INTRODUCTION

The buccal microwear analyses have been carried out on numerous past populations. Focusing mainly on inter- and intra-population variability within non-occlusal striation pattern on postcanine dentition, these analyses have yielded valuable information about dietary habits (Puech, Pant 1980, Pérez-Pérez et al. 1994, Lalueza et al. 1996, Pérez-Pérez 1990, 2004, Romero et al. 2004, etc.). As proved, there is a tendency to exhibit less striations and higher frequency of vertical striations on the dental surface in meat eaters than in vegetarians. High incidence of abrasive particles in plant foods (phytoliths) results in higher scratch densities and increasingly horizontally oriented vestibular microwear pattern in agricultural populations (Lalueza et al. 1996). Embedment and classification of phytoliths in enamel surface has been proved in previous research made by Lalueza Fox and his colleagues (1994) in La Olmeda sample. In addition, buccal microwear is independent from individuals’ analysed teeth as the intergroup variability seems to be significantly higher than the intragroup one and seems to be independent in regards to seasonal variations in dietary habits because of its long-termed “turnover” effect in comparison to occlusal microwear pattern (Pérez-Pérez et al. 1994).
Ivana Jarošová

MATERIAL AND METHODS

Dolní Věstonice site
The archaeological site is located near Břeclav (Czech Republic) in south Moravia (Figure 1) and was being excavated in the mid-1950s. There were two Slavonic burial sites discovered in the area of present-day Dolní Věstonice village. The larger and older one, called Na Pískách (“On the Sands”), is dated between the late-8th and mid-11th century, with predominance for the graveyard in the 9th century AD (Poulík 1948–50, 1949, 1950, Tichý 1958, 1959, 1960). This extensive, but generally not well-preserved skeletal sample represents one of the three largest archaeological populations (893 individuals with more than 8,800 teeth) from the early medieval period in the area of the Czech Republic. The smaller one falls to the 12th century and is named Vysoká zahrada (“The High Garden”). Within this burial site around the church, 129 individuals were discovered with almost 1,000 teeth (Jarošová 2007).

Because of the location of both localities on the Dyje river bank, the osteological material was strongly damaged by repeated floods and after drying out both dental enamel and bone surfaces were in many cases flaking off the teeth and bones. That is why it was possible to study only some individuals for microwear analysis, i.e. those with well-preserved enamel surface.

The final analysed skeletal sample from Dolní Věstonice – Na Pískách consisted of 22 (35.5%) adult males, 26 (41.9%) adult females and 14 (22.6%) juveniles (0–19 years old). From Dolní Věstonice – Vysoká zahrada, only 17 (47.2%) adult males, 11 (30.6%) adult females, one adult individual and 7 (19.4%) juveniles (0–19 years old) were suited for microwear analysis. All data on the individuals’ sex and age-at-death was adapted from previously carried out estimations in paleodemographic analysis (Hrnčířová, Jarošová 2004, 2005, 2007, Jarošová, Hrnčířová 2005).

Comparative modern human samples
Buccal microwear has been studied in modern hunter-gatherers, pastoralists, and agriculturists originating from different ecological conditions and food gaining from all over the world. In regard to ecological criteria that, as shown, correspond with the geographical latitude underneath these people have been living, these populations might be divided into four broad groups: (1) agriculturalists (Hindus), (2) mix-diet hunter-gatherer populations from tropical forest (Andamanese and Veddas), (3) carnivorous hunter-gatherer and pastoralist populations, including Fueguians (mainly hunting and fishing), Inuits (exclusively hunting strategies), Vancouver Islanders (mainly fishing and hunting), and Lapps (predominantly reindeer herding); and (4) mix-diet hunter-gatherer populations from arid and mesothermal environments, including Bushmen, Australian

FIGURE 1. Location of Dolní Věstonice, Czech Republic.

Data collection
Teeth moulding. Although both molars and premolars from 98 individuals from Dolní Věstonice site were considered for buccal microwear analysis, only a single tooth per individual was finally analysed (Jarošová 2007). Negative impressions of the tooth’s buccal surface were obtained using polyvinylsiloxane Affinis Regular Body (Coltène®). Afterwards the bicomponent polyurethane resin Feroca Feropur was applied to make positive moulds (Galbany et al. 2004). Ultimately, the tooth replicas were sputtered coated with a 400 Å gold layer using SCD Balzers unions 040 and proceeded for SEM imaging.

SEM imaging. SEM images were obtained with Scanning Electron Microscope Tescan Vega TS 5136XM at Masaryk University, Brno (Figure 2). Micrographs were taken at 226x magnification on the medial third of the buccal surface of the tooth crown (Pérez-Pérez et al. 1994). (Note: the 226x magnification was computed because of wide-angled scanning window of Tescan Vega. These micrographs are compatible with 100x magnification of SEM Cambridge Stereoscan 120 at the SCT, University of Barcelona). All SEM pictures were digitalized using SEM Vega TC Software Image Processing, obtaining 1024x1024 pixels images that were subsequently enhanced with Adobe Photoshop v. 5.0, where the selected area of 0.56 mm² was cropped (Jarošová 2007) (Figure 3).

Data acquisition
Using image analysis software package SigmaScan Pro 5.0, the length (X), standard deviation of the length (SD), and number (N) of all striations present (T) were computed and 4 categories of orientation from 0˚ to 180˚ – in 45-degree intervals – were determined with respect to the given tooth’s orientation: V=vertical, MD=mesio-occlusal to disto-cervical, DM=disto-occlusal to mesio-cervical, and H=horizontal. Mean values for each individual’s tooth were characterized by a sum of 15 variables (Puech et al. 1980, Pérez-Pérez 1990, Lalueva, Pérez-Pérez 1993, Lalueva et al. 1993, 1996, Pérez-Pérez et al. 1999, 2003, Jarošová et al. 2006). All statistics were calculated with SPSS 14.0 Inc., and STATISTICA 7.0 StatSoft Inc. (2004) package. The significance of all statistics was evaluated at p≤0.05 level.

RESULTS AND DISCUSSION
Dolní Věstonice microwear pattern
In total, a number of 5,094 striations within the sample of 62 individuals from Dolní Věstonice – Na Pískách and 3,043 striations within the sample of 36 individuals from Dolní Věstonice – Vysoká zahrada were evaluated. No deviations from the normal distribution of all variables were observed (Kolmogorov–Smirnov normality test, p>0.05). Mean values, medians, minimums, maximums and standard deviation values are shown in Table 1a, b. The density of microstriations (NT) in modern human hunter-gatherer groups ranges between 32.0 and 74.8 (Lalueva et al. 1996), whereas the Dolní Věstonice sample reaches yet higher values (Dolní Věstonice – Na Pískách: NT=82.2 with median in 78.5; and Dolní Věstonice – Vysoká zahrada: NT=84.5 with median in 83.5) (Figure 4a). This result may indicate highly abrasive diet in Dolní Věstonice sample, based mainly on plant food. By comparing the average striations length (XT), both populations from Dolní
FIGURE 3. SEM images of selected individuals studied from Dolní Věstonice, Czech Republic. Each square enhanced with Adobe Photoshop v. 5.0.
and surface analysed covers 0.56 mm² of buccal enamel surface. Occlusal surface faces the top of micrograph. Micrograph of adult (20–39 yrs) female No. 15b from Dolní Věstonice – Vysoká zahrada (a); micrograph of adult (20–29 yrs) male No. 586a/56 from Dolní Věstonice – Na Pískách (b); micrograph of adult (20–29 yrs) male No. 37b from Dolní Věstonice – Vysoká zahrada (c); micrograph of adult (50–59 yrs) male No. 32/52-II from Dolní Věstonice – Na Pískách (d); micrograph of adult (20–29 yrs) female No. 542/55 from Dolní Věstonice – Na Pískách (e); micrograph of adult (30–39 yrs) female No. 360/55 from Dolní Věstonice – Na Pískách (f).
Věstonice approach mix-diet hunter-gatherer populations from tropical forest and arid environments (Figure 4b).

Non-parametric Kruskal–Wallis ANOVA for 15 variables gave statistically significant sex-related differences within Dolní Věstonice – Na Pískách population in number of vertical striations (nV: p=0.0122) and in density of microstriations (p=0.0116). Females from the 9th century exhibit increased number of microwear pattern than males (Figure 4a) without difference in their average length (Figure 4b). Moreover, lower values of vertical striations in males partly overlap with the values reported for carnivorous hunter-gatherers (Figure 4c). In conclusion, sexual dimorphism in dietary strategy, with predominance in vegetal food intake by females and increased meat intake by males, might be hypothesized. The total number of striations increases with age in both samples (Figure 5a) and the average length of all striations increases within the younger, and decreases within elders (Figure 5b), as it has been proved in previous studies (Pérez-Pérez et al. 1994). Similarly, age-related differences were found in a number of horizontal striations (NH: p=0.0102) in Dolní Věstonice – Na Pískách sample (Figure 5c). Individuals within the age category over 50-year-old show increased number of horizontal striations and this group is fully overlapped with Hindu farmers, whose food intake is fully vegetarian. Only the age group of 35–50-year-old from Dolní Věstonice – na Pískách come close to minimal number of horizontal striations (NH) of carnivorous hunters. Thus, increased amount of meat intake is possible to infer by this group. Because of established sex and age differences within the early medieval sample from Dolní Věstonice – Na Pískách it is possible to infer social stratification in the 9th century AD, historically known as the Great Moravian epoch.
FIGURE 4. Boxplot showing the density of microstriations (NT) (a), the length of microstriations (XT) (b), and the number of vertical microstriations (NV) (c) observed in the teeth of arid, tropical, vegetarian and carnivorous populations in comparison with the whole analysed sample (DV Písky), males (DV P M) and females (DV P F) from the human population Dolní Věstonice – Na Pískách and analysed sample (DV VZ), males (DV VZ M) females (DV VZ F) and undetermined individuals (DV VZ A) from the human population Dolní Věstonice – Vysoká zahrada.

FIGURE 5. Boxplot showing the density of microstriations (NT) (a), the length of microstriations (XT) (b), and the number of horizontal microstriations (NH) (c) observed in the teeth of arid, tropical, vegetarian and carnivorous populations in comparison with the human populations from Dolní Věstonice – na Pískách (DV P) and Vysoká zahrada (DV VZ); Sub = 15–19 yrs, YgAd = 20–35 yrs, MidAd = 35–50 yrs, Old = 50+yrs.
Dental Buccal Microwear of the Medieval Population from Dolní Věstonice, Czech Republic

The situation with microwear pattern of Dolní Věstonice – Vysoká zahrada was different. Non-parametrics Kruskal–Wallis ANOVA for 15 variables gave statistically significant sex-related differences within Dolní Věstonice – Vysoká zahrada population in XMD and standard deviation STDDM variables, but it is impossible to clearly interpret them by present-day state of research. No other differences in this population were found, except slightly lower density (nT) and shorter average length (XT) of striations in females. Thus, it may be concluded that composition of diet in males and females in the 12th century was almost identical.

There are two more individuals (without determined sex) whose microwear pattern density correlate with that of arid populations, but the average microwear length is variable. Both total number of striations and the average length of all striations increases with age in the adult sample and decreases within elders (50+ yrs) (Figure 5a, b). Despite these variances, no statistical age differences were proved using non-parametrics Kruskal–Wallis ANOVA. From this point of view it is possible to infer uniformity of dietary habits in the population from Dolní Věstonice – Vysoká zahrada.

Using one-way ANOVA, seven of fifteen variables in Dolní Věstonice – Na Pískách and nine of fifteen variables of the buccal microwear patterns in Dolní Věstonice – Vysoká zahrada differed significantly among groups (Table 2). The Bonferroni post hoc test within ANOVA (Table 3) shows that both populations from Dolní Věstonice through their dietary habits are the most similar to the tropical and arid populations, whereas carnivorous vs.

<table>
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<tr>
<th>Variable</th>
<th>Dolní Věstonice – Na Pískách</th>
<th>Dolní Věstonice – Vysoká zahrada</th>
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The situation with microwear pattern of Dolní Věstonice – Vysoká zahrada was different. Non-parametrics Kruskal–Wallis ANOVA for 15 variables gave statistically significant sex-related differences within Dolní Věstonice – Vysoká zahrada population in XMD and standard deviation STDDM variables, but it is impossible to clearly interpret them by present-day state of research. No other differences in this population were found, except slightly lower density (nT) and shorter average length (XT) of striations in females. Thus, it may be concluded that composition of diet in males and females in the 12th century was almost identical.

TABLE 2. Analysis of variance of the 15 variables studied in human populations. Seven of the fifteen variables in Dolní Věstonice – Na Pískách and nine of the fifteen variables in Dolní Věstonice – Vysoká zahrada show significant between-group differences at a 0.05 level of significance (marked with a star).

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TABLE 3. Multiple comparisons: Bonferroni post hoc test showing significant between-group differences. (* The mean difference is significant at the 0.05 level; ** the mean difference is significant at the 0.01 level.) Only the variables and groups where differences have been detected are presented (DV P = Dolní Věstonice – Na Pískách, DV VZ = Dolní Věstonice – Vysoká zahrada).

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Dolní Věstonice present the most distinct group of all (the population Na Pískách differs from carnivorous in seven variables and population from Vysoká zahrada in six variables out of fifteen). By comparing the vegetarians group to Na Pískách and Vysoká zahrada population, it is obvious that the 9th century Old-Slavonic population was more depending on vegetal / cereal food than the later dated population from Vysoká zahrada. Thus, generally high meat intake in diet was excluded, and mixed diet with predominance of cereal / vegetal food confirmed in Dolní Věstonice – Na Pískách.

To illustrate further populations’ affinities based on buccal microwear pattern, a joining tree-clustering (Euclidean distances, complete linkage) of 15 variables has been performed and Figure 6 shows the cladogram obtained. When clustering closer groups indicating likenesses in abrasiveness and composition of eaten food, then the Dolní Věstonice groups show on the one side similarities with arid groups of Tasmanians and Bushmen and tropical Veddas; on the other side great dissimilarities with carnivorous populations. An extensive research of the Veddas has been performed and Figure 6 shows the cladogram obtained. As shown in Figure 6, there is also obvious similarity between female and male diets within the whole Dolní Věstonice sample. Females of both populations make cluster with Dolní Věstonice – Na Pískách sample where predominance of vegetal / cereal food was inferred, white both male populations make cluster with Dolní Věstonice – Vysoká zahrada, where slightly greater income of meat food was found out.

**Slavonic Livelihood**

The Slavonic archaeology reached very valuable results in investigation of agricultural production. The main role in Slavonic agriculture belongs to vegetable production, whereas the main source of animal husbandry rises from breeding of domestic animals besides occasional fishing and hunting.

Historically the most valuable material is to be found in settlement sites (mostly kitchen refuse), but there were neither animal bones findings nor grain remains finds in Dolní Věstonice medieval site. The only animal bone remains found in Dolní Věstonice site were those from grave inventory. That is why we had to lean upon the written sources or findings from other connected medieval settlements in examining what the Slavs had supposedly eaten in medieval times.

**Plants.** In searching information concerning agriculture of early Slavonic states there are two sources: the rests of plants in archaeological finds and mentions in written sources, concerning the kinds of plants and ways of their use. Grain cultivation was of basic significance in early Slavonic agriculture. In Bohemia wheat prevailed, cultivated on a large scale and richly used in the consumption, whereas in other Slavonic countries main significance was given to millet and to rye. In the early Middle Ages rye was cultivated only as a secondary plant besides wheat, but at the end of that epoch (i.e. the 12th–13th centuries) rye drove out wheat from its position of the main bread source, which was a common and general source of known food mentioned in written sources besides legumes and cabbage. Millet, on the other hand, which is supposed to be the most common sort of grain in Slavonic countries, was probably cultivated on a smaller scale in Bohemia, and in the early Middle Ages markedly less than the other crops. Barley, as proved by archaeological finds, was largely cultivated, but is almost never mentioned in written sources. It was probably mainly used as fodder, and only partly as food for common people (e.g. beer and cakes). The cultivation of oat was closely connected with horse-breeding (Krzemienksa 1963).

**Animals.** Analogies from other related medieval settlements proved mostly pigs and cattle breeding. In early medieval times, their ratio varied from settlement to settlement. In south Moravian 9th century settlements, prevalence of pigs has been assessed (Kratochvíl 1969a). Hunting was quite rare in that period – bones of wild animals represented approximately only 2% of all discovered animal bones. The main source of meat food was the breeding of domestic animals (Kratochvíl 1969b). Also fluvial fishing was sporadically proved in Slavonic populations (Beranová et al. 2006).
CONCLUSION

The analysis of buccal microwear pattern, carried out on early medieval specimens from Dolní Věstonice – Na Pískách site (9th century AD) indicates plant foods with large amounts of silica phytoliths. The diet of the Dolní Věstonice population was probably highly dependent on cereal resources, since meat consumption was low. In the subsequent period partial increase in meat food was assessed, without any differences according to sex and age categories. The microwear pattern observed is in agreement with the expected results and contributes to the knowledge of buccal microwear variability for agricultural populations. This research will allow future detailed analyses of early agricultural populations and provide datasets for future comparisons.

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