

# A LIST OF CRANIODENTAL MATERIAL OF PLIOCENE URSIDS (GENUS *URSUS*) IN THE COLLECTION OF NATURHISTORISCHES MUSEUM BASEL

Jan WAGNER<sup>1</sup>

**Abstract:** Craniodental ursine material deposited in Naturhistorisches Museum Basel from five Ruscinian to Villanyian localities (Montpellier - MN 14a; Viallette - MN 16a; Les Pardines, St. Vallier, Senèze - MN 17) is listed. A basic description as well as a short discussion of their taxonomic status are given. Bears from Montpellier, Viallette, and Senèze can be determined, with some uncertainty, as members of *Ursus* gr. *minimus-thibetanus*, that from Les Pardines and St. Vallier as *Ursus* aff. *etruscus*.

**Key words:** *Ursus minimus*, *Ursus etruscus*, Ruscinian, Villanyian, France, Europe.

## INTRODUCTION

During my visit to Naturhistorisches Museum Basel (NHMB) in summer 2006 I had the opportunity to study in detail the craniodental material of Pliocene ursids. Most of these specimens have already been mentioned in the literature before, but none of these was figured or described in detail. Therefore, a list of these specimens with short comments on their morphology and taxonomical status are given below.

## MATERIAL AND METHODS

The material, including its inv. num., is listed separately for each locality in the following section.

The teeth measurements are defined according to RODE (1935) (see tab. 1 and 2), the terminology of their morphology is adopted from RABEDER (1983; 1989; 1999). Material was measured by a caliper. Each measuring was repeated three times and the median was used.

## STUDIED LOCALITIES

### MONTPELLIER

Material: Mesial fragment of M<sup>2</sup> sin (M. P. 509), coll. in 1932; M<sup>2</sup> sin (M. P. 848), coll. in 1937.

Both specimens, including their inv. nr., are men-

tioned in VIRET (1954; p. 45 - a footnote). For the specimen M. P. 848 the maximal length and breadth were noted.

Stratigraphical position of the locality: The locality is of the Lower Ruscinian age - MN 14 (FEJFAR *et al.*, 1997) or MN 14a (FEJFAR & HEINRICH, 1990), respectively. Therefore, the absolute age falls within the range of 4.9 and 4.5 M. A. (FEJFAR *et al.*, 1997). Although, it is necessary to mention that exact stratigraphical positioning is unsure in the old collections. The contamination of the Uppermost Miocene elements is not excluded (FEJFAR *in verb.* 2006).

Description of the studied material: M. P. 509: A hard abraded trigonid part of M<sup>2</sup> sin. Fossilization is grayish, in some places yellowish. Cingulum is preserved below the protocone-complex and below the mesial part of hypocone. There was probably a metaloph present between the top of metacone and protocone 2. Perhaps it was also connected with a medialwards crest of hypocone. Protocone-complex is approximately in the same line as the hypocone. It seems that there was a good developed post-hypocone. (pl. 1: 1).

M. P. 848: A hard abraded, dark pink to brownish fossilized M<sup>2</sup> sin. Cingulum is present below the protocone-complex and the hypocone on lingual side and below paracone and metacone-complex on the buccal

<sup>1</sup> Charles University, Faculty of Science, Dept. of Philosophy & History of Nature Science, Viničná 7, 128 44 Praha 2, Czech Republic. orksos@seznam.cz

Table 1  
Dimensions of the upper teeth of *Ursus* spp. from studied localities.

	Montpellier		Pardines				St. Vallier				Senèze		
	M. P. 509	M. P. 848	L. P. 199, dex	L. P. 199, sin	L. P. 199	St. V. 290, dex	St. V. 290, sin	St. V. 292	St. V. 293	St. V. 755, dex	St. V. 755, sin	St. V. 970	Se 1505
Cs/: poster-anterior diameter on crown basis	-	-	-	-	17.9	-	-	-	-	22.6	22.6	-	22.6
Cs/: medio-lateral diameter on crown basis	-	-	-	-	11.4	-	-	-	-	16.1	16.3	-	15.7
Cs/: posterior crown height	-	-	-	33.2	-	-	-	-	-	-	34.0	-	35.9
Cs/: anterior crown height	-	-	-	-	-	-	-	-	-	-	30.5	-	34.6
Cs/: poster-anterior diameter of root	-	-	-	-	-	-	-	-	-	-	-	-	24.6
Cs/: medio-lateral diameter of root	-	-	-	-	-	-	-	-	-	-	-	-	15.7
P1/: maximal length	-	-	-	-	-	-	-	6.0	-	-	-	-	-
P1/: maximal breadth	-	-	-	-	-	-	-	5.3	-	-	-	-	-
P2/: maximal length	-	-	5.9	6.4	-	-	-	-	-	-	-	-	-
P2/: maximal breadth	-	-	4.2	4.3	-	-	-	-	-	-	-	-	-
P3/: maximal length	-	-	7.6	7.2	-	-	-	-	-	-	-	-	-
P3/: maximal breadth	-	-	5.0	4.6	-	-	-	-	-	-	-	-	-
P4/: maximal length	-	-	-	-	-	-	16.1	-	16.4	16.5	-	14.9	-
P4/: maximal breadth	-	-	-	-	-	-	11.7	-	11.2	12.1	12.1	10.4	-
P4/: breadth of constriction	-	-	8.3	8.1	-	-	10.4	-	-	11.6	-	10.2	-
M1/: maximal length	-	-	19.6	19.5	-	-	ca.21.4	22.2	20.3	22.4	22.6	20.9	-
M1/: breadth of anterior lobe	-	-	-	15.0	-	-	16.5	17.3	16.5	16.7	16.5	15.6	-
M1/: breadth of posterior lobe	-	-	15.0	15.0	-	-	16.2	17.7	16.9	16.4	16.2	16.1	-
M1/: breadth of constriction	-	-	14.7	14.9	-	-	15.9	16.8	16.3	16.0	15.9	14.6	-
M1/: length of paracone	-	-	6.9	6.9	-	-	8.3	8.0	8.1	8.9	8.3	8.4	-
M1/: length of metacone	-	-	7.0	6.7	-	-	8.0	7.6	7.6	8.0	8.0	7.6	-
M2/: maximal length	-	20.8	27.6	27.7	-	31.7	31.1	-	-	31.1	31.1	31.2	-
M2/: buccal length of trigon	ca.15.1	14.9	-	-	-	-	-	-	-	-	-	20.3	-
M2/: buccal length of talon	-	8.2	-	-	-	-	-	-	-	-	-	11.0	-
M2/: maximal anterior breadth (ovar Pa)	14.6	13.9	16.1	16.4	-	17.9	17.8	-	-	17.6	17.8	17.5	-
M2/: maximal breadth behind constriction	14.1	13.3	15.6	15.7	-	16.9	17.2	-	-	16.8	16.8	17.1	-
M2/: maximal breadth of constriction	14.0	13.4	15.8	15.6	-	16.4	16.6	-	-	17.3	-	16.9	-

one. The buccal cingulum is weak. Both buccal and lingual cusp lines are a little medialwards bent in their distal part. The protocone-hypocone boundary is placed more medialwards than usually in *Ursus*. Metalophid was present. But due to abrasion, it is not clear if it was connected with paracone 2 or/and with hypocone. Talon is short and strongly rotated. VIRET (1954) gives measurements 21.2 x 13.8 for this specimen. According to the author, the maximal length is 20.8 and frontal width 13.9. The differences in maximal length are probably caused by a slightly different orientation of the tooth during measuring. (pl. 1: 2).

Comparison and discussion: The finds of *Ursus*-remains from Montpellier are the world's-oldest record of the genus. In Asia there is the oldest find of *Ursus* sp. recorded from the Gaozhung Formation (Yushe area,

China) (QIU, 2003). The age of this faunal assemblage is thought to be about 4.0 M. A. (FLYNN *et al.*, 1991; FLYNN & WU, 2001) or between 4.5 and 4.1 (QIU, 2003), respectively. The first record (determined as *Ursus abstrusus*) in North America comes from the White Bluffs fauna (Washington, USA), that is about 4.3 M. A. old (HUNT, 1998). Approximately of the same age (or a little older) is a find from Gray Site (Washington, USA), determined as “? *Ursus* sp.” (PARMALEE *et al.*, 2002). TEDFORD & HARRINGTON (2003) mentioned an Early Pliocene (5.0 - 4.0 M. A.) fauna from Ellesmere Island (Nunavut, Canada) that also includes a bear called *Ursus abstrusus*.

The mesial fragment (M. P. 209) is similar in both, morphology and size to the M<sup>2</sup> from Baróth-Köpecz (=Baraolt-Căpeni, Romania) (MAIER VON MAYERFELS, 1929; RYZIEWICZ, 1969). Similarity with a bear from Per-

Table 2  
Dimensions of the lower teeth of *Ursus* spp. from studied localities.

	Viallette		St. Vallier			Senèze	
	Vt. 94	St. V. 291	St. V. 294	St. V. 295	St. V. 296	St. V. 793	Se 1714
c/i: postero-anterior diameter on crown basis	21.5	22.4	-	-	-	-	-
c/i: medio-lateral diameter on crown basis	ca.13.7	16.5	14.2	-	-	-	-
c/i: postero-anterior diameter of root	23.3	-	-	-	-	-	-
c/i: medio-lateral diameter of root	15.5	-	-	-	-	-	-
p/2: maximal length	-	-	-	-	5.8	5.4	5.8
p/2: maximal breadth	-	-	-	-	4.6	5.3	3.2
p/3: maximal length	-	-	-	-	-	-	6.2
p/3: maximal breadth	-	-	-	-	-	-	4.5
p/4: maximal length	-	10.7	-	12.8	-	-	-
p/4: maximal breadth	-	7.2	-	7.4	-	-	7.3
p/4: height of protoconid	-	-	-	8.4	-	-	-
m/1: maximal length	-	23.0	-	-	-	-	-
m/1: buccal length of trigonid	-	14.9	-	-	-	-	-
m/1: buccal length of talonid	-	8.1	-	-	-	-	8.3
m/1: lingual length of talonid	-	-	-	-	-	-	8.7
m/1: maximal breadth of trigonid	-	9.9	-	-	-	-	9.7
m/1: maximal breadth of talonid	-	-	-	-	-	-	11.1
m/1: breadth of constriction	-	10.4	-	-	-	-	10.2
m/2: maximal length	-	23.2	-	-	-	-	23.1
m/2: buccal length of trigonid	-	14.3	-	-	-	-	14.8
m/2: buccal length of talonid	-	9.1	-	-	-	-	8.2
m/2: maximal breadth of trigonid	-	14.4	-	-	-	-	14.0
m/2: maximal breadth of talonid	-	-	-	-	-	-	14.8
m/2: breadth of constriction	-	14.9	-	-	-	-	13.8

pignan (France) is mentioned by VIRET (1954). In general character, this tooth is inside a known variability for bears of Ruscianian to Lower Villanyian. Due to a state of abrasion and a fragmentariness of the specimen, no more detail comparison is possible.

The complete left M<sup>2</sup> (M. P. 848) is more atypical. The general form of the tooth (e. g. more closed distal end of trigon, relatively medially placed Pr/Hy boundary or short talon beginning almost immediately behind the metacone tip) as well as its small size, are unusual among Pliocene ursines, for which, among others, more opened trigon, more elongated talon and maximal length <sup>3</sup> 23.00 mm are prevalent. Only a left M<sup>2</sup> (specimen no. 2) from Odesskie Katakomby is similar in size (maximal length 21.0 mm), but it has a more reduced talon (ROŠČIN, 1956). Fine morphology is not very recognizable from a published photo, but it seems little different. The age of Odesskie Katakomby is correlated to terminal Ruscianian or a transition Ruscianian-Villanyian (VANGENGEIM *et al.*, 1996). The states of characters mentioned above are thought to be of plesiomorphic character and are known,

in a more intensive development, in genus *Ursavus*. The assignment to the genus *Ursus* is problematic and it is not possible to exclude, for this time, that this specimen belongs to an advanced form of genus *Ursavus*.

Based on the above mentioned, the author supposes that both specimens could belong to the same paleopopulation of archaic bears of genus *Ursus*, representing two different poles within the intraspecific variability. The plesiomorphic characters of M. P. 848, indicating an *Ursavus*-like morphology for ancestral taxon of *Ursus*, has never been recorded in *Ursus* before (some parallels could be seen only in sbg. *Helarctos*). The taxonomical status of bear from Montpellier has already been discussed for several times. The latest revisions (BARYSHNIKOV, 1991; MAZZA & RUSTIONI, 1994a; MORLO & KUNDRÁT, 2001) synonymized this bear with *U. minimus* (the last one with *U. m. boeckhi*). New data shows, at least, that there exists a larger variability among Lower Pliocene ursids than was previously thought and therefore a new revision in detail of these forms seems to be necessary for a more precise taxonomical determination.

Table 3  
Dimensions of the mandibles of *Ursus* spp. from studied localities.

	St. Vallier	Senèze
	St. V. 291	Se 1714
length of cheek teeth row p4/ - m3/	-	76.7
p4/ - ci/ diastema length	-	34.7
p1/ - p2/ diastema length	-	2.5
p2/ - p3/ diastema length	12.0	7.4
p3/ - p4/ diastema length	4.4	7.3
labial height of the horizontal ramus under m2-3/	44.3	53.5
labial height of the horizontal ramus under m1/	43.3	49.3
breadth of the horizontal ramus between p4/ - m1/	19.3	16.4
breadth of the horizontal ramus between m2/ - m3/	20.9	23.1

## VIALETTE

Material: C<sub>i</sub> sin (Vt. 94), coll. in 1906.

An isolated canine from this locality is mentioned in DUBOIS & STEHLIN (1933; p. 62). This specimen was listed in HEINTZ *et al.* (1974; p. 177), including its inv. nr., but without any description.

Stratigraphical position of the locality: The locality is of the Lower Villanyian age - MN 16a (FEJFAR & HEINRICH, 1990; FEJFAR, 2001). According to these authors, based on the micromammals, this locality is approximately of the same age as Arondelli-Triversa (Italy) or Hajnáčka (Slovakia). The same stratigraphical position, as an equivalent of Triversa F. U. (first Villafranchian faunal unit in the Italian faunal succession schema), is for Vialette proposed by AZZAROLI *et al.* (1988) based on macromammals. The Ruscinian/Villafranchian boundary is identified with MN 15/MN 16 boundary (PALOMBO *et al.* 2000-2002) and characterized by “*Leptobos*-event” - FAD of *Leptobos* in (southwest) Europe (AZZAROLI *et al.* 1988). In this context it is remarkable that HEINTZ *et al.* (1974) revised the Vialette fauna and resulted that there is no *Leptobos* present. These authors included Vialette into “Zones des Etouaires” together with classical locality Etouaires but older than the last one. They proposed for Vialette an absolute age of about 3.8 M. A. But this date seems to be overvalued, because the MN 15/MN 16 boundary used to be placed at the Gilbert/Gauss paleomagnetic boundary - ca. 3.58 M. A. (FEJFAR *et al.*, 1998) or even later (ALBIANELLI *et al.*, 1997). According to BANDET *et al.* (1978) the age of Vialette fauna is between 3.3 M. A. and 2.6 M. A., but an age younger than 3.1 M. A. seems to be very improbable (see FEJFAR *et al.*, 1998; ALBIANELLI *et al.*, 1997).

Description of the studied material: Vt. 94: The enamel has a beige fossilization, the bone is brownish, in

some places black. An abrasion is intermediate, evident only on the top of the crown. The enamel is missing in the lower half of an anteromedial wall of the crown and in the place of a posterior enamel crest. There is a weak damage at the top of the tooth's root.

The posterior enamel crest is preserved only in a small area below the crown's top. The enamel margin of the crown is, due to the damage, indistinct in a medial half. A spiral rotation, typical for ursid lower canines, is very vague. (pl. 2: 1).

Comparison and discussion: An isolated canine can not be used for taxonomical results. A lateral enamel border seems to be less steep than that in the specimen from Wölfersheim (MORLO & KUNDRÁT, 2001) or Baróth-Köpecz, that could theoretically support its higher evolutionary stage in comparison to the Ruscinian forms.

Bears from this stratigraphical niveau (MN 16a) are relatively rare. Probably the best preserved material comes from Gaville (Castelnuovo lacustrine phase of Upper Valdarno, Italy) described in detail and determined as *U. minimus* by BERZI (1966), but no measurements or detailed figure is given for canines. The same bear species is also mentioned from Triversa (Italy) but without any information about material (AZZAROLI, 1977; PALOMBO *et al.*, 2000-2002). AZZAROLI *et al.* (1986) listed this species also in Arondelli local fauna (Italy), that is adopted with some doubtfulness by RUSTIONI & MAZZA (1993) and MAZZA & RUSTIONI (1994a). But neither BERZI *et al.* (1970) nor AZZAROLI (1977) mentioned any *Ursus* in this fauna. SABOL (2004) mentioned one isolated anterior premolar from the locality Hajnáčka I (Slovakia) determined as Ursidae gen. et sp. indet. and mentioned some similarities with black bears' anterior premolars. From Vialette itself a bear was listed under a name *U. etruscus* by HEINTZ & al. (1974, this authors included into this species also *U. minimus*).

Based on the above mentioned it seems probably that this canine belongs to a bear from *Ursus* gr. *minimus-thibetanus* sensu MAZZA & RUSTIONI (1994a), although this result is not possible on the specimen itself.

#### LES PARDINES

Material: Maxillary fragment with an almost complete set of cheek teeth (L. P. 199), coll. in 1935; C<sup>s</sup> sin. and a small fragment of canine root (both L. P. 228), coll. in 1939.

HEINTZ *et al.* (1974; p. 177) mentioned a specimen inv. nr. L. P. 199 (without any description) but incorrectly wrote, that this is a mandible.

Stratigraphical position of the locality: The locality is of the Upper Villanyian age - MN 17, probably of its lower part (FEJFAR *et al.*, 1997) but the exact position within this zone remains open. It is younger than Roccaneyra, the basal fauna of MN 17 zone with faunal assemblage of transitional character between MN 16b and MN 17 zones (e. g. present of *Leptobos elatus* or *Hipparion* sp. instead of *Equus* spp.; HEINZ *et al.*, 1974). The absolute age of Roccaneyra is indicated between 2.5 M. A. (BOUT, 1970) and 2.35 to 2.00 M. A. (BONIFAY, 1990). The locality Les Pardines is connected with a later volcanic phase in Perrier plateau than that of Roccaneyra, with the age proposed about 2.00 M. A. (BONIFAY, 1990). The fauna of Pardines contains no more archaic (MN 16b) elements (although KURTÉN (1963) mentioned co-occurrence of *Equus* and *Hipparion* in this locality, HEINTZ *et al.* (1974) listed no *Hipparion* among taxa from Pardines). The faunal assemblage is thought to be similar to that of St. Vallier (HEINTZ *et al.*, 1974) or somewhat older (GUÉRIN & FAURE, 2002; TORRE *et al.*, 2002). The higher age of Pardines is supported also by an absence of *Gallogoral*, that occurs for the first time in St. Vallier (GRÉGUT-BONNOURE, 2002).

Description of the studied material: L. P. 199: Maxillo-palatal fragment of skull with I<sup>3</sup> dex, C<sup>s</sup> dex., P<sup>2</sup>-M<sup>2</sup> dex. et sin., and an alveolus of P<sup>1</sup> dex. The enamel is fossilized from dark greyish to black, the bone mainly brownish. Most of palatal part is missing, the rostral part is damaged. All teeth, but P<sup>2-3</sup> sin. et dex, are well worn.

Teeth are relatively small. Due to the abrasion no fine morphological structures are preserved. M<sup>2</sup>s bear an intermediately developed cingulum approximately below protocone-complex and anterior half of hypocone on the lingual side and below paracone on the buccal one. These two parts were probably connected together by a mesial margin (= Mesialrand sensu RABEDER, 1999). There was probably no parastyle present at the contact between a mesial margin and paracone but the cingulum gets stron-

ger in this region. No accessory cusps are evident on the buccal side. Talon is relatively short. M<sup>1</sup>s bear cingulum along the buccal side (there is not a clear state on the lingual one due to an abrasion). Both, parastyle and metastyle are present. Metastyle is well developed, parastyle is weak. P<sup>4</sup>s bear cingulum along the buccal side and in front of protocone on the lingual one. Both fourth premolars are hard worn on the mesial slope of the paracone, the left one is moreover damaged in this part. Protocone is situated approximately opposite the groove between paracone and metacone. Protocone bears no accessory cusps. Anterior premolars are well developed, separated by fairly wide diastemata. Canine possesses an abrupt tip of crown. A posterior enamel crest is marked. (pl. 1: 3-4; pl. 2: 3).

L. P. 228: C<sup>s</sup> sin. The enamel is fossilized greyish, the bone yellow-brownish and greyish. Abrasion is weak. Approximately central third of the tooth (both, root and crown) is badly damaged in its anterior half. A posterior enamel crest is marked in all crown's length, although it is damaged in its lower part. (pl. 2: 2).

Comparison and discussion: The dimensions are relatively small, under the values obtained for St. Vallier bears deposited in NHMB but still within the variability found out by VIRET (1954). A hard abrasion makes impossible any more detailed comparison. But the gross morphology is the same as in the bears from St. Vallier. Anterior premolars were well developed. KURTÉN (1963) and HEINTZ *et al.* (1974) listed this bear under *U. etruscus*. The author finds it more suitable to call it, preliminary, *Ursus* aff. *etruscus* sensu MAZZA & RUSTIONI (1992).

#### ST. VALLIER

Material: Fragment of skull (St. V. 290), coll. in 1952; right hemimandible (St. V. 291), coll. in 1952; M<sup>1</sup> sin. (St. V. 292), coll. in 1952, left maxillary fragment with P<sup>4</sup>-M<sup>1</sup> (St. V. 293), coll. in 1952, fragment of C (St. V. 294), coll. in 1952; P<sub>4</sub> dex. (St. V. 295), coll. in 1952, anterior P (St. V. 296), coll. in 1952, fragment of skull (St. V. 755), coll. in 1952; fragment of anterior P (St. V. 792), coll. in 1953, anterior P (St. V. 793), coll. in 1953, left maxillary fragment with P<sup>4</sup>-M<sup>1</sup> (St. V. 970), coll. in 1954.

VIRET (1954; p. 40) only the mandible described in detail (St. V. 291), but gave no picture. TORRES (1992) used this material for comparison with that from Venta Micena. MAZZA & RUSTIONI (1992) studied it in detail following specimens and gave their measurements: St. V. 291-296, 792 and 970. None of these was figured.

Stratigraphical position of the locality: The locality is of the Upper Villanyian age - MN 17 (FEJFAR *et al.*, 1997). This is a type locality for MN 17 zone and the Middle

Villafranchian sensu AZZAROLI (1970; 1977). Through the new excavation two fossiliferous horizons were indicated, both approximately of the same age (DEBARD *et al.*, 1994). Most of authors proposed for this locality age about 2.0 M. A. (see GUÉRIN & FAURE (2002) for an overview).

Description of the studied material: In all specimens, but St. V. 290, enamel is fossilized whitish, bone yellow-whitish. The different color of bone in St. V. 290 could be caused by the type of conservation.

St. V. 290: A weakly deformed skull fragment without occipital, rostral a distal part of palatal region as well as zygomatic arches, with  $M^2$  dex.,  $P^4$ - $M^2$  sin., and alveoli of  $P^3$ - $M^1$  dex. and  $P^3$  sin. Enamel is fossilized whitish, a bone yellowish. All teeth are very well abraded.

In  $M^2$ s there is preserved only a rest of cingulum on the buccal side below a mesial half of paracone. Talons are short but wide. In  $M^1$ , there is missing most of the buccal slope of paracone and almost a complete parastyle. Cingulum remains only below metacone. Metastyle is well developed, parastyle was probably only weak.  $P^4$  has an oval, mesially pointed shape. Cingulum is present along a buccal side and continues uninterruptedly on the lingual one as far as protocone. Protocone is placed approximately opposite the groove between paracone and metacone. No metastyle is evident. (pl. 3: 2).

St. V. 291: A right mandible with present  $C_1$  and  $P_4$ - $M_2$ , alveolus of  $M_3$ , and a rest of alveolus of  $P_1$ . All teeth are well abraded. Most part of ascending ramus is broken off. Symphysis is damaged in its mesial part. There are present 2 - 3 foramina mentalia; the largest one is situated below  $P_4$ , the smaller one below  $P_3$ . There is probably still the third one below  $P_2$ , but this is unclear due to a state of preservation.

There is damaged buccal side of hypoconid in  $M_2$ . Entoconid-complex extends relatively mesialwards in  $M_2$ , as compared to hypoconid.  $M_1$  is damaged on the buccal slope of hypoconid and weakly also in the area between metaconid and entoconid. A very weak cingulum is present below the paraconid/protoconid as well as trigonid/talonid boundary on the buccal side. There is a mesial metastylid developed. Between the metastylid and paraconid there is a small accessory cusp of uncertain origin present. The distal arm of metaconid turns medialwards, without reaching entoconid. Entoconid is unicuspid, well developed, placed on the linguo-distal corner.  $P_4$  is unicuspid with a well developed protoconid. Protoconid bears sharp mesial and distal arm. Approximately in the half of the last one is a short lingualwards crest present. Almost around all the tooth is a cingulum

present. In  $C_1$  there is developed a posterior enamel crest only very weakly. (pl. 1: 11-13; pl. 2: 6; tab. 3).

St. V. 292: An isolated  $M^1$  sin. Hard abraded, damaged on the buccal slope of paracone and on the mesial basis of protocone. Cingulum is present along the both, lingual and buccal side. Buccal and lingual lines of cusps are approximately parallel. There are present good developed mesocone as well as parastyle and metastyle, the last one is the larger. (pl. 1: 10).

St. V. 293: A small maxillary fragment with  $P^4$ - $M^1$  sin., intermediately abraded. Cingulum is present along the both, lingual and buccal sides. Buccal and lingual lines of cusps are approximately parallel or slightly converge distalwards. There are good developed mesocone and metastyle present, parastyle extremely weak.  $P^4$  has damaged linguo-mesial side and the top of metacone. Cingulum is present around the whole crown, but on the distal end of metacone. Protocone is placed mesially from the groove between paracone and metacone. No metastyle is evident. (pl. 1: 8-9).

St. V. 294: A crown of canine, probably inf. dex., with damaged crown's basis on the medial and posterior side. Abrasion is only very weak. A posterior enamel crest is well marked in all the crown's length.

St. V. 295: An isolated  $P_4$  dex. with a damaged crown's basis in some places. A weak cingulum located in distal half of the tooth. Protoconid bears sharp serrated mesial and distal arms. Approximately in the half of the last one there is a short linguo-distalwards crest present. Protoconid is dominant, very weak hypoconid and entoconid are present as swellings of distal or disto-lingual cingulum, respectively.

St. V. 296: An isolated anterior premolar. It was determined as  $P_3$  in MAZZA *et* RUSTIONI (1992). But according to the author, the determination as  $P_2$  or  $P^2$  seems to be more probable. Abrasion is weak to intermediate. The tooth is oval without a cingulum. Only one main cusp is developed, with its point divided by a shallow notch.

St. V. 755: A skull fragment is medio-laterally deformed, with missing occipital part as well as zygomatic arches.  $I^1$  dex.,  $I^{1-3}$  sin.,  $C^s$  dex. et sin.,  $P^1$  sin.,  $P^4$ - $M^2$  dex. et sin. are present, moreover an anterior premolar is stuck on the position of  $P^3$  dex. Alveoli of  $P^{1-2}$  dex. and  $P^{2-3}$  sin. are free and relatively well preserved. An anterior premolar on the position of  $P^3$  dex. is a left one, perhaps  $P^3$  sin. Also  $P^1$  sin. seems to be secondary stuck and it is not excluded that this is  $P^2$  sin. All teeth are well abraded. This specimen was not listed in MAZZA & RUSTIONI (1992).

In  $M^2$  sin., there is damaged crown's basis below metacone. Due to a hard abrasion, neither in right nor in left

M<sup>2</sup> is a clear extent of cingulum. Only in the left one, is there a small part of cingulum preserved below a mesial half of paracone. In both M<sup>2</sup>'s, paracone bears a mesial accessory cusp and probably also parastyle was present. Talons are short and get quickly narrow. M<sup>1</sup> dex. has a damaged buccal slope of paracone and the basis below hypocone. The left one has a slight damage on the buccal slope of paracone. Both M<sup>1</sup>'s are very similar from the morphological point of view. Buccal and lingual lines of cusps are approximately parallel, metastyle and parastyle are present. The last one is smaller. Mesocone is only a small cusp wedging in between hypocone and two-pointed protocone. In P<sup>4</sup> sin. the mesial end of the tooth is broken off. Both P<sup>4</sup>'s are triangular in occlusal view, with cingulum around all tooth, protocone placed mesially from paracone/metacone boundary, and with metastyle. In both canines a posterior enamel crest is present. (pl. 2: 4; pl. 3: 1).

St. V. 792: A fragment of anterior premolar. MAZZA & RUSTIONI (1992) determined this specimen as P<sup>2</sup>. The author does not believe that such an exact determination of this fragment is possible.

St. V. 793: An anterior premolar, probably P<sup>2</sup> inf. or sup. Not mentioned in MAZZA & RUSTIONI (1992).

St. V. 970: A fragment of left maxilla with P<sup>4</sup>-M<sup>2</sup> and probably an alveolus of P<sup>3</sup>. An abrasion is only very weak. M<sup>2</sup> bears relatively weak cingulum below protocone-complex and hypocone. A small granulation is presented on the buccal wall between the paracone and metacone. Paracone is large with a strong central crest extending to a basis of protocone 1. In front of the paracone, there is a small accessory cusp that is in contact with a very weak parastyle. Metastyle is not present. A relatively strong metaloph is developed, connecting the top of metacone and a distal end of the protocone-complex. The last one is divided into two main parts but without dominant points. Hypocone is well developed, a posthypocone is not present. Talon is short but relatively huge. M<sup>1</sup> bears cingulum along the both, lingual and buccal side. Buccal and lingual lines of cusps converge slightly mesialwards. Parastyle is very weak, metastyle pronounced with a very small distal accessory cusp-like structure. Mesocone is divided into two parts, the mesial one is smaller. P<sup>4</sup> bears a cingulum around whole tooth. Protocone is placed mesially from paracone/metacone boundary. Metacone had divided its top. Metastyle was not present. (pl. 1: 6-7; pl. 2: 5).

Two more specimens are preserved in the NHMB collection as incisors of *Ursus* - St. V. 297 and St. V. 298. The first one is indetermined as I<sup>2</sup> in MAZZA & RUSTIONI

(1992). The author did not include these two teeth in this overview due to their doubtful status.

Comparison and discussion: The bears from St. Valliers have been studied in detail repeatedly since VIRET's (1954) monograph. All of these specimen, but skull fragment St. V. 755, were also included in the revision of *U. gr. etruscus* by MAZZA & RUSTIONI (1992). No important additional information was obtained in the present revision and the author can only support the idea (BARYSHNIKOV, 1991; MAZZA & RUSTIONI, 1992) of separation of these bears from the typical *U. etruscus* from Upper Valdarno. The designations of *Ursus etruscus* subsp. sensu BARYSHNIKOV (1991) or *Ursus* aff. *etruscus* sensu MAZZA & RUSTIONI (1992) seems to be adequate.

When we compare the dimensions of the same specimens published e. g. in MAZZA & RUSTIONI (1992) and those in the present paper, in some cases relative large differences can be found. The author thinks that this is not due to an inaccuracy of work. It is caused by a subjective element (e. g. orientation of tooth, decision of placing the measurement point, etc.) that is a principal and inseparable component of any measurement process (especially when someone works with bunodont teeth). This fact restricts the value of metrical characteristic as well as the possibility of comparison of data published by different authors.

#### SENÈZE

Material: Left hemimandible (Se 1714), coll. in 1928; C<sup>s</sup> sin. (Se 1505); fragment of C (? sup. sin.) (Se 1581), coll. in 1914); fragment of C (? sup. dex.) (Se 1660), coll. in 1920.

The mandible is briefly discussed in DUBOIS & STEHLIN (1933; p. 63) (there are a few measurements given, but no figure). TORRES (1992) used this material for comparison with that from Venta Micena. The left mandible could be an original of a cast discussed in MAZZA & RUSTIONI (1992; p. 114). But neither this paper nor MAZZA & RUSTIONI (1994b) specify this item enough or figure it.

Stratigraphical position of the locality: The age of fauna is uncertain. Two different niveaus are present: the earlier one of the Upper Villanyian age (younger than St. Vallier) and the later one of the Biharian age (see MAZZA & RUSTIONI (1994b) and SPASSOV (2002) for an overview). It is not clear to which faunal assemblage several taxa belong, including the bear (MAZZA & RUSTIONI, 1994b). MAZZA & RUSTIONI (1994b) discussed both possibilities (based on the character of preservation of bear material, the Pleistocene age would be more probable), on the other hand, GUÉRIN (in SPASSOV, 2002) presumed an Pliocene age for most of fauna.

Description of the studied material: Se 1714: A left hemimandible with a fragment of  $C_3$ ,  $P_2$ - $M_2$  and alveoli of  $P_1$  and  $M_3$ . Most part of the ascending ramus is broken off. The enamel is fossilized yellowish, the bone mainly brownish. An alveolus of  $M_3$  is slightly inclined and partly placed in the ascending ramus. There are three foramina mentalia present. The most distal one is located below a distal root of  $P_4$ , the largest one below  $P_3$ , and the smallest one below  $P_2$ . All three anterior premolars were present. The spacing of premolars is very similar to that of the mandible figured in MAZZA & RUSTIONI (1994b). All teeth, but  $P_{2,3}$ , are badly abraded.

$M_2$  has the lingual half of damaged distal wall. A very short segment of cingulum is present on a buccal boundary of trigonid/talonid. A large mesial metastylid is present. A mesolophid is well developed.  $M_1$  is with a broken paraconid. There is a weak cingulum below the hypoconid and the mesial end of protoconid-complex. In front of metaconid there is a large mesial metastylid present. A complete medial slope of protoconid is covered by the body of metaconid-complex. There is a small accesoric cusp in the notch between paraconid and metaconid-complex. Entoconid-complex is formed by a large main distal cusp and two small cuspids on a mesial edge.  $P_4$  is damaged at its distal end. The tooth is oval in the occlusal view, only protoconid is developed. Distal arm bifurcates in its distal half. (pl. 1: 14-16; pl. 2: 8; tab. 3).

Se 1505: Slightly abraded, good preserved canine with whitish to yellowish fossilized enamel and dark brownish bone. A posterior enamel crest is well marked in all crown's length. (pl. 2: 7).

Se 1581 and 1660: Two badly preserved fragments of canines with badly damaged crowns.

Comparison and discussion: Although the material from Senèze is very scanty and badly preserved, the author supports the opinion of MAZZA & RUSTIONI (1994b) that this bear belongs rather to *Ursus* gr. *minimus-thibetanus* than to *Ursus* gr. *etruscus*. One of the reasons, not mentioned in MAZZA & RUSTIONI (1994b), is a character of entoconid-complex. In the specimen from Senèze, it has a character of a main distal cusp with a mesially decreasing crest bearing two small cusp-like structures. On the contrary, for *U. etruscus* one well emergated cusp

without any accessory cusps or crests is more characteristic.

Correspondence in mandible and teeth measurements as well as in position of anterior premolars in right hemimandible described in MAZZA & RUSTIONI (1994b) and the left one from NHMB supports the idea that these two specimens belong to the same individual.

## RESULTS

Craniodental material of *Ursus* spp. from five Pliocene localities displayed in the Naturhistorisches Museum Basel was newly redescribed and its taxonomic status shortly discussed. Based on the above mentioned findings, the following results showed:

1) Bears from Montpellier represent the world-oldest known record of genus *Ursus*. It seems that this paleopopulation include more derived morphotypes known also in the other Ruscinian bears as well as more plesiomorphic ones that has never been described in *Ursus* before. Similarities with members of *Ursus* gr. *minimus-thibetanus* are notable.

2) An isolated and damaged canine from Vialette can not be used for detail taxonomical determination. But based on the stratigraphical position of the locality, it seems probable that it belongs to *Ursus* gr. *minimus-thibetanus*.

3) Based on both morphological and metrical characters, the material from Les Pardines can be preliminarily determined as *Ursus* aff. *etruscus*.

4) Restudy of material from St. Vallier confirmed its distinction from typical *U. etruscus* from Upper Valdarno and supported the determination as *Ursus* aff. *etruscus*.

5) Badly preserved material from Senèze can support an idea presented by MAZZA & RUSTIONI (1994b) that this bear belongs to *Ursus* gr. *minimus-thibetanus*.

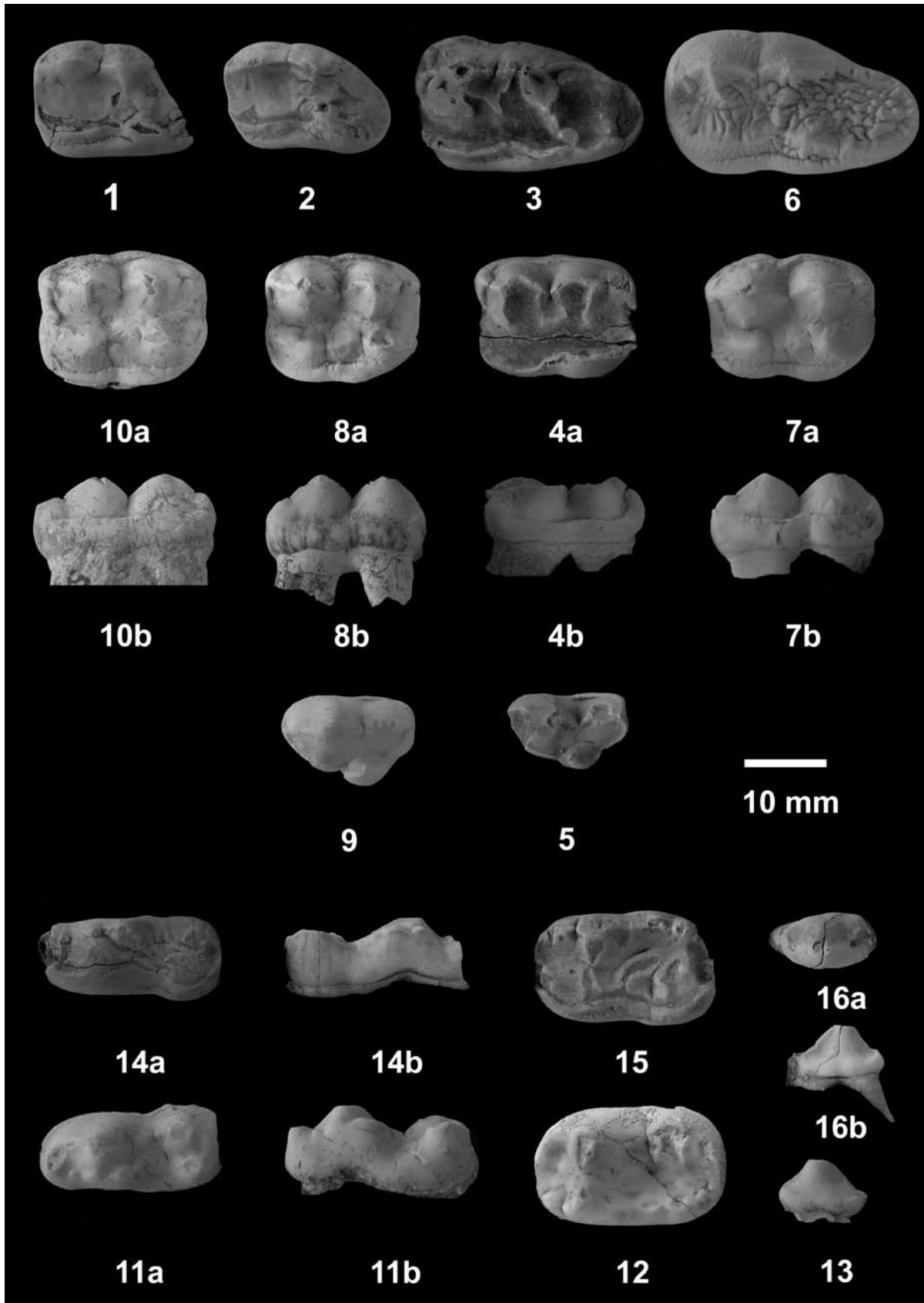
**Acknowledgements:** The author is very grateful to the Naturhistorisches Museum Basel, in particular to Dr. Burkart Engesser. Author is also very grateful to Prof. Oldřich Fejfar (Charles University, Dept. of Geology and Paleontology) for his help and support of the research. This study was supported by the Research Program CTS MSM 0021620845.

### Plate 1

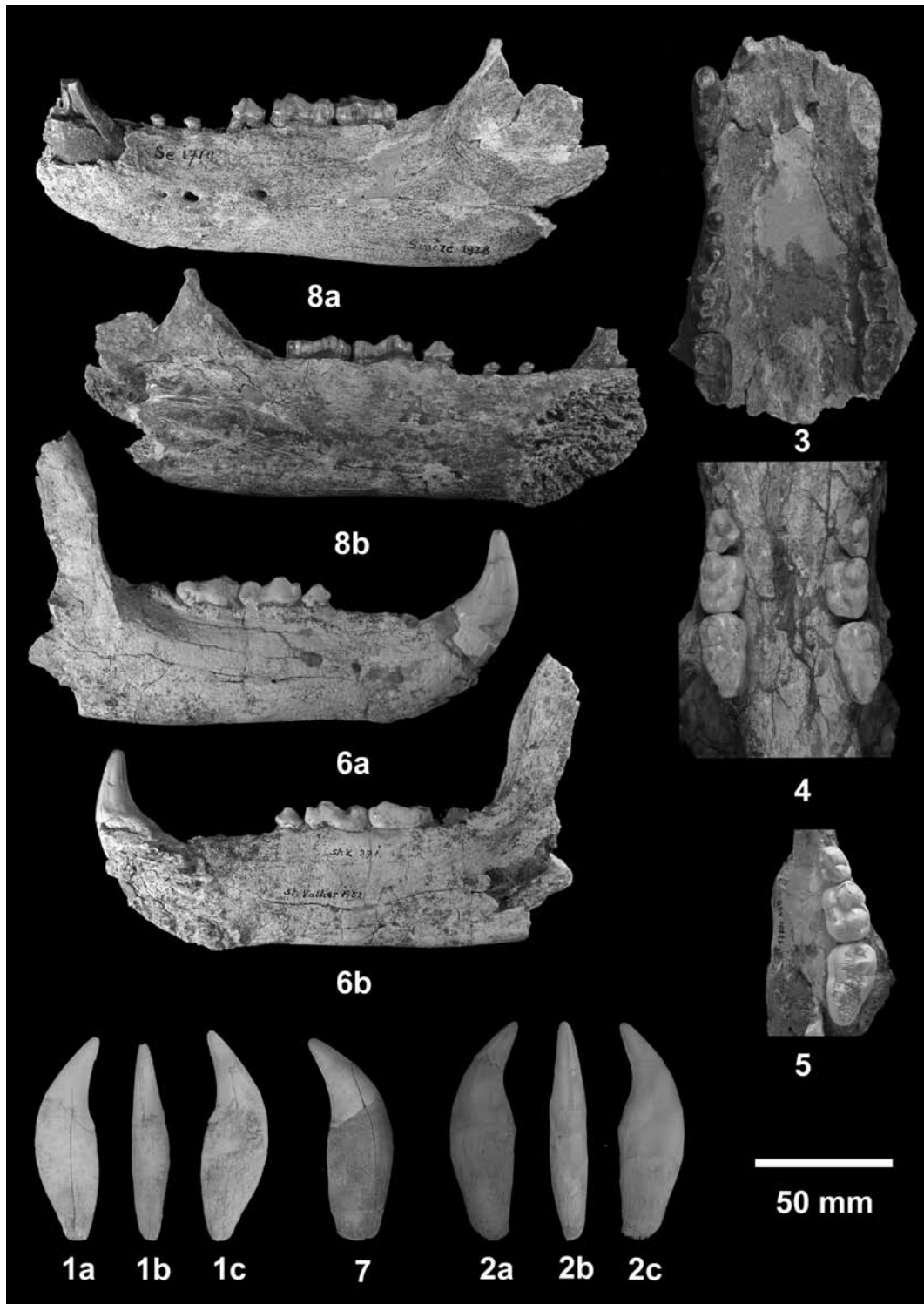
*Ursus* sp. from Montpellier. 1.  $M^2$  sin. (M. P. 509) - occlusal view. 2.  $M^2$  sin. (M. P. 848) - occlusal view. *Ursus* aff. *etruscus* from Les Pardines. 3.  $M^2$  sin. (L. P. 199) - occlusal view. 4.  $M^1$  sin. (L. P. 199) - a: occlusal view; b: buccal view. 5.  $P^4$  sin. (L. P. 199) - occlusal view. *Ursus* aff. *etruscus* from St. Vallier. 6.  $M^2$  sin. (St. V. 970) - occlusal view. 7.  $M^1$  sin. (St. V. 970) - a: occlusal view; b: buccal view. 8.  $M^1$  sin. (St. V. 293) - a: occlusal view; b: buccal view. 9.  $P^4$  sin. (St. V. 293) - occlusal view. 10.  $M^1$  sin. (St. V. 292) - a: occlusal view; b: buccal view. 11.  $M_1$  dex. (St. V. 291) - a: occlusal view; b: lingual view. 12.  $M_2$  dex. (St. V. 291) - occlusal view. 13.  $P_4$  dex. (St. V. 291) - lingual view. *Ursus* ex gr. *minimus-thibetanus* from Senèze. 14.  $M_1$  sin. (St. V. 1714) - a: occlusal view; b: lingual view. 15.  $M_2$  sin. (St. V. 1714) - occlusal view. 16.  $P_4$  sin. (St. V. 1714) - a: occlusal view; b: lingual view  
(1-2, 6-16 - photo O. Fejfar; 3-4 - photo J. W.).



Plate 1

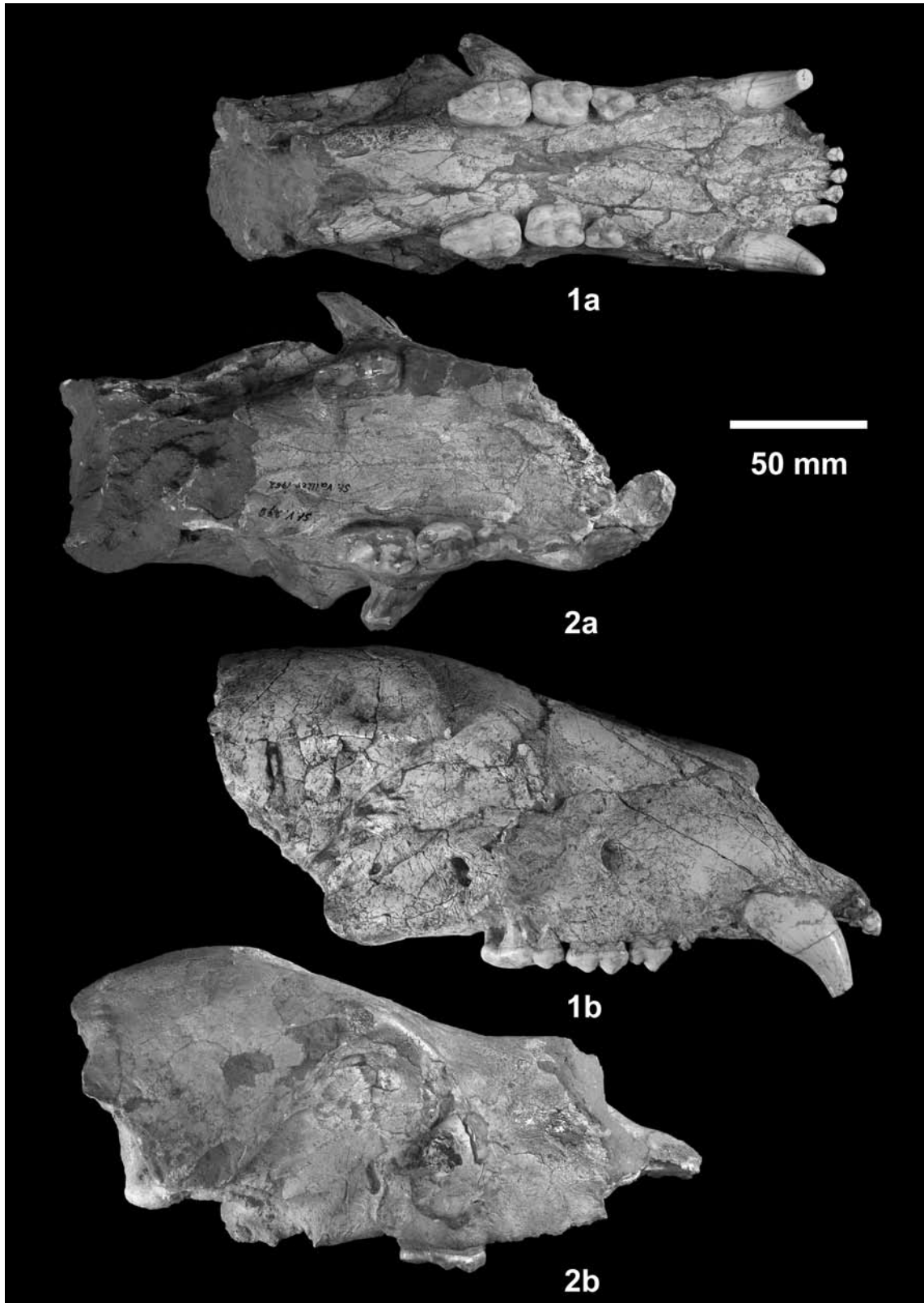


## Plate 2



*Ursus* sp. from Vialette. 1. C<sub>1</sub> sin. (Vt. 94): a: lateral view; b: posterior view; c: medial view. *Ursus* aff. *etruscus* from Les Pardines. 2. C<sup>s</sup> sin. (L. P. 228): a: lateral view; b: posterior view; c: medial view. 3. maxillar fragment with P<sup>2</sup>-M<sup>2</sup> sin et dex (L. P. 199): ventral view. *Ursus* aff. *etruscus* from St. Vallier. 4. maxillar part with P<sup>4</sup>-M<sup>2</sup> sin. et dex. (St. V. 755): ventral view. 5. maxillar fragment with P<sup>4</sup>-M<sup>2</sup> sin (St. V. 970): ventral view. 6. mandible dex with P<sub>1</sub>-M<sub>2</sub> (St. V. 291): a: lateral view; b: medial view. *Ursus* ex gr. *minimus-thibetanus* from Senèze. 7. C<sup>s</sup> sin. (Se 1505): lateral view. 8. mandible sin with P<sub>2</sub>-M<sub>2</sub> (Se 1714): a: lateral view; b: medial view. (1-2 - photo J. W.; 3-8 - photo O. Fejfar).

## Plate 3



*Ursus aff. etruscus* from St. Vallier. 1: cranium (St. V. 755): a: ventral view; b: lateral view. 2: cranium (St. V. 290): a: ventral view; b: lateral view. (photo O. Fejfar).

## REFERENCES

- ALBIANELLI, A., AZZAROLI, A., BERTINI, A., FICCARELLI, G., NAPOLEONE, G. & TORRE, D., 1997. Paleomagnetic and palynologic investigations in the Upper Valdarno basin (Central Italy): Calibration of an Early Villafranchian fauna.- *Rivista Italiana di Paleontologia e Stratigrafia*, **103**: 111-118. Milano.
- AZZAROLI, A., 1970. Villafranchian correlations based on large Mammals.- *Giornale di Geologia*, Sér. 2, **35**: 111-131. Bologna.
- AZZAROLI, A., 1977. The Villafranchian stage in Italy and the Plio-Pleistocene boundary.- *Giornale di Geologia*, Sér. 2, **41**: 61-79. Bologna.
- AZZAROLI, A., GIULI, C. DE, FICCARELLI, G. & TORRE, D., 1986. Mammal succession of the Plio-Pleistocene of Italy.- *Mem. Soc. Geol. It.*, **31**: 213-218. Roma.
- AZZAROLI, A., GIULI, C. DE, FICCARELLI, G. & TORRE, D., 1988. Late Pliocene to Early Mid-Pleistocene Mammals in Eurasia: faunal succession and dispersal events.- *Palaeogeography, Palaeoclimatology, Palaeoecology*, **66**: 77-100. Amsterdam.
- BANDET, Y., DONVILLE, B. & MICHAUX, J., 1978. Étude géologique et géochronologique du site villafranchien de Vialette (Puy-de-Dôme).- *Bull. Soc. géol. France*, sér. 7, **20**: 245-251. Paris.
- BARYSHNIKOV, G. F., 1991. *Ursus mediterraneus* in the Pleistocene of the Caucasus and comments on the history of small bears of Eurasia.- *Trudy Zoologičeskogo instituta AN SSSR*, **238**: 3-60. Sankt-Peterburg. (in Russian).
- BERZI, A., 1966. L'orso di Gaville nel Valdarno Superiore.- *Palaeontographia Italica*, **60**: 19-32. Pisa.
- BERZI, A., MICHAUX, J., HUTCHISON, J. H. & LINDSAY, E., 1970. The Arondelli local fauna, an assemblage of small vertebrates from the Villafranchian stage near Villafranca d'Asti, Italy.- *Giornale di Geologia*, Sér. 2, **35**: 133-136. Bologna.
- BONIFAY, M.-F., 1990. Relations between Paleoclimatology and Plio-Pleistocene biostratigraphic data in West European Countries.- In: "European Neogene Chronology", eds. Lindsay, E. H., Fahlbusch, V. & Mein, P.- NATO ASI-Series (A): Life Sc., **180**: 475-486. New York, London.
- BOUT, P., 1970. Absolute Ages of some Volcanic Formations in the Auvergne and Velay Areas and Chronology of the European Pleistocene.- *Palaeogeography, Palaeoclimatology, Palaeoecology*, **8**: 95-106. Amsterdam.
- CRÉGUT-BONNOURE, E., 2002. The Pliocene and Early Pleistocene Bovidae (Mammalia) from Europe. Temporal and geographical dispersion of the Tragelaphinae, Antilopinae and Caprinae.- *Annales Géologiques des Pays Helléniques*, **39**: 155-164. Athens.
- DEBARD, E., FAURE, M. & GUERIN, C., 1994. Stratigraphie du gisement villafranchien de Saint-Vallier (Drome).- *C.R. Acad. Sci. Paris*, ser. II, **318**(9): 1283-1286. Paris.
- DUBOIS, A. & STEHLIN, H.G., 1933. La grotte de Cothencher, station mousterienne.- *Mém. Soc. Paléont. Suisse*, **52**: 1-178. Basel.
- FEJFAR, O., 2001: The Arviculids from Arondelli-Triverza: a new look.- *Bollettino della Società Paleontologica Italiana*, **40**: 185-193. Modena, Giugno.
- FEJFAR, O. & HEINRICH, W.-D., 1990. Proposed biochronological division of the European continental Neogene and Quaternary based on Muroid rodents (Rodentia, Mammalia).- In: "International Symposium Evolution, Phylogeny and Biostratigraphy of Arviculids (Rodentia, Mammalia)", eds. Fejfar, O. & Heinrich, W.-D., p. 115-124. Prague.
- FEJFAR, O., HEINRICH, W.-D. & LINDSAY, E. H., 1998. Updating the Neogene Rodent biochronology in Europe.- *Mededelingen Nederlands Instituut voor Toegepaste Geowetenschappen TNO*, **60**: 533-554. Haarlem.
- FEJFAR, O., HEINRICH, W.-D., PEVZNER, M. A. & VANGENGEIM, E. A., 1997. Late Cenozoic sequences of mammalian sites in Eurasia: an updated correlation.- *Palaeogeography, Palaeoclimatology, Palaeoecology*, **133**: 259-288. Amsterdam.
- FLYNN, L. J., TEDFORD, R. H. & QIU, Z., 1991. Enrichment and stability in the Pliocene mammalian fauna of North China.- *Paleobiology*, **17**: 246-265. Lawrence.
- FLYNN, L. J. & WU, W., 2001. The Late Cenozoic Mammal Record in North China and the Neogene Mammal Zonation of Europe.- *Bollettino della Società Paleontologica Italiana*, **40**: 195-199. Modena, Giugno.
- GUÉRIN, C. & FAURE, M., 2002. The Mid-Villafranchian mammals of Saint-Vallier (Drôme, France).- *Annales Géologiques des Pays Helléniques*, **39**: 197-220. Athens.
- HEINTZ, E., GUERIN, C., MARTIN, R. & PRAT, F., 1974: Principaux gisements villafranchiens de France: Listes faunistiques et biostratigraphie.- *Mémoires du Bureau de Recherches Géologiques et Minières*, **78**: 169-182. Paris.
- HUNT, R. H. Jr., 1998. Ursidae.- In: "Evolution of Tertia-

- ry Mammals of North America. Volume 1: Terrestrial Carnivores, Ungulates, and Ungulate-like Mammals”, eds. Janis, Ch. M., Scott, K. M. & Jacobs, L. L., p. 174-195. Cambridge, New York, Melbourne.
- KURTÉN, B., 1963. Villafranchian faunal evolution.- *Societas Scientiarum Fennica, Commentationes Biologicae*, **26**: 1-18. Helsingfors.
- MAIER VON MAYERFELS, S., 1929. Zur Stammesgeschichte der europäischen Bären.- *N. Jb. f. Min., Geol. Pal.*, Beil.-Bd., **62**: 325-332. Stuttgart.
- MAZZA, P. & RUSTIONI, M., 1992. Morphometric revision of the Eurasian species *Ursus etruscus* Cuvier.- *Paleontographia Italica*, **79**: 101-146. Pisa.
- MAZZA, P. & RUSTIONI, M., 1994a. On the Phylogeny of Eurasian Bears.- *Palaeontographica*, Abt. A, **230**: 1-38. Stuttgart.
- MAZZA, P. & RUSTIONI, M., 1994b. The fossil bear from Senèze (Southern France). – *Rend. Fis. Acc. Lincei*, Ser. 9, **5**: 17-26. Roma.
- MORLO, M. & KUNDRÁT, M., 2001. The first carnivoran fauna from the Ruscium (Early Pliocene, MN 15) of Germany.- *Paläontologische Zeitschrift*, **75**: 163-187. Stuttgart.
- PARMALEE, P. W., KLIPPEL, W. E., MEYLAN, P. A. & HOLMAN, J. A., 2002. A Late Miocene-Early Pliocene Population of *Trachemys* (Testudines: Emydidae) from East Tennessee.- *Annals of Carnegie Museum*, **71**: 233-239. Pittsburgh.
- PALOMBO, M. R., AZANZA, B. & ALBERDI, M. T., 2000-2002. Italian mammal biochronology from the Latest Miocene to the Middle Pleistocene: a multivariate approach.- *Geologica romana*, **36**: 335-368. *Annals of Carnegie Museum*. Roma.
- QIU, Z., 2003. Dispersals of Neogene Carnivorans between Asia and North America.- *Bulletin of the American Museum of Natural History*, **279**: 18-31. New York.
- RABEDER, G., 1983. Neues von Höhlenbären. Zur Morphogenetik der Backenzähne.- *Die Höhle*, **34**: 67-85. Wien.
- RABEDER, G., 1989. Modus und Geschwindigkeit der Höhlenbären-Evolution.- *Schrift. Ver. Verbr. naturwissenschaftliche Kenntnisse*, **127**: 105-126. Wien.
- RABEDER, G., 1999. Die Evolution des Höhlenbären-Gebisses.- *Mitteilung der Kommission für Quartärforschung der Österreichischen Akademie der Wissenschaften*, **11**: 1-102. Wien.
- RODE, K., 1935. Untersuchungen über das Gebiß der Bären.- *Monographien zur Geol. und Paleont.*, **7**: 1-162. Leipzig.
- ROŠČIN, A. D., 1956. Verchnopliocenova fauna pivdnja Ukrainy.- *Tr. Odesskogo per. instituta*, **14**: 33-84. Odessa. (in Ukrainian).
- RYZIEWIECZ, Z., 1969. Badania nad niedzwiedziami pliocenskiemi.- *Acta Palaeont. Polonica*, **14**: 200-243. Warszawa.
- RUSTIONI, M. & MAZZA, P., 1993. The genus *Ursus* in Eurasia: Dispersal events and stratigraphical significance.- *Rivista Italiana di Paleontologia e Stratigrafia*, **98**: 487-494. Milano.
- SABOL, M., 2004. Carnivores.- In: “Early Villanyian site of Hajnáčka I (Southern Slovakia). Paleontological research 1996-2000”, ed. Sabol, M., p. 75-81. Rimavská Sobota.
- SPASSOV, N., 2002. The Late Villafranchian and biochronology of south-east Europe: faunal migrations, environmental changes and possible first appearance of the genus *Homo* on the continent.- *Annales Géologiques des Pays Helléniques*, **39**: 221-243. Athens.
- TEDFORD, R. H. & HARRINGTON, C. R., 2003. An Arctic mammal fauna from the Early Pliocene of North America.- *Nature*, **425**: 388-390. London.
- TORRE, D., MAZZA, P., ROOK, L., 2002. The «Wolf-event» in Italy.- *Annales Géologiques des Pays Helléniques*, **39**: 311-316. Athens.
- TORRES PÉREZ HIDALGO, T., 1992. Los restos de oso del yacimiento de Venta Micena (Orce, Granada) y el material de *Ursus etruscus* G. Cuvier del Villafranchiense Europeo.- In: “Proyecto Orce-Cueva Victoria (1988-1992). Presencia humana en el Pleistoceno inferior de Granada y Murcia”, ed. Gibert, J., p. 87-106. Orce.
- VANGENGEIM, E. A., VISLOBOKOVA, I. A. & SOTNIKOVA, M. V., 1996. Large Ruscian Mammalia in the Territory of the Former Soviet Union.- *Stratigraphy and Geological Correlation*, **6**: 368-382. Moskva.
- VIRET, J., 1954. Le loess a bancs durcis de Saint-Vallier (Drome) etsa faune de mammifères villafranchiens.- *Nou. Arch. Mus. Hist. Nat. Lyon*, **4**: 1-200. Lyon.