Archaeological Research in Asia xxx (xxxx) xxx

Contents lists available at ScienceDirect

Archaeological Research in Asia

journal homepage: www.elsevier.com/locate/ara

Case report

Neolithic fishing in the South Caucasus as seen from Aruchlo I, Georgia

Kenneth Ritchie [a,*], Wim Wouters [b], Guram Mirtskhulava [c], Saba Jokhadze [c], Dimitri Zhvania [c], Joni Abuladze [c], Svend Hansen [d]

[a] Department of Archaeological Sciences, Moesgaard Museum, Moesgaard Allé 15, Højbjerg 8270, Denmark
[b] Royal Belgian Institute of Natural Sciences, Brussels 1000, Belgium
[c] Georgian National Museum, Otar Lordkipanidze Archaeological Institute, Tbilisi 0105, Georgia
[d] Eurasia Department, German Archaeological Institute, Berlin 14195, Germany

ARTICLE INFO

Keywords:
Neolithic
Georgia
Southern Caucasus
Fishing
Subsistence
Feasting

ABSTRACT

The spread of the Neolithic way of life from its centers of origins remains one of the central topics of archaeological research, with ongoing debates about the importance of economic, demographic, and cultural changes in the transition. The Southern Caucasus, while close to one area where agriculture emerged, has remained understudied regarding this spread. Here, information about the role of fish, a topic that has been almost completely neglected until now is presented. Fish remains are scarce in this region. Moreover, isotope analyses seem to indicate that freshwater fish were not an important food source. For the first time, fishbones have been found in larger quantities at the site of Aruchlo I from some layers in ditches. It is the largest assemblage of fish bones safely dated to the sixth millennium BC in the South Caucasus. The interpretation of these finds is not straightforward due to the lack of other comparable finds and the absence of fishing gear. Fishing appears to have been conducted in the waters close to the settlement. It is unclear if fishing was a year-round activity, although the way these bones were concentrated in different layers in the ditches suggests that this was not the case. We think that the bounteous catch of spawning fishes at certain times of the year can be linked to special social events like feasting, showing the importance of a food resource that is usually greatly underrepresented archaeologically. Introducing more precise recovery methods for animal remains at other excavations will hopefully refine our understanding.

1. Introduction

The Caucasus, including the territory of modern Georgia, represents an important archaeological area with sites from the early Paleolithic until the Middle Ages. A crucial aspect of Caucasian archaeology is the development of an agricultural lifestyle (see Helwing et al., 2017; Hansen and Helwing, 2018), one of the most momentous periods of cultural development because of its impact on so many aspects of human societies. While Neolithization has been used in many different forms, here we focus primarily on the term as denoting the adoption of domesticated plants and animals. The Fertile Crescent of southwestern Asia represents the earliest center of domestication of plants and animals and the spread of these innovations by settlers since the 7th millennium BC (all dates refer to calibrated BC) to neighboring areas had important consequences for cultural trajectories in many regions. Compared to other regions like Anatolia and southeastern Europe in the west and Iran in the east, the Neolithization of the Southern Caucasus started relatively late, in the early 6th millennium BC (Lyonnet et al., 2012; Nishiaki et al., 2013).

Here, we report on the role of fishing in Neolithic Georgia as evidenced at the site of Aruchlo I (Fig. 1), an aspect of the Neolithic economy of this region that has been almost completely ignored until now. While there are some indications of fishing, fish bones are scarce, and fish do not seem to have played a major role in subsistence. It seems improbable that people living next to the confluence of two productive fishing rivers ignored this resource.

2. Aruchlo and the development of the Neolithic in Georgia

Archaeological research concerning the Neolithic period in Georgia began in the second quarter of the 20th century. Remains of the Neolithic farming way of life were initially investigated in the western part of Georgia, near the Black Sea coast (Kiguradze, 2011; Nebieridze, 1972). Later, during the mid-1960s to 1980s, extensive research was

* Corresponding author.
E-mail address: kcritchie@hotmail.com (K. Ritchie).

https://doi.org/10.1016/j.ara.2020.100252
Received 20 September 2020; Received in revised form 15 December 2020; Accepted 21 December 2020

carried out at Neolithic settlement mounds in the southern part of Georgia and at about the same time in the Kazakh region of Azerbaijan (Narimanov, 1965). Two key sites were excavated during this time, Shulaveri Gora on the Marneuli plain of Georgia and Shomutepe in Azerbaijan (Sagona, 2017:93–94), which are the type sites of the "Shulaveri-Shomutepe" Neolithic culture. According to new archaeological data and radiocarbon dates, Shulaveri-Shomutepe culture generally belongs to the 6th millennium BC (Hansen et al., 2017:291–295; Nishiaki et al., 2015b). With its remarkable architecture and other material culture, Shulaveri-Shomutepe was recognized as one of the most unique Neolithic cultures in the Southern Caucasus (Dzhaparidze and Dzhavakhishvili, 1971; Kiguradze, 1986).

Much attention has been focused on the Neolithic settlement mound Aruchlo I since early in the history of investigation of this culture due to the size of the site and its location. It is the westernmost site of the Shulaveri-Shomutepe group. Aruchlo is located near the modern village of Nakhiduri, 50 km southwest of the Georgian capital Tbilisi (Hansen et al., 2007; Helwing et al., 2017). It lies in the large triangle formed by the confluence of two main rivers, the Khrami and the Mashavera, which later join the Kura River (Fig. 2). The satellite image shows that many other Neolithic settlements formed a dense network of land use. An anthropogenic mound of settlement remains rising about 6 m from the modern surface is prominent on the landscape, surrounded by agricultural fields. On top of the Neolithic strata a poorly documented Achaemenid settlement stratum was deposited. Aruchlo I was excavated from 1966 until 1985, but only 16 fish bones were recovered (Chelidze and Gogelia, 2004; Chikovani et al., 2015). Afterwards, for around two decades practically no excavation was carried out at Aruchlo or other Neolithic settlements in southern Georgia, mostly because of political and economic reasons.

The aim of the new excavations in Aruchlo, which started in 2005, was to explore the stratigraphy of the settlement, house construction, the functional use of space and the economic strategies of the inhabitants. For this purpose, an extensive network of 14C-dates was created to fix the position of this and related settlements within the 6th millennium BC (Hansen et al., 2007). In 2007 small scale excavations started in Gadashrili gora near Marneuli (Batiuk et al., 2017; Hamon et al., 2016; Jalabadze et al., 2010). Three years after the start of our excavations, F. Guliyev and Y. Nishiaki started excavation at Göytepe, an 8 m high, 145 m diameter tell dated to 5650–5300 cal BC in the middle Kura valley. In Armenia, R. Badalyan and his team had already worked at the Neolithic settlements of Aratashen and Aknashen with very similar buildings and material culture (Badalyan et al., 2004; Badalyan et al., 2010).

The Neolithic settlement of Aruchlo was documented in detail by the new excavations and can be considered an exemplary case study for the South Caucasian Neolithic. According to the results of the new excavations the settlement was occupied for about four centuries beginning shortly before 5800 BC and ending around 5400 BC (Hansen et al., 2017). These dates compare favorably with new results from other South Caucasus sites, *e.g.*, the already mentioned Göytepe (Nishiaki et al., 2015b).

Two stages of settlement could be distinguished. The younger stage, known from previous excavations, consists of round buildings combined into larger units by corresponding wall connections. The older settlement at Aruchlo, however, consisted of round buildings and ditches. The importance of these ditches was first recognized in the recent investigations and they were stratigraphically excavated for the first time.

The circular buildings (Fig. 3) at Aruchlo are mostly too small to live in (although a few are up to 4–6 m in diameter). Perhaps these circular buildings were used for storage or other non-residential activities and the actual domiciles must be sought in the immediate vicinity. The lack

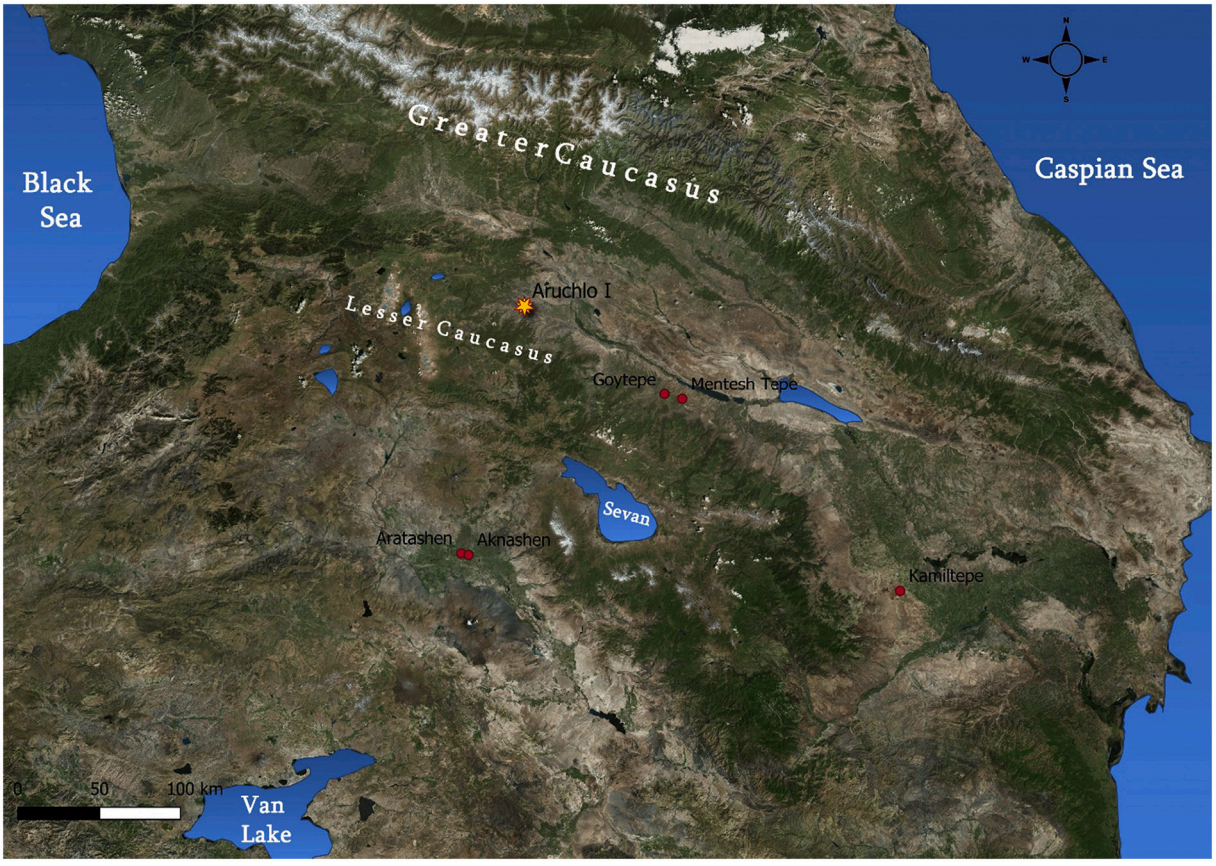

Fig. 1. The location of Aruchlo I and selected other sites of the Shulaveri-Shomutepe culture in the South Caucasus (map: S. Jokhadze using satellite image from Bing Virtual Earth).

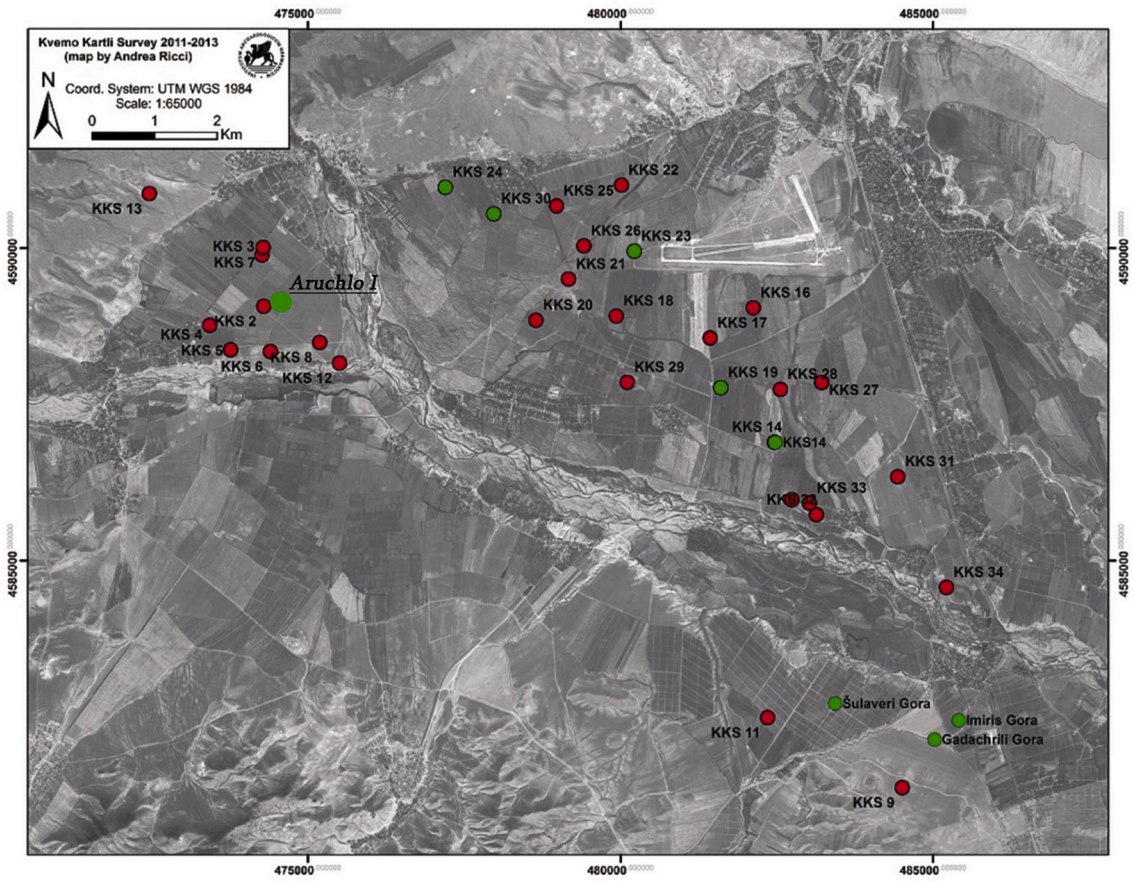

Fig. 2. Satellite image showing the location of Aruchlo I in relation to the rivers' confluence. Green dots: Neolithic sites; red dots: sites later than the Neolithic (map: A. Ricci, in Helwing et al., 2017: 319, Fig. 21 – modified by S. Jokhadze).

Fig. 3. Circular structures excavated at Aruchlo I (Photo: S. Hansen).

of ovens in the round buildings that are typical for Neolithic houses of that time support this hypothesis.

The material culture is very rich. Characteristic, slightly egg-shaped ceramic vessels, often decorated with knobs at the edges and in rare cases representations of dancers, are often found (Bastert-Lamprichs, 2017). Grinding stones are numerous. Large and small mills were used to process grain, but also roots and meat and additionally for the production of color pigments (Abuladze, 2017). River pebbles served as

percussive instruments. Volcanic obsidian was used to produce sharp knife blades. By far the most common tools are simple bone awls that could be used to perforate many materials. Very rare are decorative beads and clay statuettes. For the first time, phallus representations made of deer antlers could be identified. Various indications suggest that copper had already attracted the attention of the settlers, hammered flat and shaped into beads (Hansen and Helwing, 2018; Hansen and Ullrich, 2017).

3. The ditches at Aruchlo

With the discovery of two ditches in 2011, a new and exciting excavation phase began (Hansen and Ullrich, 2017). In the later campaigns 8 new ditches were discovered. Their greatest measured depth was 4.80 m and the greatest width 4.50 m. As a rule, they are V-shaped and very narrow at the bottom. Some ditches were filled and built upon. In some cases, the construction of a new ditch traverses one or more older ditches (Fig. 4).

A detailed description of these ditches is given by Hansen et al. (2017). A review of unpublished documentation of other Neolithic settlements in Georgia showed that ditches were also observed at Khramis Didi Gora and Imiris Gora (Ioseliani, 2017). In Azerbaijan they have been attested at Shomutepe and Toyratepe, but only in the modern excavations in Kamiltepe were complex ditches similar to those at Aruchlo documented (Helwing and Aliyev, 2017). These occasional observations were rarely systematically verified by excavations or published. Thus, Aruchlo is the only Neolithic site in which these ditches were documented in detail. Even if their meticulous investigation is still not finished, it can be said that the digging and refilling of ditches is an expression of culture which sheds new light on the site of Aruchlo and probably all other settlements of the Shulaveri-Shomutepe group.

Fig. 4. Cross-section of a ditch at Aruchlo (Photo S. Hansen).

The ditches cut into existing settlement layers and seem to have been refilled within a year or two after having been dug, not with the excavated material but with fresh soil brought in for this purpose (Hansen et al., 2017). In some ditches structured fillings could be seen, thick layers of sterile clay alternating with concentrated thinner layers mainly of ash and animal bones. This ashy material was collected and dry sieved on a 4 mm mesh (Fig. 5) yielding fishbones. Most of the fish bones in Aruchlo were found in ditch 7, almost all of them originate from an area on the northern profile of trench U (Fig. 6). In this ditch, four subsequent layers of ash were observed. Among the finds from the ditches are many antler hoes and axes but pottery and stone tools are quite rare.

The ditches required a considerable amount of work, an indication that in the Neolithic many workers could be mobilized towards a common goal. This suggests a social reason behind the trenches, separating people and dividing society. Filling up ditches, still a common metaphor today, could be interpreted as a kind of healing process aimed at unifying society. The fact that these ditches in Aruchlo were not refilled with the original soil but with fresh new earth may have had a symbolic meaning, closing the rift with new material as a fresh start.

According to the analysis by N. Benecke (2017, 367) the village "relied on animal keeping rather than exploiting wild animal resources. The assemblage in Aruchlo mainly consists of the remains of domestic mammals with sheep and goats being the most frequent species according to NISP, followed by cattle and pig. Within the ovicaprids, sheep are much more frequent than goats." Sheep and cattle were of fundamental importance in providing meat. Data on age distribution and sex ratios suggest that, in addition to serving as providers of meat, some of the sheep, goats and cattle may have been exploited for their milk. The Neolithic farmers cultivated legumes such as lentils and peas. Wheat was also cultivated, initially the early spelt wheat varieties Emmer and Einkorn, as well as linseed.

Fishing is only documented by the bones presented in this study. There is no bone hook or other material evidence for fishing in the materials from Aruchlo as we know from other Neolithic sites (Hansen, 2015), but fishing with nets or fish traps seems likely at Aruchlo.

The 14C data from settlements of the Shulaveri-Shomutepe group all belong to the 6th millennium BC (Hansen et al., 2017; Nishiaki et al., 2015a). After 5400/5300 BC at the latest, no traces of this early Neolithic settlement can be found. For several centuries no remains of rural settlements in the Caucasus can be proven. The subsequent Chalcolithic mostly is dated between 5000 and 4000 BC, its late phase between 4000 and 3500 BC (Sagona, 2017). The South Caucasian Sioni culture, however, is very poorly documented and archaeologically poorly defined. It is assumed that a more mobile way of life and a higher proportion of animal husbandry are characteristic features (Benecke, 2017). This is presumably also associated with increasing settlement at higher elevations (Sagona, 2017; Varoutsikos et al., 2017). With the abandonment of Aruchlo and other Neolithic settlements, the peasant way of life apparently finds an abrupt end in the South Caucasus. Why is unclear. Violent conflicts as well as economic crises or epidemic diseases are possible explanations. It is a case of failed Neolithization that deserves more in-depth study, as similar processes are likely to have taken place in certain regions of southeastern Europe.

4. Materials and methods

In general, fishbones in archaeological excavations are underrepresented due to their low structural density and therefore poor chance of preservation (Van Neer et al., 2005). The small number of fishbones in Aruchlo, and probably the other Shulaveri-Shomutepe villages is not only the result of excavation techniques and the lack of sieving on site. All round buildings in Aruchlo were filled with rubbish from elsewhere. Therefore, there is no single *in situ* situation in a round building as we know it from contemporary houses in Anatolia or southeastern Europe. This is probably one reason for the small number of fish remains. Due to

Fig. 5. Dry-sieving ditch fill to recover small artifacts (Photo S. Hansen).

the very hard sediment in Aruchlo it was necessary to use spades during excavation in 10 cm steps and to check these small sediment blocks by trowel. The fish bones represented in this study were first identified in the ditch, where they were covered with earth probably immediately or shortly after their deposition. After this first find we began sieving in the field because of the importance of this singular find. We then used a locally produced sieve with a mesh-size of 4 mm. The fishbones discovered in the sieve were collected from three ditches (5, 7 and 9; Fig. 6) .

The bones were identified with the aid of comparative collections at the Landesmuseen Schleswig-Holstein Schloss Gottorf, Schleswig, Germany; the Royal Belgian Institute of Natural Sciences, Brussels; and comparative specimens prepared in Tbilisi, Georgia in June 2019. Identifications went to the lowest taxon possible. Fish sizes were estimated based on comparisons with reference skeletons of known total length (TL). It seems that most fishes arrived complete on the site, so we estimated both NISP (number of individual specimens as well as the MNI (minimum number of individuals).

5. Results

Almost all the fish bones were discovered in ditch 7 (10) (NISP = 1739 or 99% of the total or 97% by weight of the identified material) while ditches 5 and 9 (NISP = 13 and 8 respectively) contribute just 1% of the analyzed material (see Tables 1 and 2). Because of the very few bones found in ditches 5 and 9, we will primarily focus on the bones from ditch 7 (10).

The majority of the fish bones belong to the carp family (Cyprinidae). Although the bones of this family are very distinct from other fishes, identifications to species within the family is rather difficult (Lepiksaar and Heinrich, 1977). Of the material studied, about 63% could be identified (74% by weight) at least to family level (Tables 1 and 2). Cyprinids dominate the assemblage (99% of the identified specimens). Salmonidae is the only other fish family present. Three Cyprinidae species could be identified: *Capoeta capoeta*, khramulya; *Luciobarbus mursa*, mursa and *Luciobarbus capito*, bulatmai barbel. The number of bones for each taxon are given in Table 1.

Although differences in the potential for species-level identifications of particular elements varies between these fishes and taphonomic biases may also exist, the data show that khramulya were the favored catch over mursa in a roughly 3:1 ratio, with only a single bulatmai barbel specimen (from a total of 167 species-identified cyprinid specimens). The weight of bone shows a similar distribution to the count of specimens (Table 2).

The sizes of cyprinids were estimated based on 99 different bones, representing a minimum number of individuals (MNI) of 24 fish (Table 3).

Most fish bones are from medium-sized fishes and relatively few large fishes are represented in the material. Due to the use of 4 mm mesh during sieving, we cannot exclude that smaller fishes were present at the site. The use of smaller mesh sizes would clarify this question.

Identification was done on the basis of the angular, dentary, hyomandibular, maxillary, pharyngeal plate and quadrate, basioccipital, ceratohyal, epihyal, parasphenoid, supracleithrum and urohyal bones. The elements present in the material (Table 4) suggest that whole fish carcasses were discarded at the site as all regions of the body are represented. Vertebrae represent about 55% of the cyprinids remains and 75% of the salmonid remains. In the absence of evidence for differential deposition of parts of the fish (*e.g.*, an overrepresentation of cranial elements compared to axial elements), the conclusion is that whole, fresh fish were consumed at the site, presumably caught in the waters nearby. No cutmarks or other signs of butchery were observed on the bones, although 54 of them were burnt either white or black. Whether they were transformed by fire during the process of meal preparation or after the fish were consumed is not possible to determine.

The 16 salmonid bones compare well with trout or salmon, but due to a lack of comparative specimens it was not possible to determine the actual species. Comparison with reference material of trout/salmon (*Salmo trutta/salar*) from northern Europe suggests a size of 40–50 cm and a weight up to 1 kg. Fishbase mentions only one species for Georgia, *Salmo rizeensis*. This fish reaches maximum sizes of 25 cm SL and can be excluded. This indicates that fish ranges may have changed due to climatic and anthropogenic effects over the last 7–8000 years.

6. Discussion

6.1. Species composition

The fish bones found in the assemblage represent species that all could have been caught in the river near the site (Çiçek and Birecikligil, 2016; Froese and Pauly, 2020). Khramulya (*Capoeta capoeta*) occurs in Western Asia and the Caucasus in both the upper and lower reaches of rivers (Blanc et al., 1971). They eat mostly aquatic vegetation but also small invertebrates and reach a maximum size of 40 cm (Bănărescu,

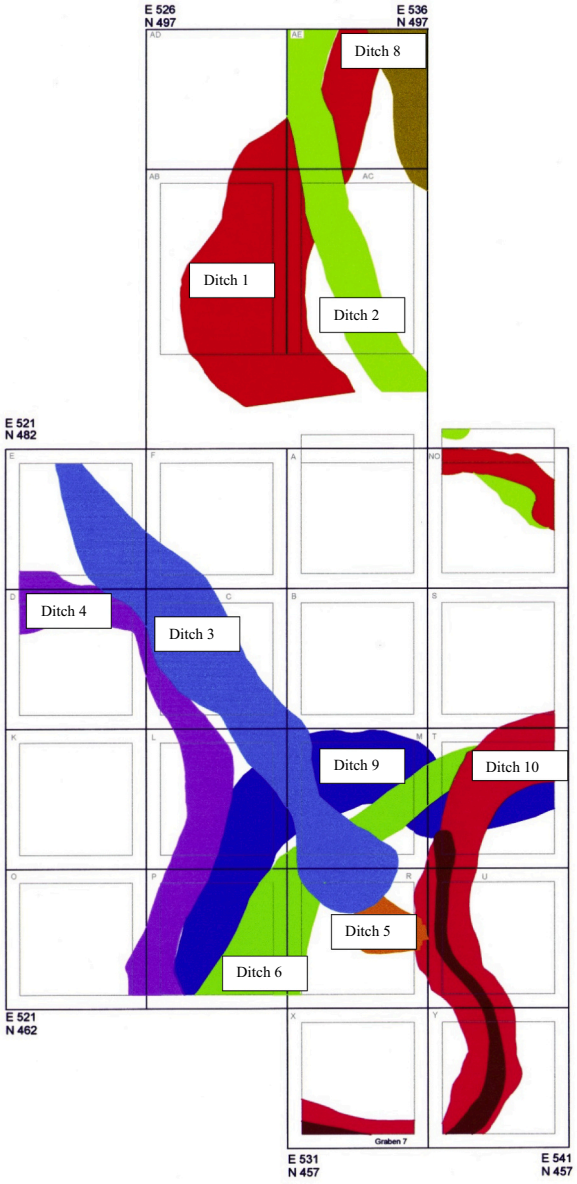

Fig. 6. Map showing location of the ditches in the 5 by 5 m grid at Aruchlo I (Plan: M. Ullrich).

Table 1
Number of fish bones at Aruchlo I.

	Ditch 5	Ditch 7	Ditch 9	∑
Cyprinidae	9	1563	7	1579
Capoeta capoeta	3	118		121
Luciobarbus mursa	1	42		43
Luciobarbus capito		1		1
Salmo sp.		15	1	16
Total identified	13	1739	8	1760
Unidentified	21	1003	7	1031
Total	34	2742	15	2791

1999; Riede, 2004; Talwar and Jhingran, 1991). "Like most large rheophilic and potamal cyprinid species, *C. capoeta* quite probably undertakes upstream migrations over various distances during the spawning season," (Bănărescu, 1999:398–399). Mursa (*Luciobarbus mursa*) is also endemic to the rivers of Asia, preferring fast-flowing

Table 2
Weight (grams) of bone.

	Ditch 5	Ditch 7	Ditch 9	∑
Cyprinidae	1.94	193.21	1.54	196.69
Salmo sp.		2.74	0.24	2.98
Unidentified	1.61	67.47	0.58	69.66
Total	3.55	263.42	2.36	269.33

Table 3
Size estimates for the cyprinid specimens identified at Aruchlo I based on the MNI. The last row (Max. size (TL)) displays the maximum known total length (TL) attained by the species.

	Capoeta capoeta	*Luciobarbus mursa*	*Luciobarbus capito*	Cyprinidae
10–20 cm	2	2		
20–30 cm	7	7		3
30–40 cm	1			1
40–50 cm			1	
Max. size	41 cm	39.5 cm	105 cm	

waters with sand or gravel bottoms, but it can also be found in lakes (Berg, 1964; Bogutskaya, Bănărescu and Almaça in Bănărescu and Bogutskaya, 2003; Coad, 1995; Solak, 1977). Maximum size of this species is about 43 cm (Jolodar and Abdoli, 2004). They spawn in May and June in Georgia today and are considered delicious food (Abdurakhmanov, 1962). In contrast, bulatmai barbel (*Luciobarbus capito*) more commonly occur in the sea and make spawning migrations to the upper reaches of rivers that empty into their saltwater habitats. They prefer streams with strong currents and sandy bottoms for spawning, which takes place almost the whole year in the Kura River, although with concentrations in the fall and spring. Bulatmai barbel are one of the larger cyprinids, commonly reaching a size up to 65 cm and in some cases over 100 cm (Berg, 1964; Bogutskaya, Bănărescu and Almaça, in Bănărescu and Bogutskaya, 2003; Kazancheev, 1981; Kottelat and Freyhof, 2007).

There is no reason to suspect that the main fishery occurred elsewhere than in the immediate vicinity of the settlement, although fishing activity was surely not always restricted to these waters. While some fishing may have continued year-round, the spawning movements of all four fishes in the Aruchlo assemblage, especially salmonid and bulatmai barbel, presented opportunities for the mass harvesting of large, high-quality fish. Based on recent reports of fish behavior, these runs would have been especially heavy in the spring and fall months (Abdurakhmanov, 1962; Bănărescu, 1999; Bănărescu and Bogutskaya, 2003). Exploitation of migrating fish is often accomplished with the aid of fish fences or weirs to concentrate the fish so they can be more readily trapped, netted, or speared. However, this is not proven for Aruchlo and other technologies could have been used to exploit these events.

It is remarkable that there is no overlap in species composition with the earlier excavations from the 1966–1985 campaigns. On the one hand, different recovery techniques (collecting by hand *versus* sieving) could play a role. However, the species recovered in the earlier campaigns (kutum, (*Rutilus frisii*); crucian carp, (*Carassius carassius*); barbel (*Barbus* sp.); and pike, (*Esox lucius*)) prefer slow-flowing to still waters as opposed to the rheophilic species we identified (Chikovani et al., 2015:16–36, Kottelat and Freyhof, 2007). It is possible that this material belongs to a more recent occupation of the site during the Iron Age when fish and fishing were viewed differently.

Table 4
Element representation in the assemblage.

	Cyprinidae	*Capoeta capoeta*	*Luciobarbus mursa*	*Luciobarbus capito*	Salmonidae
Caudal vertebra	457				8
Precaudal vertebra	411				4
Vertebra	99				
Angular	9	6	1		1
Basioccipital	43	8			
Basipterygium	56				
Ceratohyal	12	10			
Circumorbital	11				
Cleithrum	67				
Coracoid	12				
Cranium, unspecified	17				
Dentary	10	14	13	1	1
Epihyal	2	3			
Frontal	1				
Hyomandibular	38	37	5		
Maxillary	10	7	7		
Mesocoracoid	5				
Opercle	23				
Opercular series	36				
Palatine	3				
Parasphenoid	15				
Pharyngeal	24	18	14		
Postcleithrum	22				
Premaxillary	2				
Preopercle	24				
Pterotic	1				
Pterygiophore	122				
Quadrate	3	14	3		1
Scapula	6				
Supracleithrum	10	1			
Urohyal	8	3			
Vomer	8				1
Other	12				

6.2. Low fish consumption in the "Shulaveri-Shomutepe" Neolithic culture?

Despite the growing number of excavations in this region, fish remains are very scarce and not well documented. During the early excavations of Aruchlo, four different species were identified despite the small assemblage of 16 bones: kutum, crucian carp, barbel, and pike (Chikovani et al., 2015:16–36). Benecke (in Lyonnet et al., 2012) just mentions the presence of some bones from the carp family, identified as barbel. Moreover, there are no traces of fishing gear found in Aruchlo in the shape of net weights or other evidence of fishing while this is the case in some other Neolithic or Chalcolithic sites (Hansen, 2015). Benecke (in Lyonnet et al., 2012) identified a few bones of carp fish and sturgeon from the site Kamiltepe. A meager result compared to the total number of around 50,000 animal bones. Nishiaki et al. (2019) mentions 23 bones of freshwater fish (from a total of 3500 bones) without further information regarding species for the site of the Damjili Cave in West Azerbaijan over the Mesolithic and Neolithic period together. For the site of Haci Elamxanli Tepe (Neolithic) in the same country, only 2 fish bones were recovered out of 5602 bones only collected by hand (Nishiaki et al., 2015a). More details about size reconstructions or skeletal element representation are lacking for these sites. Ongoing studies from the Neolithic site of Aknashen-Khatunarkh (Badalyan et al., 2010) reported two species from the Cyprinidae: common carp (*Cyprinus carpio*) and tench (*Tinca tinca*) together with bones of catfish (*Silurus glanis*). Fishes were medium to large in size with the catfish around 150 cm. For all these sites mentioned, the way of collecting animal bones by hand will have biased the number of fish bones thoroughly. We support Berthon, (2014) who broke a lance for more sieving and flotation in the field to get a clearer view on the rise of the commensal mammals in these sites. But the same is applicable for fishes. Although even then the results are meager. In an earlier study, Nishiaki et al., 2013 recovered bones with the aid of sieving and flotation in the Haci Elamxanli Tepe site but recorded no fish bones although frog bones were found. From the Neolithic site of Mentesh Tepe, we have scant information about the presence of fish bones of cyprinids collected by flotation (Herrscher et al., 2018).

The core research of Herrscher, however, dealt with stable isotope analysis of human remains from the Mentesh Tepe site. These results indicate that people survived mainly on a staple of C-3 plants and freshwater fish. This would imply that fish bones should be found in larger amounts in excavations. Itahashi et al. (2020) contradicted the hypothesis of Herrscher by using a newer technique. This proved that a higher nitrogen compound similar to fish consumption was a result of the intake of C-4 plants. If this is the case, fish was not an important food staple in this culture. It seems contradictory that people living at a site close to two rivers had such little interest in fishing, especially considering the demonstrated importance of rivers to other aspects of settlement and subsistence (*e.g.*, Ollivier et al., 2018).

6.3. Fish used as a means for feasting?

The fact that fish remains were found in greater amount in some ditches in Aruchlo indicates that we are dealing with something special. Indeed, if fish was eaten on a regular basis, we would find fish bones spread out over the ditches and in every layer. This is not the case; they are found in layers separated by clean earth. This strongly suggests that these time-consuming works were interrupted by celebrations or rituals, probably directed to create or support community. The remains of the feasting were deposited later in the ditch.

These observations raise new questions which can hopefully be answered with more bone finds and more precise excavation techniques. Was fishing a seasonal activity only meant to provide fishes for these feasts? Some ditches contain layers of ash with fish bone while other ditches are sterile. Why? Another open question is whether most of the fish were consumed immediately or some were processed for storage.

Due to the fact that the residential units are still not found, a broader view about fishing is still lacking for this site and for Neolithic Georgia as a whole.

7. Conclusion

The fortunate discovery of fish bones in the ditches of Aruchlo is first of all significant from a methodological point of view. The special form of their intentional deposition in the ditch was decisive for their preservation. In contrast, fish bones as normal settlement waste have much less chance for survival. Therefore, fish remains are usually extremely underrepresented in settlements and do not give a realistic picture of the importance of this economic activity.

The fish bones recovered at the site attest the existence of a good local fishery, but its extent and integration into the farming economy is harder to discern. We have no indications yet to state that fishing was a year-round activity. The scarcity of fish bones and the results of stable isotope analysis seem to indicate this was not the case. Were fish seen as a highly anticipated delicacy during spawning time or did fish consumption have a more social meaning? Were they caught by many or exploited by a guild of expert fishers who provisioned the community? It is not possible to answer these questions with this one modestly sized assemblage, but the data here show the potential for further work in this area. To explore this potential in depth, it would be desirable to use even finer meshes for sieving in future excavations to provide extra information about fishing techniques and seasonality. It could be a helpful tool in the complex puzzle of how and why the people of Aruchlo invested so much time and energy into the construction of these ditches only to fill them again within a year or two. In addition to the archaeological interest, these fish bones provide more information about archaic fish populations in this region.

Declaration of Competing Interest

None.

Acknowledgements

The excavation is a joint project between the Eurasian Department of the German Archaeological Institute and the Otar Lordkipanidze Archaeological Centre of the Georgian National Museum. For their constant support we wish to thank Prof. David Lordkipanidze and Dr. Zurab Makharadze. The excavation was funded by the Deutsche Forschungsgemeinschaft (DFG). Funding for analysis of the fish remains came partly from ARISC (American Research in the South Caucasus), ARISC Research Fellowship (Ritchie 2019). We thank the two anonymous reviewers of our manuscript for their critical view to improve this article.

References

Abdurakhmanov, Y.A., 1962. Freshwater Fishes of Azerbaijan. Akademii Nauk Azerbaidzhanskoi SSR, Institute Zoology, Baku, Azerbaijan.

Abuladze, J., 2017. A typological and statistical setting of grinders. In: Helwing, B., Aliev, T., Lyonnet, B., Guliyev, F., Hansen, S., Mirtskhulava, G. (Eds.), The Kura Projects, New Research on the Later Prehistory of the Southern Caucasus. Archäologie in Iran und Turan, Band 16. Dietrich Reimer Verlag, Berlin, pp. 261–266.

Badalyan, R., Lombard, P., Chataigner, C., Avetisyan, P., 2004. The Neolithic and Chalcolithic Phases in the Ararat Plain (Armenia): The view from Aratashen. In: Sagona, A. (Ed.), A View from the Highlands. Archaeological Studies in Honour of Charles Burney, Ancient Near East Studies, Supplement 12. Peeters Publishers, Leuven, pp. 399–420.

Badalyan, R., Harutyunyan, A., Chataigner, C., Le Mort, F., Brochier, J., Bălăşescu, A., Radu, V., Hovsepyan, R. (2010). The settlement of Aknashen-Khatunarkh, a Neolithic site in the Ararat Plain (Armenia): excavation results 2004–2009, TÜBA-AR. Turkish Acad. Sci. J. Archaeol. 13: 185–218.

Bănărescu, P.M., 1999. The Freshwater Fishes of Europe. Volume 5. Cyprinidae 2. Part I: Rhodeus to Capoeta. AULA-Verlag, Wiebelsheim.

Bănărescu, P.M., Bogutskaya, N.G., 2003. The Freshwater Fishes of Europe Cyprinidae 2. Part II. Barbus. AULA-Verlag, Wiebelsheim.

Bastert-Lamprichs, K., 2017. Das neolithische Aruchlo: Die Keramik der Kampagnen 2012–2014. In: Helwing, B., Aliyev, T., Lyonnet, B., Guliyev, F., Hansen, S., Mirtskhulava, G. (Eds.), The Kura Projects, New Research on the Later Prehistory of the Southern Caucasus. Archäologie in Iran und Turan, Band 16. Dietrich Reimer Verlag, Berlin, pp. 233–246.

Batiuk, S.D., Jalabadze, M., Graham, A., Koridze, I., Abu Jayyab, K., 2017. The Gadachrili Gora regional archaeological project. Anatolica 43, 173–202.

Benecke, N., 2017. Exploitation of animal resources in Neolithic settlements of the Kura region (South Caucasia). In: Helwing, B., Aliyev, T., Lyonnet, B., Guliyev, F., Hansen, S., Mirtskhulava, G. (Eds.), The Kura Projects, New Research on the Later Prehistory of the Southern Caucasus. Archäologie in Iran und Turan, Band 16. Dietrich Reimer Verlag, Berlin, pp. 357–370.

Berg, L.S., 1964. Freshwater fishes of the U.S.S.R. and adjacent countries. volume 2, 4th edition. Israel Program for Scientific Translations Ltd, Jerusalem. Russian version published 1949.

Blanc, M., Gaudet, J.L., Banarescu, P., Hureau, J.C., 1971. European inland water fish. A multilingual catalogue. Fishing News (Books) Ltd., London.

Chelidze, L., Gogelia, D., 2004. Aruchlo I: an early-farming site. J. Georgian Archaeol. 1 (2004), 46–92.

Chikovani, G., Abuladze, J., Zhvania, D., 2015. Settlements of the Early Farming Period Culture Explored by Kvemo Kartli (Aruchlo) Archaeological Expedition (1966–1988). Georgian National Museum, Otar Lordkipanidze Centre of Archaeology, Tbilisi.

Çiçek, E., Birecikligil, S.S., 2016. Ichthyofauna of the Turkish parts of Kura-Aras River Basin. FishTaxa 1 (1), 14–26.

Coad, B.W., 1995. Freshwater fishes of Iran. Acta Sci. Nat. Acad. Sci. Brno. 29 (1), 1–64.

Dzhaparidze, O., Dzhavakhishvili, A., 1971. Early Farming Society Culture in Georgia. Sabchota Saqartvelo, Tbilisi.

Froese, R., Pauly, D., 2020. FishBase. World Wide Web electronic publication. www.fishbase.org. version 02/2019.

Hamon, C., Jalabadze, M., Agapishvili, T., Baudouin, E., Koridze, I., Messager, E., 2016. Gadachrili Gora: architecture and organisation of a Neolithic settlement in the middle Kura Valley (6th millennium BC, Georgia). Quat. Int. 395, 154–169.

Hansen, S., 2015. Pietrele – Lakeside Settlement, 5200–4250 BC. In: Hansen, S., Raczky, P., Anders, A., Reingruber, A. (Eds.), Neolithic and Copper Age between the Carpathians and the Aegean Sea. Chronologies and Technologies from the 6th to 4th Millennium BC. Bonn, pp. 273–294.

Hansen, S., Helwing, B., 2018. Der Beginn der Landwirtschaft im Kaukasus. In: Giemsch, L., Hansen, S. (Eds.), Gold und Wein. Georgiens älteste Schätze. Begleitband zur Sonderausstellung 6. Oktober 2018 -10 Februar 2019. Mainz, Archäologisches Museum Frankfurt, pp. 26–41.

Hansen, S., Ullrich, M., 2017. Report on the 2012–2014 Excavation Campaign in Aruchlo. In: Helwing, B., Aliyev, T., Lyonnet, B., Guliyev, F., Hansen, S., Mirtskhulava, G. (Eds.), The Kura Projects, New Research on the Later Prehistory of the Southern Caucasus. Archäologie in Iran und Turan, Band 16. Dietrich Reimer Verlag, Berlin, pp. 201–222.

Hansen, S., Mirtskhulava, G., Bastert-Lamprichs, K., Benecke, N., Gatsov, I., Nedelcheva, P., 2007. Aruchlo 2005–2006. Bericht über die Ausgrabungen in einem neolithischen Siedlungshügel. Archäologische Mitteilungen aus Iran und Turan 38, 1–34.

Hansen, S., Bastert-Lamprichs, K., Kromer, B., Ullrich, M., 2017. Stratigraphy and radiocarbon dating. In: Helwing, B., Aliev, T., Lyonnet, B., Guliyev, F., Hansen, S., Mirtskhulava, G. (Eds.), The Kura Projects, New Research on the Later Prehistory of the Southern Caucasus.Archäologie in Iran und Turan, Band 16. Dietrich Reimer Verlag, Berlin, pp. 291–296.

Helwing, B., Aliyev, T., 2017. Excavations in the Mil Plain Sites, 2012–2014. In: Helwing, B., Aliyev, T., Lyonnet, B., Guliyev, F., Hansen, S., Mirtskhulava, G. (Eds.), The Kura Projects, New Research on the Later Prehistory of the Southern Caucasus. Archäologie in Iran und Turan, Band 16. Dietrich Reimer Verlag, Berlin, pp. 11–42.

Helwing, B., Aliyev, T., Lyonnet, B., Guliyev, F., Hansen, S., Mirtskhulava, G., 2017. The Kura Projects, New Research on the Later Prehistory of the Southern Caucasus. Archäologie in Iran und Turan, Band 16. Dietrich Reimer Verlag, Berlin.

Herrscher, E., Poulmarc'h, M., Pecqueur, L., Jovenet, E., Benecke, N., Decaix, A., Lyonnet, B., Guliyev, F., André, G., 2018. Dietary inferences through stable isotope analysis at the Neolithic and Bronze Age in the southern Caucasus (sixth to first millennium BC, Azerbaijan): from environmental adaptation to social impacts. Am. J. Phys. Anthropol. 167, 856–875. https://doi.org/10.1002/ajpa.23718.

Ioseliani, V., 2017. Ditches at Aruchlo and other Shomu-Shulaveri Sites. In: Helwing, B., Aliyev, T., Lyonnet, B., Guliyev, F., Hansen, S., Mirtskhulava, G. (Eds.), The Kura Projects, New Research on the Later Prehistory of the Southern Caucasus. Archäologie in Iran und Turan, Band 16. Dietrich Reimer Verlag, Berlin, pp. 223–232.

Itahashi, Y., Ananyevskaya, E., Yoneda, M., Miller, A.R.V., Nishiaki, Y., Matuzeviciute, G. M., 2020. Dietary diversity of Bronze-Iron Age populations of Kazakhstan quantitatively estimated through the compound-specific nitrogen analysis of amino acids. Journal of Archaeological Science: Reports 33, 102565.

Jalabadze, M., Esakvia, K., Rusishvili, N., Qvavadze, E., Koridze, I., Shaqulashvili, N., Tsereteli, M., 2010. Report on archaeological work carried out on Gadachrili gora in 2006–2007. Dziebani, J. Georgian Archaeol. 19, 17–25.

Jolodar, M.N., Abdoli, A., 2004. Fish Species Atlas of South Caspian Sea Basin (Iranian Waters). Iranian Fisheries Research Organization, Tehran.

Kazancheev, E.N., 1981. Ryby Kaspiiskogo Morya [Fishes of the Caspian Sea]. Legkaya i Pischchevaya Promyshlennost, Moscow.

Kiguradze, T., 1986. Neolithische Siedlungen von Kvemo-kartli. *Georgien*. Verlag C.H, Beck, München.

Kiguradze, T., 2011. Neolithic and Eneolithic Cultures of East Georgia. Georgian National Museum, Tbilisi.

Kottelat, M., Freyhof, J., 2007. Handbook of European Freshwater Fishes. Publications Kottelat, Cornol and Freyhof, Berlin.

Lepiksaar, J., Heinrich, D., 1977. Untersuchungen an Fischresten aus der frühmittelalterlichen Siedlung Haithabu. Neue Ausgrabungen in Haithabu 10. Wachholtz Verlag, Neumünster.

Lyonnet, B., Guliyev, F., Helwing, B., Aliyev, T., Hansen, S., Mirtskhulava, G., 2012. Ancient Kura 2010-2011: the first two seasons of joint field work in the southern Caucasus. Archäologische Mitteilungen aus Iran und Turan 44, 1–190.

Narimanov, I.G., 1965. Arkheologicheskie issledovaniia poseleniia Shomu- Tepe v 1963 g. In: Vaidov, R.M. (Ed.), Arkheologicheskie Issledovaniia v Azerbaidzhane. Izd- vo Akademii nauk Azerba ĭ dzhanskoii SSR, Baku, pp. 45–53.

Nebieridze, L., 1972. Neolithic in western Georgia. Sakartvelos CCR Mecnierebata Akademia. Iv. Javakhishvili named history. Archaeology and Ethnology Institute, Mecniereba, Tbilisi.

Nishiaki, Y., Guliyev, F., Kadowaki, S., Arimatsu, Y., Hayakawa, Y., Shimogama, K., Miki, T., Akashi, C., Arai, S., Salimbeyov, S., 2013. Hacı Elamxanlı Tepe: excavations of the earliest pottery Neolithic occupations on the middle Kura, Azerbaijan, 2012. Archäologische Mitteilungen aus Iran und Turan 45, 1–25.

Nishiaki, Y., Guliyev, F., Kadowaki, S., Alakbarov, V., Miki, T., Salimbayov, S., Akashi, C., Arai, S., 2015a. Investigating cultural and socioeconomic change at the beginning of the pottery Neolithic in the Southern Caucasus: the 2013 excavations at Hacı Elamxanlı Tepe, Azerbaijan. Bull. Am. Sch. Orient. Res. 374, 1–28.

Nishiaki, Y., Guliyev, F., Kadowaki, S., 2015b. Chronological contexts of the earliest pottery Neolithic in the South Caucasus: radiocarbon dates for Göytepe and Hacı Elamxanlı Tepe, Azerbaijan. Am. J. Archaeol. 119 (2015), 279–294.

Nishiaki, Y., Zeynalov, A., Mansrov, M., Akashi, C., Arai, S., Shimogama, K., Guliyev, F., 2019. The Mesolithic-Neolithic Interface in the Southern Caucasus: 2016–2017 Excavations at Damjili Cave, West Azerbaijan. Archaeol. Res. Asia 19, 100–140.

Ollivier, V., Fontugne, M., Hamon, C., Decaix, A., Hatté, C., Jalabadze, M., 2018. Neolithic water management and flooding in the lesser Caucasus (Georgia). Quat. Sci. Rev. 197, 267–287.

Riede, K., 2004. Global Register of Migratory Species - from Global to Regional Scales. Final Report of the R&D-Projekt 808 05 081. Federal Agency for Nature Conservation, Bonn.

Sagona, A., 2017. The archaeology of the Caucasus: From Earliest Settlements to the Iron Age (Cambridge World Archaeology). Cambridge University Press, Cambridge.

Solak, K., 1977. Çoruh-Aras Havzası, Caner ve Murzu Balıklarının (Barbus Türleri) Dağılışında Populasyon Dinamiği Üzerine Araştırmalar [Investigations on the population dynamics of the Barbus species (Caner and Murzu) in the Çoruh-Aras basin]. Ege Üniversitesi Fen Fakültesi Dergisi, Seri B 1 (4), 361–374.

Talwar, P.K., Jhingran, A.G., 1991. Inland Fishes of India and Adjacent Countries, vol. 1. A.A. Balkema, Rotterdam.

Van Neer, W., Zohar, I., Lernau, O., 2005. The emergence of fishing communities in the eastern Mediterranean region: a survey of evidence from pre- and Protohistoric periods. Paléorient 31 (1), 131–157.

Varoutsikos, B., Mgeladze, A., Chahoud, J., Gabunia, M., Agapishvili, T., Martin, L., Chataigner, C., 2017. From the Mesolithic to the chalcolithic in the South Caucasus: New data from the Bavra Ablari rock shelter. In: Batmaz, A., Bedianashvili, G., Michalewicz, A., Robinson, A. (Eds.), Context and Connection: Essays on the Archaeology of the Ancient Near East in Honour of Antonio Sagona. Peeters, Leeuven, pp. 233–255.