Chapter 5
Azokh Cave Hominin Remains

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Abstract Hominin remains have been discovered at Azokh Cave from three different entrance passageways during the early and present phases of excavation. Evidence for three different species of hominin – *Homo heidelbergensis*, *Homo neanderthalensis*, and *Homo sapiens* – has been found at Azokh Cave. A fragment of hominin mandible was found in Azokh 1 in 1968. Previous studies, published in Russian and summarized here, suggest this specimen is most similar to the Ehringsdorf (adult) specimen which may now be considered as an early Neanderthal. An original assessment of a replica of the mandible carried out here indicates the specimen is similar to European Middle Pleistocene hominins, and we assign it tentatively to *Homo heidelbergenis*. A complete permanent first upper left molar tooth was found higher in the Azokh 1 sequence by the present excavation team. Preliminary description and metric analyses of the tooth indicate the specimen is typical of Neanderthal first upper molars and is most similar to Neanderthal specimens from Krapina, Croatia. A partial skeleton and two teeth of modern *Homo sapiens* have been found in Azokh 2 by the current excavation team, and evidence suggests death was accidental. Eight modern *Homo sapiens* teeth, discovered in Azokh 5 and thought to represent a minimum of three individuals (a child, a juvenile and an adolescent), are described here.

Резюме В данной главе рассматриваются останки гоминид, обнаруженные в трех различных входных камерах Азохской пещеры в течение предшествующего и современного этапов раскопок. К настоящему времени на стоянке выявлены свидетельства присутствия трех различных видов гоминид – *Homo heidelbergensis, Homo neanderthalensis* и *Homo sapiens*. В *Азох 1* фрагмент нижней челюсти гоминида был найден предшествующей группой исследователей в период раскопок, проводимых в 1960-х гг. Есть неопределенность относительно возраста находки, которая была обнаружена в отложениях 250–400-тысячелетней давности. Образец представляет собой фрагмент правой половины нижней челюсти и содержит полностью сохранившийся третий моляр. Результаты предыдущих исследований, опубликованные на русском языке, обобщены в данном разделе. Находка имеет наибольшее сходство с образцом (взрослая особь) из Эрингсдорфа и может представлять собой локальный вариант того же вида. Мы провели тщательную экспертизу реплики данного фрагмента, которая показала, что находка хорошо вписывается в морфологические

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границы европейских среднеплейстоценовых гоминид. Использование различных моделей для объяснения эволюции данной группы гоминид показывает, что рассматриваемый образец может быть классифицирован как *H. heidelbergensis* или ранний неандерталец. Основываясь на примитивных признаках находки и некоторых специфических деталях, мы отдаем предпочтение предшествующему предположению и относим ее к виду *Homo heidelbergensis*.

Во время раскопок, проводимых нашей группой в 2010 г., в верхних слоях *Азох 1*, в отложениях возрастом около 100 тыс. лет, был найден полностью сохранившйхся коренной первый верхний левый моляр гоминида. В данной главе представлены предварительное описание и метрический анализ находки. Полученные результаты указывают, что обнаруженный зуб является типичным первым верхним моляром неандертальца и наиболее близок по форме к неандертальским образцам из Карпины (Хорватия). Третья серия находок датируется голоценом: останки расчлененных нижних конечностей современного *Homo sapiens* были обнаружены в *Азох 2* в течение полевого сезона 2007 г. Найдены также два зуба – верхний правый премоляр и нижний правый боковой резец, которые могли принадлежать той же особи, возраст которой был оценен в 12–13 лет на момент смерти. В текущей фазе раскопок в *Азох 5* были обнаружены зубы и фаланга, принадлежащие анатомически современному человеку.

Keywords *Homo heidelbergensis* • Neanderthals • *Homo sapiens* • Teeth • Mandible

Introduction

Azokh 1 was intensively excavated over many years. In 1968 a fragment of a hominin mandible was found by a team of Azerbaijani and Russian scientists (Huseinov 1985; Lioubine 2002). It was thought to represent the transition between *Homo erectus* and *Homo neanderthalensis* (Gadziev and Huseinov 1970), and the species was subsequently regarded as a local variant of early "*Palaeoanthropus*" (Kasimova 1986, 2001). Ten stratigraphic layers were described: Layer III was associated with Mousterian stone tool technology, Layer V was associated with Acheulian lithics together with the hominin mandible, while pebble tools discovered in the lower layers (VII to X) were described as having affinities with those found at Olduvai (Huseinov 1985). In addition, a rich fauna of large and small vertebrates was described, with 45 species from Layer V (Huseinov et al. 1985). The faunal remains and stone tools recovered from these extensive initial excavations are currently housed at the Natural-Historical Museum and Medical University of Baku in Azerbaijan.

Excavations were resumed by the present international and multidisciplinary research group in 2002 and continue to the present day (see Fernández-Jalvo et al. 2016). This new phase of excavation has revealed a long and almost continuous stratigraphic sequence at Azokh 1 from the Middle Pleistocene to the Holocene. A number of new cave entrances have been discovered during the course of this work, including Azokh 2 and 5, both of which are intact chambers with undisturbed fossiliferous and archaeological remains (Murray et al. 2010, 2016; Fernández-Jalvo et al. 2010, 2016). There is now evidence of three species of hominin: from Azokh 1 the partial mandible now referred to *Homo heidelbergensis* and an isolated molar of *H. neanderthalensis*; and several specimens of *H. sapiens* recovered from Azokh 2 and 5. We follow Rosas and Bermúdez de Castro (1998) for the definition of *H. heidelbergensis*, considered as the European Middle Pleistocene species directly ancestral to Neanderthals.

Here we focus on the hominin remains found at Azokh Cave, which span the period from the Middle Pleistocene to the Holocene. The partial mandible found in 1968 from Layer V is associated with a Middle Pleistocene fauna, and its description forms the first part of this chapter based on the publications in Russian describing the specimen. This section also includes an original assessment of the Azokh mandible using direct observations made on a cast of the specimen. This is followed by a preliminary description, presented for the first time here, of a recently discovered Neanderthal tooth from Unit II in Azokh 1. The last part of the chapter focuses on the modern human Holocene remains that have been discovered during recent excavations in Azokh 2 and Azokh 5 Caves.

Hominin Mandibular Fragment from Azokh 1

In 1968 a fragment of hominin mandible was discovered during excavations of Azokh 1 (Fig. 5.1). It was recovered from Unit V, which was assigned to the end of the "Mindel-Riss" period (Gadziev and Aliev 1969; Kasimova

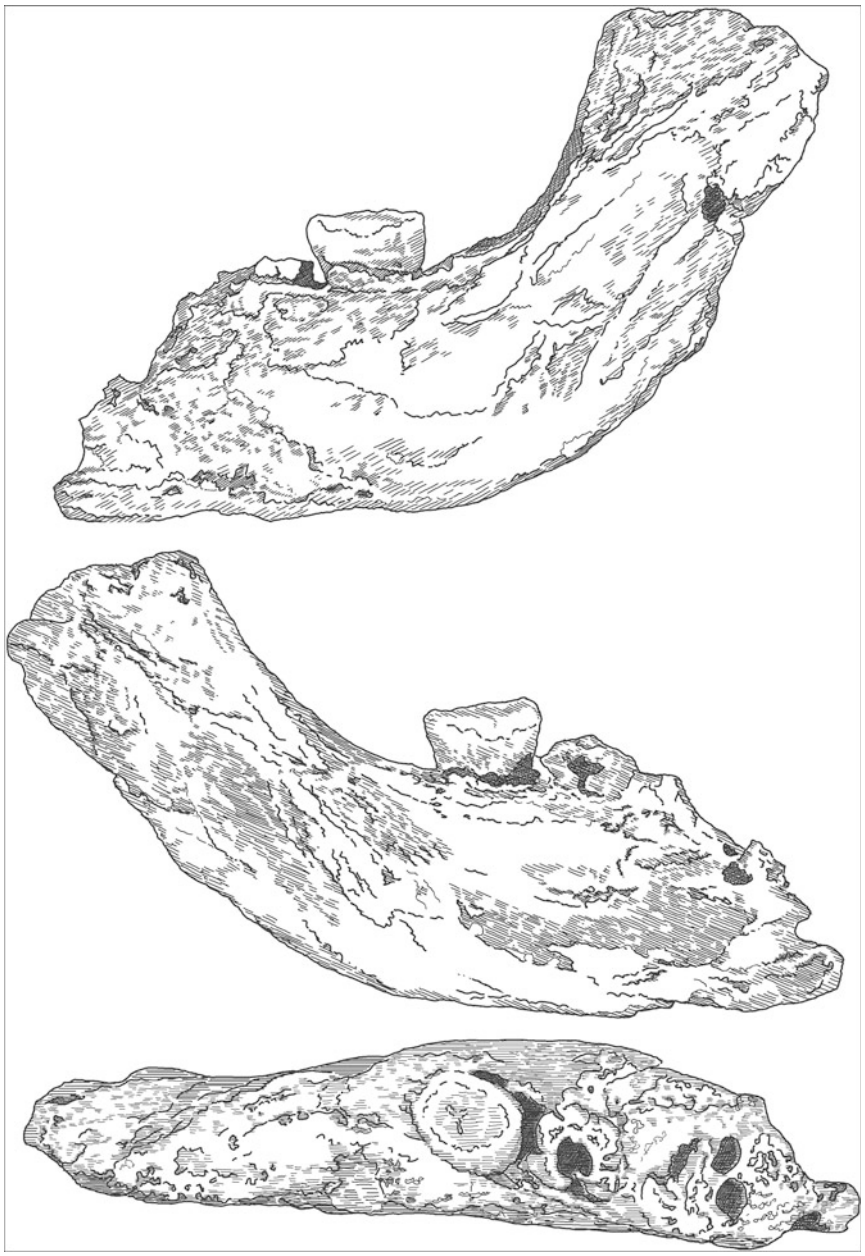

Fig. 5.1 Illustration of the Azokh 1 mandible. Lateral (top), medial (middle) and occlusal (bottom) views are shown

2001). Stone tools recovered from this level have been identified as Acheulian (Djafarov 1983; Doronichev 2008), and an extensive fossil fauna was analyzed (Huseinov 1985).

There is uncertainty about the exact location of the mandible within Layer V, which was subdivided into six horizons, thereby making it difficult to provide a precise age for the specimen. No radiometric dating was carried out during this phase of excavations. Gadziev and Huseinov (1970, p. 15) state that the fragment was recovered from the third horizon of Layer V, which was said to have an age of 250,000 years (Huseinov 1973, p. 20). However, in another publication, the specimen is reported as coming from the fifth horizon of Layer V with an age of 350,000–400,000 years (Huseinov et al. 1985). These dates were apparently based on correlations with the old concept of glacial-interglacial cycles.

One study of the mandible has been carried out to date and published in Russian (Kasimova 1986), with a more recent, shorter version published in English (Kasimova 2001). Kasimova describes it as a fragment of right mandible consisting of the posterior portion of the body and inferior part of the ramus, which is incomplete (Fig. 5.1). The mandibular body is broken at the level of the second premolar, and the inferior border is broken at the level of the mental foramen (Kasimova 1986, 2001). The ramus lacks the coronal and condylar processes. The third molar is present and complete with roots, the second molar is broken off at the base of the crown with the roots remaining, and the first molar is absent except for its distal root (Kasimova 1986, 2001). The third molar is worn and polished but does not have any dentine exposures (Kasimova 1986).

Morphology and Metrics of the Azokh Mandible

According to Kasimova (2001) the mandibular body is broad, with its greatest thickness at the level between M_2 and M_3, and it has a relatively low height in comparison with breadth. The alveolar margin is thicker than the basal edge, and widens towards the ramus (Kasimova 2001). The molar tooth crypts are positioned in the middle of the alveolar edge (towards the center), such that they are positioned far from the lingual margin; the distance from the alveolar margin lingually to the molar tooth crypts is 3 mm, rising to 5 mm at the level of M_3 posteriorly. On the lateral surface the oblique line is weakly developed. On the medial surface the mylohyoid line is barely visible. The mandible has a single large mental foramen 15 mm from the alveolar edge, at the level of the fourth premolar. A retromolar space is present, which Kasimova in (1986, 2001) states is 38 mm in length. However, in her 1986 publication she also states the length of the retromolar space is 8.0 mm, and from the views of the mandible presented in Fig. 5.1 it is apparent that the length of the retromolar space is more consistent with the latter measurement than the former, and appears to be similar in length to the M_3.

The ramus is oriented posteriorly, and the medial surface is smoother than the lateral surface. A foramen mandibula is present on the medial surface and has a diameter of 2 mm. Also present on the medial surface is a weakly developed lingula mandibula and posterior to this is the mylohyoid groove. On the lateral surface there is a weakly developed attachment for the masseter muscle, and a more strongly developed and longer attachment for the pterygoid muscle. The medial pterygoid is strongly developed and has a greater extension than the lateral pterygoid (Kasimova 2001).

Kasimova (1986) provides a metric comparison between the Azokh mandible, modern humans, and a series of different hominin groups. In some instances, these measurements have been taken at points that are non-standard in the literature, which may in part reflect absence of key landmarks/anatomy due to the fragmentary nature of the Azokh specimen. In order to characterize the thickness of the Azokh mandible Kasimova devised a "massiveness index": the percentage ratio of mandibular body thickness to mandibular height measured between M_2 and M_3, the point at which thickness of the mandibular body is greatest (Kasimova 1986, 2001). This index is equivalent to the mandibular corpus robusticity index normally measured at M_1. In addition, Kasimova (1986) has provided three sets of data describing and comparing the Azokh specimen: (i) the Azokh mandible only; (ii) the Azokh mandible and modern humans; and (iii) the Azokh mandible and a number of other hominins. However, these data sets do not compare the same suite of measurements.

Comparison with Modern Humans According to Kasimova (2001), the Azokh mandible differs markedly from modern humans due to its "massiveness". The Azokh mandible is larger than modern humans for each variable measured apart from robustness at the basal edge and mandibular body height (both measured between M_2 and M_3 where thickness is greatest). According to Kasimova (1986) the Azokh mandible differs from modern humans in the morphology of the alveolar edge, and in the distance from the alveolar margin lingually to the molar tooth crypts (3 mm, rising to 5 mm at the level of M_3 distally in the Azokh specimen, whereas modern humans usually have a smaller distance between the alveolar margin and molar tooth crypts). The Azokh mandible is similar to modern humans in having a single mental foramen.

Comparisons with Other Hominins The thickness of the Azokh mandible at M_2–M_3 is 19.0 mm. This is most similar to values for the Le Moustier Neanderthal (19.0 mm), *Homo erectus* (Zhoukoudian G/I) (19.6 mm), *Homo heidelbergensis* from Arago (Arago II) (18.0 mm) and early modern *Homo sapiens* from Skhul V (18 mm). Body height at the level of M_2–M_3 in the Azokh mandible is 23 mm, and is most similar to values for *Homo erectus* (25.0 mm), and *Homo neanderthalensis* from Ehringsdorf (26.0 mm). The

robustness of the Azokh mandible stands out from most other hominins in having a high index (that is, high robusticity), the index being 82.6%. In this regard it groups closely with *Homo heidelbergensis* from Arago (Arago XIII) (85.7%). Other similarities with *Homo heidelbergensis* include the well-developed alveolar edge and the large distance between the alveolar margin on the lingual side and the molar teeth (3–5 mm in the Azokh mandible). Kasimova (1986) notes that there is strong, broad development of the alveolar edge present in the Azokh M_3 as well as *Homo heidelbergensis* from Arago (Arago XIII) and the (adult) specimen from Ehringsdorf, which might be considered now as early Neanderthal (Stringer 2012). In addition these latter two specimens also have a wide space between the alveolar margin lingually and the molar teeth (approximately 4 mm), as does the Azokh specimen (Kasimova 1986).

Morphology and Metrics of the Dental Remains

Kasimova (1986) describes the single preserved tooth according to the odontoglyphic system developed by Russian anthropologist A.A. Zubov. There are five cusps present on the M_3 described as "smooth" or rounded. The largest is the protoconid, the metoconid smaller, as in modern humans, and the smallest cusp is the hypoconulid, which is located centrally, again as in modern humans. The Azokh M_3 trigonid is larger than its talonid, in contrast with modern humans. The most prominent of the furrows separating the cusps are the mesial and distal furrows. The distal furrow is positioned slightly lingually. The lingual furrow is weakly developed. In addition to the intertubercular furrows, Kasimova (1986) notes the presence of disto-vestibular grooves, and she states that all these features give the occlusal surface a "+5A" form (Zubov 1968). The frontal fossa (anterior fovea) is clearly pronounced. The crest joining the protoconid with the metaconid (mid-trigonid crest) is well developed, and separates the frontal fossa from the mesial sulcus. Occurrence of mid-trigonid crest in M_3 increases through the Middle Pleistocene and is unusual in *Homo heidelbergensis*. It is also unusual in early (archaic) *Homo sapiens* (Kasimova 1986, 2001). The mesio-distal diameter (length) is 11.0 mm, and the bucco-lingual diameter (breadth) is 8.9 mm. Crown area (length × breadth) is 97.9 and crown index (ratio of breadth:length expressed as a percentage (breadth/length × 100)) is 80.9%.

The roots of the second and third molars are convergent on the Azokh specimen (Kasimova 1986). X-ray imaging showed that the pulp cavity of the Azokh M_3 is large and extends into the roots, indicating that the tooth is taurodont (Kasimova 2001).

Comparison with Modern Humans In comparison with modern humans Kasimova (1986) shows that the length and breadth of the Azokh M_3 is smaller than the mean M_3 length and breadth for a sample of modern humans (11.5 mm and 9.8 mm, respectively) (Kasimova 1986). Crown area (length × breadth) is slightly less for the Azokh M_3 as compared with the sample of modern humans, but the Crown Index (breadth/length × 100) is much less in the Azokh M_3.

Comparison with Other Hominins The Azokh M_3 preserved in the mandible is most similar in size to hominin specimens from the Middle and Late Pleistocene (Kasimova 1986) such as the early Neanderthal specimen from Ehringsdorf (adult) (length 11.0 mm, breadth 9.0 mm) and the *Homo heidelbergensis* specimen Arago II (length 10.8 mm, breadth 9.6 mm), and the early modern human Skhul IV (length 11.0 mm, breadth 9.0 mm). Similarly, the values for crown area and crown index in the Azokh M_3 are most similar to those of the early Neanderthal specimen from Ehringsdorf (99.0 and 81.8% respectively) and the early modern human Skhul IV (99.0 and 81.8% respectively).

Discussion of Early Work on the Azokh Mandible

Kasimova (1986, 2001) states that the Azokh mandible is larger and more robust in comparison to modern humans. She observes that usually robustness is related to the development of the dental system, but she points out that this is weakly developed in the Azokh mandible, as evidenced by the small size of the M_3 and the weakly developed attachment areas for the muscles of mastication. On the basis of size of the mandible, muscle markings and occlusal surface of the M_3, Kasimova (2001) suggests that the mandible belonged to a female aged 20–25 years.

Other traits present in the Azokh mandible and M_3 that differ from modern humans include the broad alveolar edge in comparison to the basal edge of the Azokh mandible, the elongation of the M_3 mesio-distally, the large trigonid, the well-developed frontal fossa of the trigonid, and taurodontism. Taurodontism is found in *Homo erectus*, *Homo floresiensis*, and *Homo antessesor* from Atapuerca, and the teeth in the mandibular fragment from Atapuerca TD-6 display this trait (Carbonell et al. 2005), with the third molar being mesotaurodont and the second molar appearing to be hypotaurodont. Taurodontism is also found in Middle Pleistocene hominin specimens such as those from Mauer, Arago, and Ehringsdorf. Weidenreich (1937) noted the presence of taurodontism in the chimpanzee and orang-utan, and so thought it was a primitive trait, but this seems unlikely given the much greater extent of the hominin fossil record now.

Similarities with modern humans include the rounded, flattened, low cusps of the Azokh M_3. In addition, Kasimova (1986) states the Azokh M_3 is similar to those of modern humans in the greater size of the protoconid relative to the metaconid, the centrally placed hypoconulid, the "+5A" pattern of the cusps, convergent roots, reduction in the size of M_3, and absence of a cingulum. Kasimova (1986) observes that the Azokh specimen displays a suite of primitive and derived traits making it difficult to assign it to a hominin species. She lists the primitive and derived traits as follows:

- Derived characters shared between the Azokh hominin and *Homo erectus* referred to as "Archanthropus" by Kasimova (1986): transformation of "dryopithecus-pattern" to plus-pattern ("+5A"). Kasimova (2001) notes that she has also observed this trait in *Homo heidelbergensis* and *Homo erectus*. However, this character is more strongly developed in the Azokh specimen than the latter two groups.
- Specific characters differentiating the Azokh hominin from *Homo erectus* (again, referred to as by Kasimova 1986): a small mandibular body height in the region of M_2 and M_3, and a large retromolar space.

Kasimova (2001) observes that there are more differences between *Homo erectus* and the Azokh specimen than similarities. She notes that the comparatively small sizes of third molar and the large mandibular body size are similarities that link the Azokh mandible with *Homo heidelbergensis*, but states that there are other differences between these two taxa. Based on the dental and mandibular morphology and metric evidence, Kasimova (2001) observes that there are derived characters linking the Azokh hominin, on the one hand to the chronologically closer group of early *Homo neanderthalensis*, specifically to the Ehringsdorf hominin, and on the other hand to the chronologically later hominin Skhul IV. Kasimova (2001) also suggests that the combinations of very archaic and derived characters present in the Azokh mandible give support to assigning this specimen to an early form of what she called "*Palaeoanthropus*", which later evolved into modern humans (*Homo sapiens*).

New Assessment of the Azokh Mandibular Remains Based on a Replica of the Specimen

One of us (AR) has been able to examine a replica of the Azokh mandible (Fig. 5.2), which is housed in the collection of Profs. Henri and Marie Antoinette de Lumley. This has provided further information about its morphology and taxonomic assignment. The alveolar plane is thick giving a robust appearance to the bone. The alveolar border follows a straight trajectory, even at the level of M_3. This disposition, together with the fact that the anterior border of the ramus lies just behind the M_3, indicates that the Azokh mandible has a well-developed retromolar space. This is confirmed when the mandible is observed in superior view, as two anatomical features that further define the presence of a retromolar space, the external crest of the buccinator and the secondary crest of the retromolar triangle, are evident. A narrow extramolar sulcus can be seen, defined by a smooth external oblique line that runs on the body for a short stretch. Behind this line, part of a relatively deep masseteric fossa is preserved.

On the ramus, the triangular torus is thick, denoting a robust architecture of the mandible. In addition, the alveolar wall is thick at the level of M_3. The mylohyoid groove is open, and, even though the region is eroded, it is evident that the mental foramen opening differs from the O-D type present in Neanderthals.

The Azokh mandible presents a combination of features that allow a tentative taxonomic attribution. The great thickness of the mandibular body, the relatively small size of the molar in relation to the mandible, and the large retromolar space are all features that are typical of the *Homo heidelbergensis – Homo neanderthalensis* evolutionary line (*sensu* Rosas and Bermúdez de Castro 1998). However, the presence of a deep masseteric fossa excludes the specimen from being a classic Neanderthal. Thus, the Azokh mandible falls well within the morphological pattern of the European Middle Pleistocene hominins.

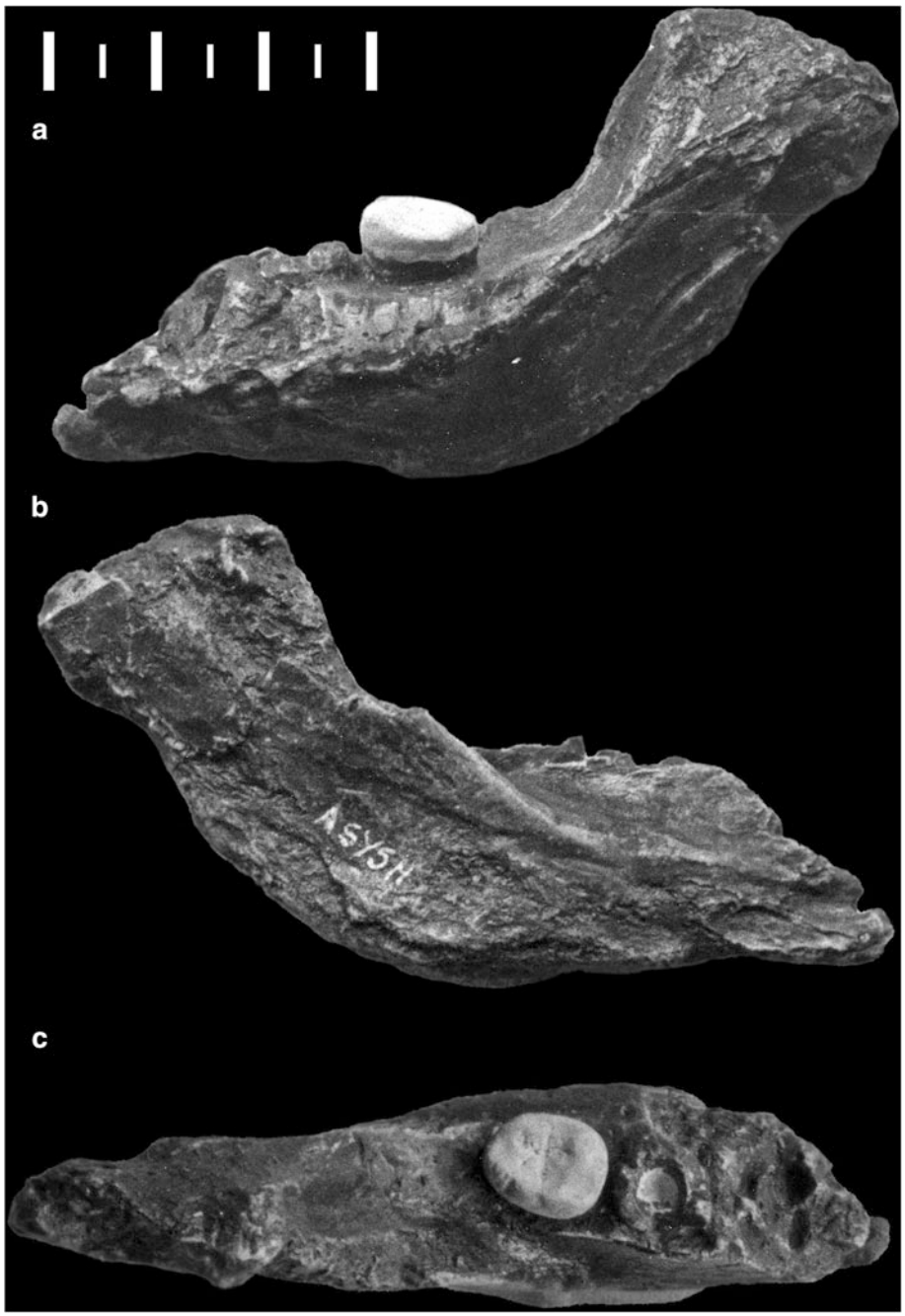

Fig. 5.2 Images of a replica of the Azokh 1 mandible: medial (top), lateral (middle) and occlusal (bottom) views of the specimen are shown

Discussion, Azokh Mandible

Kasimova (2001) states that the Azokh mandible has the closest affinity with the Ehringsdorf specimen, thus, to what may be considered as *Homo neanderthalensis* (Stringer 2012). She states further that the particular combination of characters evident in the Azokh mandible, as well as the geological age (>300 kyr) and material culture (Middle Acheulian) present in Unit V, indicate it may have been a local variant or primitive form of this species.

We note that the specimen combines a primitive robust architecture of the bone (elevated robusticity and thickness of the mandibular walls, and a smooth mylohyoid line) with a derived aligned disposition of the mandibular body and ramus (as denoted by a weak and short external oblique line and a retromolar space). This mosaic of features is reminiscent of older European Pleistocene specimens, such as those from

Mauer (Germany), Arago (France) and Atapuerca-SH (Spain). In this way, depending on the evolutionary model used for western Eurasian Middle Pleistocene hominin evolution, the Azokh mandible can be considered either as an archaic Neanderthal or as a member of the ancestral species to the Neanderthals, *H. heidelbergensis* (Stringer 2012, *sensu* Rosas and Bermúdez de Castro 1998). Even though the number of preserved features is rather small, we favor the last view on the basis of the primitive features present in the specimen and some specific details (e.g., relief of the mylohyoid line). In any case, the morphology of this mandible fits well with its supposed associated Acheulian cultural context (Asryan et al. 2016) and mid-Pleistocene faunal remains (Van der Made et al. 2016). Thus, this specimen is tentatively assigned to *Homo heidelbergensis*.

Neanderthal Remains from Azokh 1

In August 2010, during excavations of Azokh 1 Cave by the current excavation team, an isolated hominin tooth was discovered by I. Caceres. The tooth was found in sediments located towards the top of the stratigraphic sequence in Unit II in a part of the excavation adjacent to the cave wall, where a high concentration of cave bear remains (*Ursus spelaeus*) has also been found. ESR (electron spin resonance) dating of a cave bear molar from this level in Unit II has indicated an age of 100 ka (±7 ka) (Appendix, ESR). A preliminary morphological and metric analysis of the tooth is provided here, which identifies the tooth as belonging to a Neanderthal.

Description of the Isolated Tooth from Azokh Cave (E52-no. 69)

The specimen is a maxillary left first permanent molar. The crown is complete and in a good state of preservation. It had three roots that have been cleanly broken off above the root trunk. There is a moderate degree of wear on the occlusal surface, the greatest mesially, with small exposures of dentine on the protocone (approximately 0.5 mm wide) and the paracone (approximately 0.3 mm wide). There is a small amount of calculus (dental plaque) on the buccal surface of the tooth. A mild hypoplastic furrow occurs on the lingual surface approximately one mm from the cervix.

The grading system of the Arizona State University Dental Anthropology System (ASUDAS) (Turner et al. 1991) is used to describe the morphology of the Azokh tooth. The method of Moorrees (1957) is used for the measurement of the mesio-distal (M-D) and bucco-lingual (B-L) diameters of the tooth crown.

Images of the specimen are shown in Fig. 5.3. The crown has the swollen hypocone and the skewed shape that are typical of Neanderthal upper first molars (Bailey 2004). The metacone is well developed in the Azokh specimen, exceeding the size of the highest grade on the ASUDAS plaque (see Fig. 5.3). The hypocone is also well developed and, likewise, exceeds the size of the highest grade on the ASUDAS plaque. A small cusp 5 (grade 1) is present on the distal margin and two small metaconule cusps, with associated mesial and distal ridges, can be seen on the oblique ridge. Two small accessory tubercles occur on the mesial marginal ridge just lingual to its interruption by the mesial occlusal groove. Carabelli's Trait is present on the Azokh specimen as a large Y-shaped depression, scored as grade 4. There is also a grade 2 parastyle in the form of an attached cusp, with an additional weakly developed mesial vertical groove on the buccal surface of the metacone. An anterior transverse ridge is present connecting to the mesial marginal ridge and running distolingually to the mesial occlusal groove, but it does not connect to the triangular ridge of the mesiobuccal cusp (paracone). An offshoot running lingually from the anterior transverse ridge forms a crest across the mesial occlusal groove that delineates a deep anterior fovea. Amongst morphological traits not found are wrinkling of the enamel, buccal cingulum, anomalies of the buccal groove, enamel extension, and pearls.

The three roots of the tooth are well separated and with single canals. X-ray imaging of the tooth shows an expanded pulp chamber, indicating that it is taurodont (see Fig. 5.4). Most methods of quantifying the degree of taurodontism depend on the roots being complete. However, Shifman and Chananel (1978) used the distance between the bicervical line and the highest point on the floor of the pulp cavity of the tooth to distinguish between taurodont and non-taurodont molars, and proposed the following categories: non-taurodont molars (<2.5 mm); taurodont molars: hypotaurodont (2.5–3.7 mm); mesotaurodont (3.7–5.0 mm) and hypertaurodont (5.0–10.0 mm). The measurement for the Azokh tooth is 4.5 mm making it mesotaurodont.

Measurements of the Azokh molar are presented in Table 5.1. The mesio-distal diameter (length) is 12.5 mm, and the bucco-lingual diameter (breadth) is 12.6 mm. This is close to the mean figures for the Krapina Neanderthals: crown length 12.4 mm and crown breadth 12.6 mm (Compton and Stringer 2012, calculated from data in Wolpoff 1979). Measurements at the cervix of the crown were also taken, using the method described by Hillson et al. (2005). The M-D cervical diameter is 9.8 mm and the B-L cervical

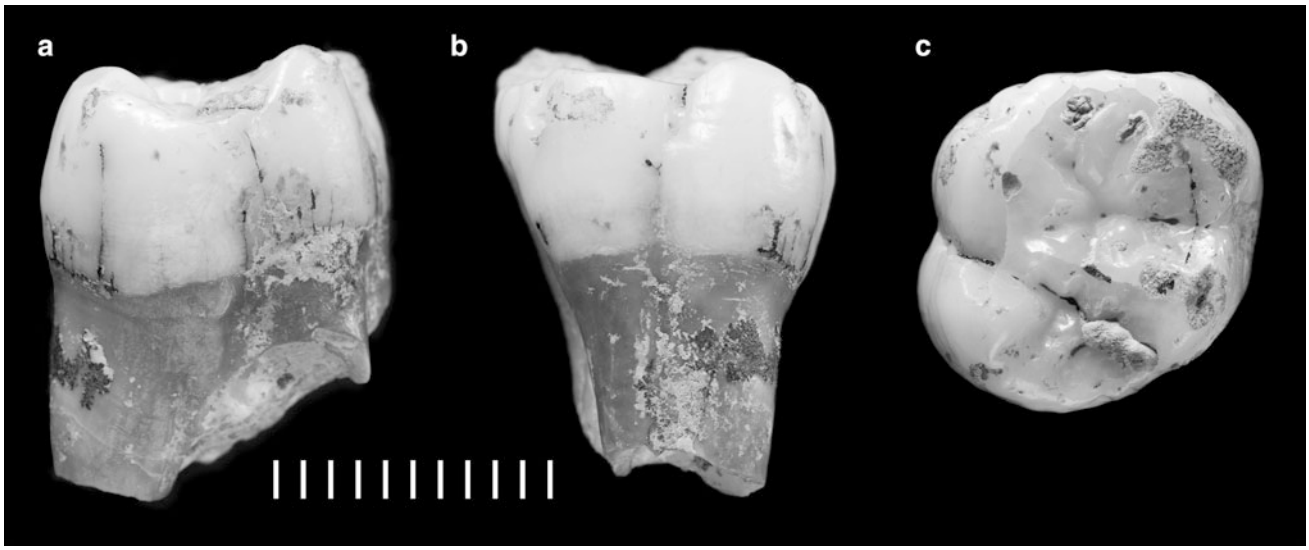

Fig. 5.3 Azokh 1 Neanderthal tooth. **a** distal, **b** lingual, and **c** occlusal views

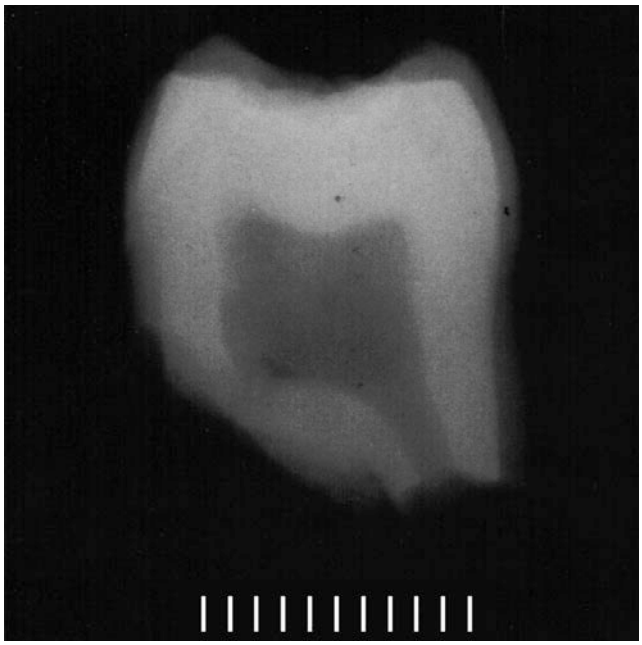

Fig. 5.4 X-ray image of the Azokh 1 Neanderthal molar. Examination and measurement of the pulp chamber indicates that it is mesotaurodont

diameter is 12.2 mm. Crown height (the disto-buccal measurement taken on the metacone) is 7.2 mm (Moorrees 1957). Finally, root robusticity at the cervix (defined as M-D diameter × B-L diameter at the cervix) was determined (Weidenreich 1937; Compton and Stringer 2012). The M-D diameter of the root is 9.0 mm and the B-L diameter is 12.1 mm, giving a root robusticity value of 109, also close to the mean value of 110 for Krapina (Higham et al. 2011).

Table 5.1 Dental measurements of the Azokh 1 Neanderthal tooth

	Measurement (mm)
Crown	
M-D* Length	12.5
B-L** Breadth	12.6
Crown height***	7.2
Cervical	
M-D	9.8
B-L	12.2
Root Robusticity	
M-D	9.0
B-L	12.1
M-D × B-L	109

Key
*M-D mesio-distal
**B-L bucco-lingual
***Disto-buccal measurement taken on the metacone

Hominin Remains from Azokh 2

Modern human remains have been found in two other cave passageways at Azokh, named Azokh 2 and Azokh 5. Both have been trenched and preliminary excavations made, but both still remain to be further explored by the present excavation team. The sites and stratigraphy are described by Murray et al. (2016) and by Domínguez-Alonso et al. (2016).

Azokh 2 is located approximately 42 m NNW from the main chamber Azokh 1 (Murray et al. 2016). The lithology of the sediments is similar to that of Azokh 1, but there is no way of correlating the sediments in the two caves. In 2002 and 2003 two test pits were dug in order to better understand the stratigraphy of the infill (see Murray et al. 2016 for full

details). Excavation was started in 2007 when the two pits were re-opened, and articulated remains of a modern *Homo sapiens* were discovered. AMS radiocarbon dating has provided an estimated age of Holocene age for the skeleton (Appendix, radiocarbon).

Two human teeth were also found in the test pits, a permanent lower right lateral incisor and a permanent maxillary right third premolar. The incisor has completed its development, having a closed root apex. Based on the work of Al Qatani et al. (2010) this might indicate an age at death of at least 9 years if maturation was fast or 13 years if maturation slow. However, the tooth is worn with an extensive dentine exposure, correlating with wear stage 5 (Murphey 1959), and suggesting this individual was older than 13 years at death. The premolar is complete with one root. It has also completed its development. Based on the work of Al Qatani et al. (2010) this might suggest an age at death of at least 13 years if maturation was fast or 15 years if maturation slow. The tooth has wear facets but no dentine exposures, correlating with wear stage 2 (Murphey 1959). The appearance, developmental stage and degree of wear of both teeth suggest that they could belong to the same individual, which was older than 15 years at death.

Human Remains from Azokh 5

Azokh 5 Cave is located approximately 100 m NNW from Azokh 1 (Murray et al. 2016). Four stratigraphic units – A (top) to D (bottom) (Murray et al. 2016) – have been described, and again the lithology of the sediments is similar to that of Azokh 1, but there is no way of correlating the sediments in the two caves. There is also a cone of collapsed sediments that contains fossil remains of a number of macro- and micro-fossil species from these four stratigraphic units. Several human teeth were discovered in place in unit A in 2006 and are described here (Table 5.2). They were associated with charcoal that has been radiocarbon dated to ~2300 years BP (384calBC_OxA 17589; see Appendix, radiocarbon). A single middle phalanx was also found (Specimen 6). Seven of the specimens are displayed in Fig. 5.5, and details of the dimensions are given in Table 5.3.

Table 5.2 List of human specimens and specimen numbers from Azokh 5

Specimen number	Specimen
1	Permanent maxillary right second molar
2	Permanent maxillary left canine
5	Permanent mandibular right first molar
6	Second phalanx
7	Deciduous maxillary right third premolar
8	Permanent mandibular left second molar
9	Permanent maxillary left third premolar
10	Permanent mandibular right canine
11	Permanent maxillary left first molar

Table 5.3 Azokh 5 human tooth crown dimensions

Specimen	Bucco-lingual length (mm)	Mesio-distal length (mm)
1	11.37	9.32
2	8.17	6.98
5	10.38	11.12
7	8.87	6.82
8	9.95	11.40
9	8.15	6.98
10	6.76	7.10
11	11.59	9.26

1. Specimen 1, permanent maxillary right second molar. The crown is quadrilateral in shape. There is destruction of the enamel particularly on the distal surfaces and mesial lingual cusp. The largest cusp is the mesio-lingual cusp. Three roots are present and two are complete in their development, with the apical canal of the lingual root still open. Based on the work of Al Qatani et al. (2010) this might suggest an age of 14 years if maturation was fast in this individual or 17 years if maturation was slow. This tooth is little worn, with wear facets visible but no dentine exposures present, which correlates with attrition category 2 (Murphey 1959), and on the basis of this and the developmental stage, the age at death of this individual may have been 15 years (see Table 5.4). This specimen may be associated with specimens 2, 5, 8, and 10 (see Table 5.4).
2. Specimen 2, permanent maxillary left canine. The crown is intact with a large dentine exposure distally on the labial surface. Four linear enamel hypoplasias are evident around the circumference of the crown. The root is intact and has completed its development. The root apex is fully closed. Using the work of Al Qatani et al. (2010) this might suggest an age of 12 years in this individual if maturation was slow or an age of 15+ years if maturation was accelerated. However, wear displayed by this specimen correlates with wear category 3 (Murphey 1959), indicating that this individual was most likely aged 15+ years at death (see Table 5.4). This specimen may belong to the same individual as specimens 1, 5, 8, and 10 (see Table 5.4).
3. Specimen 5, permanent mandibular right first molar. There is very little wear on the crown surface, indicating it may be associated with wear stage 3 (Murphey 1959). There are two roots. The distal root is broken. The light

wear present indicates a younger adult individual, and it could represent an adolescent who was about 15 years old at death (see Table 5.4). It may belong to the same individual as Specimens 1, 2, 8, and 10 (see Table 5.4).

4. Specimen 6, middle phalanx.
5. Specimen 7, deciduous maxillary right third premolar. The crown is intact and is quadrilateral in shape. It has four cusps – the largest is the mesio-buccal cusp. There is a small dentine exposure on the occlusal surface of the mesio-buccal cusp, with a larger dentine exposure on the mesio-lingual cusp. The degree of wear present correlates with wear stage 3 (Murphey 1959). There is a prominent tubercle on the buccal surface (Brown 1985). This tooth had three roots, the bucco-distal and lingual roots broken almost at the mid point of their lengths and the mesio-buccal root broken just below the crown. The dimensions of the tooth crowns are given in Table 5.3. The degree of wear present and the fact that there has been no root resorption suggest that the age of this individual at death was about 5 years (see Table 5.4).
6. Specimen 8, permanent mandibular left second molar. The tooth crown has moderate wear, with greater wear on the buccal cusps, but no dentine exposure. There is a small caries mesially on the occlusal surface in the groove between the mesio-lingual and mesio-buccal cusps. The roots have broken off. There are wear facets apparent on the tooth crown surface but no dentine exposures, and the category of wear may be stage 2 (Murphey 1959). This specimen may represent an individual aged about 15 years at death based on the wear and may belong to the same individual as Specimens 1, 2, 5 and 10 (see Table 5.4).
7. Specimen 9, permanent maxillary left third premolar. This specimen is a tooth crown with little wear present. Perikymata are visible to the naked eye. Horizontal bands spanning the circumference of the tooth crown may represent linear enamel hypoplasias. The root has broken off at the margin with the tooth crown. There are no wear facets present on the occlusal surface nor any visible dentine patches, indicating the tooth either had not yet erupted or was newly erupted but not in occlusion. Thus the category of wear corresponds to stage 1 (Murphey 1959).
8. Specimen 10, permanent right mandibular canine. The root has broken, off at the margin of the crown. This specimen has very little wear, with small wear facets of minimal size, which may correspond to wear category 2 (Murphey 1959). Perikymata can be seen by the naked eye. Linear enamel hypoplasias are evident around the circumference of the tooth crown. Given the stage of wear it is likely that this was an adolescent individual, and although the roots are broken by wear stage comparison it may belong to the same individual as Specimen 2 (upper left canine), which is likely to be aged about 15 years, and hence also associated with specimens 1, 2, 5, and 8 (see Table 5.4).
9. Specimen 11, permanent maxillary left first molar. The specimen is square in shape with four cusps. It is heavily worn with dentine coalescence between the mesio-lingual and disto-lingual cusps. The enamel is polished and no perikymata are visible by naked eye or microscopically. The tooth has three roots that are intact – two buccal roots and one lingual root that have not quite completed their development, with the apical canals being still open. Thus, if this individual matured at a fast rate it would have been about 8 years at death and if maturation was slow age at death would have been about 13 years (Al Qatani et al. 2010). The level of wear apparent in this specimen corresponds to category 5 (Murphey 1959). Taking both the developmental and wear stages into consideration indicates this individual may have been about 11 years at death, and may belong to the same individual as Specimen 9 (see Table 5.4).

Table 5.4 Wear stages, age estimations and associations of human tooth specimens from Azokh 5

Specimen No.	Identification	Wear category	Age estimation (years)	Associated with other specimens
1	Permanent maxillary right second molar	2	15	2, 5, 8, 10
2	Permanent maxillary left canine	3	15	1, 5, 8, 10
5	Permanent mandibular right first molar	3	15	1, 2, 8, 10
7	Deciduous maxillary right third premolar	3	5	
8	Permanent mandibular left second molar	2	15	1, 2, 5, 10
9	Permanent maxillary left third premolar	1	11	11
10	Permanent mandibular right canine	2	15	1, 2, 5, 8
11	Permanent maxillary left first molar	5	11	9

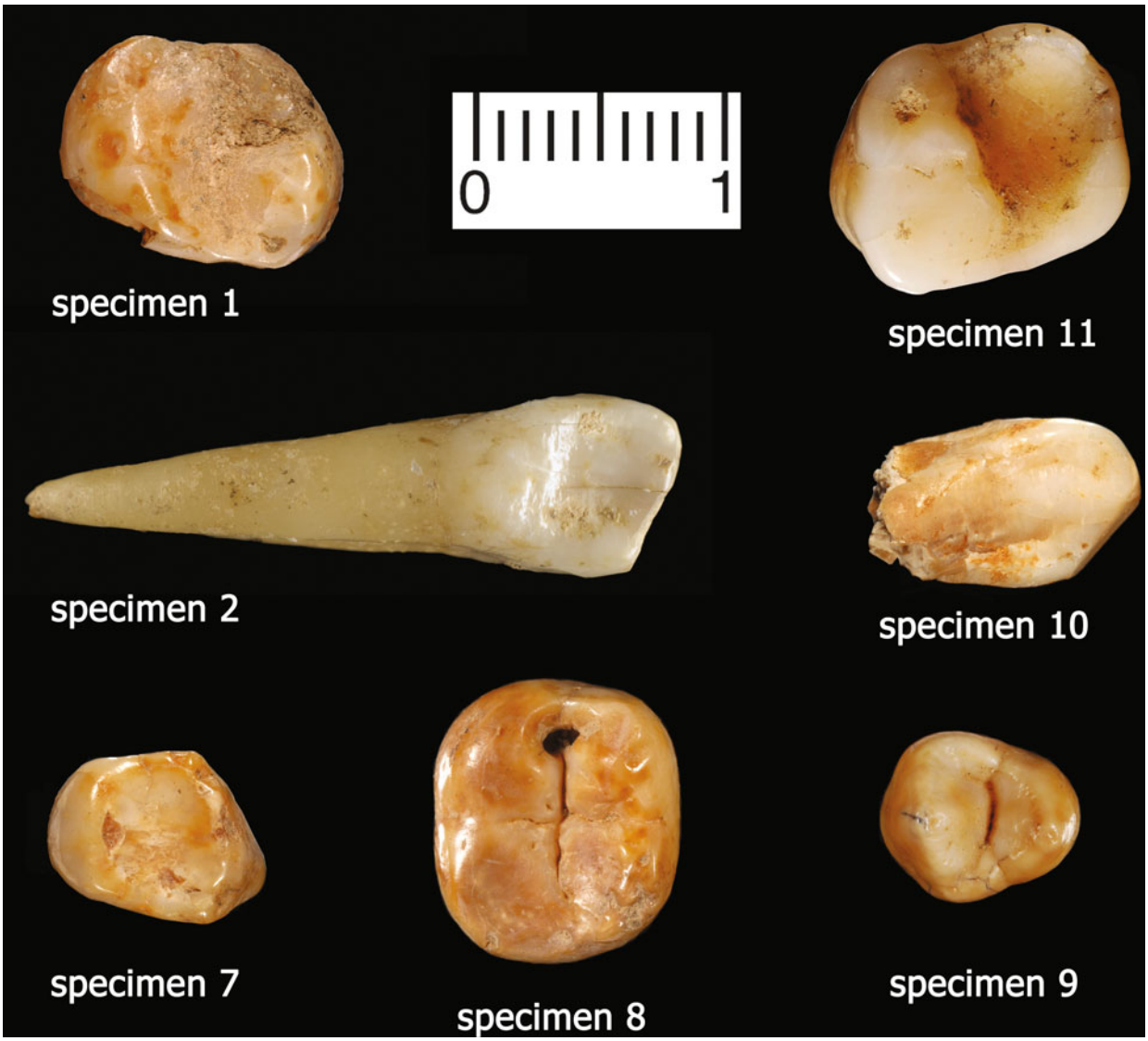

Fig. 5.5 Azokh 5 human teeth. Anti-clockwise from top left: Specimen1 (right M^2, occlusal view), Specimen 2 (left upper canine, lingual view), Specimen 7 (deciduous right P^3, occlusal view), Specimen 8 (left M_2, occlusal view), Specimen 9 (left P^3, occlusal view), specimen 10 (right lower canine, lingual view), Specimen 11 (left M^1, occlusal view)

Conclusions

1. The mandible from Azokh 1, dated ca. 250,000–400,000 ka is tentatively assigned to *Homo heidelbergensis* after analysis of previously published data and a replica.
2. The maxillary left first permanent molar from Azokh 1 from Unit II has an age of 100 ka (±7 kyr). It is identified as Neanderthal on the basis of morphology (swollen hypocone and skewed shape) and taurodontism, and the crown dimensions and root robusticity are similar to the mean figures for Neanderthal upper first molars from the similarly dated site of Krapina in Croatia, dated at ~130,000 ka (Rink et al. 1995).
3. DNA analysis, and a full description and morphometric analysis of the Azokh 1 Neanderthal molar are currently underway.
4. The two modern teeth from Azokh 2, associated with skeletal remains dated to 1265 ± 23 y BP, may be from the same individual, an adolescent who was aged about 12–13 years at death.
5. The eight modern human teeth from Azokh 5, dated to ~2300 years BP, comprise a minimum of three individuals: a child aged about 5 years at death, a juvenile aged about 11 years at death, and an adolescent aged about 15 years at death.
6. Enamel growth disruptions (linear enamel hypoplasias) are evident on some of the teeth.

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References

Al Qahtani, S. J., Hector, M. P., & Liversidge, H. M. (2010). Brief communication: The London atlas of human tooth development and eruption. *American Journal of Physical Anthropology, 142*(3), 481–490.

Appendix: Fernández-Jalvo, Y., Ditchfield, P., Grün, R., Lees, W., Aubert, M., Torres, T., et al. (2016). Dating methods applied to Azokh Cave sites. In Y. Fernández-Jalvo, T. King, P. Andrews & L. Yepiskoposyan (Eds.), *Azokh Cave and the Transcaucasian Corridor* (pp. 321–339). Dordrecht: Springer.

Asryan, L., Moloney, N., & Ollé, M. (2016). Lithic assemblages recovered from Azokh 1. In Y. Fernández-Jalvo, T. King, L. Yepiskoposyan & P. Andrews (Eds.), *Azokh Cave and the Transcaucasian Corridor* (pp. 85–101). Dordrecht: Springer.

Bailey, S. E. (2004). A morphometric analysis of maxillary molar crowns of Middle–Late Pleistocene hominins. *Journal of Human Evolution, 47*, 183–198.

Brown, W. A. B. (1985). *Identification of Human Teeth*. Institute of Archaeology, 1985, Bulletin No. 21/22.

Carbonell, E., Bermudez de Castro, J. M., Arsuaga, J. L., Allué, E., Bastir, M., Benito, A., et al. (2005). An early Pleistocene hominin mandible from Atapuerca-TD6, Spain. *Proceedings of the National Academy of Sciences USA, 102*(16), 5674–5678.

Compton, T., & Stringer, C. B. (2012). The Human Remains. In S. Aldhouse-Green, R. Peterson E. A. Walker (Eds.), *Neanderthal s in Wales: Pontnewydd and the Elwy Valley Caves* (pp. 118–230). Oxbow Books: Oxford.

Djafarov, A. (1983). Mustierskaya kultura Azerbajana (po materialam Taglarskoi pesheri) (The Mousterian Culture of Azerbaijan). Baku.

Domínguez-Alonso, P., Aracil, E., Porres, J. A., Andrews, P., Lynch, E. P. & Murray, J. (2016). Geology and Geomorphology of Azokh Caves. In Y. Fernández-Jalvo, T. King, L. Yepiskoposyan & P. Andrews (Eds.), *Azokh Cave and the Transcaucasian Corridor* (pp. 55–84). Dordrecht: Springer.

Doronichev, V. B. (2008). The Lower Palaeolithic in Eastern Europe and the Caucasus: A reappraisal of the data and new approaches. *PaleoAnthropology*, pp. 107–157.

Fernández-Jalvo, Y., King, T., Andrews, P., Yepiskoposyan, L., Moloney, N., Murray, J., et al. (2010). The Azokh Cave complex: Middle Pleistocene to Holocene human occupation in the Caucasus. *Journal of Human Evolution, 58*, 103–109.

Fernández-Jalvo, Y., King, T., Andrews, P., & Yepiskoposyan, L. (2016). Introduction: Azokh Cave and the Transcaucasian Corridor. In Y. Fernández-Jalvo, T. King, L. Yepiskoposyan & P. Andrews (Eds.), *Azokh Cave and the Transcaucasian Corridor* (pp. 1–26). Dordrecht: Springer.

Gadziev, D. V., & Aliev, S. D. (1969). Plaeontological reasoning of the stratigraphy of the Palaeolithic site of Azokh (Paleontologicheskoe obosnovanie stratigrafii Azychskoi paleoliticheskoi stoyanki). UZ Azgosmedinstitut, T. XXX (in Russian).

Gadziev, D. V., & Huseinov, M. M. (1970). Pervaya dlyz SSSR nakhodka ashel'skogo cheloveka (Azerbaijan, Azykh Cave) (The first find of Acheulean man in the USSR). Compendium of Azerbaijan State Medical Institute, vol. XXXI.

Hillson, S., FitzGerald, C., & Flinn, H. (2005). Alternative dental measurements: Proposals and relationships with other measurements. *American Journal of Physical Anthropology, 126*, 413–426.

Huseinov, M. M. (1973). *Tainy Azykhskoi peschery (The mysteries of Azykh cave)*. Gyanjlik: Baku. (in Azerbaijani).

Huseinov, M. M. (1985). Drevniy paleolit Azerbaidjana (cul'tura Kuruchay i etapy ee razvitia) (Lower Palaeolithic of Azerbaijan (*Kuruchai* culture and its development periods)). Baku.

Huseinov, M. M., Aliev, S. D., Velichko, A. A., Gadziev, D. V., Djafarov, A. K., Mamedov, A. V., et al. (1985). Main results of the complex research works of the Early Palaeolithic cave site of Azykh (Glavnie itogi komleksnikh issledovanii drevnepaleoliticheskoi peshernoi stoianki Azykh). In Achievements of Soviet anthropologists. Baku.

Higham, T., Compton, T., Stringer, C., Jacobi, R., Shapiro, B., Trinkaus, E., et al. (2011). The earliest evidence for anatomically modern humans in northwestern Europe. *Nature, 479*, 7374, 521–524 & SI 1–76.

Kasimova R. M. (1986). Pervaya nakhodka samogo drevnego peschernogo cheloveka na territorii SSSR (Azerbaidzhanskaia SSR. Azykh). – Baku: Elm, 1986. – 68 s. [The first find of the most ancient cave human on the territory of the USSR (Azerbaijan SSR. Azykh). – Baku: Elm, 1986. – 68 p.].

Kasimova, R. M. (2001). Anthropological research of Azykh Man osseous remains. *Human Evolution, 16*, 37–44.

Lioubine, V. P. (2002). *L'Acheuléen du Caucuase*. ERAUL 93 Études et Recherches Archéologiques de l'Université de Liège. Liège.

Moorrees, C. F. A. (1957). *The Aleut Dentition*. Cambridge: Harvard University Press.

Murphey, T. (1959). The changing pattern of dentine exposure in human tooth attrition. *American Journal of Physical Anthropology, 17*, 167–178.

Murray, J., Domínguez-Alonso, P., Fernández-Jalvo, Y., King, T., Lynch, E. P., Andrews, P., et al. (2010). Pleistocene to Holocene stratigraphy of Azokh 1 Cave, Lesser Caucasus. *Irish Journal of Earth Sciences, 28*, 75–91.

Murray, J., Lynch, E. P., Domínguez-Alonso, P., & Barham, M. (2016). Stratigraphy and Sedimentology of Azokh Caves, South Caucasus. In Y. Fernández-Jalvo, T. King, L. Yepiskoposyan & P. Andrews (Eds.), *Azokh Cave and the Transcaucasian Corridor* (pp. 27–54). Dordrecht: Springer.

Rink, W. J., Schwarcz, H. P., Smith, F. H., & Radovčić, J. (1995). ESR ages for Krapina hominids. *Nature, 378*, 24.

Rosas, A., & Bermúdez de Castro, J. M. (1998). The Mauer mandible and the evolutionary significance of *Homo heidelbergensis*. *Geobios, 31*, 687–697.

Shifman, A., & Chananel, I. (1978). Prevalence of taurodontism found in radiographic dental examination of 1,200 young adult Israeli patients. *Community Dental. Oral Epidemiology, 6*, 200–203.

Stringer, C. (2012). The Status of *Homo heidelbergensis* (Schoetensack 1908). *Evolutionary Anthropology, 21*, 101–107.

Turner II, C. G., Nichol, C. R., & Scott, G. R. (1991). Scoring procedures for key morphological traits of the permanent dentition: The Arizona State University Dental Anthropology System. In M. Kelley & C. Larsen (Eds.), *Advances in Dental Anthropology* (pp. 13–31). New York: Wiley Liss.

Van der Made, J., Torres, T., Ortiz, J. E., Moreno-Pérez, L., & Fernández-Jalvo, Y. (2016). The new material of large mammals from Azokh and comments on the older collections. In Y. Fernández-Jalvo, T. King, L. Yepiskoposyan & P. Andrews (Eds.), *Azokh Cave and the Transcaucasian Corridor* (pp. 117–159). Dordrecht: Springer.

Weidenreich, F. (1936). The mandibles of *Sinanthropus pekinensis*: A comparative study. *Palaeontologia Sinica*, series D, *7*, 1–162.

Weidenreich, F. (1937). The dentition of Sinanthropus pekinensis: A comparative odontography of the Hominids. *Palaeontologia Sinica. Whole series 101, New series D1*, 1–180.

Weidenreich, F. (1943). The skull of Sinanthropus pekinensis: A comparative study on a primitive hominin skull. *Palaeontologia Sinica*, Series *127*, 1–298.

Wolpoff, M. H. (1979). The Krapina dental remains. *American Journal of Physical Anthropology, 50*, 67–114.

Zubov A. A. (1968). Odontology. Methods of anthropological research/Odontologia. Metodika antropologicheskikh isledovanii. The Science Publishers, Moscow.