**INTRODUCTION**

Hunting, fishing, and gathering – these are the main economic fields which prevailed in the territory of Lithuania throughout the entire Stone Age period. With the help of the mentioned economic branches, prehistoric people were able to provide for themselves all the necessities for living: food, clothes, tools, and other kinds of resources (Daugnora, Girininkas, 1998, p. 229–230; 2004; Girininkas, Daugnora, 2015, p. 67–80, 96, 138–139; Rimantienė, 1992, p. 110; 1996, p. 96–99; 2005, p. 385–386). Dynamical changes within the environment that occurred through the Late Pleistocene, Early and Middle Holocene periods in the territory of Lithuania (Stańczak, 2004, fig. 9) created good living conditions for various species of fauna, which satisfied the nourishment resource gathering needs of local communities. The resources were supplemented by fishing and gathering. Thanks to a convenient economic model, the prevailing economics in the territory of Lithuania during the Late Neolithic and Early Bronze Age remained to be hunting, fishing and gathering.

In Lithuanian archaeological material research, one of the less studied remains the field of tools used for animal butchering in prehistory. An abundance of animal bones is obtained during archaeological excavations, some of the bones bearing clear cutting marks (Leduc, 2012, p. 66; Luik, Piličiauskienė, 2016, p. 190; Mannermaa, Storå, 2006, p. 441; Ritchie et al., 2013, p. 57). Usually, this reflects traces of butchering technology. Archaeological field studies sometimes identify specific animal butchering sites, or “slaughter places”. One of these slaughter sites with wild and domestic animal bone remains was found during the archaeological examinations of the Kretuonas IC settlement (Švenčionys district, eastern
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Lithuania) (Daugnora, Girininkas, 2004a, fig. 1, table 1; Girininkas, 2012, fig. 3). These results led us to believe that during the settlement’s existence time it was inhabited by a specific type of people who specialized in animal butchering (Daugnora, Girininkas, 2009, p. 48). The archaeological excavations of Stone Age and Early Bronze Age settlements in Lithuania frequently present an abundant flint tools inventory which demonstrates specific economic activities of the site.

Currently, experimental and use-wear analysis methods allow us to present more relevant data about various prehistoric processes. With the help of latter methods, the present article aims to represent experimental and use-wear analysis results, which were obtained by experimenting with meat and fish processing tools – flint and bronze knives. Experiments were performed on wild and domestic animals. An accomplished use-wear analysis allowed to look more into knife manufacturing technology, its importance within prehistoric economics and function. The received results supplemented additional data about the economic model of Late Neolithic – Early Bronze Age communities in the territory of present Lithuania.

MATERIALS AND METHODS

This study is based on experimental and use-wear analysis methods. Experimentally made flint knives were used for animals processing. These tools were made of blades and flakes, which typologically replicates knives used during the Late Neolithic – Early Bronze Age (Girininkas, 2013, fig. 55). For the comparison of butchering efficiency, a bronze knife was also manufactured and used on the same animals. The effectiveness of flint and bronze knives was compared through the recordings of work productivity and use-wear analysis.

Knives were used for domesticated goat (Capra aegagrus hircus), bison (Bison bonasus), and pike (Esox lucius) carcass processing. During the experimental work, we tried to prepare meat and fish for daily consumption, possibly like the prehistoric communities during the Stone – Early Bronze Age did. All processes were arranged into steps. First, the furs of all animals were skinned off, later their limbs were separated. All useful material – skin, long bones, and tendons – were saved and kept for future experiments.

The next stage of research was performed by use-wear analysis. This method was used for the studies of the working edges of flint and bronze knives. The use-wear analysis was conducted in the Experimental Archaeology and Traseology Laboratory at Klaipėda University. Olympus SZX16 microscope with an attached Olympus DP72 camera was used for image recording. Image-Pro express version 6.3 software was used for processing traseological photos. The use-wear traces of skinning, sawing and stabbing on the working edges of knives were best obtained between 10x-80x magnification.

EXPERIMENTAL WORK

Flint knives were made of raw material from southern Lithuania, Rügen island (north-eastern Germany), and France. There are many similarities between raw flint material from southern Lithuania and Rügen Island. The visually noticeable ones are color (grey or black, often with chalk inclusions), and quality of knapping. Raw material from France has light brown/yellowish colour. This type of flint was appropriate for knapping as well. Knapped blades and flakes were sharp and of suitable shape; thus, this type of flint was acceptable for the experiments. Only massive blades and flakes were knapped for knives manufacturing. The ones who had at least one sharp edge and were suited for bigger mammal butchering were selected. Some parts of knives were retouched perpendicularly. This way, the working hand was protected from serious injuries (Tsirk, 2014, p. 27). Similar types of flint knives were collected during the archaeological excavations of Late Neolithic – Early Bronze Age periods settlements of Barzdžio miškas, Karaviškės 6, Kretuonas 1C, and Papiškės 4 (Brazaitis, 2004, fig. 15, 16; Girininkas, 2013, fig. 55; Piličiauskas, 2004, fig. 18; Rimantienė, 1999, fig. 18).

The bronze knife was made by casting a copper alloy strip, which was heated up to 600–800°C and cooled off in 10–15°C water. Metal was forged in order to form blade and handle. The blade was formed in a V shape, whilst the handle was made to be of rectangular shape. The cooling-off was repeated every 2–3
minutes. The last stage of bronze knife production was polishing. The knife blade was polished with sandpaper and cattle hide (Fig. 1). This was done to shape a clear working surface, so as all microscopic traces from bones, cartilages, and soft tissues could be easily detected during use-wear examinations (Dolfini, Crel- lin, 2016; Molloy et al., 2016).

The processing of a domesticated goat began with skinning (Fig. 2). First, a flint knife was used to cut both rear legs toward the udder. Second, the belly was cut from the lower part toward chest. A straight cut was made beginning with the front legs to the chest line, where an incision was made before. The line was continued toward the neck up to its arteries. After that, the skinning process continued with other flint knives. Blades or flakes of curly shape were perfectly fit for skinning. After skinning, the udder was removed from the skin, and later from the whole body. Skinning continued from the belly toward ribs. Further skinning continued with skin removal from the back. The tail was cut and split from pelvis, sacrum, and waist bones. After reaching the front limbs, further work was related with the chest. Skinning of the chest continued toward front limbs and back, and later carried out from the shoulders toward the nape and neck. After this, skinning process was finally accomplished.

Flint knives were also used to remove bone, muscle tissues and internal organs. After the removal of internal organs, foot bones within wrists were also separated. A flint knife was used to cut joints and tendons. Later, back and chest muscles were removed. This was done so as to separate shoulder bones from the front leg (Fig. 3). The same action was repeated on the other front leg. When front legs were removed, vertebra bones were separated from the waist. The whole process was accomplished with a flint knife cutting through joints. The whole lower part of the body was separated. Rear legs and waist were separated from the pelvis, the nape – from chest bones, the muscle group – from vertebra bones. The butchering of a goat was then concluded.

Flint knives were used on bison butchering. The animal was about 1,5 years old. This time, different skinning knives were used, i.e., ones made of flint and bronze. A bronze knife was also used to cut the bison’s Achilles tendons and the quadriceps femoris muscle. The bison skinning process started with an oval cut from the heel bones and continued toward the ventral part of the belly. The next cut was made from the animal’s sternum up to its pubis (Ossa coxae). The front limb skin was cut in an oval incision around the wrist joint, and then the process continued with cutting the inner front leg surface toward the second segment of sternum. After the right half of the animal was skinned, the bison was rolled over and the other half was processed as well. When the skinning process was completed, the animal’s head was separated from the first vertebra (Atlas).

Carcass processing began with the front limbs. A flint knife was used to cut the inner half muscles and shoulder cartilages which connected the front limbs.
Fig. 2. A moment from a domestic goat (*Capra aegagrus hircus*) skinning process using a flint knife. Photo by A. Girininkas.

2 pav. Naminės ožkos (*Capra aegagrus hircus*) odos dyrimas titnaginiu peilu. A. Girininko nuotrauka

Fig. 3. A moment from a domestic goat (*Capra aegagrus hircus*) front leg separation process. Photo by A. Girininkas.

3 pav. Naminės ožkos (*Capra aegagrus hircus*) priekinės kojos atidalijimo procesas. A. Girininko nuotrauka
with the chest. When the shoulder bow and deep chest muscles were removed, then both of the front limbs were separated. The separation of rear limbs from the animal’s body was completed when the loins, rear leg muscles and tendons were cut off. Tail skin was removed after tail separation. Neck and back parts were split into several pieces: neck, chest, waist and sacrum. The chest was split by separating the sternum with the rib cartilages section, and with the cutting of intercostal muscles. After cutting the joint ribs tubercle surface and bending the bone section of the ribs, both sides of the rib head that held ligaments and proximal intercostal muscles were separated.

A pike (about 800 g in weight) was used in the third butchering stage. For this process, only a single flint knife was used (Fig. 4). Butchering began with scale peeling. Later, the fish underbelly was cut and all internal organs were removed. The cut was made from the gills toward the anal flipper. After separating the head, the fish body was separated into three parts. The process lasted about 10–15 minutes.

**USE-WEAR ANALYSIS OF FLINT KNIVES**

The butchering of a goat, bison and pike required 37 flint knives and 1 bronze knife in total. After the process, all knives had visually noticeable use-wear traces. These traces were fixated in detail with an *Olympus SXX16* microscope. Knives designed for different tasks (skinning, limb separation, etc.) had different use-wear marks.

Only flint knives were used for goat butchering. They were made from flint blades. Two shapes of these knives were used: a straight and curved blade (Fig. 5). For the animal skinning process, the curved knives were the best. The curved part functioned as the main work spot, thus most of the use-wear traces were concentrated there. Working with these knives had lasted between 20 to 40 minutes. When the working knife blade was magnified with a microscope between 20x and 40x, minor utilization traces had been detected in the obverse and reverse halves. Small cleavages, minimal polish traces, and more intensive use-wear traces were noticed in the reverse part (Fig. 6). Although work duration was quite long and the use-wear traces were noticeable, the working parts of the knives had remained quite effective even after the accomplished work.

A flint knife made of light grey flint was used for goat butchering. The knife’s proximal part (handle) was wrapped in birch bark (Fig. 7). Before wrapping, birch bark was soaked in hot water. This way, the bark’s elastic characteristics were improved. This knife was used for about 27 minutes (in cutting the leg muscles, separating the shoulder bone from the animal body and separating the body from the waist). A use-wear analysis showed small serrations on the distal part of the blade. Also, after magnifying the image by 25x, polish traces on small sharp edges were visible (Fig. 8). Use-wear traces on this knife were more evident than the ones on the knife used for skinning.
Fig. 5. Flint knife with a curved blade for domestic goat (*Capra aegagrus hircus*) skinning. Photo by T. Rimkus and G. Slah.

5 pav. Titnaginis peilis su išlenktais ašmenimis, skirtas naminės ožkos (*Capra aegagrus hircus*) odai dirti. T. Rimkaus ir G. Slah nuotrauka

Fig. 6. Use-wear traces from domestic goat (*Capra aegagrus hircus*) skinning. Magnification 20x. Photo by G. Slah.

6 pav. Darbo pėdsakai, likę nudyrus odą naminėi ožkai (*Capra aegagrus hircus*). Objekto vaizdas padidintas 20 kartų. G. Slah nuotrauka

Fig. 7. Flint knife with a straight blade used for separating the leg muscles and vertebra of a domestic goat (*Capra aegagrus hircus*). Photo by T. Rimkus and G. Slah.

7 pav. Titnaginis peilis su tiesiais ašmenimis, naudotas naminės ožkos (*Capra aegagrus hircus*) kojų raumenims ir stuburui atidalyti. T. Rimkaus ir G. Slah nuotrauka

Fig. 8. Use-wear traces of a flint knife with a straight blade. Magnification 16x. Photo by G. Slah.

8 pav. Darbo pėdsakai, aptikti ant peilio su tiesiais ašmenimis. Objekto vaizdas padidintas 16 kartų. G. Slah nuotrauka
Flint and bronze knives were used for bison butchering. A flint knife, which was used for bison skinning process, was manufactured from dark grey flint (Fig. 9). The skinning process with this knife lasted about 30 minutes. A use-wear analysis showed regular micro retouch with polished spots on blade traces (Fig. 10). Other evident use-wear traces not detected. This kind of utilization is similar to the tools used for goat skinning.

Use-wear traces of the bronze knife had formed after about 20 minutes of work. This knife was used for skinning and tail vertebra cutting. During the skinning process, the bronze knife was fairly handy; however, with it we were not able to cut the bison’s skin. Joint cutting with this knife was not very smooth either. This part of the process had required considerable effort.

A magnified image of the bronze knife showed some clear use-wear traces. Some of them had formed from polishing (during the knife manufacturing process), while others originated from the cutting and skinning process. In the area of the working part, use-wear traces of dullness were apparent (Fig. 11). These traces formed after unsuccessful efforts to cut the animal’s skin. Other use-wear traces were related with cartilage and bone cutting. A deformation of metal was noticed in the area of the blade (Fig. 12). This kind of metal deformation remains undetectable without the help of a microscope.

In comparing the knives made of flint and bronze, some similarities of use-wear traces can be observed. Flint knives, which were used for cartilage and bone cutting, had very similar use-wear traces in the blade area (Fig. 13). However, due to material differences, the flint blade had cracked, whilst the metal blade only deformed. It is important to note that during the work process, the bronze knife frequently became dull; therefore, it required re-sharpening. As was noticed during the experiments, the flint knives were much better suited for the butchering process.

The last experiment was related with fish butchering. Fish cutting and scale peeling required only a single flint knife. The tool was made from a light brown
So far, not many studies on experimental use-wear analysis were conducted in Lithuanian scientific works (Rimkus, 2016, p. 31–33). The present article holds data on the function of flint and metal knives, which enables us to supplement more information about the usage of these tools in prehistoric animal butchering techniques. Flint tools were prevailed in Lithuanian
According to archaeological data, knives were made of massive blades or flakes, constantly producing them with a hard percussion technique (Girininkas, 2009, p. 166). Based on this provision, similar experimental flint knives were manufactured as the representatives of a latter chronological period.

During experimentation, it was noticed that the work process was strongly influenced by the shape of the tools. For the skinning, the knives which were of a curved blade were more appropriate. The curvature of the blade had enabled the skinning process to be more effective. The same can’t be said about the knives with a straight working blade. After 20 minutes’ work with curved shape tools, they still could have been used for more work. Observed use-wear traces were typical for soft material.

Knives with a straight working blade were used for various muscle groups, as well as the separation of cartilages, internals, joints and limbs. Knives used for softer tissues (muscles) had use-wear traces typical to meat processing. This class of instruments had sharp splits with polish. Archaeological parallels found during use-wear examinations of the Katra 1 settlement flint inventory (Varėna district, southern Lithuania) (Girininkas, 2000, p. 12–14). One of the archaeological knives was made from the blade (Fig. 15). Use-wear traces were detected only on the one edge that was used for work. A microscopic analysis showed that in this part of the tool, use-wear traces characteristic to soft material can be seen (Fig. 16). It is important to express that in the distal part of the tool, use-wear traces characteristic to hard material carving were found as well. This led us to believe that this tool served as a double function knife.

Another very similar knife from the Katra 1 settlement had similar use-wear traces (Fig. 17). The distal part of the working blade had parallel utilization as the knives used for the experiments (Fig. 18). It is interesting that on tools proximal we had encountered hafting traces (Fig. 19). Like the one from the experiment, this knife could have been also wrapped in tree splint, skin, birch bark or other organic material.

Hard material (bones, joints, etc.) sawing traces were detected while analyzing a flint knife from the Janapole 2 settlement (Telšiai district, western Lithuania). This tool was obtained during an archaeological survey and...
Fig. 17. A flint knife from the 1st Katra settlement. Photo by T. Rimkus and G. Slah.

17 pav. Titnaginis peilis, rastas Katros 1-ojoje gyvenvietėje. T. Rimkaus ir G. Slah nuotrauka

Fig. 18. Use-wear of soft organic material. Magnification 40x. Photo by G. Slah.

18 pav. Darbo pėdsakai, likę nuo minkštos organinės kilmės medžiagos. Objekto vaizdas padidintas 40 kartų. G. Slah nuotrauka

Fig. 19. Hafting traces. Magnification 32x. Photo by G. Slah.

19 pav. Įtvėrimo pėdsakai. Objekto vaizdas padidintas 32 kartus. G. Slah nuotrauka

Fig. 20. A flint knife from the 2nd Janapolė settlement. Drawing by T. Rimkus.

20 pav. Titnaginis peilis, rastas Janapolės 2-ojoje gyvenvietėje. T. Rimkaus piešinys
Knives made of flint and metal were used for bison butchering. Thus, two different materials were compared in the work process. The bronze knife was used for skinning, as well as cutting the Achilles tendons and the quadriceps femoris muscle. In our opinion, this knife was not good enough for these tasks. Even a sharpened bronze knife was not that effective as the flint ones. Furthermore, this knife’s working blade became dull very rapidly, thus the work process was not productive. However, flint tools functioned much better. Even a novice craftsman with respective knapping skills could manufacture them quickly and easily. During the work process, each of us had additional copies of knives and raw material for quick production. After the flint knives’ blades became dull, we simply changed them with another one, or renewed them with the help of retouch. This way, the work process was more effective.

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LITERATURE


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**EKSPERIMENTINIAI IR TRASOLOGINIAI TITNAGINIŲ PEILIŲ TYRIMAI. SKERDIMO TECHNOLOGIJŲ PRIEŠISTORINĖJE LIETUVOJE REKONSTRUKCija**

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**Santrauka**

Šis straipsnis skirtas titnaginių ir metalinių peilių eksperimentinei trasologijai analizuoti. Naudojant titnaginius ir vieną iš bronzos pagamintą peilikį, buvo paskersti trys gyvūnai – naminė ožka (*Capra aegagrus hircus*), stumbras (*Bison bonasus*) ir lydeka (*Esox lucius*). Straipsnio tikslas yra atlikti eksperimentinių peilių trasologinę analizę, taip pat palyginti titnaginių ir metalinių peilių efektyvumą skerdant gyvūnus. Šie tyrimai leidžia pateikti naujų duomenų apie vėlyvojo neolito–ankstyvojo bronzos amžiaus bendruomenių ūkį.


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