appendix 3: catalogue of non-metric traits - permanent dentition

the title corresponds to the trait number on the data recording form and to its name

a summary of traits is presented on the following page: traits 1-32 are observed on the maxilla and traits 33-59 on the mandible

we have intentionally sub-divided the presentation of certain traits, when they are recorded on opposed quadrants

the catalogue contains six headings for each trait:

synonymous terms

the different terms encountered in the literature

references

useful references for description of the traits

application

this heading presents the teeth on which the trait is observed

definition

a brief description of the trait is given, largely based on or simply a translation of that given by the author who first defined the trait

data recording system

the data recording system selected for documenting observations; we also note here any changes in the recording system used, typically a simplification of the gradation of a trait

gradation

the gradations presented here are in general those retained in the recording system used

1 - congenital absence
2 - radical number
3 - radiculae appendiciformes
4 - premolar root number
5 - molar root number
6 - radix Carabelli
7 - radix paramolaris
8 - idiopathische radices
9 - winging
10 - labial convexity
11 - interruption groove
12 - akzessorische Höckerchen
13 - cingulum
14 - talon cusp
15 - shoveling
16 - tuberculum dentale
17 - double-shoveling
18 - canine mesial ridge
19 - canine distal accessory ridge
20 - accessory cusp
21 - odontome
22 - enamel extensions
23 - parastyle
24 - Carabelli's trait
25 - metacone
26 - hypocone
27 - metaconule
28 - distal accessory tubercle
29 - mesial paracone tubercle
30 - mesial accessory tubercle
31 - protoconule
32 - lingual paracone tubercle
33 - congenital absence
34 - radical number
35 - radiculae appendiciformes
36 - canine root number
37 - Tomes root
38 - molar root number
39 - radix Citroen
40 - radix paramolaris
41 - radix entomolaris
42 - idiopathische radices
43 - shoveling
44 - double shoveling
45 - distal accessory ridge
46 - odontome
47 - lingual cusp variation
48 - deflecting wrinkle
49 - anterior fovea
50 - mid trigonid crest
51 - distal trigonid crest
52 - cusp number
53 - groove pattern
54 - protostylid
55 - hypoconulid
56 - entoconulid
57 - metaconulid
58 - tuberculum paracone
59 - tuberculum Citroen

1 - congenital absence

Synonymous terms
size reduction: peg-shaped, diminutive conical, triform, missing tooth: aplasia, agenesis

References
Garn et al. (1962), Brothwell et al. (1963), Carbonell & Goose (1963), Dahlberg (1963b), Sofaer et al. (1971), Suarez & Spence (1974), Turner et al. (1991), Alt (1997), Wang et al. (2000), Stephen et al. (2002), Kau et al. (2003), Fujiwara et al. (2000)

Application
I^2, P^2, M^3

Definition
a continuum from the reduction of the relevant tooth size to its congenital absence

Data recording system
ASU_DAS (Turner et al. 1991, Scott & Turner 1997)
merging of two ASU_DAS traits: peg-shaped tooth and congenital absence (relevant tooth is termed peg-shaped when its crown is small and barrel-shaped, lacking the normal crown morphology and congenital absence is non-formation of the relevant tooth)

Gradation
I2 and M3
0. tooth present, including any trace of an impacted tooth
1. incisor reduced in size but having a normal crown form
2. peg-shaped tooth as defined above
3. congenitally missing tooth
P1
0. tooth present, including any trace of an impacted tooth
3. congenitally missing tooth

2 - radical number

Synonymous terms
none

References
Turner (1967), Schulze (1987), Turner et al. (1991), Scott & Turner (1997)

Application
all teeth

Definition
the number of divisions (radicals) created by the developmental grooves, which may partition a root; the latter can be separated by these divisions or not

Data recording system
ASU_DAS (Turner et al. 1991, Scott & Turner 1997)

Gradation
1. one radical, no developmental grooves
2. two radicals: 2 developmental grooves and 1 root or 2 roots with no developmental grooves
3. three radicals, 3 developmental grooves and 1 root or 1 root with no developmental grooves and 1 root with 2 developmental grooves...
4. four radicals, as above
5. five radicals, as above
6. six radicals, as above
7. seven radicals, as above
8. eight radicals, as above

3 - radiculae appendiciformes

Synonymous terms
none
References
Alt (1997), Schulze (1987)

Application
I^1, I^2, C^-, P^1, P^2

Definition
small additional root - or radice- which is often located, but not always, close the junction of the roots

Data recording system
FU_DTS (Alt 1997, Alt et al. 1998)

Gradation
0. absence
1. presence

4 - premolar root number

Synonymous terms
none

References
Turner (1967), Turner (1981), Turner et al. (1991), Scott & Turner (1997), Loh (1998)

Application
P^1, P^2

Definition
premolar root number

Data recording system
ASU_DAS (Turner et al. 1991, Scott & Turner 1997)

Gradation
1. one root, with possible bifid tip
2. two roots, separate roots must be greater than one-quarter to one-third of total root length
3. three roots, separate roots must be greater than one-quarter to one-third of total root length

5 - molar root number

Synonymous terms
none

References
Turner (1967), Turner et al. (1991), Alt (1997), Scott & Turner (1997)

Application
M^1, M^2, M^3

Definition
molar root number

Data recording system
ASU_DAS (Turner et al. 1991, Scott & Turner 1997)
inclusion of the pyramidalism trait – root in the form of a single cone – in the first grade

Gradation
1. one root, with possible bifid tip and deep grooves
2. two roots, each separate root must be greater than one-quarter to one-third of total root length
3. three roots, as above
4. four roots, as above

6 - radix Carabelli

Synonymous terms
none

References
Schulze (1987), Alt (1997), Carlsen & Alexandersen (2000)

Application
M^1, M^2, M^3

Definition
mesiolingual additional root

Data recording system
FU_DTS (Alt 1997, Alt et al. 1998)

Gradation
0. absence
1. presence

7 - radix paramolaris

Synonymous terms
none

References
Schulze (1987), Alt (1997), Carlsen & Alexandersen (1999)

Application
M^1, M^2, M^3

Definition
mesiobuccal additional root

Data recording system
FU_DTS (Alt 1997, Alt et al. 1998)

Gradation
0. absence
1. presence

8 - idiopathische radices

Synonymous terms
none

References
Schulze (1987), Alt (1997)

Application
M^1, M^2, M^3

Definition
additional root located neither mesiobucally (radix paramolaris position) nor mesiolingually (radix Carabelli position)

Data recording system
FU_DTS (Alt 1997, Alt et al. 1998)

Gradation
0. absence
1. presence

9 - winging

Synonymous terms
mesial-palatal torsion, bilaterally rotated incisors

References
Enoki & Dahlberg (1958), Enoki & Nakamura (1959), Turner (1967), Escobar et al. (1976), Nichol (1989), Turner et al. (1991), Scott & Turner (1997)

Application
I^1

Definition
rotation of the upper central incisors

Data recording system
ASU_DAS (Turner et al. 1991, Scott & Turner 1997)
this system applies a scale of four phases based on their position: 2 sub-phases are present for bilateral rotation (phase 1A: angle > 20° and 1B: angle < 20°), this has been simplified here by merging the two phases retaining only the presence of rotation and ignoring the angle formed by the incisors

Gradation
1. bilateral winging: central incisors are rotated mesiolingually giving a V-shaped appearance when viewed occlusally
2. unilateral winging: one or other of the incisors is rotated
3. straight: both incisors follow the curvature of the dental arcade
4. counter-winging: one or both teeth are rotated disto-lingually

10 - labial convexity

Synonymous terms
none

References
Nichol et al. (1984), Turner et al. (1991), Scott & Turner (1997)

Application
I^1, I^2

Definition
convexity of the maxillary incisor buccal surface

Data recording system
ASU_DAS (Turner et al. 1991, Scott & Turner 1997)

Gradation
0. buccal surface is flat
1. trace convexity
2. weak convexity
3. moderate convexity
4. pronounced convexity

11 - interruption groove

Synonymous terms
corono-radicular groove, marginal interruption, *dens invaginatus*

References
Turner (1967), Turner et al. (1991), Lukacs (1983a/b)

Application
I^1, I^2

Definition
grooves which cross the cingulum and may continue down to the root

Data recording system
ASU_DAS (Turner et al. 1991, Scott & Turner 1997)

Gradation
0. none: the lingual surfaces of the incisors are smooth
M. an interruption groove occurs on the mesiolingual border

D. an interruption groove occurs on the distolingual border
Med. an interruption groove occurs on the medial area of the cingulum. Care must be taken in the presence of grade 2/3 shoveling, as this can simulate a medial interruption
MD. grooves occur on both the mesio- and the distolingual borders

12 - akzessorische Höckerchen

Synonymous terms
none

References
Alt (1997), Alt et al. (1998)

Application
I^1, I^2

Definition
small tubercle sited on the incisors distal border

Data recording system
FU_DTS (Alt 1997, Alt et al. 1998)

Gradation
0. absence
1. presence

13 - cingulum

Synonymous terms
none

References
Schulze (1987), Alt (1997), Alt et al. (1998)

Application
I^1, I^2

Definition
bulge or cingulum of the buccal surface

Data recording system
FU_DTS (Alt 1997, Alt et al. 1998)

Gradation
0. absence
1. presence

14 - talon cusp

Synonymous terms
margoïde differenzierung

References
Schulze (1987), Alt (1997), Alt et al. (1998), Dash et al. (2004), Mays (2005)

Application
I^1, I^2, C^-

Definition
pinching of the buccal surface which generates a T- or Y-shaped incisive edge

Data recording system
FU_DTS (Alt 1997, Alt et al. 1998)

Gradation
0. absence
1. presence

15 - shoveling

Synonymous terms
shovel-shaped tooth

References
Hrdlickà (1920), Rothhammer et al. (1968), Lee & Goose (1972), Scott (1973, 1975), Portin & Alvesalo (1974), Blanco & Chakraborty (1977), Berry (1978), Harris (1980), Mizogushi (1985), Turner et al. (1991), Tsai et al. (1996), Alt (1997), Scott & Turner (1997)

Application
I^1, I^2, C^-

Definition
development of lingual marginal ridges

Data recording system
ASU_DAS (Turner et al. 1991, Scott & Turner 1997)

Gradation
0. none: the lingual surface is essentially flat
1. faint: very slight marginal ridges: can be more easily palpated than seen
2. trace: slight marginal ridges can be easily seen
3. semishovel: the ridging is stronger and tends to converge at the cingulum
4. semishovel: convergence and ridging are than in grade 3
5. shovel: strong development of ridges
6. marked shovel: strongest development
7. barrel: barrel-shaped tooth (lateral incisor only)

16 - tuberculum dentale

Synonymous terms
lingual tubercle, cingular ridge, *tuberculum dentis*, canine tubercle, lingual cusp, dental tubercle

References
Scott (1973, 1975), Berry (1976, 1978), Turner et al. (1991), Alt (1997), Scott & Turner (1997)

Application
I^1, I^2, C^-

Definition
crests or tubercle arising from the cingulum region on the lingual surface

Data recording system
ASU_DAS (Turner et al. 1991, Scott & Turner 1997)
the system proposes a scale of six expressions for the tuberculum dentale, the second-to-last subdivided into two phases "5-" and "5", here they are continuously numbered, such that phase 5 corresponds to the ASU-DAS phase 5-, phase 6 to phase 5 and phase 7 to phase 6

Gradation
0. no expression, smooth cingular region
1. faint ridging on the cingular region
2. trace ridging
3. strong ridging
4. pronounced ridging
5. a weakly developed cuspule is attached to the mesio- or distolingual marginal ridge, but the cuspule apex is not free
6. weakly developed cuspule with a free apex
7. strong cusp with a free apex

17 - double-shoveling

Synonymous terms
labial marginal ridges

References
Dahlberg & Mikkelsen (1947), Dahlberg (1956), Snyder (1960), Turner (1970), Turner et al. (1991), Alt (1997), Scott & Turner (1997)

Application
I^1, I^2, C^-, P^1

Definition
development of buccal marginal ridges

Data recording system
ASU_DAS (Turner et al. 1991, Scott & Turner 1997)

Gradation
0. none: buccal surface is smooth
1. faint: mesial and distal ridges can be seen in strong contrasting light
2. trace: ridging is more easily seen and palpated
3. semi double-shovel: ridging can be readily palpated
4. double-shovel: ridging is pronounced on at least one-half of the total crown height
5. pronounced double-shovel: ridging is very prominent
6. extreme double-shovel

18 - canine mesial ridge

Synonymous terms
Bushman canine

References
Morris (1975), Turner et al. (1991), Irish & Morris (1996), Scott & Turner (1997)

Application
C^-

Definition
mesiolingual marginal ridge of the upper canine is more developed than the distal, instead of being of equal size

Data recording system
ASU_DAS (Turner et al. 1991, Scott & Turner 1997)

Gradation
0. mesial and distal lingual ridges are of the same size
1. mesiolingual ridge is larger than the distolingual ridge and is faintly attached to the cingular region
2. mesiolingual ridge is larger than the distolingual ridge and one can easily see that it is attached to the cingular region
3. mesiolingual ridge is much larger than the distolingual ridge and is fully incorporated into the tuberculum dentale (Morris's type form)

19 - canine distal accessory ridge

Synonymous terms
none

References
Morris (1970), Scott (1975, 1977), Turner et al. (1991), Alt (1997), Scott & Turner (1997)

Application
C^-

Definition
accessory ridge occurring in the distolingual fossa between the tooth apex and the distolingual marginal ridge

Data recording system
ASU_DAS (Turner et al. 1991, Scott & Turner 1997)

Gradation
0. trait absent
1. very faint distal accessory ridge visible in strong contrasting light
2. weakly developed, narrow accessory ridge
3. moderately developed accessory ridge
4. strongly developed accessory ridge
5. very pronounced accessory ridge

20 - accessory cusps

Synonymous terms
accessory marginal tubercle

References
Turner et al. (1991), Alt (1997), Scott & Turner (1997)

Application
P^1, P^2

Definition
small accessory cusps at the mesial and/or distal ends of the sagittal grooves

Data recording system
ASU_DAS (Turner et al. 1991, Scott & Turner 1997)

Gradation
0. absence
1. presence

21 - odontome

Synonymous terms
tuberculated premolars, occlusal tubercle, premolar central cusp

References
Reichart & Tantiniran (1975), Schulze (1987), Turner et al. (1991), Alt (1997), Scott & Turner (1997)

Application
P^1, P^2

Definition
any pin-sized, spike-shaped enamel and dentine projection occurring on the occlusal surface, occurring mostly in or near the sagittal sulcus

Data recording system
ASU_DAS (Turner et al. 1991, Scott & Turner 1997)

Gradation
0. absence
1. presence

22 - enamel extensions

Synonymous terms
none

References
Masters & Hoskine (1964), Turner (1969), Turner et al. (1991), Scott & Turner (1997)

Application
P^1, P^2, M^1, M^2, M^3

Definition
cervical crown margin extension down at a root furcation, in the form of a thin band of enamel (exclusion of the recording of enamel pearls)

Data recording system
ASU_DAS (Turner et al. 1991, Scott & Turner 1997)

Gradation
0. enamel border straight or curved, any extension not attached to crown is absent
1. faint 1 mm long extension
2. medium 2 mm long extension
3. lengthy extension > 4 mm

23 - parastyle

Synonymous terms
paramolar cusp, Bolk cusp, buccal pit (for grade 1)

References
Lukacs (1983a/b), Turner et al. (1991), Scott & Turner (1997)

Application
M^1, M^2, M^3

Definition
trait occurring on the buccal surface ranging in expression from a pit to a large and well-separated cusp

Data recording system
ASU_DAS (Turner et al. 1991, Scott & Turner 1997)

Gradation
0. buccal surfaces of cusps 2 and 3 are smooth
1. a pit is present in or near the buccal groove between cusps 2 and 3
2. a small cusp with an attached apex is present
3. a medium cusp with a free apex is present
4. a large cusp with a free apex is present
5. a pronounced cusp with a free apex is present
6. extreme shape: a free peg-shaped crown attached to the root

24 - Carabelli's trait

Synonymous terms
mesiolingual tubercle, protostyle, Carabelli's tubercle, Carabelli anomaly, *tuberculus anomalus*

References
Kraus (1951), Meredith & Hixon (1954), Tsuji (1958), Kraus (1959), Dahlberg (1963a), Garn et al. (1966a), Goose & Lee (1971), Sofaer et al. (1972a/b), Biggerstaff (1973), Alvesalo et al. (1975), Scott (1978, 1979, 1980), Townsend & Brown (1980), Reid et al. (1991), Turner et al. (1991), Townsend & Martin (1992), Tsai et al. (1996), Scott & Turner (1997)

Application
M^1, M^2, M^3

Definition
trait occurring on the lingual side of the mesiolingual cusp (protocone), ranging in expression from a pit to a large and well-separated cusp

Data recording system
ASU_DAS (Turner et al. 1991, Scott & Turner 1997)

Gradation
0. smooth mesiolingual surface
1. a groove is present
2. a pit is present
3. a small Y-shaped depression is present
4. a large Y-shaped depression is present
5. a small cusp without a free apex is present, the distal border of the cusp does not touch the lingual groove separating cusps 1 and 4
6. a medium-sized cusp with an attached apex makes contact with the mediolingual groove
7. a large free cusp is present

25 - metacone

Synonymous terms
distobuccal cusp, cusp 3

References
Dahlberg (1963a), Turner et al. (1991)

Application
M^1, M^2, M^3

Definition
development of the distobuccal cusp or cusp 3

Data recording system
ASU_DAS (Turner et al. 1991, Scott & Turner 1997)

Gradation
0. metacone absent
1. an attached ridge is present at the site of the distobuccal cusp, but there is no free apex
2. a faint cuspule with a free apex is present
3. a weak cusp is present
4. an intermediate cusp is present
5. the metacone is large, but slightly smaller than the hypocone
6. the metacone is equal in size to the hypocone

26 - hypocone

Synonymous terms
distolingual cusp, cusp 4

References
Hanihara et al. (1970), Scott (1979, 1980), Turner et al. (1991), Hunter & Jernvall (1995), Scott & Turner (1997)

Application
M^1, M^2, M^3

Definition
development of the distolingual cusp or cusp 4

Data recording system
ASU_DAS (Turner et al. 1991, Scott & Turner 1997)

Gradation
0. no hypocone
1. faint ridging present at the site
2. a faint cuspule with a free apex is present
3. a small cusp is present
4. an intermediate sized cusp is present
5. a large cusp is present
6. cusp is as large as cusps 1 and 2, maximum expression of the cusp

27 - metaconule

Synonymous terms
none, but according to some people confusion with distal accessory ridge or cusp 5 (trait 28)

References
Kanazawa et al. (1990), Turner et al. (1991), Alt (1997), Scott & Turner (1997), Alt et al. (1998)

Application
M^1, M^2, M^3

Definition
cusp on the oblique groove between the metacone and the hypocone

Data recording system
FU_DTS (Alt 1997, Alt et al. 1998)

Gradation
0. absence
1. presence

28 - distal accessory tubercle

Synonymous terms
cusp 5 and confusion with metaconule (trait 27) according to some people

References
Harris & Bailit (1980), Townsend et al. (1986), Kanasawa et al. (1990), Nichol (1990), Turner et al. (1991), Alt (1997), Scott & Turner (1997)

Application
M^1, M^2, M^3

Definition
a small fifth cusp nestling in the distal fovea between the metacone and the hypocone

Data recording system
ASU_DAS (Turner et al. 1991, Scott & Turner 1997)

Gradation
0. absence of the cusp
1. faint cuspule
2. trace cuspule
3. small cuspule
4. small cusp
5. medium-sized cusp present

29 - mesial paracone tubercle

Synonymous terms
none

References
Alt (1997), Alt et al. (1998)

Application
M^1, M^2, M^3

Definition
additional tubercle belonging to the *accessory tubercle complex* of the mesial border, between the paracone and the protocone, mesiobuccally located tubercle compared to the other tubercles

Data recording system
FU_DTS (Alt 1997, Alt et al. 1998)

Gradation
0. absence
1. presence

30 - mesial accessory tubercle

Synonymous terms
none

References
Alt (1997), Alt et al. (1998)

Application
M^1, M^2, M^3

Definition
additional tubercle belonging to the *accessory tubercle complex* of the mesial border, between the paracone and the protocone, mediomesially located tubercle compared to the other tubercles

Data recording system
FU_DTS (Alt 1997, Alt et al. 1998)

Gradation
0. absence
1. presence

31 - protoconule

Synonymous terms
none

References
Alt (1997), Alt et al. (1998)

Application
M^1, M^2, M^3

Definition
additional tubercle belonging to the *accessory tubercle complex* of the mesial border, between the paracone and the protocone, mesiolingually located tubercle compared to the other tubercles

Data recording system
FU_DTS (Alt 1997, Alt et al. 1998)

Gradation
0. absence
1. presence

32 - lingual paracone tubercle

Synonymous terms
none

References
Kanazawa et al. (1990), Alt (1997), Alt et al. (1998)

Application
M^1, M^2, M^3

Definition
additional tubercle located on the mesiobuccal cusp on mesiodistal position

Data recording system
FU_DTS (Alt 1997, Alt et al. 1998)

Gradation
0. absence
1. presence

33 - congenital absence

Synonymous terms
size reduction: peg-shaped, diminutive conical, triform, missing tooth: aplasia, agenesis

References
Brothwell et al. (1963), Suarez & Spence (1974), Turner et al. (1991), Alt (1997), Wang et al. (2000), Stephen et al. (2002), Kau et al. (2003), Fujiwara et al. (2000), Pirinen et al. (2001)

Application
I_1, P_2, M_3

Definition
a continuum from the reduction of the relevant tooth size to its congenital absence

Data recording system
ASU_DAS (Turner et al. 1991, Scott & Turner 1997)
merging of two ASU_DAS traits: peg-shaped tooth and congenital absence (relevant tooth is termed peg-shaped when its crown is small and barrel-shaped, lacking the normal crown morphology and congenital absence is non-formation of the relevant tooth)

Gradation
I1 and M3
0. tooth present, including any trace of an impacted tooth
1. incisor reduced in size but having a normal crown form
2. peg-shaped tooth as defined above
3. congenitally missing tooth
P2
0. tooth present, including any trace of an impacted tooth
3. congenitally missing tooth

34 - radical number

Synonymous terms
none

References
Turner (1967), Schulze (1987), Turner et al. (1991), Scott & Turner (1997)

Application
all teeth

Definition
the number of divisions (radicals) created by the developmental grooves, which may partition a root; the latter can be separated by these divisions or not

Data recording system
ASU_DAS (Turner et al. 1991, Scott & Turner 1997)

Gradation
1. one radical, no developmental grooves
2. two radicals: 2 developmental grooves and 1 root or 2 roots with no developmental grooves
3. three radicals, 3 developmental grooves and 1 root or 1 root with no developmental grooves and 1 root with 2 developmental grooves...
4. four radicals, as above
5. five radicals, as above
6. six radicals, as above
7. seven radicals, as above
8. eight radicals, as above

35 - radiculae appendiciformes

Synonymous terms
none

References
Schulze (1987), Alt (1997)

Application
I_1, I_2, C_-, P_1, P_2

Definition
small additional root - or radice- which is often located, but not always, close the junction of the roots

Data recording system
FU_DTS (Alt 1997, Alt et al. 1998)

Gradation
0. absence
1. presence

36 - canine root number

Synonymous terms
none

References
Alexandersen (1962), Turner (1967), Turner et al. (1991)

Application
C_-

Definition
canine root number

Data recording system
ASU_DAS (Turner et al. 1991, Scott & Turner 1997)

Gradation
1. one root, the tip may be bifid
2. two roots, separated for more than one-quarter of the length of the tooth

37 - Tomes root

Synonymous terms
none

References
Turner et al. (1991)

Application
P_1

Definition
degree of grooving of the root surfaces, from a single to a double-rooted tooth

Data recording system
ASU_DAS (Turner et al. 1991, Scott & Turner 1997)

Gradation
0. developmental grooving is absent, or if grooving is present shallow
1. developmental grooving is present and has a shallow V-shaped cross-section
2. developmental grooving is present and has a moderately deep V-shaped cross-section
3. developmental grooving is present and has a deep V-shaped cross-section
4. developmental grooving is deeply invaginated on both the mesial and distal borders
5. 2 free roots separate for at least one-fourth to one-third

38 - molar root number

Synonymous terms
none

References
Turner (1967), Turner et al. (1991), Scott & Turner (1997)

Application
M_1, M_2, M_3

Definition
molar root number

Data recording system
ASU_DAS (Turner et al. 1991, Scott & Turner 1997)
inclusion of the pyramidalism trait – root in the form of a single cone – in the first grade

Gradation
1. one root, with possible bifid tip and deep developmental grooves
2. two roots, each separate root must be greater than one-quarter to one-third of total root length
3. three roots, as above

39 - radix Citroen

Synonymous terms
none

References
Schulze (1987), Alt (1997), Carlsen & Alexandersen (2000)

Application
M_1, M_2, M_3

Definition
mesiolingual additional root connected to the presence of the Citroen tubercle

Data recording system
FU_DTS (Alt 1997, Alt et al. 1998)

Gradation
0. absence
1. presence

40 - radix paramolaris

Synonymous terms
radix praemolarica

References
Schulze (1987), Alt (1997), Carlsen & Alexandersen (1999)

Application
M_1, M_2, M_3

Definition
mesiobuccal additional root

Data recording system
FU_DTS (Alt 1997, Alt et al. 1998)

Gradation
0. absence
1. presence

41 - radix entomolaris

Synonymous terms
three-rooted lower molars

References
Schulze (1987), Alt (1997), Carlsen & Alexandersen (2000)

Application
M_1, M_2, M_3

Definition
distolingual additional root

Data recording system
FU_DTS (Alt 1997, Alt et al. 1998)

Gradation
0. absence
1. presence

42 - idiopathische radices

Synonymous terms
none

References
Schulze (1987), Alt (1997), Alt et al. (1998)

Application
M_1, M_2, M_3

Definition
additional root located neither mesiobucally (radix paramolaris position), neither mesiolingually (radix Citroen position) nor distolingually (radix entomolaris position)

Data recording system
FU_DTS (Alt 1997, Alt et al. 1998)

Gradation
0. absence
1. presence

43 - shoveling

Synonymous terms
shovel-shaped incisors

References
Lee & Goose (1972), Blanco & Chakraborty (1977), Berry (1978), Turner (1967), Harris (1980), Nichol (1989), Turner et al. (1991), Alt (1997), Scott & Turner (1997)

Application
I_1, I_2

Definition
development of lingual marginal ridges

Data recording system
ASU_DAS (Turner et al. 1991, Scott & Turner 1997)

Gradation
0. none: the lingual surface is essentially flat
1. faint: very slight marginal ridges
2. trace: slight marginal ridges can be easily seen
3. semishovel: the ridging is stronger

44 - double shoveling

Synonymous terms
labial marginal ridges

References
Snyder (1960), Turner (1970), Turner et al. (1991), Alt (1997), Scott & Turner (1997)

Application
I_1, I_2

Definition
development of buccal marginal ridges

Data recording system
ASU_DAS (Turner et al. 1991, Scott & Turner 1997)

Gradation
0. none: buccal surface is smooth
1. faint: mesial and distal ridges can be seen in strong contrasting light
2. trace: ridging is more easily seen and palpated
3. semi double-shovel: ridging can be readily palpated
4. double-shovel: ridging is pronounced on at least one-half of the total crown height
5. pronounced double-shovel: ridging is very prominent
6. extreme double-shovel

45 - distal accessory ridge

Synonymous terms
none

References
Morris (1970), Scott (1975, 1977), Turner et al. (1991), Alt (1997), Scott & Turner (1997)

Application
C-

Definition
accessory ridge occurring in the distolingual fossa between the tooth apex and the distolingual marginal ridge

Data recording system
ASU_DAS (Turner et al. 1991, Scott & Turner 1997)

Gradation
0. trait absent
1. very faint distal accessory ridge visible in strong contrasting light
2. weakly developed, narrow accessory ridge
3. moderately developed accessory ridge
4. strongly developed accessory ridge
5. very pronounced accessory ridge

46 - odontome

Synonymous terms
tuberculated premolars, occlusal tubercle, premolar central cusp

References
Reichart & Tantiniran (1975), Schulze (1987), Turner et al. (1991), Alt (1997), Scott & Turner (1997)

Application
P_1, P_2

Definition
any pin-sized, spike-shaped enamel and dentine projection occurring on the occlusal surface, occurring mostly in or near the sagittal sulcus

Data recording system
ASU_DAS (Turner et al. 1991, Scott & Turner 1997)

Gradation
0. absence
1. presence

47 - lingual cusp variations

Synonymous terms
none

References
Kraus & Furr (1953), Ludwig (1957), Scott (1975), Turner et al. (1991), Scott & Turner (1997)

Application
P_1, P_2

Definition
development and relative size of the lingual cusp(s)

Data recording system
ASU_DAS (Turner et al. 1991, Scott & Turner 1997)

Gradation
0. no lingual cusp, possibly with a ridge present
1. one lingual cusp
2. two lingual cusps, the mesial cusp being much larger than the distal
3. two lingual cusps, the mesial cusp being slightly larger than the distal
4. two lingual cusps, the mesial cusp being equal in size to the distal
5. two lingual cusps, the mesial cusp being slightly smaller than the distal
6. two lingual cusps, the mesial cusp being much smaller than the distal
7. two lingual cusps, the mesial cusp being very much smaller than the distal
8. three lingual cusps, of the same size
9. three lingual cusps, the mesial cusp being larger than the medial and/or the distal

48 - deflecting wrinkle

Synonymous terms
none

References
Weidenreich (1937), Morris (1970), Axelsson & Kiverskari (1982), Turner et al. (1991), Scott & Turner (1997)

Application
M_1

Definition
a fold in the distal side of the mesiolingual cusp, giving it a pronounced L shape in occlusal view

Data recording system
ASU_DAS (Turner et al. 1991, Scott & Turner 1997)

Gradation
0. absence of the trait
1. the medial ridge of cusp 2 is straight but shows a midpoint constriction
2. the medial ridge is deflected distally
3. the medial ridge is deflected distally forming an L-shaped ridge, the medial ridge contacts cusp 4

49 - anterior fovea

Synonymous terms
precuspidal fossa

References
Hrdlickà (1924), Turner et al. (1991), Wu & Turner (1993)

Application
M_1

Definition
a pit or groove occurring on the anterior occlusal surface, between cusps 1 and 2

Data recording system
ASU_DAS (Turner et al. 1991, Scott & Turner 1997)

Gradation
0. anterior fovea absent, uninterrupted sulcus
1. a weak ridge connects the mesial aspects of cusps 1 and 2, producing a faint groove
2. deeper groove
3. even deeper groove
4. long groove and marked mesial ridge

50 - mid trigonid crest

Synonymous terms
none

References
Wu & Turner (1993), Turner et al. (1991)

Application
M_1, M_2, M_3

Definition
a low enamel ridge occurring connects the middle portions of the mesial cusps (cusps 1 and 2)

Data recording system
ASU_DAS (Turner et al. 1991, Scott & Turner 1997)
the system defines a scale with two sub-phases (phases 1A and 1B), this trait is here recorded on a presence/absence basis

Gradation
0. absence
1. presence

51 - distal trigonid crest

Synonymous terms
none

References
Hrdlickà (1924), Weidenreich (1937), Hanihara (1961), Turner et al. (1991), Scott & Turner (1997)

Application
M_1, M_2, M_3

Definition
a low enamel ridge occurring connects the distal portions of the mesial cusps (cusps 1 and 2)

Data recording system
ASU_DAS (Turner et al. 1991, Scott & Turner 1997)

Gradation
0. absence
1. presence

52 - cusp number

Synonymous terms
none

References
Gregory (1916), Dahlberg (1961), Turner (1967), Sofaer et al. (1972), Lee & Goose (1972), Perzigian (1976), Nichol (1989), Scott & Turner (1997)

Application
M_1, M_2, M_3

Definition
lower molar cusp number (1 to 6 only)

Data recording system
ASU_DAS (Turner et al. 1991, Scott & Turner 1997)

Gradation
4. cusps 1 to 4 are present
5. cusp 5 (distobuccal) is also present
6. cusp 6 (lingual to the distobuccal cusp) is also present

53 - groove pattern

Synonymous terms
fissure pattern, Dryopithecus pattern (Y expression)

References
Gregory (1916), Jørgensen (1956), Suzuki & Sakai (1956), Garn et al. (1966a), Nichol (1989), Turner et al. (1991), Scott & Turner (1997)

Application
M_1, M_2, M_3

Definition
pattern drawn by the sulci linking the cusps

Data recording system
ASU_DAS (Turner et al. 1991, Scott & Turner 1997)

Gradation
Y. cusps 2 (mesiolingual) and 3 (centrobuccal) are in contact, forming a Y-shape when the occlusal surface is viewed with its lingual edge lower-most
+. cusps 1, 2, 3, 4 are in contact at a point in the centre of the occlusal surface
X. cusps 1 (mesiobuccal) and 4 (distolingual) are in contact, forming an X-shape when the occlusal surface is viewed with its lingual edge lower-most

54 - protostylid

Synonymous terms
paramolar cusp or tubercle, buccal pit, *foramen caecum* (for grade 1), tubercle of Bolk

References
Suzuki & Sakai (1954), Dahlberg (1945, 1947, 1950, 1956, 1963a), Turner (1967), Scott (1975, 1978), Berry (1976), Turner et al. (1991), Mayhall (1992), Scott & Turner (1997)

Application
M_1, M_2, M_3

Definition
a continuum of paramolar features (from a pit to a well developed tubercle) that can be found on the buccal surface of cusp 1 (mesiobuccal cusp), similar in its different expressions to the parastyle

Data recording system
ASU_DAS (Turner et al. 1991, Scott & Turner 1997)

Gradation
0. no expression, the buccal surface is smooth
1. a pit occurs in the buccal groove
2. the buccal groove is curved distally
3. a faint secondary groove extends mesially from the buccal groove

4. the secondary groove is slightly more pronounced
5. the secondary groove is stronger and can be easily seen
6. the secondary groove extends across most of the buccal surface of cusp 1
7. a cusp with a free apex occurs

55 - hypoconulid

Synonymous terms
cusp 5, distobuccal cusp

References
Turner et al. (1991), Scott & Turner (1997)

Application
M_1, M_2, M_3

Definition
hypoconulid or cusp 5 is situated on the distal occlusal aspect of the lower molars, between cusps 3 and 4, respectively hypoconid and entoconid

Data recording system
ASU_DAS (Turner et al. 1991, Scott & Turner 1997)

Gradation
0. no expression of cusp 5
1. cusp 5 is very small
2. cusp 5 is small
3. cusp 5 is medium-sized
4. cusp 5 is large
5. cusp 5 is very large, as large as the other cusps

56 - entoconulid

Synonymous terms
cusp 6, *tuberculum sextum*, *tuberculum accessorium posteriore internum*

References
Turner (1969), Turner et al. (1991), Townsend et al. (1990), Mayhall (1992), Scott & Turner (1997)

Application
M_1, M_2, M_3

Definition
entoconulid or cusp 6 occurring in the distal fovea of the lower molars, lingual to cusp 5, and is scored relative to the size of cusp 5

Data recording system
ASU_DAS (Turner et al. 1991, Scott & Turner 1997)

Gradation
0. cusp 6 is absent
1. cusp 6 is much smaller than cusp 5
2. cusp 6 is smaller than cusp 5
3. cusp 6 is equal in size to cusp 5
4. cusp 6 is larger than cusp 5
5. cusp 6 is much larger than cusp 5

57 - metaconulid

Synonymous terms
cusp 7, *tuberculum intermedium*, *tuberculum accessorium mediale internum*

References
Turner (1969), Turner (1970), Hanihara (1976), Axelsson & Kirveskari (1982), Nichol (1989), Scott et al. (1983), Turner et al. (1991), Mayhall (1992), Scott & Turner (1997)

Application
M_1, M_2, M_3

Definition
metaconulid or cusp 7 occurring in the lingual groove of the crown, between cusps 2 and 4, respectively entoconid and metaconid

Data recording system
ASU_DAS (Turner et al. 1991, Scott & Turner 1997)
the system identifies a scale in four phases: from microforms corresponding to phase 1, subdivided into two phases (1A and 1B), to the development of an entirely separate cusp (phase 4), the option here is a simplified recording without subdivision of the first phase, but a continuous gradation using the same ASU-DAS definitions (phases 1 to 5)

Gradation
0. absence of cusp 7
1. a faint cusp is present, with two lingual grooves present
2. a faint cusp 7 is expressed as a bulge on the lingual surface of cusp 2
3. cusp 7 is more marked, but small
4. cusp 7 is medium sized
5. cusp 7 is large

58 - tuberculum paracone

Synonymous terms
none

References
Alt (1997), Alt et al. (1998)

Application
M_1, M_2, M_3

Definition
centromesial tubercle sited in the mesial marginal crest area between the mesiobuccal cusp (protoconid) and the mesiolingual cusp (metaconid)

Data recording system
FU_DTS (Alt 1997, Alt et al. 1998)

Gradation
0. absence
1. presence

59 - tuberculum Citroen

Synonymous terms
metastylid, mandibular Carabelli's trait

References
Alt (1997), Alt et al. (1998)

Application
M_1, M_2, M_3

Definition
tubercle placed on the lingual side of the metaconid (mesiolingual cusp)

Data recording system
FU_DTS (Alt 1997, Alt et al. 1998)
this system suggests a four-grading graduation (from micro expressions to well-developed tubercle), this trait is here recorded on a presence/absence basis

Gradation
0. absence
1. presence