LIMB BONES

Some new measurements (for example several distal articular diameters introduced for the humerus) will no doubt prove interesting. Many readers will probably also find useful the illustrations of carpal and tarsal bones and of their mutual relations, as well as lists of their different names.

Some changes would be completely neutral if they did not hinder the use of "similar" but not "exactly identical" data. Such are the replacements, for the metapodials, of diameters taken on the lateral condyles by diameters taken on the medial condyles. Or the replacement of lateral lengths by medial lengths (in the original system, lateral lengths were chosen because they are easier to measure on mounted skeletons). For some of us, these replacements actually amount to the introduction of new measurements, because it would be senseless to stop gathering data in the same way as they were collected for years and years.

A special problem arises for the phalanges of the central digit. Obviously, anterior and posterior phalanges should be measured separately. In *Equus*, the discrimination between fore and hind phalanges can usually be done (Prat, 1957), at least in the case of first phalanges (Eisenmann & De Giuli, 1974b; Dive & Eisenmann, in press). But no equivalent studies have yet been conducted on hipparions so that we do not know if the measurements used for the discrimination in *Equus* will be of any use in *Hipparion*. They are figured in the system, however, since the methodology is intended for the bones of both genera.

Not all the bones of the posteranial skeleton are considered in this paper. The pelvis is usually broken so that only one measurement (articular) is proposed here. The vertebrae are completely omitted, and no measurements are proposed for the small carpals and tarsals. We suggest that people who need study these bones take the measurements proposed by von den Driesch (1976) for the pelvis and the vertebrae, and by Gromova (1952) for the small carpals and tarsals.

FIGURE 11: SCAPULA AND PELVIS

A. Scapula: Lateral view
B. Scapula: Cross section at the highest point of the spina
C. Scapula: Distal view
D. Peluis: Lateral view

SCAPULA

PRESENT PAPER	VE	AVD
1. Maximal length: measured parallel to the spina	5	DHA
2. Minimal breadth at the neck	4	SLC
3. Maximal breadth of the articular process	3	GLP
4. Articular maximal breadth	1	LG
5. Articular maximal depth (this measurement is usually not at right angle with the latter)	2	BG
6. Maximal depth of the spina: to be taken with a compass because of the concavity of the scapula; alternatively, a calliper may be used if an object of known thickness, (about 2 cm) is put between the measured point on the concave face of the scapula and the end of the calliper.	-	-

See also von den Driesch, 1976, p. 75.

PELVIS

PRESENT PAPER	VE	AVD
1. Diameter of acetabulum	1	LAR

See also van den Driesch, 1976, p. 83.

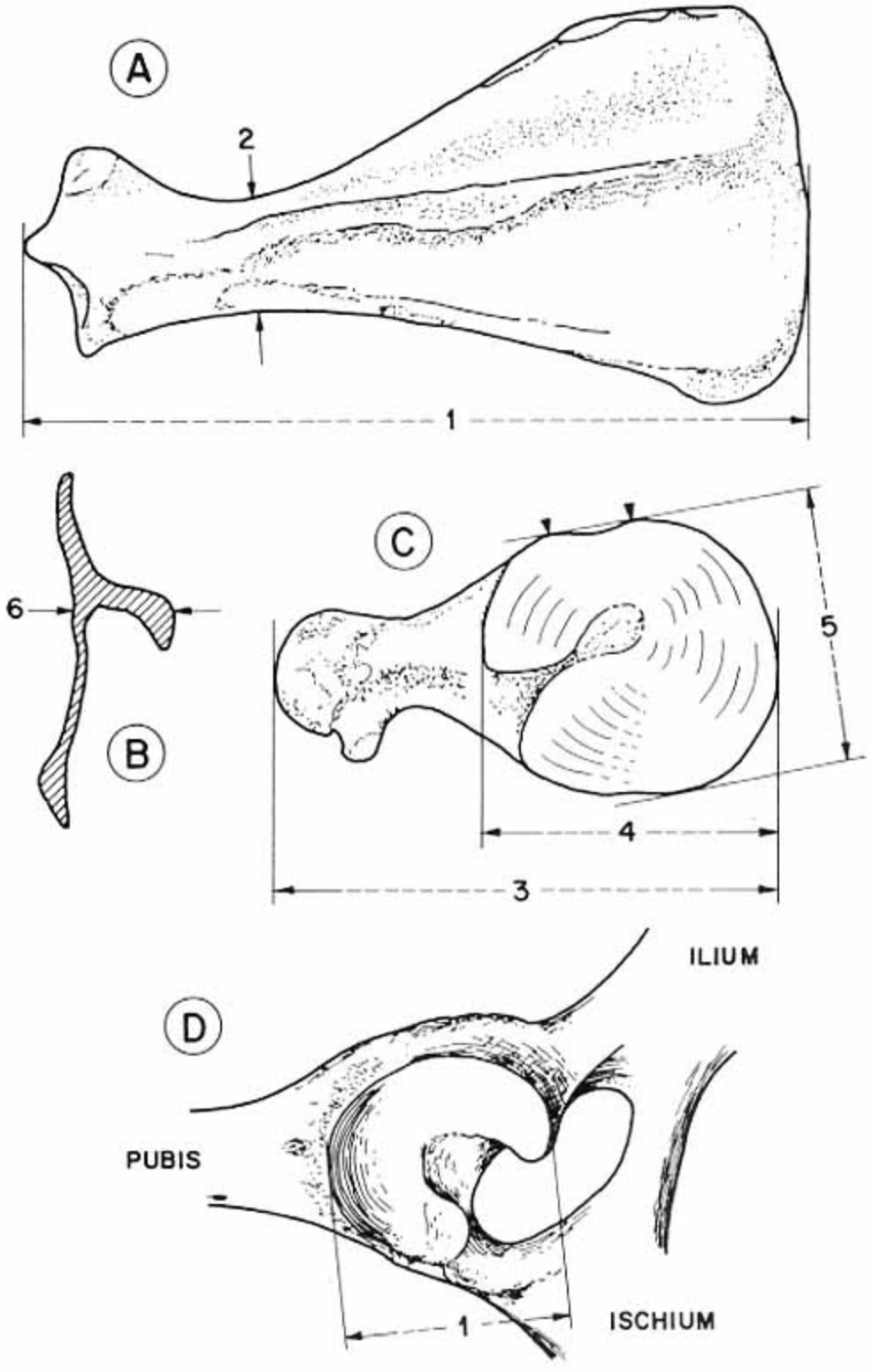

A
2
1
6
B
C
5
4
3
D
ILIUM
PUBIS
1
ISCHIUM

FIGURE 12: HUMERUS

A: Proximal view
B: Anterior view
C: Medial view
D: Cross section at the level of arrows 3 and 4

PRESENT PAPER	VE	AVD
1. Maximal length	1	GL
2. Maximal length from caput	2	GLC
3. Minimal breadth (oblique)	3	SD
4. Diameter perpendicular to, and at the level of 3	-	-
5. Proximal maximal breadth	4	Bp
6. Proximal depth at the level of the median tubercule	5	-
7. Maximal breadth of the trochlea	6	BT
8. Distal maximal depth	7	-
9. Maximal trochlear height (medial)	-	-
10. Minimal trochlear height (in the middle)	8	-
11. Trochlear height at the sagittal crest (near the condyle)	-	-

See also von den Driesch, 1976, p. 77.

Although not adopted by the New York Conference, a 12th measurement may be interesting: that of the length of the deltoid crest, taken from the proximal articular surface on the lateral side of the bone, to the (more or less defined) distal end of the crest. This measure cannot be precise but it seems nevertheless to differ from one species of *Equus* to another (V.E.).

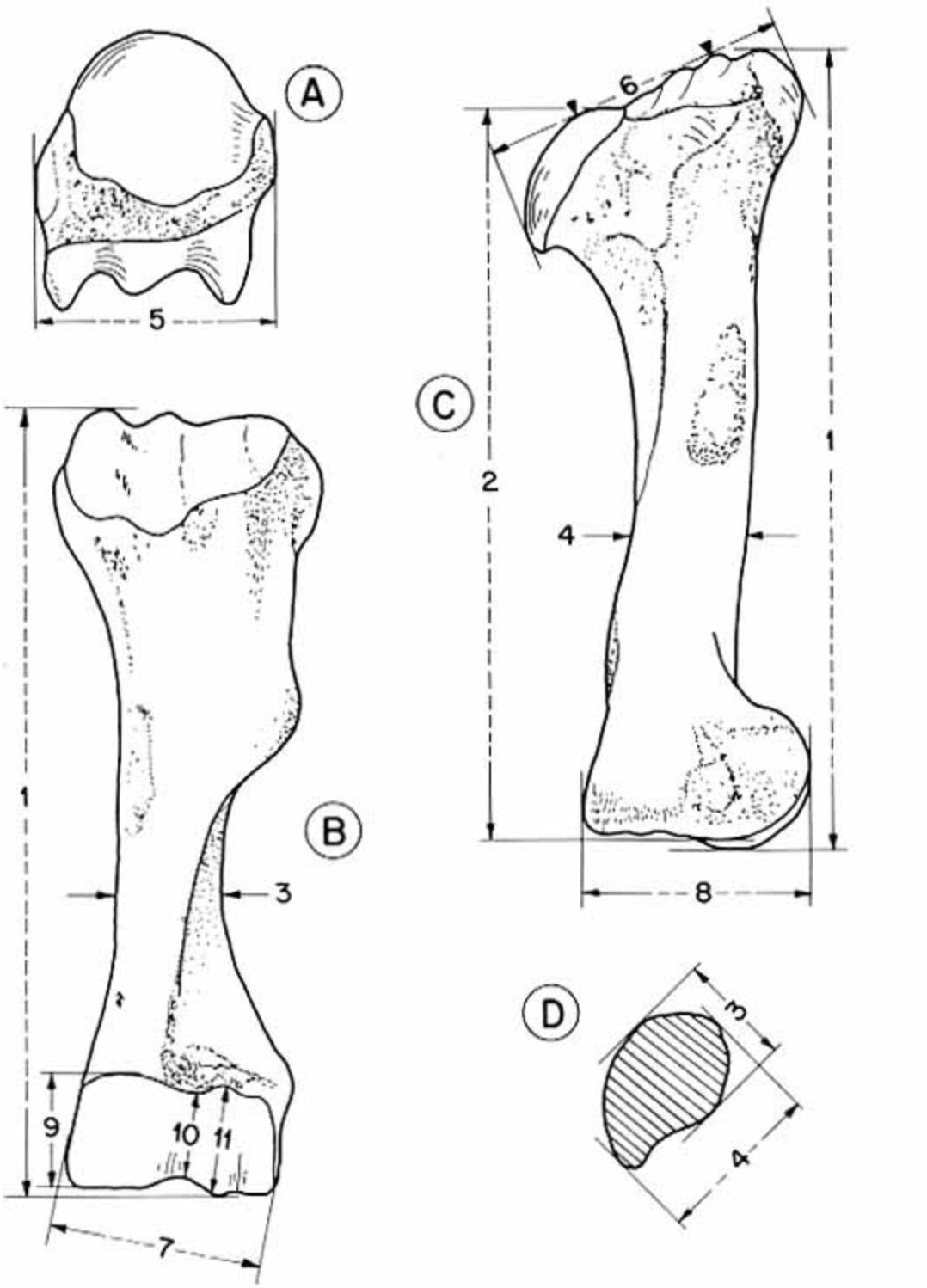

A
5
B
1
3
9
10
11
7
C
6
2
4
1
8
D
3
4

FIGURE 13: RADIUS

A: Proximal view
B: Anterior view
C: Lateral view
D: Distal view

PRESENT PAPER	VE	AVD
1. Maximal length	1	GL
2. Medial length	*	*
3. Minimal breadth	3	SD
4. Depth of diaphysis at level of 3	-	-
5. Proximal articular breadth	5	BFp
6. Proximal articular depth	6	-
7. Proximal maximal breadth	4	Bp
8. Distal articular breadth	8	BFd
9. Distal articular depth	9	-
10. Distal maximal breadth	7	Bd
11. Breadth of the radial condyle	10	-
12. Breadth of the ulnar condyle	11	-
*. Lateral length	2	LI

See also von den Driesch, 1976, p. 79.

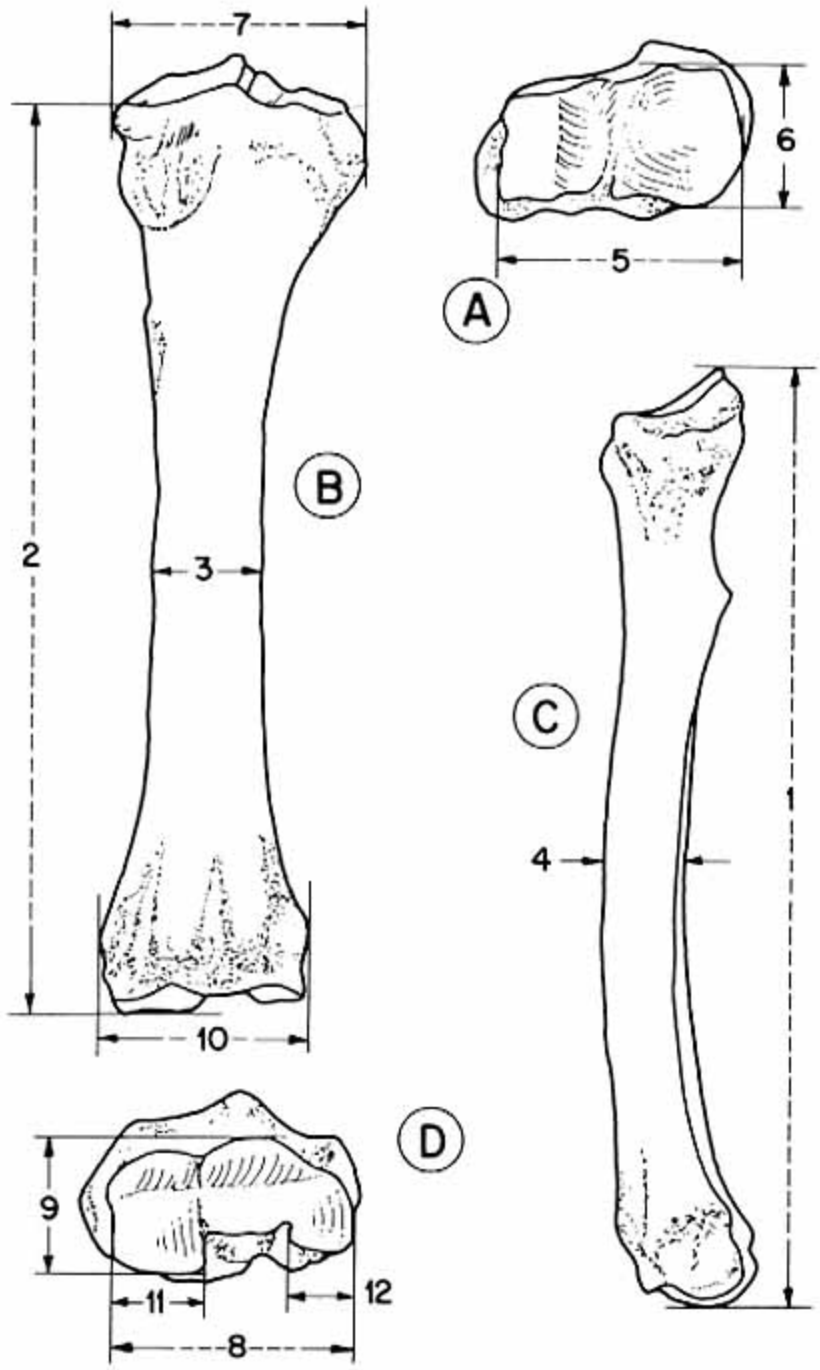
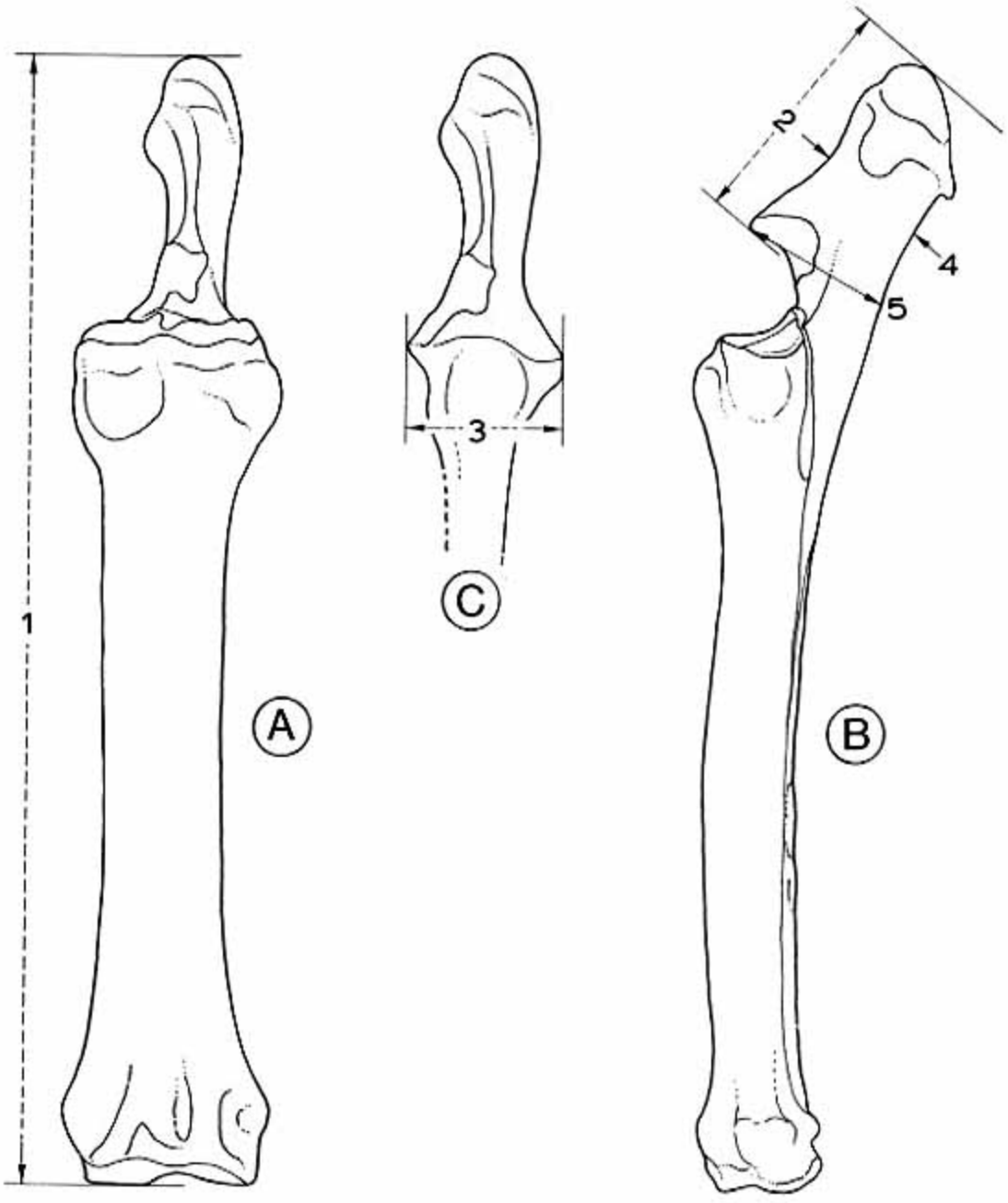

7
2
3
10
B
A
6
5
C
1
4
D
9
11
12
8

FIGURE 14: ULNA

A. Anterior view
B. Lateral view
C. Proximal end, anterior view

PRESENT PAPER	AVD
1. Maximal length	GL
2. Length of the olecranon	LO
3. Maximal articular breadth	BPC
4. Minimal depth of the olecranon	SDO
5. Depth across the Processus anconaeus	DPA

After von den Driesch (1976, p. 79-81).


1
A
3
C
2
4
5
B

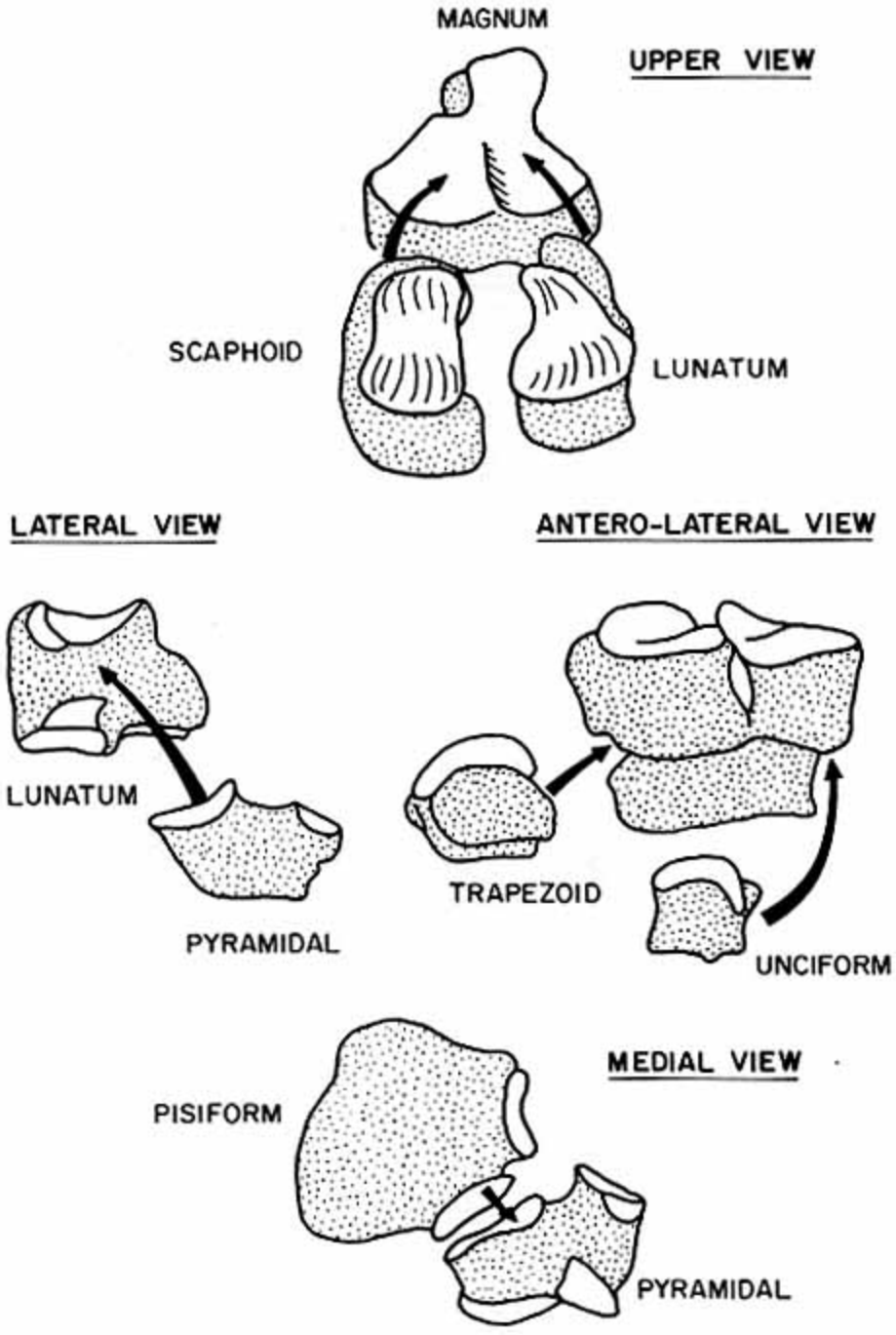
FIGURES 15, 16, 17: CARPUS

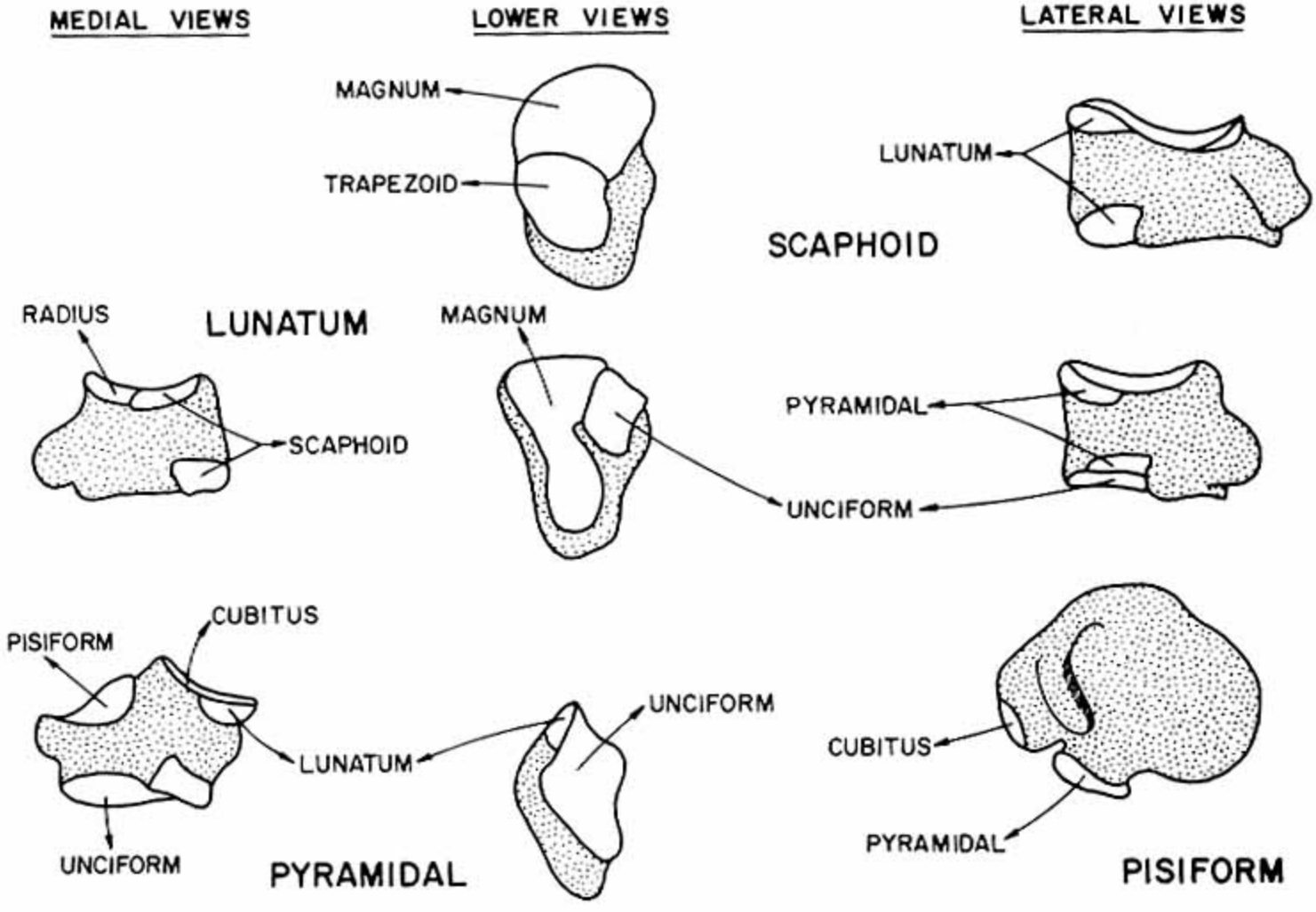
The International New York Equid Conference did not recommend definite measurements for the carpals but wished that they be illustrated to show their place inside the carpus as a whole, and the function of their articular facets (see figures 16 and 17).

Since some carpal bones may be differently named, we give here a list of synonyms. We note also to which measure of the central metacarpal (MC III) they correspond.

Fig. 16: First row of Carpals
- Radial = Scaphoid = os carpale radiale
- Intermedium = Lunatum = Semilunaire = os carpi intermedium
- Ulnar = Triquetrum = Pyramidal = os carpi ulnare
- Pisiform = os carpi accessorium

Fig. 17: Second row of Carpals
- First carpal = Trapezium
- Second carpal = Trapezoid (MC III, 9)
- Third carpal = Magnum = capitatum (MC III, 7)
- Fourth carpal = Unciform = hamatum (MC III, 8 and 16)


MAGNUM
UPPER VIEW
SCAPHOID
LUNATUM
LATERAL VIEW
ANTERO-LATERAL VIEW
LUNATUM
PYRAMIDAL
TRAPEZOID
UNCIFORM
MEDIAL VIEW
PISIFORM
PYRAMIDAL


MEDIAL VIEWS
LOWER VIEWS
LATERAL VIEWS
MAGNUM
TRAPEZOID
LUNATUM
SCAPHOID
RADIUS
LUNATUM
SCAPHOID
MAGNUM
PYRAMIDAL
UNCIFORM
PISIFORM
CUBITUS
LUNATUM
UNCIFORM
PYRAMIDAL
UNCIFORM
CUBITUS
PYRAMIDAL
PISIFORM

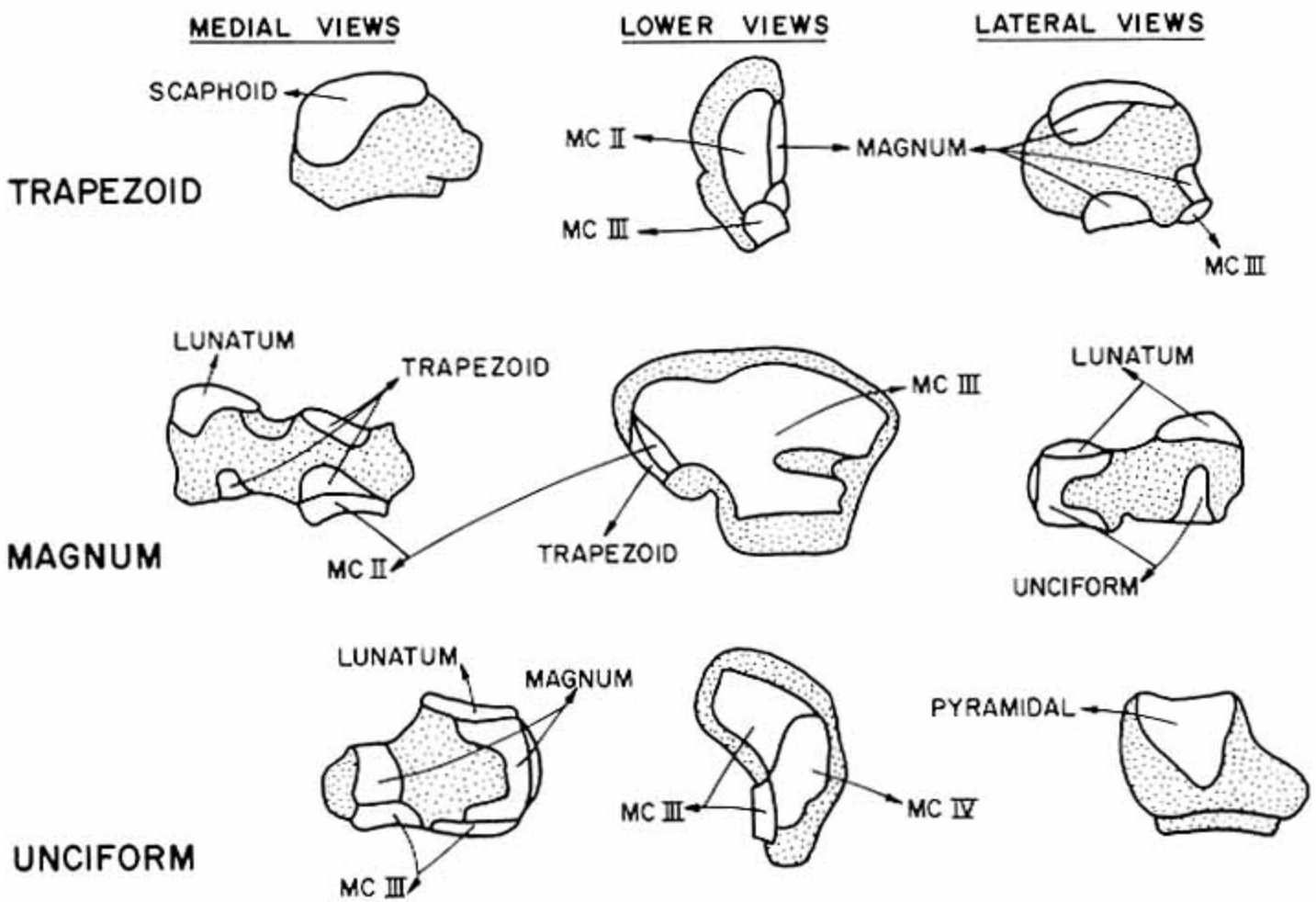

MEDIAL VIEWS
LOWER VIEWS
LATERAL VIEWS
TRAPEZOID
SCAPHOID
MC II
MC III
MAGNUM
MC III
MAGNUM
LUNATUM
TRAPEZOID
MC II
TRAPEZOID
MC III
LUNATUM
UNCIFORM
UNCIFORM
LUNATUM
MAGNUM
MC III
MC III
MC IV
PYRAMIDAL

FIGURE 18: THIRD METACARPAL

A. *Equus*: Proximal view
B. *Equus*: Anterior view
C. *Equus*: Lateral view
D. *Equus*: Distal view
E. *Hipparion*: Proximal view
F. *Hipparion*: Posterior view

PRESENT PAPER	VE	AVD
1. Maximal length	1	GL
2. Medial length	*	*
3. Minimal breadth (near the middle of the bone)	3	SD
4. Depth of the diaphysis at level of 3	4	-
5. Proximal articular breadth	5	Bp
6. Proximal articular depth	6	-
7. Maximal diameter of the articular facet for the third carpal	7	-
8. Diameter of the anterior facet for the fourth carpal	8	-
9. Diameter of the articular facet for the second carpal	9	-
10. Distal maximal supra-articular breadth	10	**
11. Distal maximal articular breadth	11	**
12. Distal maximal depth of the keel	12	Dd
13. Distal minimal depth of the lateral condyle	***	-
14. Distal maximal depth of the medial condyle	14	-
15. Angle measuring the dorso-volar development of the keel (this character may be studied by projecting the outline of the keel on a sheet of paper, finding the center of this nearly circular outline, and measuring the corresponding angle from that center)	-	-
16. Diameter of the posterior facet for the fourth carpal	8'	-
*. Lateral length	2	Ll
**. Distal maximal breadth	10 or 11	
***. Distal minimal depth of the medial condyle	13	-

See also von den Driesch, 1976, p. 93.

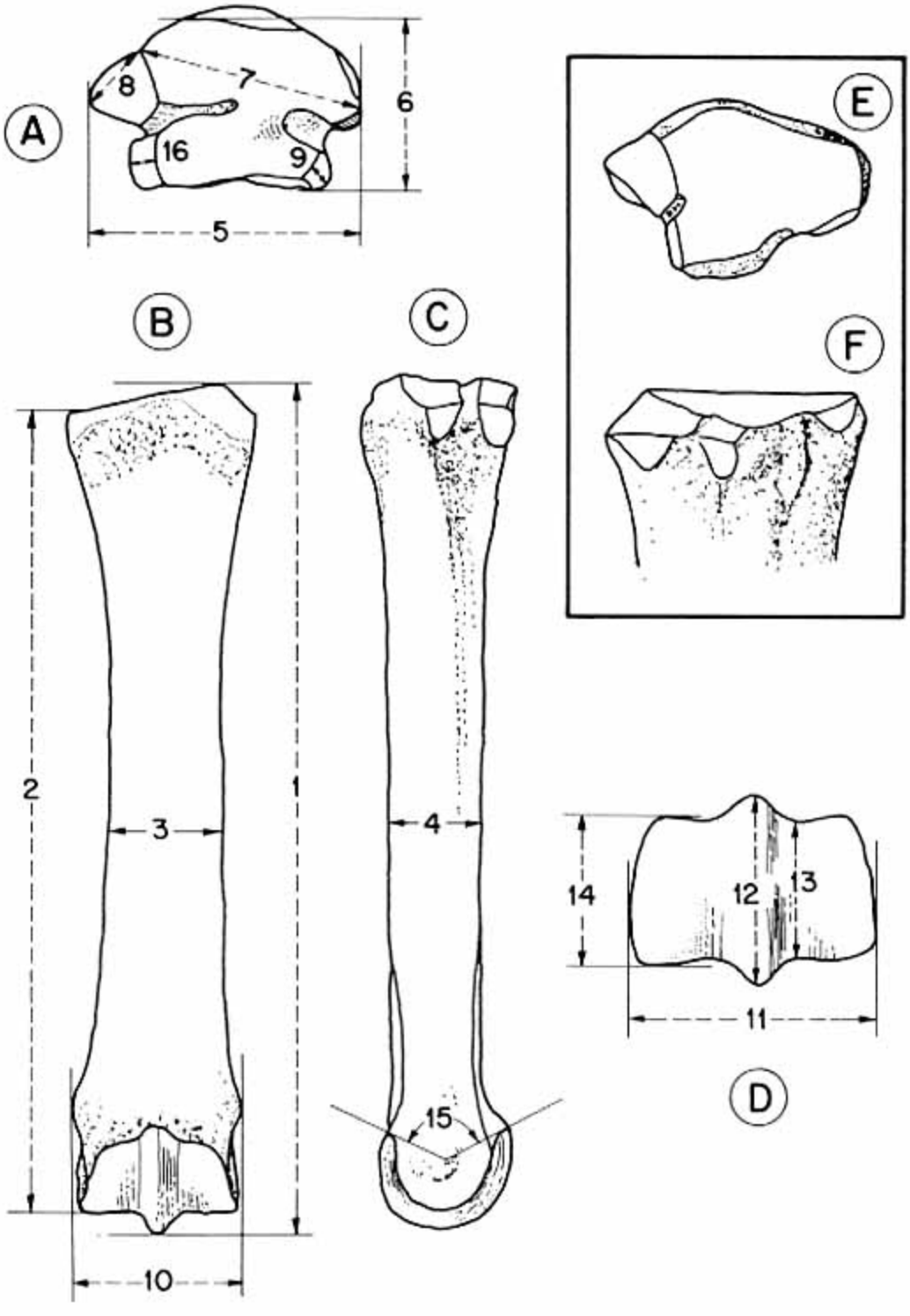

A
8
7
6
16
9
5
B
C
E
F
2
1
3
4
14
12
13
11
D
15
10

FIGURE 19: FEMUR

A. Lateral view
B. Anterior view
C. Cross secton at level of arrows 3 and 4
D. Distal view
E. Medial view

PRESENT PAPER	VE	AVD
1. Maximal length	1	GL
2. Length from caput femoris to lateral condyle	*	*
3. Minimal breadth (oblique)	3	SD
4. Diameter perpendicular to, and at the level of 3	-	-
5. Proximal maximal breadth	4	Bp
6. Proximal maximal depth	5	-
7. Distal maximal breadth	7	Bd
8. Distal maximal depth (not at right angle with the long axis of the bone)	9	-
9. Maximal breadth of the trochlea	8	-
10. Maximal depth of caput femoris	6	DC
*. Medial length from caput femoris to medial condyle	2	GLC

See also von den Driesch, 1976, p. 85.

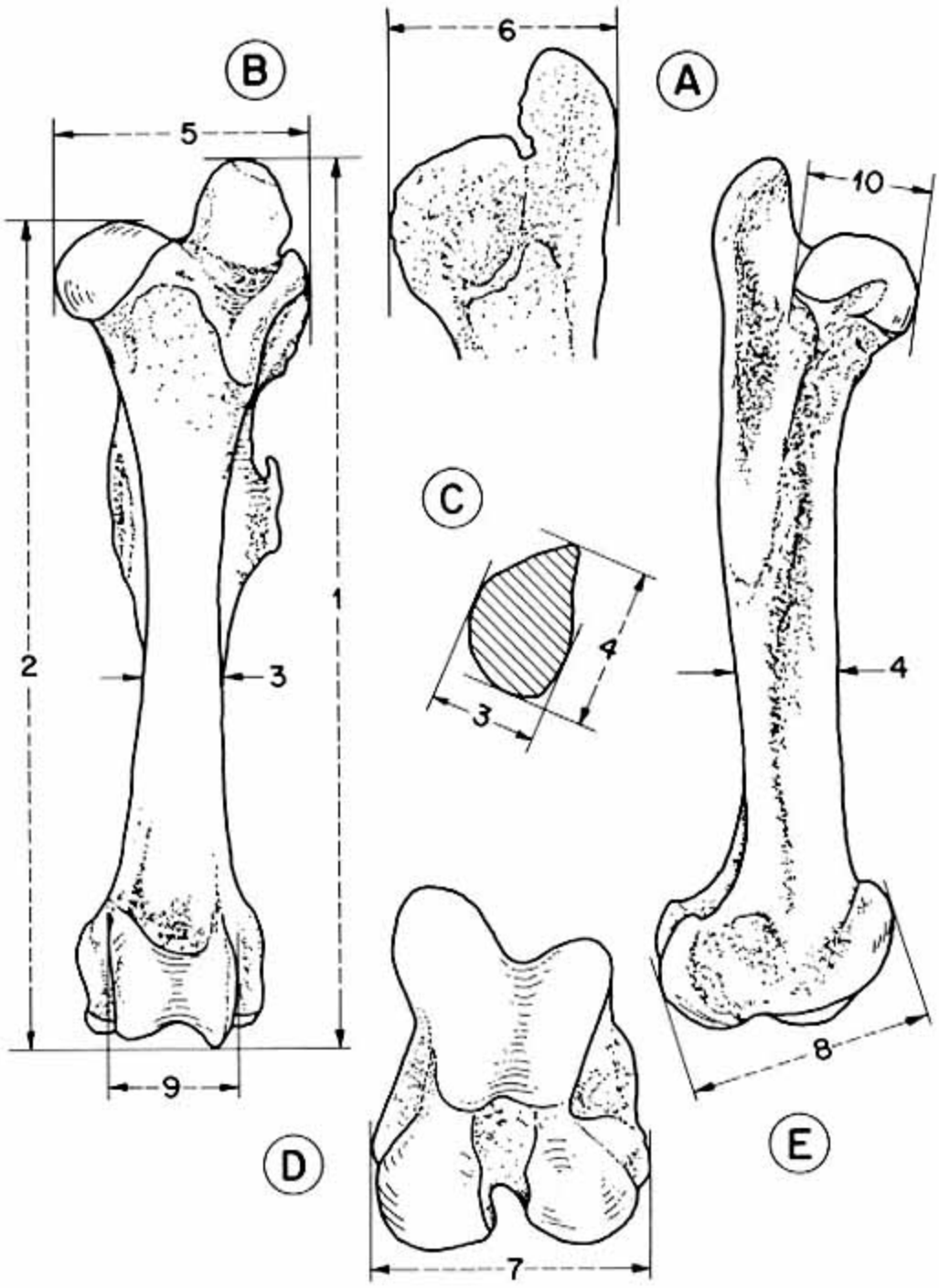
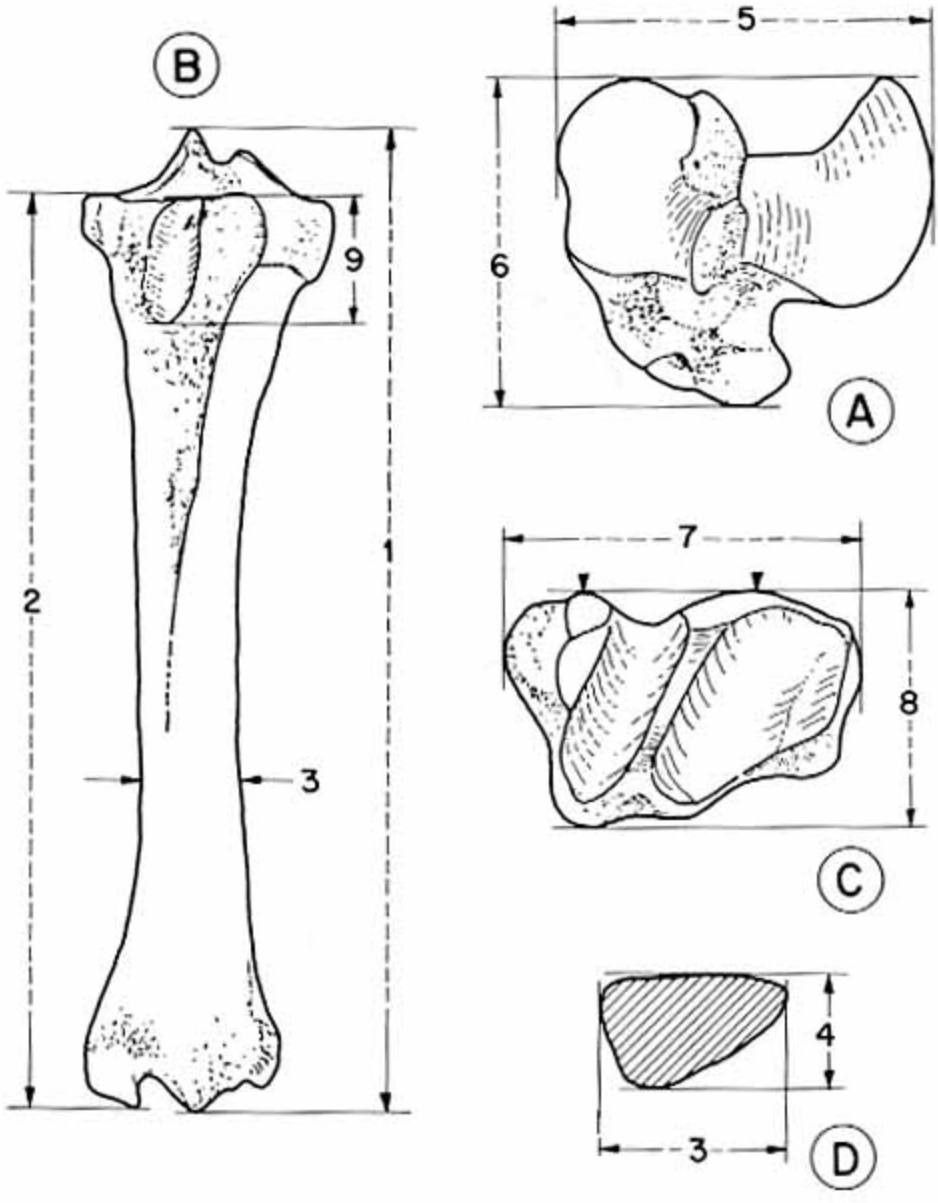

B
5
1
2
3
9
D
6
A
10
C
4
3
4
8
E
7

FIGURE 20: TIBIA

A. Proximal view
B. Anterior view
C. Distal view
D. Cross section at level of arrow 3

PRESENT PAPER	VE	AVD
1. Maximal length	1	GL
2. Medial length	*	**
3. Minimal breadth	3	SD
4. Minimal depth of the diaphysis (more or less at the level of 3)	4	-
5. Proximal maximal breadth	5	Bp
6. Proximal maximal depth	6	-
7. Distal maximal breadth	8	Bd
8. Distal maximal depth	7	Dd
9. Length of the fossa digitalis (this measure is not precise. Proximally, the caliper should touch the highest points of both bordering crests; distally, the calliper should touch the middle of the crest ending the fossa digitalis)	9	-
*. Paralateral length from the proximal lateral condyle to the same distal point as in 1	2	3
**. True lateral length, on the lateral side of the bone	-	Ll

See also von den Driesch (1976, p. 85).


B
9
1
2
3
5
6
A
7
8
C
4
3
D

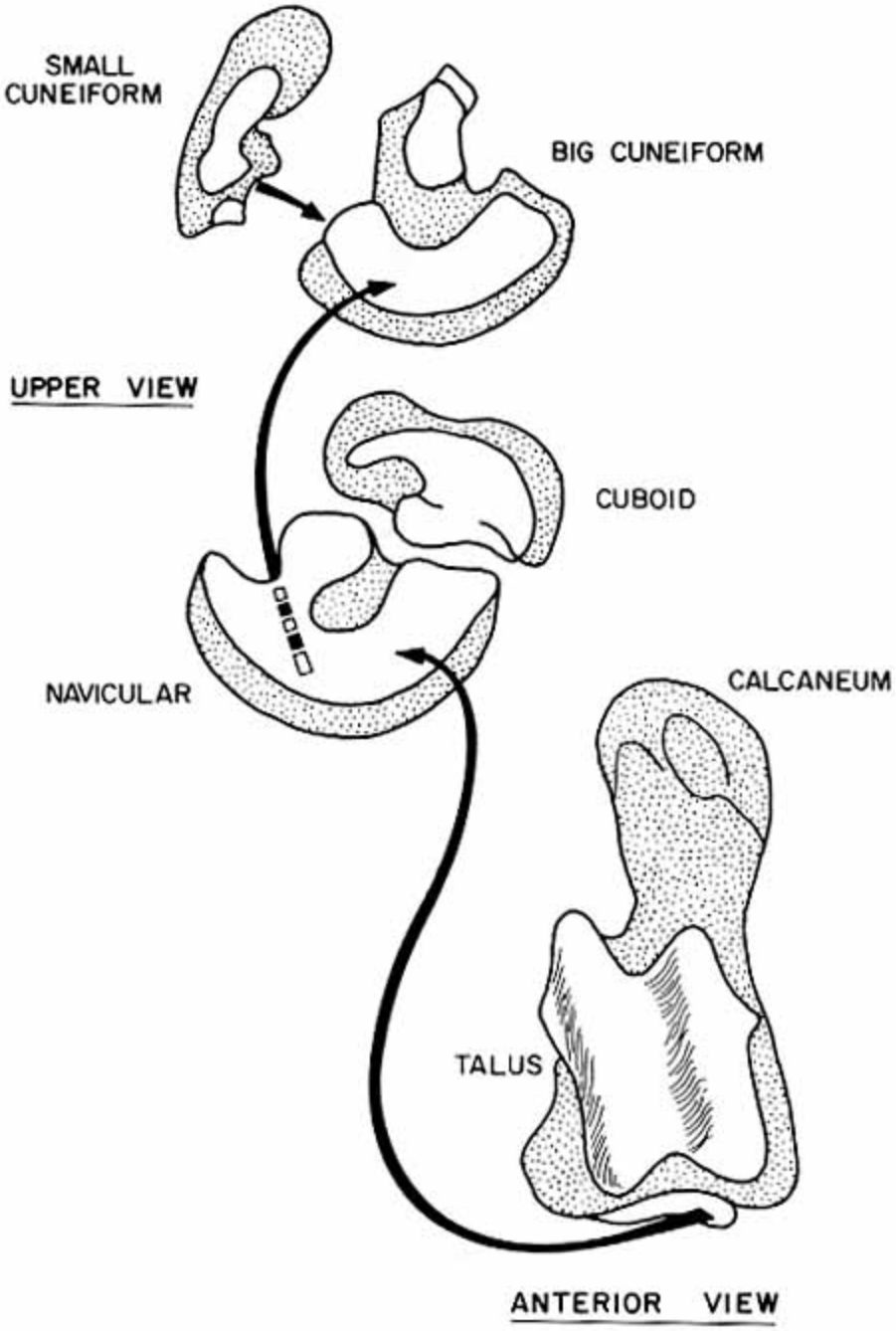


FIGURE 21: TARSUS

General structure.

See next pages for calcaneus (fig. 22), talus (fig. 23) and other tarsal bones (fig. 24)

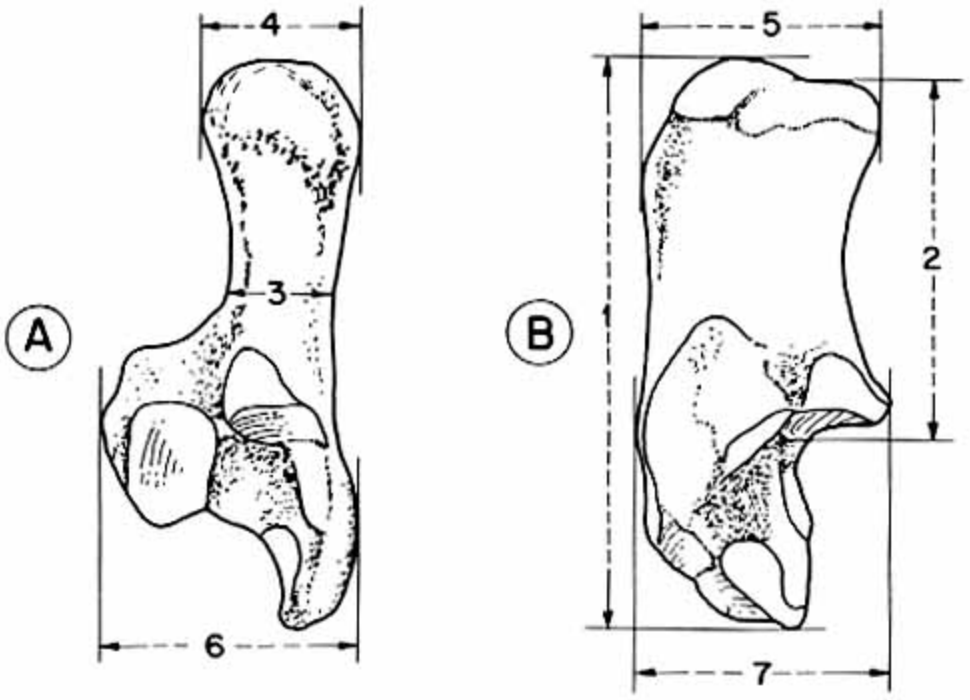
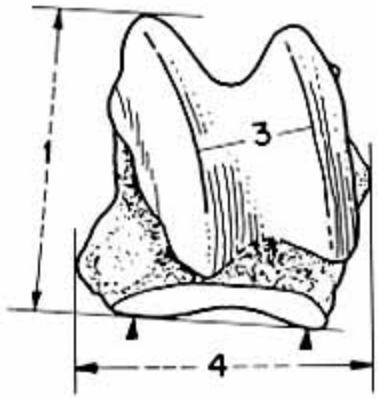


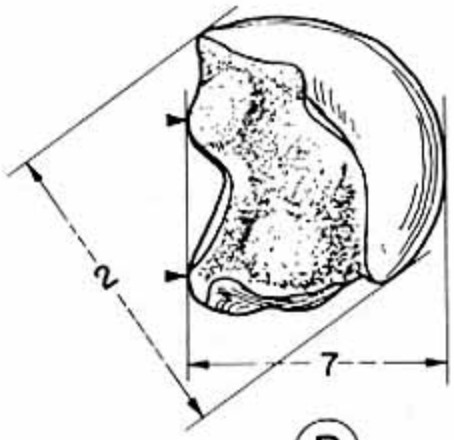
FIGURE 22: CALCANEUS (OR CALCANEUM), A: Anterior view
B: Medial view

PRESENT PAPER	VE	AVD
1. Maximal length	1	GL
2. Length of the proximal part	2	-
3. Minimal breadth	4	-
4. Proximal maximal breadth	5	-
5. Proximal maximal depth	6	-
6. Distal maximal breadth	3	GB
7. Distal maximal depth	7	-

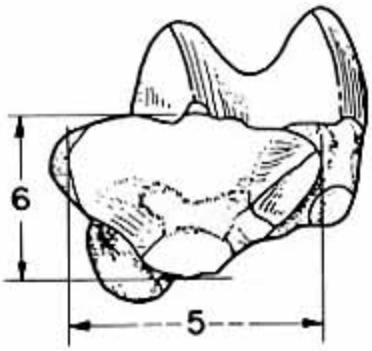
V.E. suggests that the measure of the maximal length of the articular facet on the sustentaculum tali may be of interest.



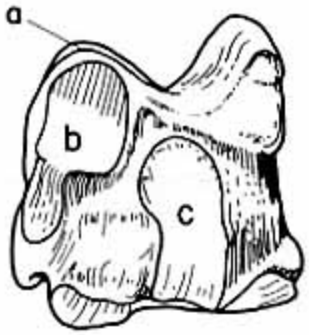
A



B



C



D

FIGURE 23: TALUS (or Astragalus), A: Anterior view
B: Medial view
C: Distal view
D: Posterior view

PRESENT PAPER	VE	AVD
1. Maximal length	*	GH
2. Maximal diameter of the medial condyle	2	LmT
3. Breadth of the trochlea (at the apex of each condyle)	4	-
4. Maximal breadth	3	GB
5. Distal articular breadth	5	BFd
6. Distal articular depth	6	-
7. Maximal medial depth	7	-
*. Maximal length from the medial condyle to the most distal point on the lateral part of the distal articular surface (Eisenmann, 1986, p. 116)	1	-

The observation of the articular facets on the posterior face of the talus may be of interest for discriminating *Equus* and *Hipparion* (Eisenmann, 1985, p. 32, pl. 3, fig. 3). In *Hipparion*, the posterior edge of the lateral condyle for the tibia (a) is thin and sharp; the underlying facet articulating with the calcaneum (b) is bordered by this edge but the two articular surfaces are in continuity. In most species of *Equus*, the edge is blunt and some non-articular bone comes in between a and b (exceptions may be found in Asses and Hemiones). Other differences may also be found between species of *Equus*: for example, in *Equus zebra*, the distal end of the articular surface for the calcaneum (c) is very often separated from the articular surface for the MT III; in most other *Equus*, the two surfaces are in continuity (V.E.).

FIGURE 24: OTHER TARSALS

A. Medial views
B. Distal views
C. Lateral views

The International New York Equid Conference did not recommend definite measurements for these bones but wished that they be illustrated to show their place inside the tarsus as a whole (see fig. 21), and the function of their articular facets (this figure).

Since most of these bones may be differently named, we give here a list of synonyms. We note also to which measure of other bones they correspond.

First + second tarsal = Small cuneiform (MT III, 9)
Third tarsal = Large cuneiform (MT III, 7)
Fourth tarsal = Cuboid (MT III, 8)
Navicular = Scaphoid = os tarsi centrale (Talus, 5)

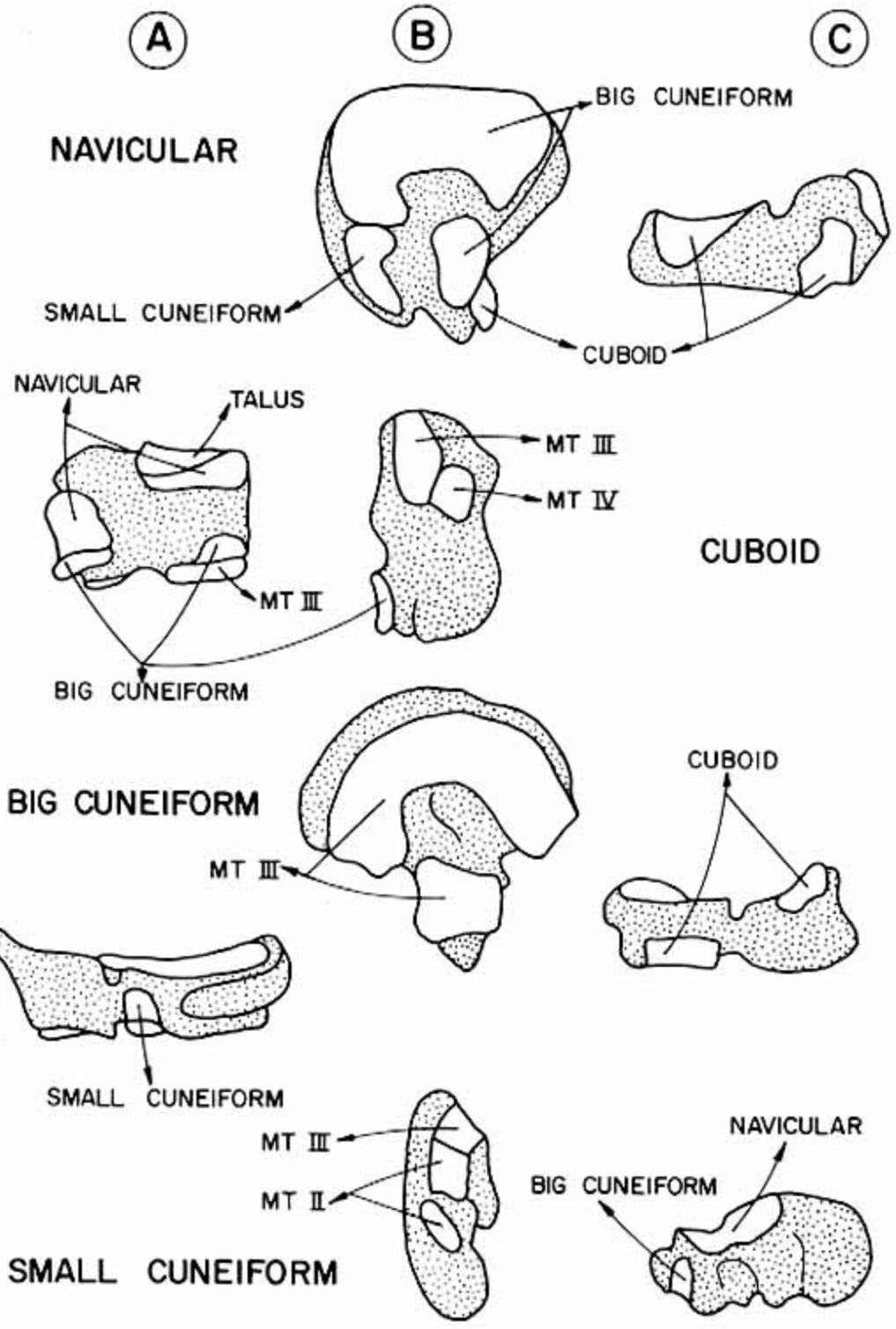
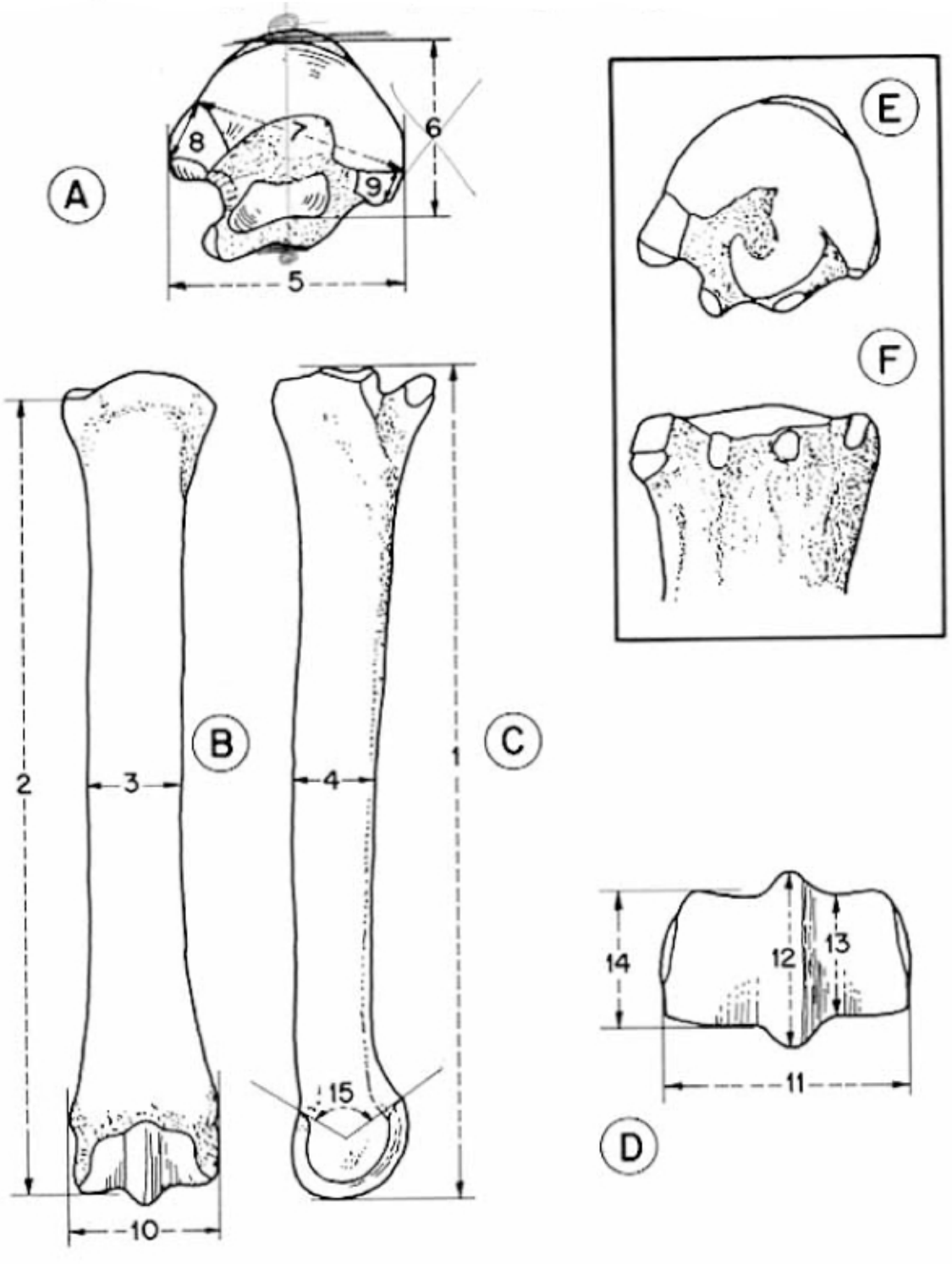

A
B
C
NAVICULAR
BIG CUNEIFORM
SMALL CUNEIFORM
CUBOID
NAVICULAR
TALUS
MT III
MT IV
CUBOID
MT III
BIG CUNEIFORM
BIG CUNEIFORM
MT III
CUBOID
SMALL CUNEIFORM
MT III
MT II
SMALL CUNEIFORM
NAVICULAR
BIG CUNEIFORM

FIGURE 25: THIRD METATARSAL

A. *Equus*: Proximal view
B. *Equus*: Anterior view
C. *Equus*: Lateral view
D. *Equus*: Distal view
E. *Hipparion*: Proximal view
F. *Hipparion*: Posterior view

PRESENT PAPER	VE	AVD
1. Maximal length	1	GL
2. Medial length	*	*
3. Minimal breadth (near the middle of the bone)	3	SD
4. Depth of the diaphysis at level of 3	4	-
5. Proximal articular breadth	5	Bp
6. Proximal articular depth	**	**
7. Maximal diameter of the articular facet for the third tarsal	7	-
8. Diameter of the articular facet for the fourth tarsal	8	-
9. Diameter of the articular facet for the second tarsal	9	-
10. Distal maximal supra-articular breadth	10	***
11. Distal maximal articular breadth	11	***
12. Distal maximal depth of the keel	12	Dd
13. Distal minimal depth of the lateral condyle	****	-
14. Distal maximal depth of the medial condyle	14	-
15. Angle measuring the dorso-volar development of the keel (this character may be studied by projecting the outline of the keel on a sheet of paper, finding the center of this nearly circular outline, and measuring the corresponding angle from that center)	-	
*. Lateral length	2	Ll
**. Proximal maximal depth	6	Dp
***. Distal maximal breadth	10 or 11	
****. Distal minimal depth of the medial condyle	13	-

See also von den Driesch, 1976, p. 93.

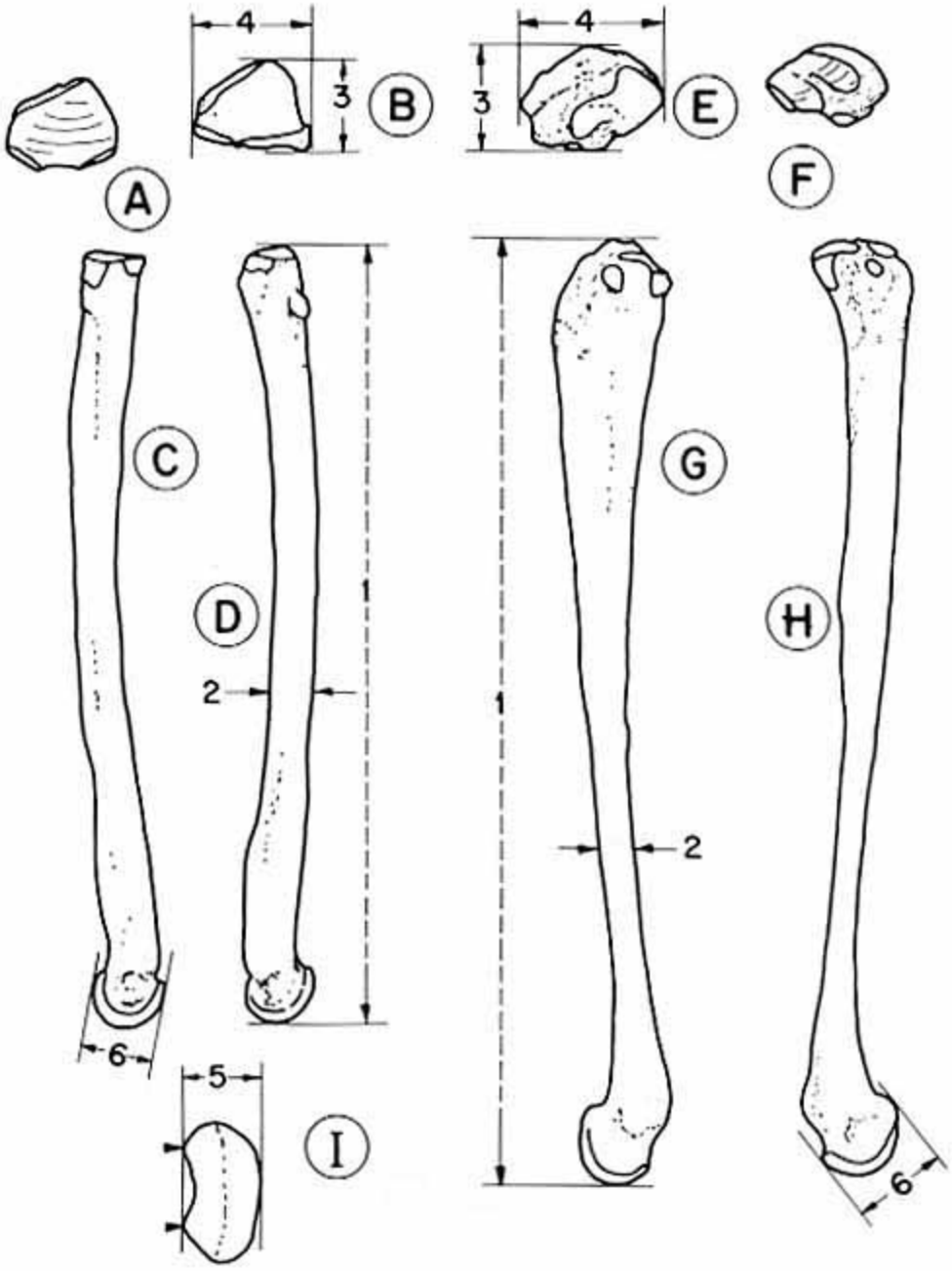


Please see corrections and explanations in the “System of measurements for Hipparion skulls and limb bones.

Figure 26: Lateral Metapodials of Hipparion

A: Proximal view of Metacarpal IV
B: Proximal view of Metacarpal II
C: Medial view of Metacarpal IV
D: Medial view of Metacarpal II
E: Proximal view of Metatarsal IV
F: Proximal view of Metatarsal II
G: Medial view of Metatarsal IV
H: Medial view of Metatarsal II
I: Distal view of a lateral Metapodial

1. Maximal length
2. Minimal depth of the diaphysis
3. Proximal maximal breadth
4. Proximal maximal depth
5. Distal articular breadth
6. Distal articular depth



See also 'Hipparion, MT II, MT IV, left'

FIGURE 27: FIRST PHALANGES OF EQUUS AND HIPPARION

(Only a lateral first phalanx of *Hipparion* is illustrated; the first phalanx of the central digit of *Hipparion* may be measured as in *Equus*).

Equus and *Hipparion*, A and E: Proximal views
B and F: Lateral views
C and G: Anterior views
Equus, D: Posterior view

PHALANX OF THE CENTRAL DIGIT (A, B, C and D)

PRESENT PAPER	VE	AVD
1. Maximal length	1	GL
2. Anterior length	2	-
3. Minimal breadth	3	SD
4. Proximal breadth	4	Bp
5. Proximal depth	5	Dp
6. Distal breadth at the tuberosities	6	Bd
7. Distal articular breadth	14	BFd
8. Distal articular depth	15	-
9. Minimal length of the trigonum phalangis	8	-
10. Medial supratuberosital length	10	-
11. Lateral supratuberosital length	11	-
12. Medial infratuberosital length	12	-
13. Lateral infratuberosital length	13	-

See also von den Driesch, 1976, p. 97.

Eisenmann and De Giuli (1974b) have found that the relative position of the distal tuberosities was a good character for distinguishing fore and hind *Equus* first phalanges; multivariate analysis confirmed this observation (Dive & Eisenmann, in press). We decided for this reason to add the relevant measures (10, 11, 12 and 13) to the list of measures adopted by the International New York Equid Conference. Their discriminant value in *Hipparion* has not been investigated.

LATERAL FIRST PHALANX OF HIPPARION (E, F and G)

1. Maximal length
2. Proximal maximal breadth
3. Proximal maximal depth
4. Distal maximal breadth
5. Minimal breadth of the diaphysis

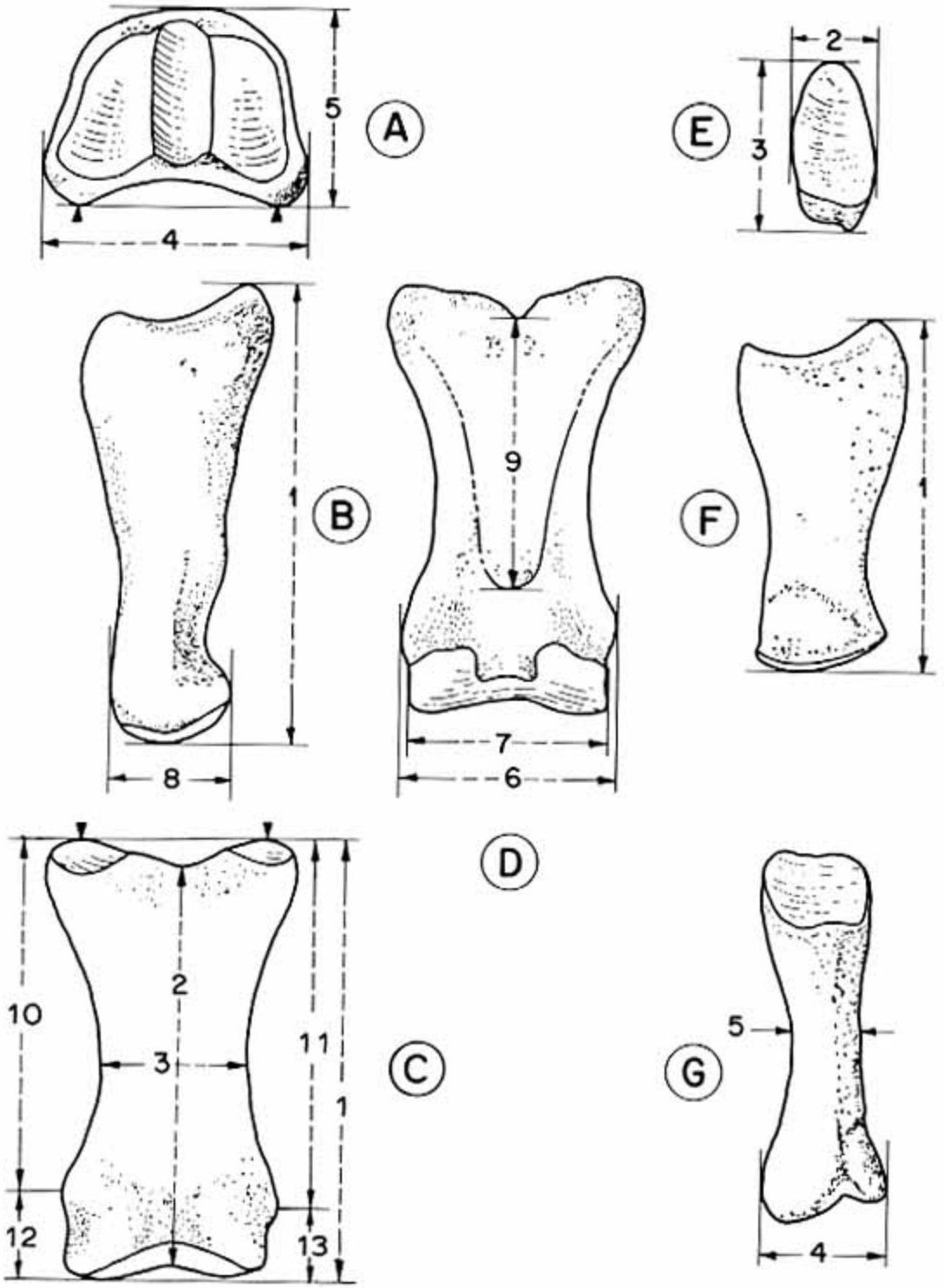

A
5
4
E
2
3
B
1
8
9
7
6
F
1
D
C
10
2
3
11
1
12
13
G
5
4

FIGURE 28: SECOND PHALANGES OF EQUUS AND HIPPARION

(Only a lateral second phalanx of *Hipparion* is illustrated; the second phalanx of the central digit of *Hipparion* may be measured as in *Equus*).

Equus and *Hipparion*, A and C: Proximal views
Equus, B: Anterior view
Hipparion, D: Lateral view
E: Distal view

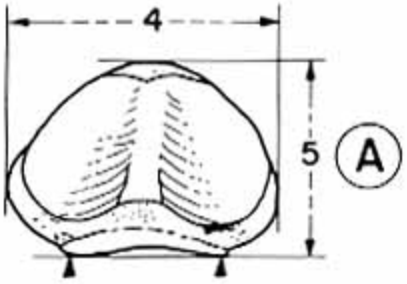
PHALANX OF THE CENTRAL DIGIT (A and B)

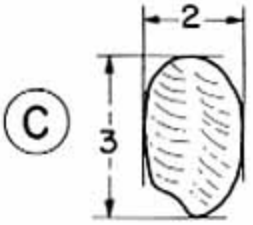
PRESENT PAPER	VE	AVD
1. Maximal length	1	GL
2. Anterior length	2	-
3. Minimal breadth	3	SD
4. Proximal maximal breadth	4	Bp
5. Proximal maximal depth	5	Dp
6. Distal articular maximal breadth	6	Bd

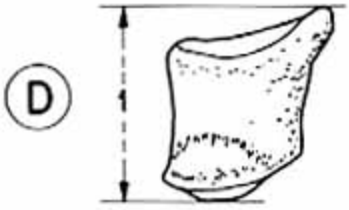
See also von den Driesch, 1976, p. 99.

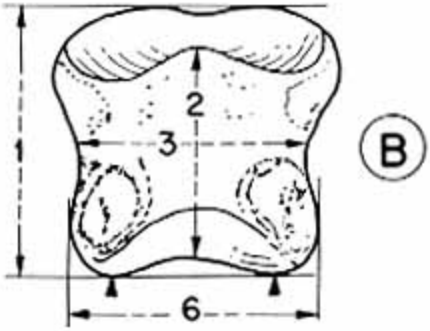
LATERAL SECOND PHALANX OF HIPPARION (C, D and E)

1. Maximal length
2. Proximal maximal breadth
3. Proximal maximal depth
4. Distal maximal breadth


4
5
A


2
C
3


D
1


2
3
B
6

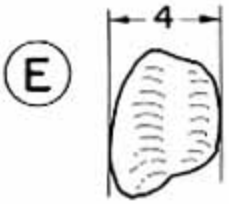

4
E

FIGURE 29: THIRD PHALANGES OF EQUUS AND HIPPARION

(Only a lateral third phalanx of *Hipparion* is illustrated; the third phalanx of the central digit of *Hipparion* may be measured as in *Equus*).

Equus and *Hipparion*, A and D: proximal views
C and E: Lateral views
Equus, B: Anterior view

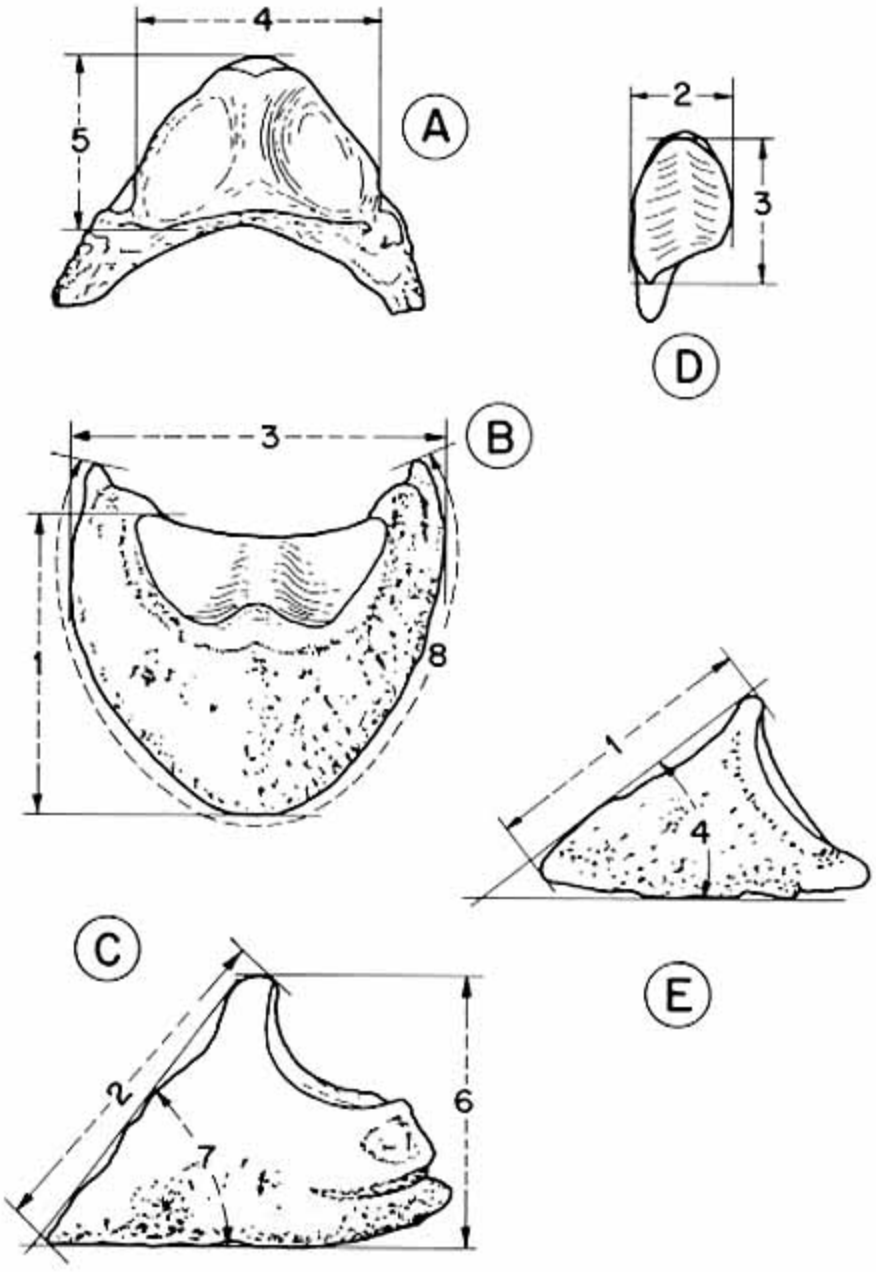
PHALANX OF THE CENTRAL DIGIT (A, B and C)

PRESENT PAPER	VE	AVD
1. Length from the posterior edge of the articular surface to the tip of the phalanx (this measure corresponds best to the maximal length of first and second phalanges although it is not maximal).	-	-
2. Anterior length	1	Ld
3. Maximal breadth	4	GB
4. Articular breadth	6	BF
5. Articular depth	5	LF
6. Maximal height	3	HP
7. Angle between the sole and the dorsal line (this angle should be measured with the phalanx laid on an even plane)	-	
8. "Circumference" of the sole	7	-
*. Maximal depth	2	GL

See also von den Driesch, 1976, p. 101.

LATERAL THIRD PHALANX OF HIPPARION (D and E)

1. Anterior length
2. Proximal articular breadth
3. Proximal articular depth
4. Angle between the sole and the dorsal line (may be measured after projecting the profile of the phalanx on a sheet of paper)


4
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A
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D
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E

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MC IV, left

Lateral view

Front

Front

Medial view

Front

MT II, left

Medial view

Front

Front

Lateral view

Front

MT IV, left

Lateral view

Medial view

Front

Front

Front