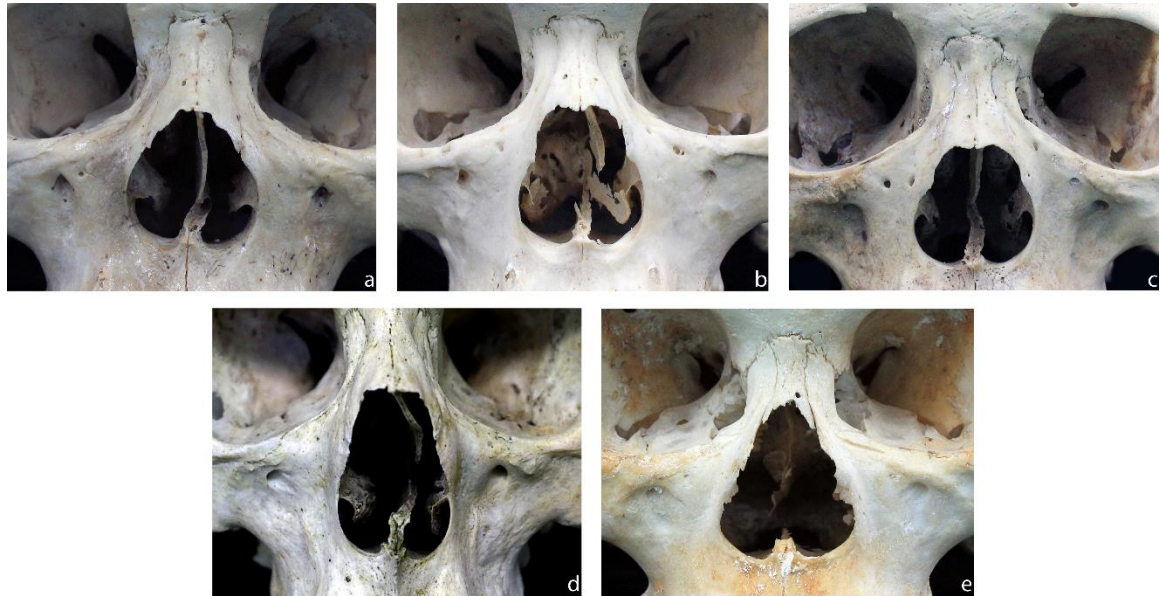


Figure 5.2: Character states of INA. Scores: a) 1 = deep, posterior sloping; b) 2 = slight, anterior sloping; c) 3 = no sloping or sill; d) 4 = weak ridge; e) 5 = pronounced ridge



Figure 5.3: Example of subnasal grooves, particularly on the left portion of the nasal floor.

5.3 *Interorbital Breadth (IOB):*

Interorbital breadth assesses the space between both orbits relative to the facial skeleton. The trait is assessed by using a ratio of IOB to the overall facial breadth. IOB is essentially visually observing the space between two cranial landmarks at left and right dacryon. This trait is scored using three character states (narrow, intermediate, and broad) translated numerically as 1, 2, and 3. Figure 5.4 illustrates the three character states and associated scores.

1 = a narrow IOB or 1:5 ratio of the interorbital space relative to the facial skeleton.

2 = a medium IOB or 1:4 ratio of the interorbital space relative to the facial skeleton.

3 = a broad IOB or 1:3 ratio of the interorbital space relative to the facial skeleton.



Figure 5.4: Character states of IOB. Scores: a) 1 = narrow; b) 2 = medium; c) 3 = broad.

5.4 Malar Tubercle (MT)

The malar tubercle is defined as a caudally protruding tubercle on the inferior margin of maxilla and zygomatic bones. This feature is commonly located at the inferior end of the zygomaticomaxillary suture. Size of the tubercle is assessed and scored on a 0, 1, 2, and 3 scale. The side with the greatest expression of MT should be scored. It should be noted that a completely absent MT is rare. Figure 5.5 illustrates the character states of MT.

This trait is assessed by placing a transparent ruler at a point approximately 0.5 cm lateral to the inferior terminus of the zygomaticomaxillary suture (*zygomaxillare*), extending to the deepest superior incurvature on the maxilla. A score is assigned on regarding the extent of the bone protruding past the ruler's inferior edge.

- 0 = There is no projection of bone
- 1 = There is a trace tubercle below the ruler's edge; approximately 2 mm or less
- 2 = The tubercle exhibits a medium protrusion below the ruler's edge; approximately 2 to 4 mm.
- 3 = There is a pronounced tubercle that protrudes approximately 4 mm or more below the ruler's edge.

****Note:** A malar tubercle might be present on either the maxilla, zygomatic, or at the zygomaticomaxillary suture. Observations should not consider any tubercles on the lateral portion of the zygomatic arch. When a tubercle is directly on or just posterior to the zygomaticomaxillary suture, the ruler should extend from the deepest incurvature of the maxilla to a point approximately 0.5 cm lateral to *zygomaxillare*.



Figure 5.5: Variation in character states of MT. Scores from left to right (top to bottom): a) 0 = no projection of bone; b) 1 = trace; c) 2 = medium; d) 3 = pronounced.

5.5 Nasal Aperture shape (NAS)

The nasal aperture shape is defined by the lateral contours of the nasal aperture and their greatest projection on the lateral margins. There are

three character states scored as 1, 2, and 3. Figure 5.6 illustrates the three character states of NAS.

This trait is scored by placing the cranium in anatomical position and examining the anterior portion of the face. The relative shape of the nasal aperture is assessed, with emphasis in determining the location of the greatest projection of the lateral margins of the nasal aperture lateral walls.

1 = The nasal aperture exhibits a teardrop shape, with a projection of the lateral margins intermediate to character states 2 and 3.

2 = The nasal aperture exhibits a bell shape, with the greatest projection of the lateral margins at the inferior portion of the nasal aperture.

3 = The nasal aperture is bowed, and the greatest projection of the lateral margins is at the midline.

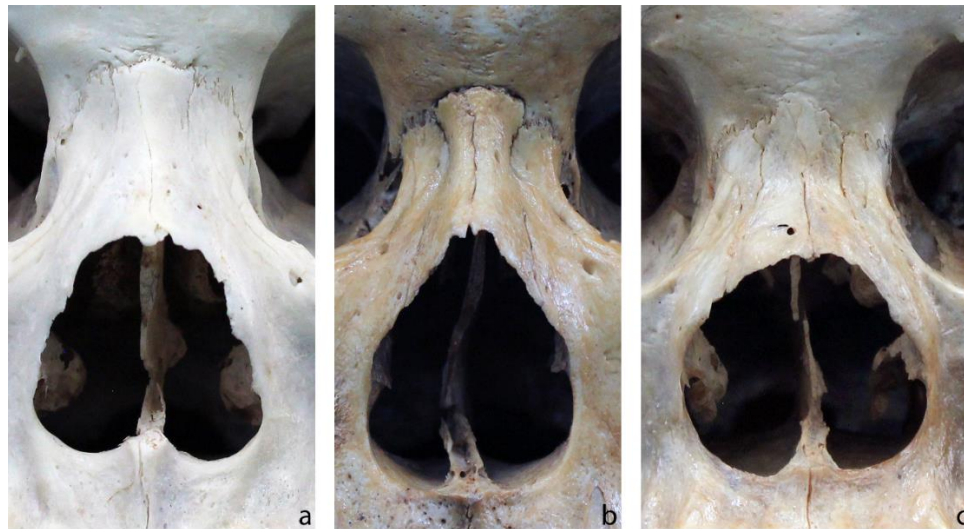


Figure 5.6: Character states of NAS. Scores: a) 1 = teardrop; b) 2 = bell shape; c) 3 = bowed

5.6 Nasal Aperture Width (NAW)

This trait is defined as the width of the nasal aperture relative to the entire facial skeleton. NAW should be assessed using a ratio of nasal aperture width to the overall width of the facial skeleton. This trait is captured in three character states, scored as 1, 2, and 3. Figure 5.7 illustrate the character states for NAW.

1 = NAW is narrow; ratio of 1:5 (NAW: width of facial skeleton)

2 = NAW is intermediate; ratio of 1:4 (NAW: width of facial skeleton)

3 = NAW is broad; ratio of 1:3 (NAW: width of facial skeleton)

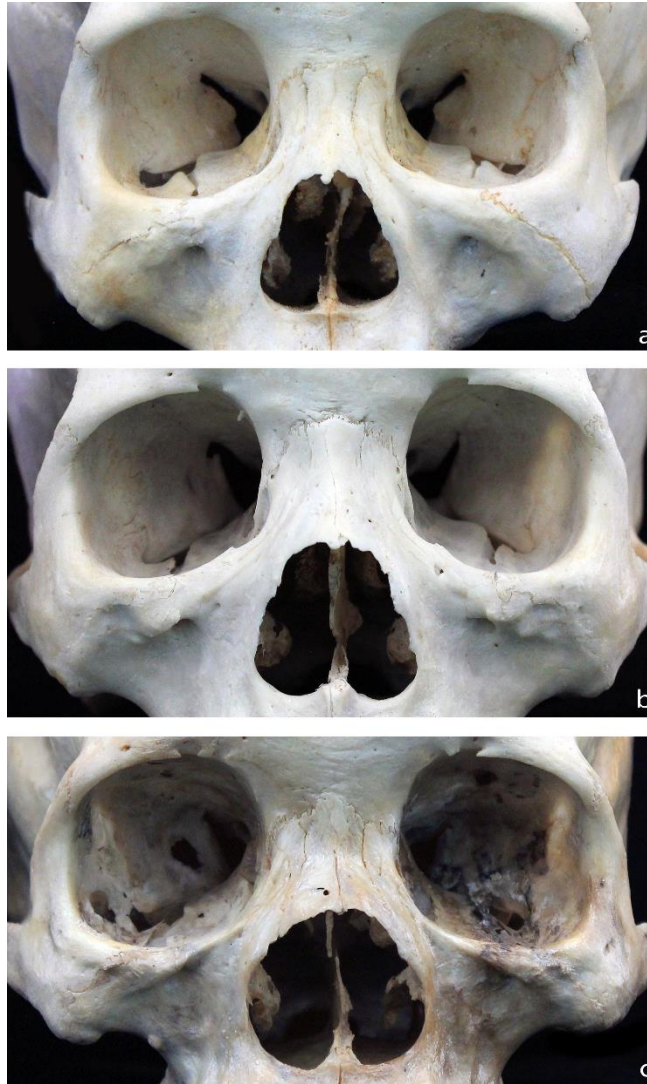


Figure 5.7: Character states of NAW. Scores: a) 1 = narrow; b) 2 = medium; c) 3 = broad

5.7 *Nasal Bone Contour (NBC):*

This trait is defined as the curvature of the midfacial region, specifically the nasal bones and frontal process of both maxillae at 1 cm below the cranial landmark *nasion*. This trait presents itself as five possible character states scored as 0, 1, 2, 3, and 4. Figure 5.8 illustrates four character states for NBC.

Visual assessment of NBC is not recommended due to a high level of inter- and intra-observer error. It is recommended that this trait be scored with a contour gauge, as this tool permits a more objective assessment of NBC. To score this trait, the user should place the contour gauge directly on the nasal bones 1 cm below *nasion*. Keeping the contour gauge perpendicular to a transverse plane and parallel to the sagittal plane (Figure 5.9), the observer should apply gentle but firm, consistent pressure until the deepest points on the contour gauge are reached. This process should be repeated

multiple times along the length of the contour gauge to ensure correct assessment of NBC.

0 = NBC exhibits a low and rounded nasal bone contour

1 = NBC exhibits an oval contour with elongated, high, and rounded lateral walls

2 = This character state exhibits steep lateral walls and a broad (approximately 7 mm or more), flat plateau. On the contour gauge, the plateau is identified by a flat cluster of seven or more needles at the same height.

3 = At this score, NBC exhibits steep-sided lateral walls and a narrow surface plateau.

4 = This character state is triangular in cross-section and lacks a surface plateau.

****Note:** Each needle on the contour gauge represent 1 mm. Make sure the needles on the gauge do not separate when pressing the instrument on the nasal bones. This will create space and inaccurately model the true shape of the nasal contour.

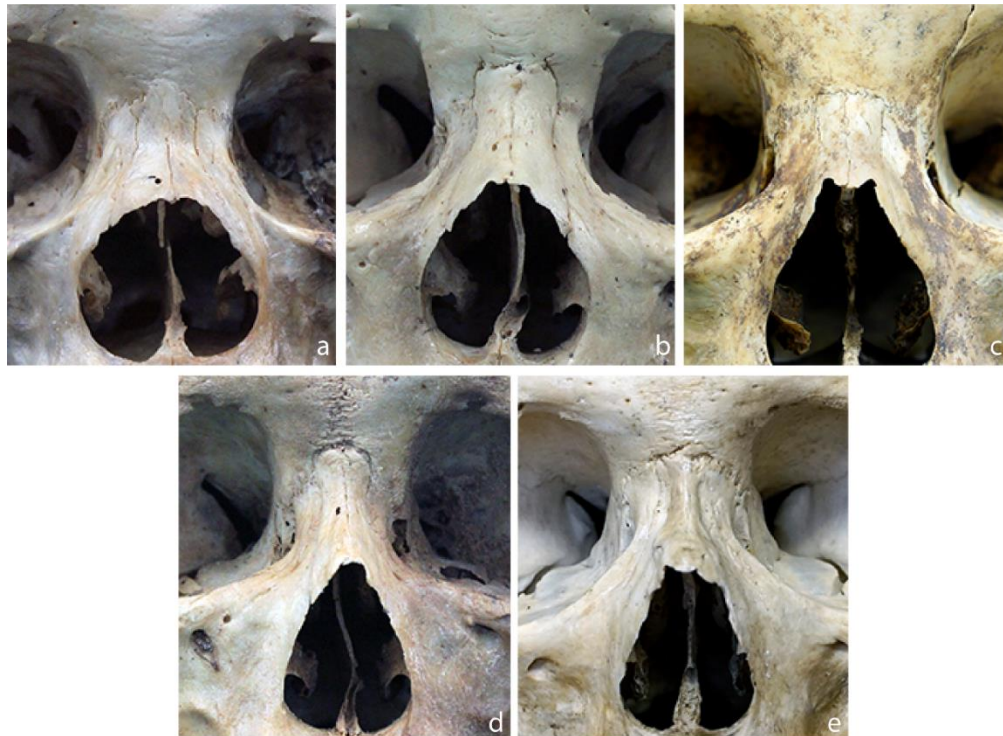


Figure 5.8: Character states of NBC. Scores: a) 0 = low, rounded, circular; b) 1 = high rounded, oval; c) 2 = broad plateau; d) 3 = narrow plateau; e) 4 = triangular.



Figure 5.9: Trait assessment using the contour gauge.

5.8 *Nasal Bone Shape (NBS)*

This trait is defined as the relative contour of the nasal bones at their lateral edges. There are four possible character states for this trait, scored as 1, 2, 3, and 4. Figure 5.10 illustrates the four character states for NBS.

This trait is visualized and assessed while holding the cranium in its approximate anatomical position, with the anterior view directly in front of the observer. In order to make a correct observation, keep in mind the position of the nasal pinch (if present) and the amount of lateral bulging (if present). Do not consider the frontonasal suture, the nasal suture, or the symmetry of the nasal bones.

- 1 = The lateral edges of the nasal bones show no pinching. The nasal bones here may be wide or narrow in shape.
- 2 = In this character state, the nasal bones exhibit a superior pinch and minimum bulging on the lateral edges of the bones.
- 3 = The lateral edges of the nasal bones exhibit a superior pinch and a pronounced lateral bulging of the inferior region.
- 4 = The lateral edges of the nasal bones form a triangle.

****Note:** To differentiate between a score of 2 and 3, the amount of lateral bulging at the inferior lateral ends of the nasal bones should be assessed.

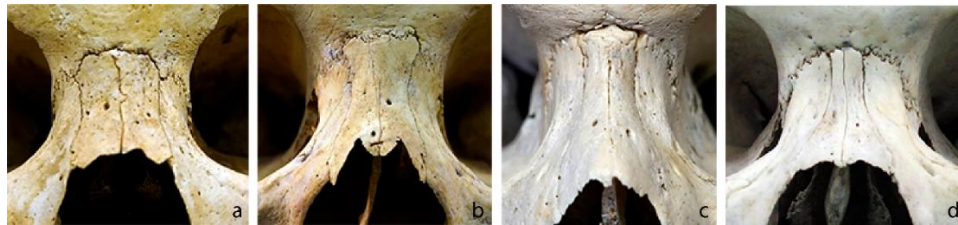


Figure 5.10: Character states of NBS. Scores: a) 1 = no nasal pinch; b) 2 = superior pinch, minimal lateral bulge; c) 3 = superior pinch, pronounced lateral bulge; d) 4 = triangular.

5.9 Nasal Overgrowth (NO)

Nasal overgrowth is defined as the projection of the lateral border of the nasal bones at their inferior edge beyond the maxilla at the cranial landmark *nasale inferious*. This trait exhibits two character states based on presence or absence of overgrowth. Figure 5.11 illustrates the character states of NO.

This trait is visualized by close inspection of the inferior lateral border of the left nasal bone where it articulates with the maxilla. It may be useful to gently run your finger along the border of the maxilla and nasal bones at *nasale inferious* to determine whether a projection is present.

0 = no bony overgrowth at *nasale inferious*.

1 = any projection of bone from the lateral border of the nasal bones beyond the maxillary border at *nasale inferious*.

****Note:** If the left side is damaged, the right side may be used to assess the trait. If both nasal bones are missing, fractured (ante- or peri-mortem), or damaged, do not score nasal overgrowth. Be careful to closely examine this feature for postmortem so that the individually is not incorrectly scored as having no nasal overgrowth.

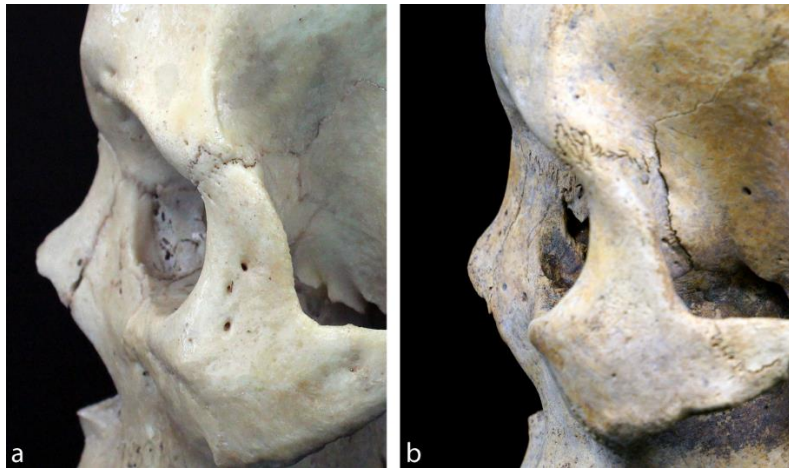


Figure 5.11: Character states of NO. Scores: a) 0 = no overgrowth; b) 1 = overgrowth.

5.10 Nasofrontal Suture (NFS)

This trait is defined as the shape of the suture separating the nasal bones from the frontal bone. There are four variations of the suture; round, square, triangular, and irregular. Figure 5.12 illustrates the character states of NFS.

To score the trait, hold the cranium in anatomical position, with the anterior portion of the cranium facing the observer. Do not assess this trait from a lateral view. When scoring, disregard the symmetry of the nasal bones and score for overall shape of the suture.

- 1 = In this character state, the nasofrontal suture is round and does not have any angles.
- 2 = In this character state, the nasofrontal suture is square and contains approximate right angles at *nasale superious*.
- 3 = The nasofrontal suture appears triangular
- 4 = The nasofrontal suture is irregular and lacks any definitive shape.

Note: If the nasal bones exhibit extreme pinching of the superior border (as in NBS score 4), do not score NFS.



Figure 5.12: Character states of NS. Scores: a) 1 = round; b) 2 = square; c) 3 = tented; d) 4 = irregular.

5.11 *Orbital Shape (OBS)*

This trait is defined as the shape of the eye orbits. OBS exhibits three non-metric variants, or character states, scored as 1>2>3. Figure 5.13 illustrates the three character states of OBS.

To score OBS, hold the cranium at a distance of approximately one foot, covering the right orbit and view anteriorly. The orbital margins define the shape. The medial orbital border is denoted by the anterior lacrimal crest and the maxillary process of the frontal bone.

- 1 = The eye orbits are rectangular in shape. The horizontal margins are longer than the vertical margins, and are mostly parallel.
- 2 = The eye orbits are circular in shape. The orbital margin is approximately equidistant from the center at any point.
- 3 = The eye orbits are rhombic in shape. The medial border is shorter in height than the lateral border. This shape resembles aviator sunglasses.

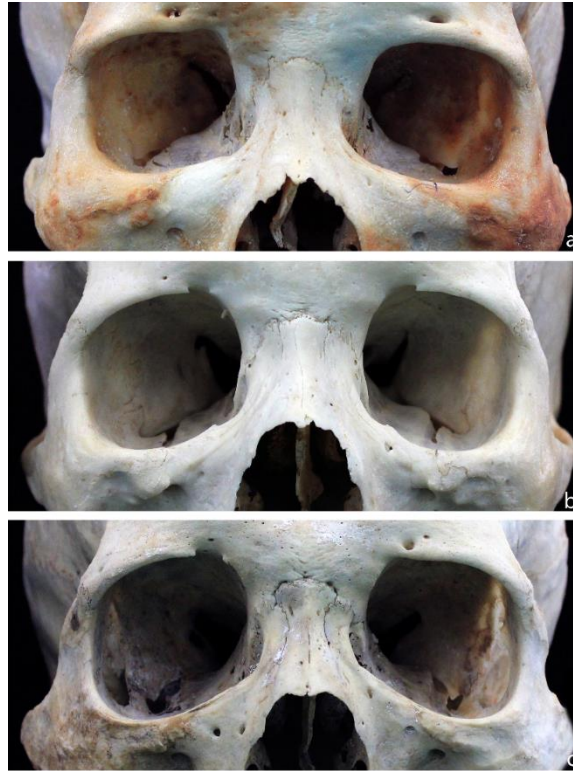


Figure 5.13: Character states of OBS. Scores: 1 = rectangular; 2 = circular; 3 = rhombic (aviator sunglasses).

5.12 Postbregmatic Depression (PBD)

This trait is defined as a depression along the sagittal suture posterior to the cranial landmark, *bregma* that is not a result of pathology. This trait is scored based on its presence or absence as 0, 1. Figure 5.14 illustrates the character states of PBD.

To score this trait, hold the cranium in a lateral profile view and look for a depression posterior to *bregma*. It may be helpful to palpate the area.

0 = No depression present posterior to *bregma*

1 = Any depression posterior to *bregma* along the mid-sagittal plane.

****Note:** PBD can be assessed using the contour gauge to detect small expressions of this trait. The gauge should be held vertically with the pins directly on the skull. The gauge should be positioned with the midpoint of the instrument superior to *bregma* and the posterior portion aligned with the sagittal suture. The anterior edge should align with the midline of the frontal bone. Press the contour gauge firmly, but gently, with consistent pressure to replicate the shape of the postbregmatic region. If the gauge exhibits any signs of postbregmatic depression, it should be scored as present (score of 1).

Be careful scoring individuals with obliterated sutures because the bone along the suture sites may be elevated, giving the appearance of a depression for the surrounding bone. The key is to determine if the sagittal suture contours just posterior to *bregma* and extends superiorly to return to the original elevation.



Figure 5.14: Character states of PBS. Scores: a) 0 = absent; b) 1 = present.

5.13 Posterior Zygomatic Tubercle (PZT)

This trait is defined as the posterior projection of the zygomatic bone as viewed laterally on the cranium. This projection, also referred to as the marginal process, is viewed at approximately the midorbit level. This trait exhibits four character states, scored as 0, 1, 2, and 3. The side with the greatest expression is scored. Figure 5.15 illustrates the character states for this trait.

This trait is scored by viewing the cranium in lateral view. By placing a transparent ruler on the frontal process of the zygomatic that extends from the two cranial landmarks, *frontomolare posterale* to *jugale*, the degree of protrusion of the tubercle can be assessed. A score is assigned on the extent of the bone protruding past the ruler's edge.

- 0 = There is no projection of bone past the ruler's edge.
- 1 = There is a weak projection of bone that extends less than 4 mm past the ruler's edge.
- 2 = There is a moderate projection of bone that extends approximately 4 to 6 mm past the ruler's edge.
- 3 = There is a marked projection of bone extending more than 6 mm past the ruler's edge.

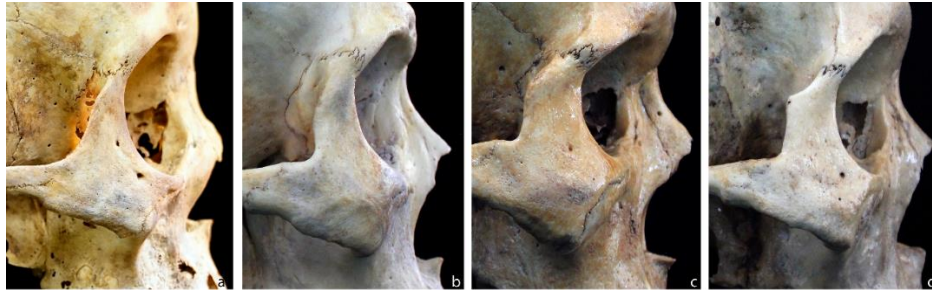


Figure 5.15: Example character states of PZT. Scores: a) 0 = no projection; b) 1 = weak projection; c) 2 = moderate projection; d) 3 = marked projection.

5.14 Supranasal Suture (SPS)

This trait is defined as the secondary complex superior to the cranial landmark *nasion* that may persist into adulthood. This suture may also be referred to as *sutura supernasalis*. This trait exhibits three character states scored as 0, 1, and 2. Figure 5.16 illustrates the character states for SPS.

This trait is scored by viewing the cranium anteriorly. SPS is not the nasal portion of a persistent metopic suture, but is the fusion of the nasal portion of a frontal suture. SPS appears as a complex suture of interlocking bony spicules at the cranial landmark *glabella*.

- 0 = the SPS is completely obliterated
- 1 = the SPS is open and unfused
- 2 = the SPS is closed but visible



Figure 5.16: Example character states of SPS. Scores: a) 0 = obliterated; b) 1 = open, unfused; c) 2 = closed but visible.

5.15 *Transverse Palatine Suture (TPS)*

This trait is defined as the shape of the course of the transverse palatine suture on the hard bony palate. The entire suture is observed, but the assessment should focus on the medial half of the palatine suture. Be careful to not focus solely on the area directly surrounding the median palatine suture, but instead, score the overall shape of the transverse palatine suture from approximately the left midpoint to the right midpoint. If the suture is asymmetrical or the right and left transverse palatine sutures do not meet at the median palatine suture, score the general shape of the suture following the character states. This trait has four character states, scored as 1, 2, 3, and 4. Figure 5.17 illustrates the four character states of TPS.

To assess this trait, view the cranium inferiorly, at the hard palate. Follow the TPS and note how deviation occurs near the intersection with the median palatine suture.

1 = In this character state, the suture crosses the palate perpendicular to the median palatine suture. There is no significant deviation either anteriorly or posteriorly. The suture is relatively straight.

2 = The suture crosses the palate perpendicular to the median palatine suture, however there is an anterior deviation or bulge near the intersection of the two.

3 = As the suture crosses the palate, there are slight deviations both anteriorly and posteriorly resulting in a 'M' shape near the intersection with the median palatine suture.

4 = At the intersection with the median palatine suture, the TPS bulges posteriorly.

****Note:** If the suture is obliterated, do not score TPS. Do not consider slight undulations of the suture when scoring, particularly the area directly adjacent to the median palatine suture.

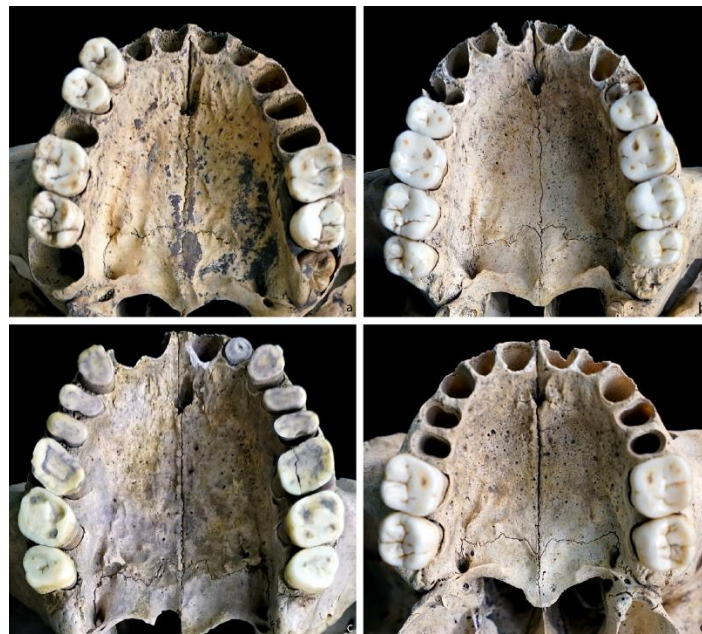


Figure 5.17: Example character states of TPS. Scores: a) 1 = straight, b) 2 = anterior bulge, c) 3 = M-shaped; d) 4 = posterior bulge.

5.16 Palate Shape (PS)

This trait is defined as the contour of the dental arcade, defined by the curvature of the hard palate in the transverse plane, as viewed from the occlusal/inferior aspect of the maxillae. Palate shape is based on the overall morphology and arch shape of the anterior and posterior dentition, assessed as a midline-projection through the individual teeth along their mesio-distal axis. This trait is illustrated in Figure 5.18.

To assess PS, hold the cranium from the inferior view and focus on the occlusal/inferior aspect of the maxilla. Draw an imaginary line through the midline-projection of the individual teeth along their mesio-distal axis. Assess the overall shape of this line relative to the four character states.

1 = elliptical; smooth, round curvature of the anterior portion of the palate combined with a mid-arch (ca. M1 and M2) widening relative to M3, contributing to the appearance of constricted (medially-positioned) 3rd molars.

2 = parabolic A; smooth rounded curvature of the anterior portion of the palate, combined with an even, gradual flaring of the posterior dentition.

3 = parabolic B; smooth, rounded curvature of the anterior portion of the palate, but combined with an even, gradual flaring of the posterior dentition. The only distinction is the longer relative length to breadth ratio in Form B.

4 = hyperbolic; smooth, slightly flattened curvature of the anterior portion of the palate, combined with a straight, more-or-less parallel configuration of the posterior portions of the arch.

****Note:** Do not score edentulous individuals as resorption can cause the palate shape to change. It should also be noted that it may difficult to distinguish between score 1 and 3 in individuals with resorbed 3rd molars.

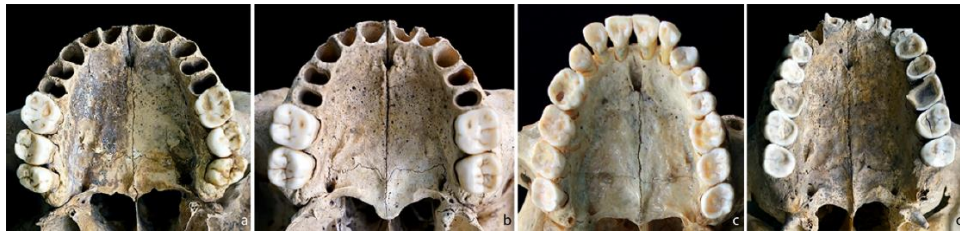


Figure 5.18: Example character states of PS: a) 1 = elliptical; b) 2 = parabolic A; c) 3 = parabolic B; d) 4 = hyperbolic.

5.17 Zygomaticomaxillary Suture Course (ZS)

This trait is defined as the suture between the maxilla and zygomatic. Observations should be based on the approximate location of the greatest lateral projection of the suture and the number of major angles present. ZS has three character states, scored as 0,1,2. Figure 5.19 illustrates the character states of ZS.

This trait is scored from viewing the cranium in the anterior view. The left side should be scored. Any infraorbital sutures should be ignored when scoring ZS.

0 = ZS has no angles, and the greatest lateral projection of the suture is at the inferior margin of the malar.

1 = ZS has one angle, and the greatest lateral projection is near the midline.

2 = ZS has two or more angles that have a jagged or S-shaped appearance.

The greatest lateral projection of this character state is variable.

****Note:** Sutures with the greatest lateral projection at the inferior margin with a slight angle near the midpoint of the suture should be scored as 0.



Figure 5.19 Character states of ZMS. *Scores:* a) 0 = no angles; a) 1 = one angle; c) 2 = jagged/s-shaped.

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