Techno -economy of lithic raw materials in Piedmont (north-western Italy). A first life-like scenario

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Abstract:

Data about Palaeolithic peopling, settlement dynamics and techno-economy of the south-western margin of the Alpine region are sketchy. In this area, the lack of systematic research and the scarcity of lithic raw materials, spread the idea that Piedmont was not inhabited during Palaeolithic. In 2009, the re-starting of the excavations at the Ciota Ciara cave, gave rise to new questions and to the development of research projects at a regional scale.

The Ciota Ciara cave is the only Middle Palaeolithic site object of multidisciplinary and systematic investigations. Its lithic assemblage, analysed through a techno-economic approach, allows to understand in detail the technological choices and the land mobility of the Neanderthal groups on a local and sub-regional scale. Other Middle Palaeolithic assemblages are known in the region and are all issued from surface collections. They come from the northern part of the region, from Vaude Canavesane, Trino, Baragge biellesi and Colline Novaresi. The technological study of these assemblages led to the identification of strong similarities in the technological choices of the Middle Palaeolithic human groups: they based their technology on the exploitation of vein quartz, a rock diffused all over the regional territory, from time to time accompanied by other local (spongolite, rhyolite, metamorphic rocks, jasper) and allochthonous (radiolarite and flint) lithic resources, with technological adaptation to their quality and mechanical properties both when it comes to predetermined methods (Levallois and discoid) and when expedient reduction sequences are used. Concerning Upper Palaeolithic, the only lithic assemblage issued from an archaeological excavation (and therefore with a clear stratigraphic context) is that from the Epigravettian site of Castelletto Ticino. Other lithic artefacts referable on a techno-typological basis to Upper Palaeolithic are from Trino and Colline Novaresi. As for Middle Palaeolithic, the techno-economic approach used in the analysis of these lithic assemblages, allow to have, for the first time, reliable data at a regional scale.

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In this work we present the data obtained after about ten years of research in Piedmont: they outline a scenario where, even in the limits of analysis mostly based on materials issued from surface collections, we can see both clear differences between the Middle and the Upper Palaeolithic technological behaviours and hypothesise the land mobility of the hunter-gatherers' groups that inhabited the region.

Keywords: Middle Palaeolithic; Upper Palaeolithic; Piedmont; vein quartz; lithic technology

1. Introduction

Piedmont is a region located in north-western Italy, at the south-western margin of the Alps (Figure 1). In this area, studies about Palaeolithic are still quite underdeveloped and it is just in the last ten years that a certain interest arose for this area of the Italian peninsula. Although part of this backwardness is due to the lack of specific research, it must be considered that the geological and geomorphological characteristics of the territory have also played an important role. The Po Valley occupies the central, eastern and partly southern sectors of the region; the thick alluvial Quaternary coverings have here completely obliterated any possible evidence of Palaeolithic frequentations; the Alpine arc, present in the northern sector of the region, is here made up almost exclusively of metamorphic rocks, an element that prevented the formation of caves and karst cavities, privileged contexts for prehistoric archaeology. Moreover, Piedmont, depending on its geological background, is almost devoid of flint outcrops (except for the Monte Fenera area) (Daffara *et al.* 2019). The most used rock for the production of lithic tools is vein quartz: as observed experimentally (de Lombera-Hermida 2009; Tallavaara *et al.* 2010), instruments produced in vein quartz show particular knapping scars and in general the outcome of the anthropic action is more difficult to recognize. This is the reason why the first vein quartz lithic assemblages issued from sporadic findings and from the first archaeological excavations carried out in the region were described as rough or as belonging to underdeveloped cultures, *i.e.*, the Alpine Mousterian (Battaglia 1953; Lo Porto 1957).

Until the early 1960s, apart from some sporadic and unreliable nineteenth-century reports, there were very few elements attesting a Palaeolithic frequentation of Piedmont. At the time, this lack was attributed to an alleged environmental inhospitality which was believed to have continued uninterruptedly throughout the Pleistocene (Fedele 1985).

What can be considered as the first solid indications of a frequentation of the region during Middle Palaeolithic are undoubtedly the results of the archaeological excavations conducted by F. Fedele (Fedele 1966; 1972) at Monte Fenera (Belvedere shelter, Ciota Ciara cave, Ciutarun) between the '60s and '70s of the last century (Figure 1). In the regional context, Monte Fenera represents the widest and most important portion of the Mesozoic sedimentary cover (Fantoni *et al.* 2005); the Oligocene - upper Miocene karstification occurred within the carbonate rocks of the mount and originated several caves that favoured the preservation of evidence of human frequentation of the area from Middle Palaeolithic to Early Middle Ages (Bini & Zuccoli 2004; Gambari 2005). F. Fedele was the first to deal with paleo-environmental studies and to propose a reconstruction of the modalities of frequentation of the Monte Fenera area during Middle Palaeolithic, with the hypothesis of seasonal occupations of the caves (Belvedere shelter and Ciota Ciara cave) and the production of quartz tools within the sites (Fedele 1966; 1968; 1972; 1988). Other researches took place at the Ciota Ciara cave during the 90s, but data were never shared or published, except for the discovery of two human teeth within sediments transported outside the cave by water and identified as belonging to *Homo neanderthalensis* (Busa *et al.* 2005; Villa & Giacobini 2005).

At the same time, archaeological excavations at Boira Fusca cave (Figure 1), attesting frequentations between the end of Upper Palaeolithic and the Copper age (Fedele 1990), together with sporadic surface findings of isolated lithic artefacts or of small lithic assemblages in different sectors of the region, started to give rise to the idea that Piedmont had actually been the subject of rather important human frequentations during Palaeolithic (Table 1).

Table 1. List of the sporadic surface findings of Palaeolithic lithic industries in Piedmont between the 1970s and 1990s with indication of year, proposed chronology, geographic context, number of lithic artefacts and bibliographic references. L.P. = Lower Palaeolithic; M.P. = Middle Palaeolithic; U.P. = Upper Palaeolithic. The location of the site mentioned here is reported in Fig. 1. The precise location of the findings indicated as "Astigiano" and "Tanaro valley" is not known, so they are not reported in Fig. 1.

Site	Year	Chronology	Geographic context	N° of lithic artefacts	References
Vaude canavesane	1970	M.P.	Hills	≈350	(Rubat Borel *et al.* 2013)
Trino Vercellese	1974	L.P. M.P.	Hills	≈300	(Fedele 1974)
Masserano	1975	M.P. (?)	Flood plain	14	(Giacobini 1976)
Astigiano	1983	M.P.	Hills	5	(D'Errico & Gambari 1983)
Molino di Tigliole	1990	M.P.	Hills	≈100	(Forno & Mottura 1993)
Tanaro valley	1992 1993	M.P. U.P. (?)	Fluvial valley	-	(Mottura 1994)
Briona	-	M.P.	Hills	3	(Guerreschi & Giacobini 1998)
Pombia	-	M.P.	Hills	1	(D'Errico & Gambari 1983)
Buronzo	-	U.P.	Flood plain	1	(D'Errico & Gambari 1983)

Despite this new awareness, no systematic and multidisciplinary archaeological research was undertaken to verify this hypothesis and the knowledge about the Palaeolithic peopling of Piedmont remained anecdotal until the early 2000s. It is precisely in these years that the Epigravettian site of Castelletto Ticino (Figure 1) comes to light; as it will be explained later in detail, this is the first Upper Palaeolithic site in the region to be investigated stratigraphically but its discovery remained an isolated fact, which was not followed by further researches (Berruti *et al.* 2017). It was only in 2009 with the beginning of systematic archaeological excavations at the Ciota Ciara cave that modern studies began at a regional level on the themes of the Palaeolithic peopling of this part of the Italian peninsula; the projects developed in these years involved the revision of old lithic collections, the study of lithic assemblages collected in different sectors of the region and the realization of survey campaigns that led to the discovery of new archaeological evidence attesting the importance of the Palaeolithic of the region (Angelucci *et al.* 2019; Arzarello *et al.* 2012; Berruti, *et al.* 2016a; Caracausi *et al.* 2018; Daffara *et al.* 2019; 2021a; Rubat Borel *et al.* 2013; 2016; 2020).

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The present work aims to provide a picture of the state of the art in Piedmont after about ten years of research. It brings together old data and results of new research concerning the most important lithic assemblages of the region. Within the limits dictated by the provenance of most of the lithic assemblages here considered from non-systematic surface collections, a first hypothesis is proposed concerning technology and management of raw materials at the regional scale. Regarding this last aspect, the aim is to underline similarities and differences between the lithic assemblages attributed to the Middle Palaeolithic and those attributed to the Upper Palaeolithic.

The proposed work is intended to represent a first step towards an updated and detailed knowledge of the Palaeolithic of Piedmont as well as a valid starting point for setting up and carrying out further archaeological research.

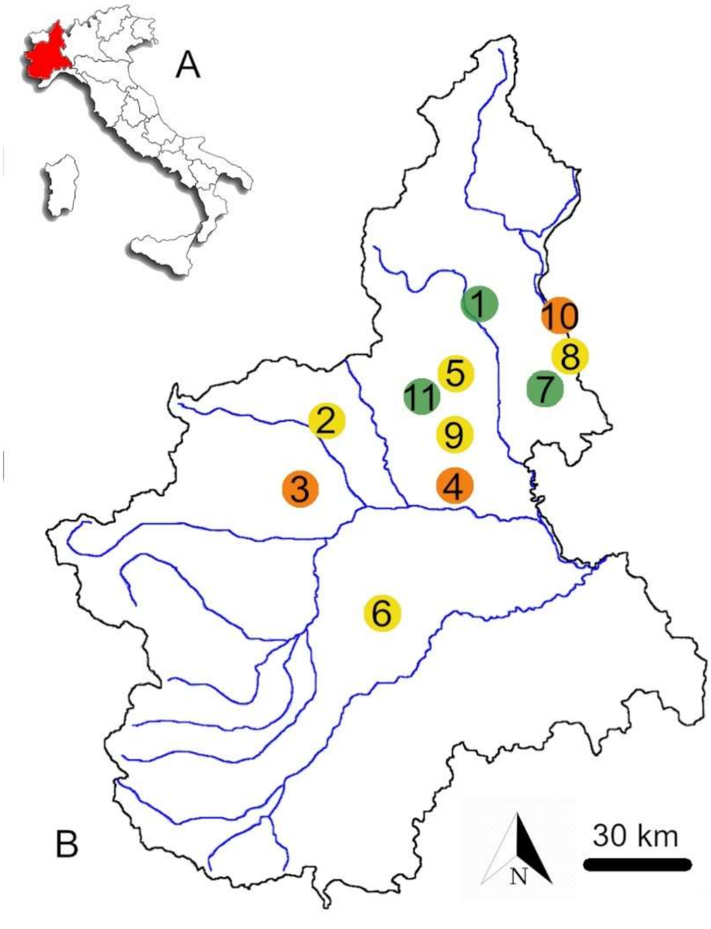

Figure 1. Geographic location of Piedmont (A); map of Piedmont with location of the Palaeolithic sites currently known. Yellow dots = isolated lithic artefacts and lithics from excavations not considered in the present work; Orange dots = lithic assemblages object of new technological studies; green dots = lithic assemblages issued from new research projects. Ciota Ciara cave and Monte Fenera area (1); Boira Fusca (2); Vaude Canavesane (3); Trino (4); Masserano (5); Molino di Tigliole (6); Briona and Colline Novaresi (7); Pombia (8); Buronzo (9); Castelletto Ticino (10); Baragge Biellesi (11).

2. Materials

The present work considers lithic assemblages coming from different sector of Piedmont and attesting a Palaeolithic frequentation of the region (Table 2).

Table 2. Summary of the considered lithic assemblages with indication of the number of artefacts and of the raw materials used. The location of the sites is reported in Figure 1.

Site	Vein quartz	Radiolarite	Chert	Others	Total
Ciota Ciara	5019	97	1848	142	7106
(layers 103, 13,14, 15)	70.6%	1.4%	26%	2.0%	100%
Castelletto Ticino	-	67	189	-	256
(layer 105a)	-%	26.2%	73.8%	-%	100%
Vaude Canavesane	319	-	18	15	352
(surface collection)	90.7%	-%	5.1%	4.2%	100%
Baragge Biellesi	11	-	-	1	12
(surface collection)	91.7%	-%	-%	8.3%	100%
Colline Novaresi	8	74	262	33	377
(surface collection)	2.1%	19.7%	69.5%	8.7%	100%
Trino	1475	153	302	34	1964
(surface collection)	75.6%	7.8%	15.4%	1.8%	100%

Some of the considered assemblages (Vaude Canavesane, Trino, Colline Novaresi) are issued from not-systematic surface collections completed approximately between the ‘70s and the ‘90s; in the last years these assemblages have been object of new technological studies and interpretations by the authors (Berruti *et al.* 2021; Daffara, *et al.* 2021b; 2022; Rubat Borel *et al.* 2013). The Baragge Biellesi lithic artefacts come from a survey campaign realized in 2015 (Berruti *et al.* 2016b; Rubat Borel *et al.* 2016) as well as part of the Colline novaresi assemblage was collected during systematic surveys completed in 2018 (Berruti *et al.* 2021; Daffara *et al.* 2022). Just two of the considered lithic assemblages are issued from systematic archaeological excavations and are those from the Ciota Ciara cave (Middle Palaeolithic) (Angelucci *et al.* 2019; Arzarello *et al.* 2012; Berto *et al.* 2016; Buccheri *et al.* 2016; Daffara *et al.* 2014; 2019; 2021a) and from Castelletto Ticino (Upper Palaeolithic - Epigravettian) (Berruti *et al.* 2017; Berruti & Viola 2011). These two sites are very important for the aim of the proposed work since they represent the only believable term of comparison for the interpretation and analysis of the lithic assemblages lacking a clear stratigraphic context. Here, all the data obtained from the technological studies carried out are considered together as to outline a first regional scenario.

2.1 The corpus of sites

2.1.1. Ciota Ciara cave

The Ciota Ciara cave is a still active karst cave located in the north-eastern part of Piedmont. The cave opens on the west side of Monte Fenera at 670 m a.s.l. and it develops over more than 80 m on its principal axe (Brecciaroli Taborelli 1995; Fedele 1966). The archaeological importance of the Ciota Ciara cave is known since the beginning of the XXth century (Conti 1931) but systematic investigations started just in the 60s, when some test pits were realized (Busa *et al.* 2005; Fedele 1966; 1972; Gambari 2005). In the 90s, two brief excavation campaigns took place after the funding of two teeth within sediments transported outside the cave by water and attributed to *H. neanderthalensis* (Villa & Giacobini 1993; 2005). The investigated area was in the atrial part of the cave, the same where systematic and multidisciplinary research started again in 2009 and are still ongoing (Figure 2). In this sector, a 2 m tick stratigraphic sequence was unearthed (Angelucci *et al.* 2019) and four main stratigraphic units have been identified (103, 13, 14, 15) (Angelucci *et al.* 2019; Arzarello *et al.* 2012; Daffara *et al.* 2021a).

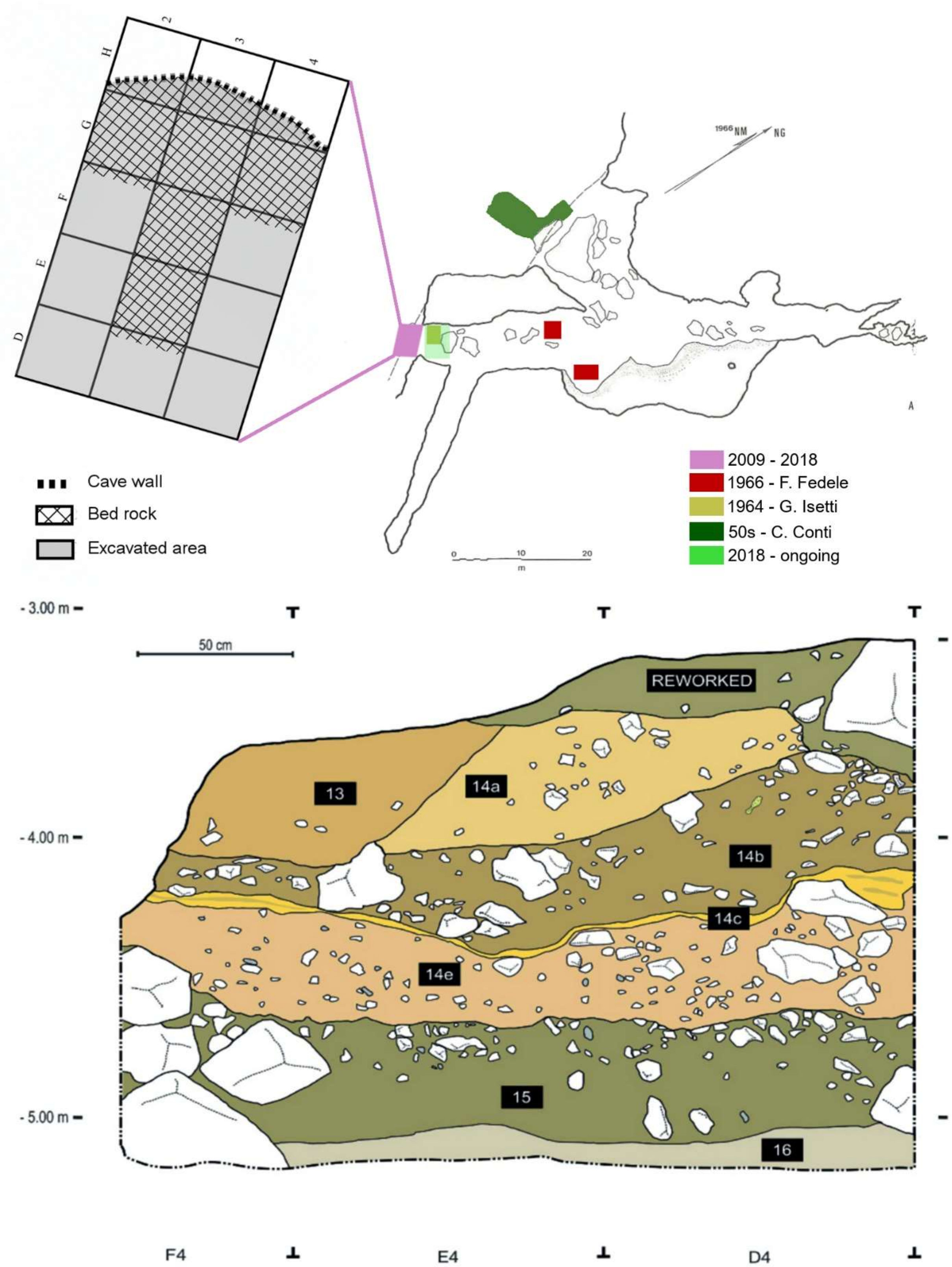

Figure 2. Top: planimetry of the Ciota Ciara cave with indication of all the sector investigated from the 50s until today (from Daffara *et al.* 2021a); bottom: stratigraphic profile of the site (from Angelucci *et al*. 2019).

The paleoenvironmental reconstruction, achieved through the paleontological analysis of macro and micro mammals remains, shows that a woodland environment was predominant during the frequentation of the site, but a climatic change is visible between level 13 and 14, from warmer to cold and humid conditions (Berto *et al.* 2016). The macro mammals' assemblage is dominated by carnivore remains in all the units (*Ursus spelaeus, Ursus arctos, Canis lupus, Vulpes vulpes, Meles meles, Martes martes, Lynx lynx, Panthera leo* and *Panthera pardus*), while the importance of herbivores (*Rupicapra rupicapra, Cervus elaphus,* cf. *Dama*, *Bos primigenius, Bos* sp., *Bos* vel. *Bison, Sus scofa, Stephanorinus* sp.) increases in level 14 (Berto *et al.* 2016; Cavicchi 2018: 66-78). Cut marks related to skinning activities and flesh extraction are attested not only on herbivore remains but also on some *Ursus spelaeus* remains (Buccheri *et al.* 2016). Preliminary numerical dating indicate that the human frequentation of the Ciota Ciara cave may date to the second half of the Middle Pleistocene (Vietti 2016: 66-68). During the last four years, a new excavation area was opened in the interior part of the cave where an archaeological layer corresponding to level 13 has been identified on an area of 10 m^2 and it is now under investigation. The considered lithic assemblage comes from the atrial sector of the Ciota Ciara cave (layers 103, 13, 14, 15), and it counts 7106 lithic artefacts (Table 3). Today, it represents the most important Middle Palaeolithic lithic assemblage of the region, and its study is fundamental evidence of the technological behaviour of the hunter-gatherers' groups of Piedmont. The state of preservation of the lithic assemblage is good in all the units, even if lithics from level 15 and 103 are often affected by post depositional surface modifications of mechanical origin (Angelucci *et al.* 2019; Daffara *et al.* 2021a). Chemical alterations are present in different proportions in the considered level, but their intensity is not so strong to prevent the technological analysis (Daffara *et al.* 2021a).

Table 3. Composition of the lithic assemblage of the Ciota Ciara cave (from Daffara *et al.* 2021a).

	Cores	Flakes	Retouched tools	Debris	Unworked blanks	Total
S.U. 103	13	238	9	157	11	428
	3%	55.6%	2.1%	36.7%	2.6%	
S.U. 13	35	511	19	324	2	891
	3.9%	57.4%	2.1%	36.4%	0.2%	
S.U. 14	132	2686	74	1090	17	3999
	3.3%	67.2%	1.9%	27.3%	0.4%	
S.U. 15	54	1094	27	585	28	1788
	3%	61.2%	1.5%	32.7%	1.6%	
Total	234	4529	129	2156	58	7106
	3.2%	63.8%	1.8%	30.4%	0.8%	

2.1.2 Castelletto Ticino

In 2003, during a preventive archaeological excavation realized by *G.S.A.C.* (*Gruppo Storico Archeologico Castellettese*) for the recovery of a Golasecca's necropolis (Iron age) located in the city of Castelletto sopra Ticino (NO) - Via del Maneggio (Figure 1), some flint tools were found in an archaeological layer emerging at the bottom of one of the Iron age burials under excavation. To clarify the meaning of these tools, that in no way could have been related with the necropolis, a test pit was opened on an area of 3 m^2. It led to the identification of an archaeological layer (S.U. 105a) with an Epigravettian lithic industry and a fireplace. To the detriment of the importance of the find, the excavation area was not enlarged and the investigations of the Epigravettian level did not continue. The lithic assemblage recovered is composed by 256 chert elements (Table 4), eight are retouched tools and microliths (among them: 3 microgravettes, 1 end-scraper, 1 truncated blade, 2 fragmented backed edge blades and a trapeze), one microburin and seven cores. The state of preservation of the lithic industry is very good; just a few artefacts show traces of slight alterations, all referred to heat treatment. (Berruti & Viola 2011; Berruti *et al.* 2017). The lithic assemblage from S.U. 105a of Castelletto Ticino - Via del Maneggio is the only clear Upper Palaeolithic evidence in the region and the only one from a systematic archaeological excavation. The chronology of the site was assessed on the basis of paleo-botanic and paleo-environmental data obtained through the analysis of the charcoals found in the fireplace area and correspond to 11.000 - 14.000 BP. Unfortunately, no radiometric direct dating has been done. On the other hand, the chronology proposed according to paleo-botanic analysis is consistent with those inferable from the technological study of the lithic assemblage: the tendency towards microlithisation and the presence of microgravettes place the human presence in the site in phase III of the Epigravettian culture (end of the Alleröd chronozone - beginning of the recent Dryas).

Table 4. Composition of the lithic assemblage from Castelletto Ticino - Via del Maneggio. *Débitage* products = blades, bladelettes, laminal flakes; core shaping = semi-cortical flakes, cortical flakes, *entame* flakes; core management = tablette, crete, sous crete, re-shaping of the knapping surface.

	Cores	Retouched tools	Débitage products	Core shaping	Core management	Indet
S.U. 105a	7	9	55	76	54	55
(Tot. 256)	2.7%	3.5%	21.5%	29.7%	21.1%	21.5%

2.1.3 Vaude Canavesane

Vaude Canavesane is a wide area in western Piedmont (Figure 1). From the geological point of view, it corresponds to the terraced paleo-conoid of the Stura river, and it is a residual part of the wide plains formed during Pleistocene. Over the centuries, this area has been the subject of scarce anthropic interventions and it is currently partly a protected area, partly intended for military exercises (Rubat Borel *et al.* 2013).

In 2012, during the rearrangement of the storage rooms of *Museo di Antichità di Torino*, a huge number of archaeological materials from a 1981 requisition covering a chronological timespan going from Middle Palaeolithic to the Late Ancient period was rediscovered. The materials were collected between the '60s and the '70s during un-authorized research in the military area of Vaude Canavesane (*Poligono Esperienze Militari per l'Armamento dell'Esercito Italiano*) but the precise location of the collection areas has never been identified. Part of the confiscated materials corresponds to a vein quartz lithic assemblage that was object of technological study. Once the geofacts were discarded, the lithic assemblage was made up of 319 vein quartz lithic artefacts referable to Middle Palaeolithic (Table 5). Thirty-three lithic tools made in flint, jasper, opal, limestone and obsidian were excluded from the study because their provenience from the Vaude Canavesane area is uncertain and their presence in the assemblage is more likely the result of exchanges between collectors (Rubat Borel *et al.* 2013). The state of preservation of the vein quartz artefacts is generally good, and just slight mechanical post depositional alterations are visible on the surfaces; the homogeneity of the identified post depositional alterations was an important element to attest the good reliability of the quartz assemblage. In the absence of a stratigraphic context, it is not possible to make any hypothesis about the chronology of the Middle Paleolithic frequentation of the Vaude Canavesane area.

Table 5. Composition of the vein quartz lithic assemblage from Vaude Canavesane.

Cores	Flakes	Retouched tools	Total
40	267	12	319
12.5%	83.7%	3.8%	100%

2.1.4 Baragge Biellesi

The plateaus known as Baragge, located between 40 and 80 m above the Cervo stream (Figure 1) have the same geological characteristics described for the Vaude Canavesane area: *i.e.*, they are residual part of the wide plains formed during Pleistocene and therefore they represent one of the few sectors of the Po plain where Palaeolithic frequentations can be identified. The archaeological interest of this area is also determined by the pedogenetic conditions of the soil that have not favored the spread of crops, thus limiting the anthropization of this area.

The survey campaign at Baragge Biellesi took place in 2015 under the scientific direction of *Soprintendenza Archeologia del Piemonte*. The project was carried out in collaboration between University of Ferrara, Instituto Politécnico de Tomar (Portugal), Grupo de Quaternário and Préhistoria do Centro de Geociências of the University of Coimbra (Portugal), Universidade Federal Fluminense (Brazil) and *Associazione culturale 3P - Progetto Preistoria Piemonte*. The research was possible thanks to the active collaboration of the Italian Army Staff which allowed access to areas subject to military constraints. The aim of the project was to develop an integrated research model including survey and geo-morphological investigation, with the processing of satellite images and images acquired by remote-controlled drones, for the characterization of areas with potential presence of prehistoric archaeological contexts (Rubat Borel *et al.* 2016).

During the five-days survey, two different areas with traces of Middle Palaeolithic frequentations were identified (Area 1 and Area 2), both located within the military shooting range of Massazza (270 m a.s.l.). The lithic industries (12 artefacts) were found within canals formed by rainwater flows; in one of the canals, washout affected a pebble level covered by a brown-red level within which two lithic finds were found. Ten further lithics are from inside the canals but out from their stratigraphic context. According to the geomorphological data collected, the brown-red layer where lithic were found correspond to a cold aeolian deposit, dating back between 200.000 and 75.000 BP.

2.1.5 Colline Novaresi

The Colline Novaresi area is a system of Pleistocene river terraces located in north-eastern Piedmont (Figure 1). It is bounded by the Sesia river to the west and by the Ticino river to the east, while the Maggiore and Orta lakes mark its northern border (Braga & Ragni 1969; Cazzini *et al.* 2020; Scardia *et al.* 2015; Wintenberg *et al.* 2020).

In 1988 P. Biagi (Biagi 1988) completed the technological study of a Castelnovian (late Mesolithic) lithic assemblage issued from surface collections at Bindillina (Figure. 3) and the area is generally known for the finding of important Protohistoric sites and sporadic materials belonging to a time-span going from the Copper to the Iron age (Gambari 1982; 1985; Gambari & D'Errico 1984; Gambari & Piccinini 1984).

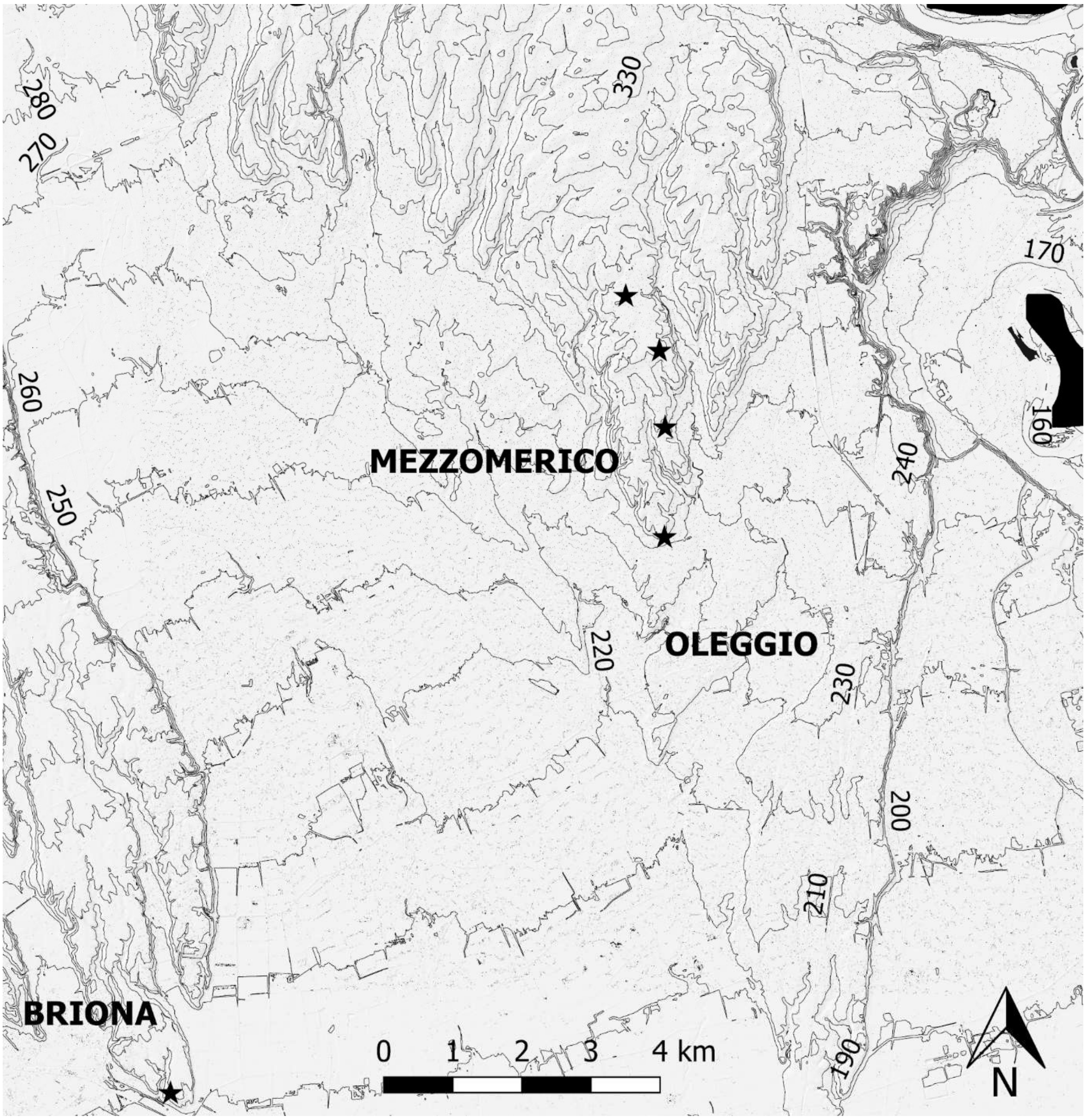

Figure 3. Detail of the Colline Novaresi area with indication of the main collection areas. At Mezzomerico, from bottom to top, black stars indicate Motto dei Cannoni, Madonna delle Vigne, Località Svizzera, Bindellina.

New research at Colline Novaresi started in 2017 under the scientific direction of *Soprintendenza Archeologia, Belle Arti e Paesaggio per le provincie di Biella, Novara, Verbano-Cusio-Ossola e Vercelli.* At first, the technological study of the lithic industries sporadically collected during the last decades was completed, then a preliminary survey activity was developed. In 2018, four localities were investigated: Bindillina, Briona, Motto dei Cannoni and Mezzomerico - I Quirghi, leading to the recovery of some lithic artefacts (Daffara *et al.* 2022) (Figure 3). The technological study involved the lithic assemblages coming from Motto dei Cannoni (147 artefacts, of which 5 are from the survey), Bindillina (139 artefacts, of which 4 are from the survey), Agrate Conturbia (12 artefacts), Madonna delle Vigne (10 artefacts), Briona (49 artefacts, of which 5 are from the survey), I Quirghi (19 artefacts from the survey) and Loc. Svizzera (1 artefact) (Daffara *et al.* 2022). For the aim of this work just the lithic assemblages for which the tecno-typological analysis allowed clear chronological attributions to Middle and Upper Palaeolithic, have been considered and they correspond to *Motto dei Cannoni, Bindillina* and *Località Svizzera* lithic finds (Table 6).

Table 6. General composition of the lithic assemblage from the Colline Novaresi area considered in the present work. “Natural blanks” indicate unworked pebbles or blocks of vein quartz and chert: at the time of their collection, they were wrongly identified as lithic artefacts, but during the present technological study it became clear the absence of any anthropic intervention on them.

		Cores	Flakes or Blades	Retouched tools	Debris	Façonnage	Natural blanks	Tot.
Motto dei Cannoni		19	77	25	9	1	18	**147**
	%	12.8%	51.7%	16.8%	6.0%	0.7%	12.1%	**100%**
Bindillina		16	87	12	15	-	9	**139**
	%	11.5 %	62.6%	8.6%	10.8%	-%	6.5%	**100%**
Loc. Svizzera		1	-	-	-	-	-	**1**
	%	100%	-%	-%	-%	-%	-%	**100%**

2.1.6 Trino

The Trino hill is an isolated relief located in north-western Italy, close to Trino municipality, result of a sequence of Pleistocene fluvial terraces (Figure 1). The hill was subject of multidisciplinary studies during the ‘70s, when, because of quarry activities and agricultural arrangements, five concentrations of lithic artefacts were recognized and referred to a Palaeolithic frequentation of the area (GSQP 1976; Fedele 1974). In that years, terracing works involved an area of about 200 m^2 in the north-eastern sector of the hill and affected different archaeological layers (Fedele 1974). In 1974, during geological surveys, a first assemblage of lithic artefacts was collected at the top of the hill; further surveys allowed to collect approximately 300 artefacts from an area of about 90x20 m^2 (TR 1). A first technological study underlined the homogeneity of the assemblage according to the general state of preservation and to the technological features: vein quartz of local origin was the most exploited raw material, followed by chert of probable non-local provenience; the presence of cores and of Levallois technology was highlighted as well. Based on technological criteria, different phases of human frequentation were recognized and attributed to Middle and Upper Palaeolithic; for some of the TR 1 lithic artefacts a Lower Palaeolithic attribution was also proposed (Fedele 1974). In the subsequent two years, systematic survey campaigns took place in the area and led to the identification of four other lithic assemblages (TR 2 - 10 lithic artefacts; TR 3 - 30 lithic artefacts; TR 4 - 10 lithic artefacts; TR 5 - 2 lithic artefacts), in addition to the finding of further lithic artefacts from TR 1 (GSQP 1976). The technological study completed in 1976 outlined the main technological features of each lithic assemblage; despite the presence of Levallois technology, according to the preferential use of local raw materials (vein quartz) and of cores mainly realized on pebbles and scarcely exploited, the lithic assemblages were mainly attributed to Lower Palaeolithic (GSQP 1976). In 2016, during the cataloguing of the archaeological materials present at *Museo Civico G. Irico*, a huge lithic assemblage (1964 artefacts) was found in the museum storage room. It is the result of further survey activities that took place in the last decades and that has never been considered for a technological study. Indeed, other concentrations of archaeological materials have been identified at the Trino hill and some of them consist of Palaeolithic lithic artefacts. Although carried out in a non-systematic way by archaeology enthusiasts, the surface collections were documented, reporting the position of the collection area and keeping separate the lithic assemblages collected in different sectors of the isolated relief. Most of these lithic assemblages count a few lithic implements, but four collection areas (3, 13 E, 13

W and 14) have significative lithic assemblages, representing the most important evidence of a Palaeolithic frequentation of the Po plain in north-western Italy (Table 7). Beside the absence of clear stratigraphic data, and therefore of a precise chronological framework, the technological analysis recently completed on these materials (Daffara *et al.* 2021b; Daffara & Giraudi 2020) contributes in the understanding of the technological behaviour of the hunter-gatherer's human groups that occupy this part of the region during Pleistocene and Holocene.
It can be assumed that the circumstances of these last surface collections are like those occurred in the '70s, with archaeological layers affected by terracing or quarry activities, even if some re-sorting of the remains had certainly occurred (personal communication by members of TRIDINUM). This hypothesis is supported by the analysis of the post depositional surface modifications: pseudo-retouch and other alterations of mechanical origin are rare in the considered lithic assemblages (10 findings - 0.5%), thus confirming that the agricultural arrangements and the quarry activities do not cause any intense re-working of the archaeological materials. Most of the surface alterations are due to water circulation and are represented by rounding and white patina. On the other hand, 51.1% of the lithic implements do not show any trace of post depositional surface modification (Daffara *et al.* 2021b).

Table 7. General composition of the lithic assemblages from Trino (from Daffara *et al.* 2021b). RIT (= *Rilievo Isolato di Trino*). RIT X includes the lithic artefacts from the Trino hill but without any precise information about the location of the collection area. Name sites not preceded by "RIT" refers to localities in the surroundings of the Trino hill: B.P.T. = Bosco della Partecipanza; C.A. = Cascina Ariosa.

	Cores	**Flakes or Blades**	**Core management**	**Retouch flakes**	**Retouched tools**	**Debris**	**Polished axes**	**Tot.**
RIT 1	8	52	5	3	6	9	-	83
%	9.6%	62.7%	6.0%	3.6%	7.2%	10.8%	-%	4%
RIT 2	-	16	1	-	1	1	-	19
%	-%	84.2%	5.3%	-%	5.3%	5.3%	-%	1.0%
RIT 3	11	110	5	2	3	6	-	137
%	8.0%	80.3%	3.6%	1.5%	2.2%	4.4%	-%	7.0%
RIT 4	1	-	-	-	-	-	-	1
%	100%	-%	-%	-%	-%	-%	-%	0.1%
RIT 7	-	5	-	-	-	1	-	6
%	-%	83.3%	-%	-%	-%	16.7%	-%	0.3%
RIT 8	-	12	-	-	-	-	-	12
%	-%	100%	-%	-%	-%	-%	-%	0.6%
RIT 10	1	-	-	-	-	-	-	1
%	100%	-%	-%	-%	-%	-%	-%	0.1%
RIT 13 E	12	75	18	2	7	8	-	122
%	9.8%	61.5%	14.8%	1.6%	5.7%	6.6%	-%	6.2%
RIT 13 W	13	100	4	1	2	1	-	121
%	10.7%	82.6%	3.3%	0.8%	1.7%	0.8%	-%	6.2%
RIT 14	63	960	150	19	41	87	-	1320
%	4.8%	72.7%	11.4%	1.4%	3.1%	6.6%	-%	67.2 %
RIT 15	2	10	-	-	-	1	-	13

	Cores	Flakes or Blades	Core management	Retouch flakes	Retouched tools	Debris	Polished axes	Tot.
%	15.4%	76.9%	-%	-%	-%	7.7%	-%	0.7%
RIT 16	-	4	2	-	-	1	-	7
%	-%	57.1%	28.6%	-%	-%	14.3%	-%	0.4%
RIT X	3	28	1	-	6	-	-	38
%	7.9%	73.7%	2.6%	-%	15.8%	-%	-%	1.9%
Casotto Diana	2	25	-	1	-	-	-	28
%	7.1%	89.3%	-%	3.6%	-%	-%	-%	1.4%
Cantone	-	-	-	-	-	-	1	1
%	-%	-%	-%	-%	-%	-%	100%	0.1%
B.P.T.	6	10	9	-	1	7	1	34
%	17.6%	29.4%	26.5%	-%	2.9%	20.6%	2.9%	1.7%
C.A.	2	13	1	-	-	-	-	16
%	12.5%	81.3%	7.7%	-%	-%	-%	-%	0.8%
Ronsecco	-	-	-	-	2	-	1	3
%	-%	-%	-%	-%	66.7%	-%	33.3%	0.2%
TRICERRO	-	-	1	1	-	-	-	2
%	-%	-%	50.0%	50.0%	-%	-%	-%	0.1%
Total	**124**	**1420**	**197**	**29**	**69**	**122**	**3**	**1964**
%	**6.3%**	**72.3%**	**10.0%**	**1.5%**	**3.5%**	**6.2%**	**0.2%**	**100%**

3. Methods

The different lithic assemblages considered have been studied following the same methodology, based on the *chaîne opératoire* approach (Geneste 1991; Pelegrin *et al.* 1988; Tixier 1978). Cores are analysed considering the number of flaking surfaces, the presence or not of a hierarchical configuration of the surfaces and the direction of the detachments. The identification of S.S.D.A. (*Système par surface de débitage alterné*) and opportunistic cores and products is based on Forestier (1993) and on Carpentieri & Arzarello (2022). The Levallois and discoid methods are identified and described according to the criteria defined by Boëda (1993, 1994: 33-76) and considering further works regarding their variability and definitions (Chazan 1997; de Lombera-Hermida & Rodríguez-Rellán 2016; Dibble & Bar-Yosef 1995; Moncel *et al.* 2020; Peresani 2003: 1-66). The analysis of laminar cores and products refers to Pelegrin (2000). For flakes, different technological features have been considered: presence and position of natural surfaces (cortex, neocortex), characteristics of the butts, sizes, direction of the negatives on the dorsal face, presence of knapping accidents, characteristics of retouch. The identification of the knapping technique is based upon the criteria listed by Inizan *et al.* (1999: 30-33). For vein quartz artefacts we refer to specific works about the identification of the knapping scars and rate and modalities of fragmentation (Colonge & Mourre 2006; Driscoll 2011; de Lombera-Hermida 2009; Manninen 2016; Di Modica & Bonjean 2009; Mourre 1996; Tallavaara *et al.* 2010). Retouched tools are distinguished following Bordes' (1961) typological list, Laplace (1987, 1972) and Fernández Eraso and García Rojas (2013). The term debris is here referred to lithics with traces of knapping scars; but whose role in the *chaîne opératoire* cannot be determined, regardless their size.

One of the main problems linked to the analysis of lithics from non-systematic surface collections is to assess the coherence of each lithic assemblage. From the collection locations come lithic artefacts belonging to different chronological horizons. Some criteria were then defined at the beginning of the study to try to refer each lithic artefact to the proper one. The knapping methods and techniques, together with typological criteria and, to a lesser extent, the raw materials employed, have been identified as the most useful elements to propose a reliable subdivision within each lithic assemblage (Barton *et al.* 2002; Burke *et al.* 2011; Seitsonen *et al.* 2018). Following these criteria, Middle Palaeolithic includes Levallois, discoid and opportunistic or S.S.D.A. cores and flakes obtained through direct hard hammer percussion and issued from the exploitation of local raw materials (e.g., vein quartz). As shown in the Results section, chert is mainly exploited through the laminar method: we can then assume that the presence of this raw material in an assemblage is mainly linked to the most recent frequentations of the area. Chert artefacts issued from Levallois reduction strategies are also placed in the Middle Palaeolithic assemblage, while the attribution to this chronology for discoid and opportunistic chert implements remains uncertain. Laminar cores and products have been referred to Mesolithic or Neolithic when realized through the pressure technique or on a typological basis. Laminar cores and products obtained through indirect percussion and direct hard hammer, or organic hammer percussion cannot be referred to a specific chronology and they have been assigned to a chronology going from Upper Palaeolithic to Neolithic.

4. Technology and raw materials data

Each of the considered sites has different technological characteristics depending on several factors that are difficult to evaluate being most of the lithic assemblages issued from surface collections. However, by putting together the technological data of each site, we try to make some general hypotheses about technology, choice and use of lithic resources and mobility on the territory at a regional scale. Clearly the results of the study and the reliability of the hypotheses formulated are strongly affected by the scarcity of multidisciplinary studies and stratigraphic references in most of the areas considered.

The technological data of each site are summarized below, with particular emphasis on the most significant aspects for the aims of the proposed work.

4.1 Ciota Ciara cave

The 7106 lithic artefacts from the atrial sector of the Ciota Ciara cave (layers 103, 13, 14 and 15) were analysed both from the technological point of view and for what concerns the characterization and identification of raw materials supply areas (Arzarello *et al.* 2012; Daffara *et al.* 2019; 2021a). All along the stratigraphic sequence, vein quartz is the main lithic resource, representing 70.6% of the assemblage. Other local raw materials, collected in secondary deposits at a distance of few hundred meters from the site, are well represented and have been identified as spongolite (*i.e.*, a local variety of chert, representing 21.1% of the assemblage), a grey-black flint outcropping on the mount at about 720 m a.s.l. (4.9%) and other rock easily available in the Monte Fenera area and sporadically present in the assemblage (1%). At a distance of about 2 km from the site, rhyolite (1%) was collected in secondary deposits located in the Sessera riverbed while a red-coloured radiolarite (1.4%) comes from primary outcrops and secondary deposits located close to the Maggiore Lake, at a distance of about 30 km from the cave (Daffara *et al.* 2019) (Figure 4).

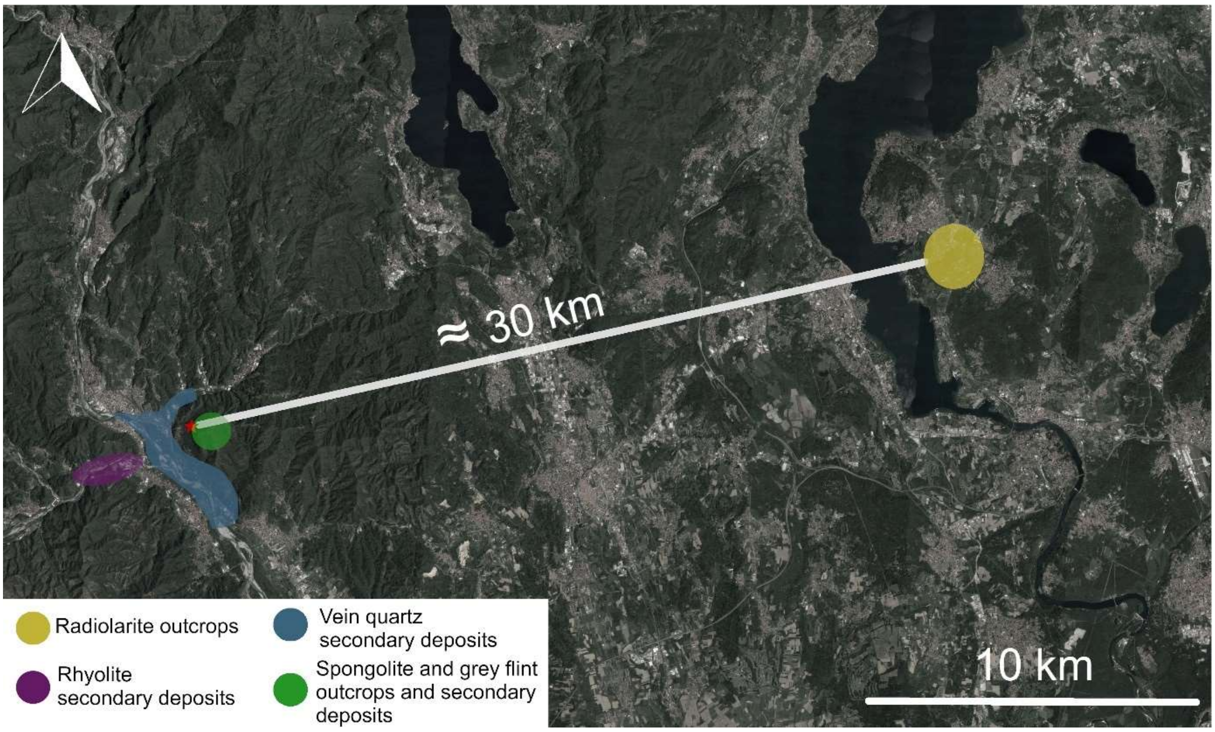

Figure 4. Location of the supply areas of lithic raw materials (modified from Daffara *et al.* 2019). The red star indicates the Ciota Ciara cave.

The reduction sequences are always complete for the local raw materials, that were brought to the site as pebbles, slabs or centimetric blocks and knapped according to different reduction sequences (Daffara *et al.* 2021a). Rhyolite and radiolarite were instead introduced in the site as finished tools, which edges have been rejuvenated several times before their discard (Daffara *et al.* 2021a). Regardless the knapping method, natural surfaces are often present (17.7%) on the dorsal faces of the flakes, especially concerning vein quartz and spongolite, thus indicating that the production developed taking advantage of the convexities already present on the blanks chosen as cores.

Different knapping methods are attested at the Ciota Ciara cave: opportunistic or S.S.D.A. (Carpentieri & Arzarello 2022; Forestier 1993;), lineal and recurrent centripetal Levallois (Boëda 1993; 1994: 33-76), discoid (Boëda 1993; Peresani 2003: 1-66) and Kombewa *s.l.* (Inizan *et al.* 1999: 68-71; Tixier & Turq 1999;). For the aims of the proposed work, the attention needs to focus on the characteristics of vein quartz and, when possible, radiolarite reduction strategies, since, if we look at the regional context, all the other lithic resources (spongolite, grey-black flint and other local rocks) are exploited only at the Ciota Ciara cave.

The opportunistic production (Figure 5) is the most represented in all the archaeological layers and for all the raw materials (from 37.9% to 48.5%). Vein quartz opportunistic cores and flakes have particular characteristics that have been interpreted as technological adaptation to the mechanical properties of this rock (Daffara *et al.* 2021a; Driscoll 2011; de Lombera-Hermida 2009; Manninen 2016; Tallavaara *et al.* 2010): *i.e.*, the butts, mainly flat or natural, suggest that these kinds of surfaces were preferentially chosen as striking platforms; the reduction sequences are short, with the use of two adjacent or orthogonal striking platform and cores are always discarded before their exhaustion; the number of products obtained from each of the exploited surfaces is limited to two or three thick flakes with not-standardized shapes and dimensions (Arzarello *et al.* 2012; Daffara *et al.* 2021a).

The Levallois method is directed towards the production of oval or quadrangular flakes, usually short and large starting from vein quartz pebbles with suitable morphologies and convexities (Daffara *et al.* 2021a) (Figure 5). The core surfaces are roughly prepared: the striking platforms are usually natural or shaped through a few removals in a centripetal direction. In the preferential modality, a single removal, perpendicular to the plan of intersection between the core surfaces, prepares the sector of the core that is to be hit to produce the preferential flake. As well as the striking platforms, also the lateral and distal convexities on the knapping surfaces are obtained through a few removals and the production of predetermined flakes takes advantage from the natural convexities present on the cores. In the absence of cores, a more accurate preparation of the surfaces can be inferred looking at the radiolarite Levallois products that always show prepared butts.

Discoid technology (Figure 5) is well attested in the bifacial and unifacial modalities in all the archaeological layers and for all the main exploited rocks. Concerning vein quartz, cores are centimetric blanks with natural suitable convexities and they are exploited through a few centripetal removals according to a *débitage* direction which is secant to the plan of intersection between the core surfaces; discoid cores are usually discarded after one production phase. Products are short and large flakes, quadrangular shaped and characterized by a pronounced thickness (Peresani 2003: 1-66; Picin & Vaquero 2016). Natural surfaces are often present on the cores and for the unifacial exploitation the striking platform is neocortical or represented by a natural fracture plane.

4.2 Castelletto Ticino

The lithic assemblage from S.U. 105a of Castelletto Ticino - Via del Maneggio (Table 4) is the only point of reference, on a regional scale, for the study of the last phases of the Upper Palaeolithic (Epigravettian). All the phases of the knapping sequence are present in the assemblage, from the shaping out to the abandonment of the cores, as attested by the numerous refittings present in the assemblage (Berruti & Viola 2011; Berruti *et al.* 2017). From the technological study of the products and by-products of knapping activities, the existence of a single reduction scheme aimed to the production of blades and bladelets arises (Figure 6). They are almost exclusively obtained through direct percussion with soft hammer, while the orientation of the negatives shows the clear preponderance of unipolar production sequences. A moderately variable set emerges from the morphometric analysis of the blades and lamellae, in which no pressing search for typical morphometries is noted. The cores found are small. The use of the microburin technique is documented by the discovery of two microburins, one of which on the back. The good conservation of the archaeological context is also proved by the great number of refitting in the lithic assemblage (16 pieces, 7% of the whole lithic industry).

The different lithic raw materials exploited at Castelletto Ticino have been macroscopically distinguished according to colouring and textural characteristics, *i.e.*, opacity, glassiness, homogeneity, cortex. Based on these criteria, a red-coloured radiolarite and three other kinds of chert have been identified. The characteristics of the cortical surfaces, present on 53% of the lithic artefacts, suggest supply areas located close to the primary outcrops together with the collection of rounded pebbles in secondary deposits. According to the geologic samplings completed, the primary outcrops could correspond to those located in the surroundings of the Varese Lake, about 15 km away from Castelletto Ticino. They belong to the formations of the Lombardian Selciferous Group for what concern the red-coloured radiolarite (Figure 4), and to the Majolica Formation, that includes nodules of grey flint comparable to those exploited at Castelletto Ticino. On the other hand, the secondary deposits could correspond to the paleo-beaches of the Maggiore Lake, to the Ticino river and to local streams riverbeds (Berruti & Viola 2011).

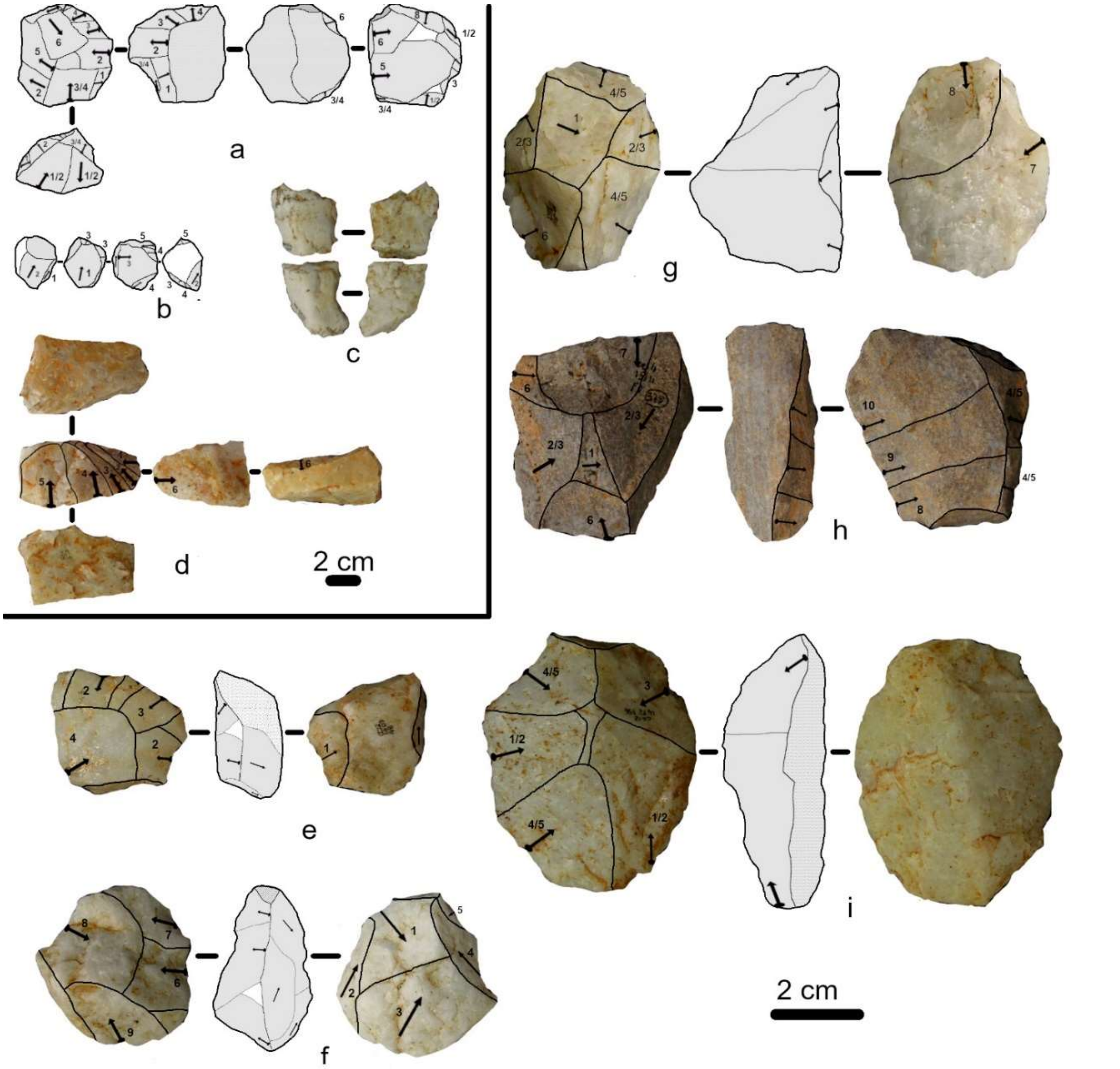

Figure 5. Ciota Ciara cave (modified from Daffara *et al.* 2021a). (a) multidirectional core on fluvial pebble; (b) opportunistic core with multidirectional removals; (c) connection between the proximal and the distal part of an opportunistic flake with neocortical dorsal face; (d) opportunistic core: the exploitation started from a flat natural surface and consists of a series of 5 removals in a unipolar direction. At the exhaustion of the convexity, another natural surface is used as striking platform to obtain a single flake; (e) preferential Levallois core; (f, i) recurrent centripetal Levallois cores; (g) bifacial discoid core; (h) spongolite bifacial discoid core. According to the results of the technological study completed on the lithic assemblage of the Ciota Ciara cave (Daffara *et al.* 2021a), for Levallois reduction strategies on vein quartz, the phases of core shaping are frequently absent especially for what concerns the recurrent centripetal Levallois modality. The Levallois exploitation takes advantage of the natural convexities present on the cores and consists in short production sequences that end at the exhaustion of the suitable convexities on the knapping surface. In the preferential modality, the lateral and distal convexities of the flaking surface are roughly prepared through a very limited number of removals; for both modalities, the striking platform is usually natural or shaped through one or two detachments in correspondence of the impact point.

The characteristics of the lithic assemblage allow to place chronologically the prehistoric occupation of the site in the Late glacial while from a cultural point of view, the site can be attributed to the Epigravettian culture, characterized by lithic industries with a strong tendency to microlithism and by the presence of microgravettes, short end-scrapers and by the appearance of the first geometric microliths (Berruti *et al.* 2017).

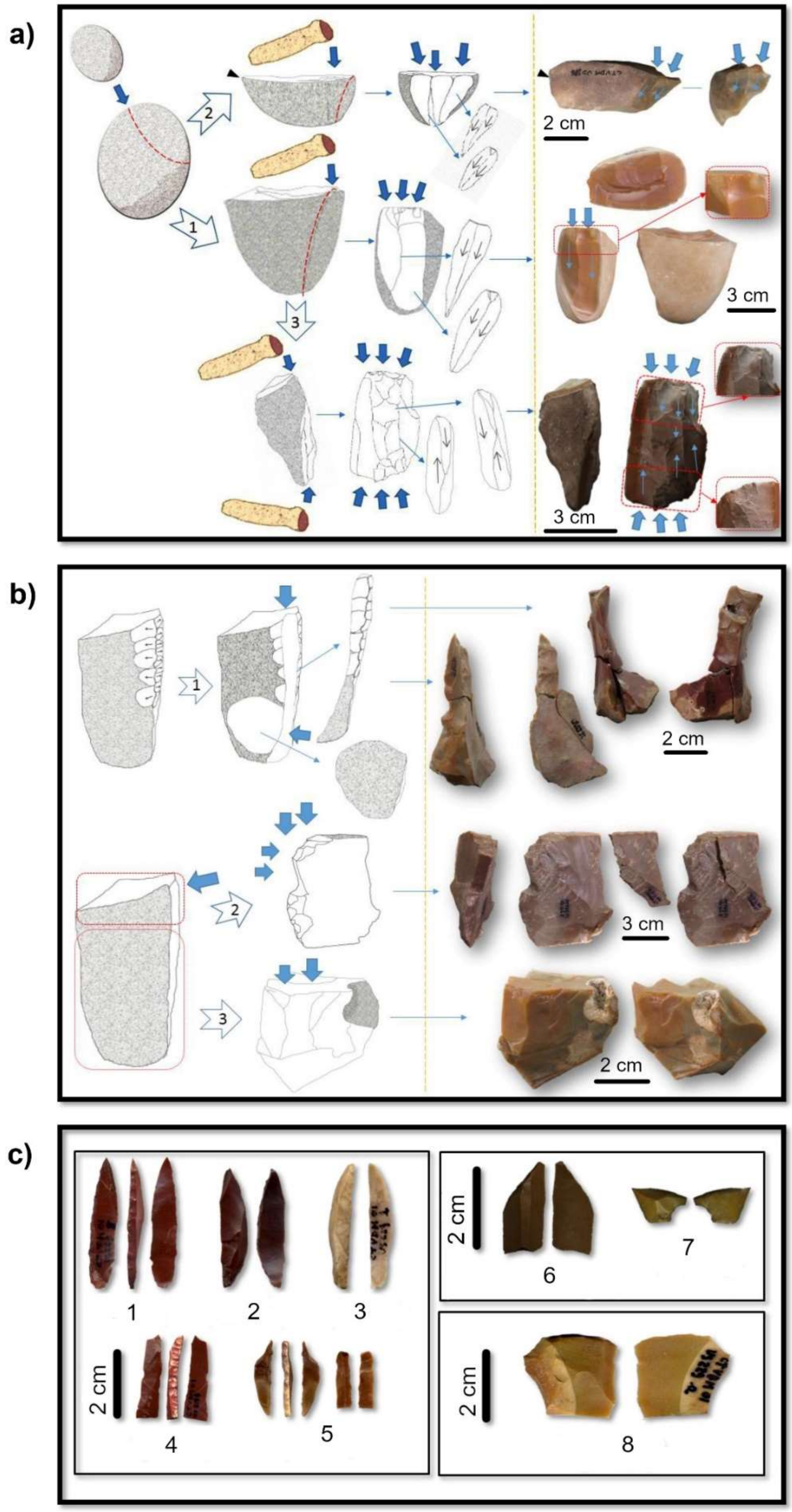

Figure 6. Castelletto Ticino. Schematic reconstruction of the laminar reduction sequence on pebbles (a); schematic reconstruction of a laminar reduction sequence on small blocks and slabs (b); retouched tools: microgravettes, end-scraper and trapezium (c) (1. PD21 p lt snx [A d c rct]; 2. BP12 p lt dxt [A d c cvx]; 3. PD21 m lt dxt [A d c rct]; 4. f PD21 p lt dxt [A d c rct]; 5. f PD/LD21 p lt dxt [A d c rct]; 6. PDT31 x lt snx dst [A d c obl -+- A dc ccv]; 7. A11 x lt dxt prx [e A d ccv]; 8. f G11 p trns dst [S c d cvx].

4.3 Vaude Canavesane

Based on technological criteria and by evaluating the homogeneity of post-depositional surface alterations, the lithics identified as Middle Palaeolithic artefacts are 319 and are all realized in vein quartz (Rubat Borel *et al.* 2013). The lithic assemblage includes 40 cores and 279 flakes. The presence of cores indicated that knapping activities took place in the site while the absence of debris must be attributed to the nature of the lithic assemblage that is the result of unsystematic surface collections; it is therefore likely that the lack of this type of finds is due to the collection of just large and easily recognizable pieces. The raw material is available in the form of pebbles of different dimensions in secondary deposits located in the Vaude Canavesane area, so a provisioning of raw material in the immediate surroundings of the sites inhabited by Middle Palaeolithic hunter-gatherers can be realistically hypothesized. Vein quartz pebbles are exploited according to opportunistic (Carpentieri & Arzarello 2022; Forestier 1993), Levallois (Boëda 1993; 1994: 33-76) and discoid (Boëda 1993; Peresani 2003: 1-66) reduction strategies (Figure 7), with adaptation to the mechanical characteristics of vein quartz visible in the shortness of the reduction strategies, in the frequent use of natural striking platforms and in the limited shaping of the core convexities for what concerns Levallois and discoid methods (de Lombera-Hermida & Rodríguez-Rellán 2016; de Lombera-Hermida 2009; Mourre 1996; Tallavaara *et al.* 2010). All the reduction sequences were carried out with the direct hard hammer percussion technique (Inizan *et al.* 1999: 30), even if for some cores the opening of the first striking platform seems to have been achieved through bipolar percussion on anvil (Bietti *et al.* 2010; Cancellieri *et al.* 2001).

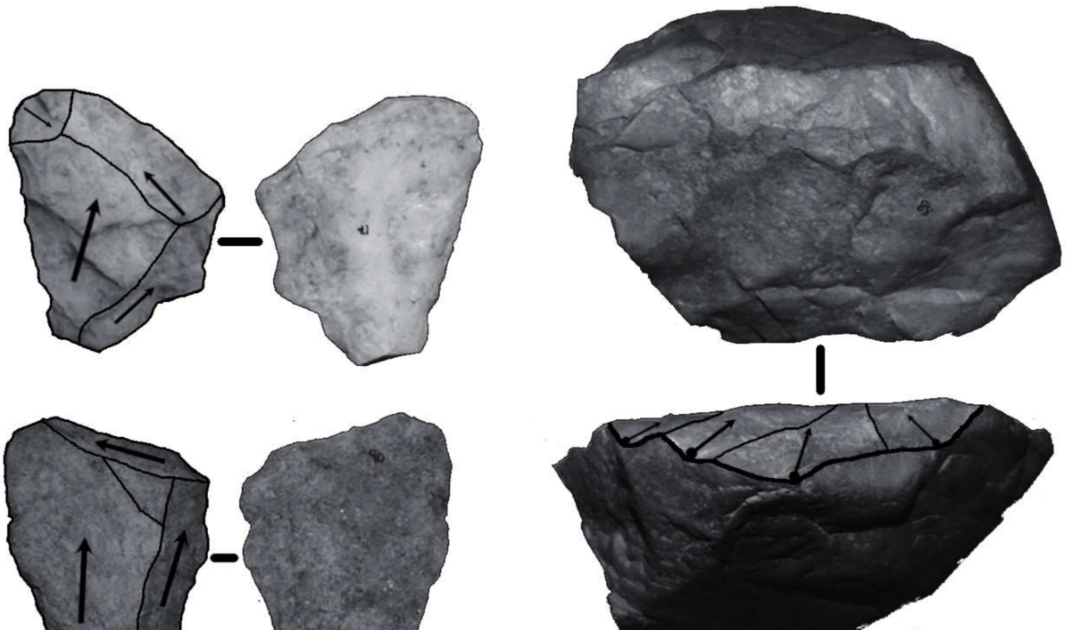

Figure 7. Vaude Canavesane. Recurrent centripetal Levallois core (on the right) and flakes (on the left) showing the reduced technological investment in core configuration phases. The core has a neocortical striking platform corresponding to the natural surface of a vein quartz pebble; the production of recurrent centripetal Levallois flakes takes advantage from the natural convexities present on the core but follows a Levallois scheme concerning the general geometry of the core (a very convex striking platform and a less convex flaking surface), the débitage direction (parallel with regards to the plan of intersection between the core surfaces) and the organization of the removals on the flaking surface with predetermined and predetermining detachments (modified from Rubat Borel *et al.* 2013).

Opportunistic production consists in the exploitation of 1 to 3 striking platforms through unipolar removals; the production ends when the convexity on the flaking surface is exhausted; then the core is discarded or the flaking surface becomes the new striking platform according to an S.S.D.A. scheme (Forestier 1993). Opportunistic products have not-standardized shape and dimensions, but they are always characterized by the presence of at least one cutting edge.

The Levallois method is almost exclusively present in the recurrent centripetal modality (Boëda 1993). Preferential flakes are rare and attested only in the last production phases. The dimensions of the Levallois products vary in function of the dimension and morphology of the cores and of the stage of the reduction sequence they belong to (Rubat Borel *et al.* 2013). The shaping of the convexities on the flaking surface is pursued through the detachment of centripetal or *débordant* flakes, a technical expedient for the reduction of the number of removals needed to obtain the wanted morphology. The striking platforms are roughly prepared and often are neocortical surfaces. The discoid method is present in the unifacial and bifacial modalities: the choice seems to have been determined by the natural morphology of the cores, *i.e.*, biconvex or with one of the surfaces flatter than the other. The discoid products share some characteristics, such as a wide butt and a thick proximal part; the dimensions are not standardized and are influenced by the dimensions and morphology of the cores. The lithic assemblage counts 12 retouched tools: 2 denticulates and 10 scrapers, of which 3 are convergent scrapers, 1 is a double scarper and 8 are sidescrapers.

4.4 Baragge Biellesi

The lithic assemblage from the Baragge Biellesi is composed by just 12 implements (Berruti *et al.* 2016b) but given the patchy regional scenario, their technological features are useful for the aim of the proposed research. On a techno-typological basis the 12 lithic artefacts can be referred to Middle Palaeolithic. The raw material employed is of local origin and for eleven of the lithic finds it is vein quartz, easily available in the Baragge Biellesi area in the form of rounded fluvial pebbles. Beside vein quartz, this small lithic assemblage attests the exploitation of two more rocks: a metamorphic rock and an igneous rock (rhyolite).

The Levallois method is documented by a recurrent centripetal core (Figure 8) where just one production phase is present, and a rough preparation of the core convexities is observed. Two cores and a flake belong to discoid exploitation strategies: small biconvex pebbles (1 vein quartz pebble and 1 metamorphic rock pebble) have been used as cores; the vein quartz core is exploited on both surfaces through centripetal detachments, according to a short reduction sequence and without any preparation of the core surfaces; the metamorphic rock core show a unifacial exploitation through centripetal detachments and the striking platform is natural. A vein quart pebble show an opportunistic exploitation: three adjacent striking platforms are visible and the production consists in unipolar removals until the convexity is exhausted; then, the flaking surface is abandoned or used as striking platform according to an S.S.D.A. scheme (Forestier 1993).

Six vein quartz and one metamorphic rock flakes show unipolar removals on the dorsal face, a pronounced thickness and various morphologies and dimensions; according to the consistency between these characteristics and those observed on the vein quartz core, they could be issued from opportunistic exploitation strategies.

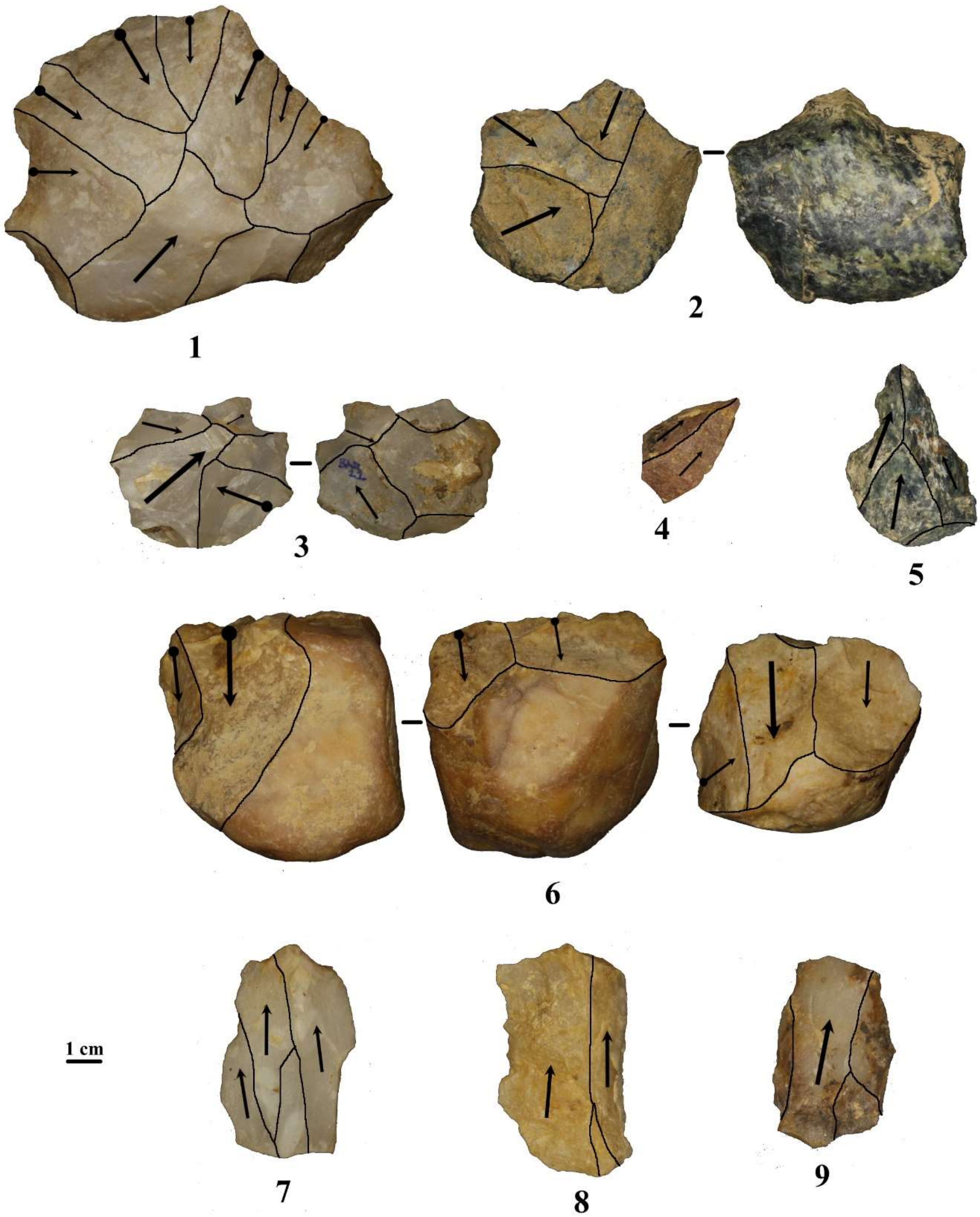

Figure 8. Baragge Biellesi Middle Palaeolithic lithic artefacts found during the survey campaign complete in 2015. Recurrent centripetal Levallois core (1); discoid cores (2-3); discoid flake (4); opportunistic flakes (5, 7-9); opportunistic core (6).

4.5 Colline Novaresi

The technological data from the Colline Novaresi area are strongly affected by the absence of stratigraphic data; even though it is likely that the prehistoric frequentations of the area took place during Middle and Upper Palaeolithic (Daffara *et al.* 2022).

The 147 lithic finds from *Motto dei Cannoni* (Table 6) are realized on radiolarite (56 artefacts) and chert (78 artefacts), while vein quartz is poorly represented (9 artefacts); in 4 cases the raw material has not been identified due to strong thermal alterations while 109 finds are indeterminate concerning their chronology because they lack any kind of diagnostic feature. 8 vein quartz and 4 radiolarite implements have been referred, on a technological basis, to Middle Palaeolithic (Figure 9) and they attest the use of opportunistic (6 flakes with unipolar and multidirectional scars on the dorsal face), discoid (3 flakes) and Levallois (1 recurrent centripetal Levallois flake) reduction strategies through direct hard hammer percussion. The retouched tools are six, 3 denticulates, 2 side-scrapers and 1 scraper + denticulate. On a technological basis and based on the comparison with the lithic assemblage from Castelletto Ticino, 16 retouched tools on laminar blanks (6 scarpers, 4 end-scrapers, 3 burins, 2 denticulates and a piece *écaillée*), 6 blades and 3 laminar cores can be ascribed to Upper Palaeolithic and are realized in chert and radiolarite. The analysis of the unretouched blades and of the laminar cores led to some observation concerning the development of the reduction sequences: the blades have flat butts, and, on the cores, the striking platforms are not prepared; the production of blades consists in the exploitation of one striking platform in a unipolar direction or using two platforms in a crossed direction through direct hard or soft hammer percussion. From this locality also a vein quartz bifacial tool was found with both faces intensively worked through direct hard hammer percussion and the distal part is retouched as to shape a pointed end (Daffara *et al.* 2022).

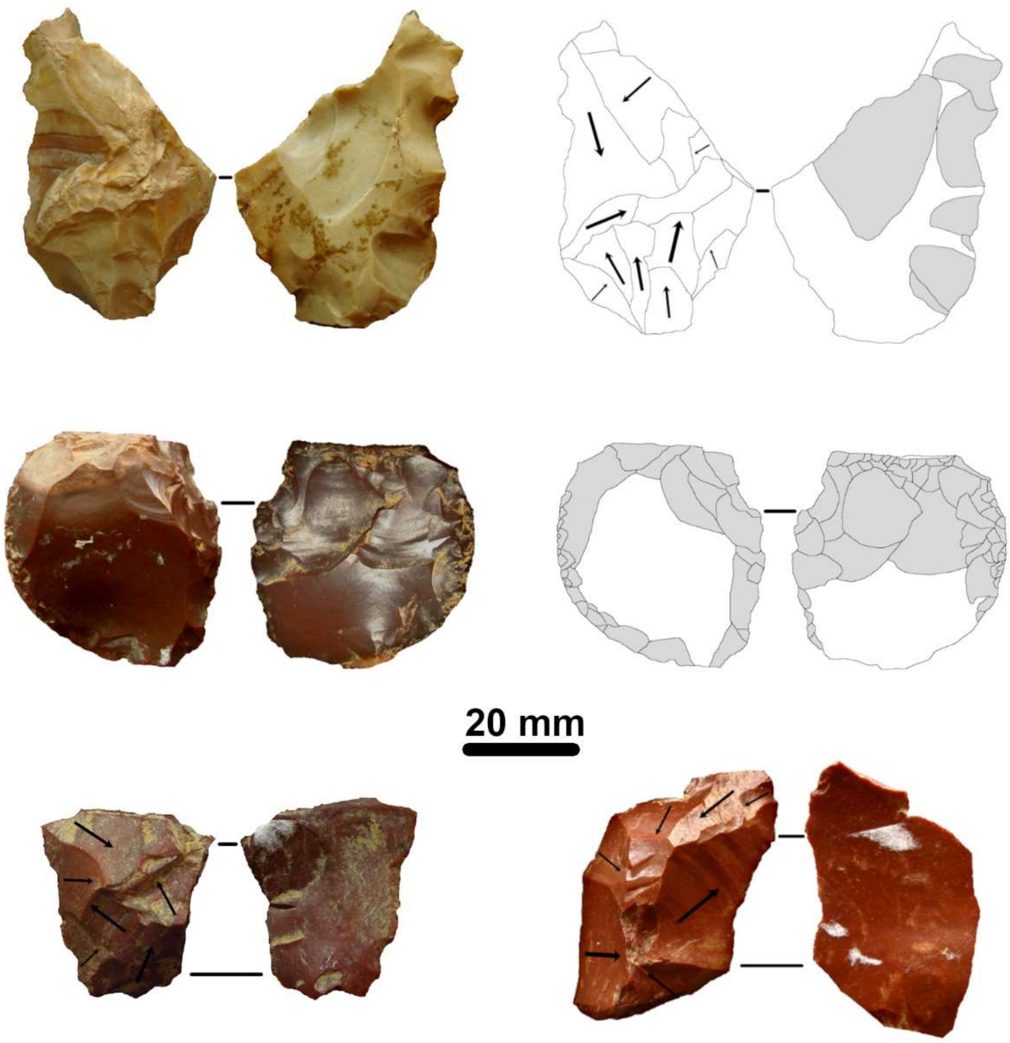

Figure 9. Colline Novaresi. Middle Palaeolithic tools from Motto dei Cannoni. From top to bottom: denticulate on a discoid chert flake; scraper on a radiolarite flake; discoid radiolarite flakes (from Daffara *et al.* 2022).

As mentioned above, *Bindillina* is the only locality of the Colline Novaresi territory already known in literature for the collection of 377 lithic artefacts belonging to the Castelnovian period (Biagi 1988). The lithic assemblage object of recent technological studies is composed by 139 artefacts in chert and radiolarite, with a sporadic presence of rhyolite (1 blade and 1 flake). 71 of them cannot be referred to any specific chronology, while 68 lithic implements have a great coherence from a techno-typological point of view and 29 of them attest for sure an Epigravettian phase of human frequentation. A circular and a front end-scarper on laminar blanks have been important elements for the identification of an Epigravettian phase, together with a borer or perforator realized on a chert blade, a simple burin and a piece *écaillée* (Figure 10). On a technological basis, 13 blades and 7 laminar cores can be referred to the Epigravettian group: blades are obtained through direct hard or organic hammer percussion according to a unipolar exploitation that starts from flat striking platforms (Daffara *et al.* 2022).

Località Svizzera is known for the finding of a vein quartz recurrent centripetal Levallois core. The core is realized on a vein quartz pebble, the striking platform is partly natural, and it still shows a neocortical surface with just two removals aimed towards the shaping of the surface. On the knapping surface 7 centripetal removals are visible, suggesting a production phase aimed to the production of big flakes, often *déebordant* (Daffara *et al.* 2022). The attribution of this core to Middle Palaeolithic is based not only on technological criteria, but also on the strict similarities between this core and the Levallois cores from the Ciota Ciara cave, Vaude Canavesane and Trino, that show similar characteristics in terms of shaping of the core surfaces and development of the Levallois production phases (Daffara *et al.* 2021a; 2021b; 2022; Rubat Borel *et al.* 2013).

4.6 Trino

At the Trino hill, the predominant raw material in all the collection areas is vein quartz (1475 artefacts; 75.6%) followed by different kind of flint of allochthonous provenience (302 artefacts; 15.4%), a red-coloured radiolarite from outcrops located close to the Maggiore Lake (Figure 4) (153 artefacts; 7.8%), limestone (6 artefacts; 0.3%) and other rocks of local origin (28 artefacts; 1.5%). In the lithic assemblages from RIT 3, RIT 13 E, RIT 13 W and RIT 14 all the phases of core exploitation are represented for all the main raw materials: the presence of cores, débitage products, flakes belonging to core management or core shaping and debris suggest that knapping activities took place in the area (Table 7). A strong limit in the technological analysis completed for the Trino hill is represented by the lack of a stratigraphic context; especially for what concerns the laminar component of the lithic assemblages (*i.e.*, unretouched blades and bladelets and flakes issued from laminar core configuration and management), for which, in the absence of diagnostic features, the chronological and cultural attribution remains indeterminate.

Given that, the results obtained from the technological study brought to the subdivision of the 1964 lithic implements from Trino in five groups (Daffara *et al.* 2021b):

- a huge Middle Palaeolithic assemblage (1555 artefacts)
- a small group of Neolithic cores, blades and retouched tools (53 artefacts), identified according to typological criteria and to the presence of the pressure technique for the production of blades
- 18 retouched tools that can be ascribed to Upper Palaeolithic on a typological basis
- a biface
- a group of laminar cores, blades, bladelets and flakes (186 artefacts) issued from shaping and management of laminar cores that it is not possible to ascribe to a precise chronology and could be the result of knapping activities that took place from Upper Palaeolithic to the Neolithic period

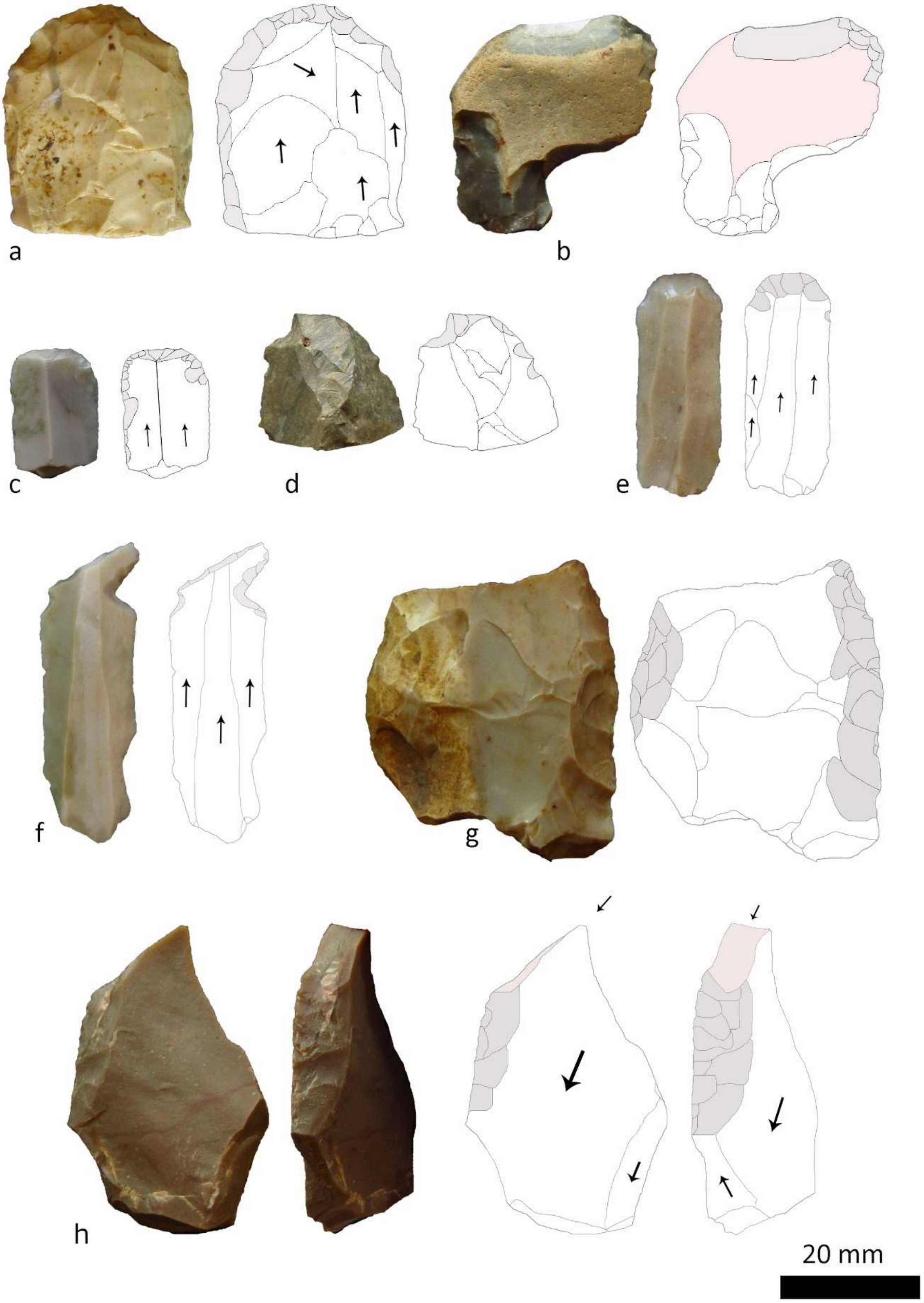

Figure 10. Colline novaresi: Upper Palaeolithic retouched tools: end scrapers from Motto dei Cannoni (a-d) and from Bindillina (e); borer or perforator from Bindillina (f); scraper from Motto dei Cannoni (g); burin from Bindillina (h) (from Daffara *et al.* 2022).

The Middle Palaeolithic assemblage (Figure 11) is the most coherent and allow to make some consideration on the technological choices of the knappers. Opportunistic vein quartz cores are exploited starting from neocortical or flat surfaces and from each flaking surface a limited number of flakes according to a unipolar direction is obtained; cores are abandoned when the natural convexities of the core are exhausted, and the opening of a new striking platform would have been necessary to continue the knapping activity. A few cores present a multidirectional exploitation, but even in these cases a low number of flakes (two or three) is obtained from each flaking surface. Discoid and Levallois technologies are well attested in the vein quartz Middle Palaeolithic assemblage. Fluvial pebbles with suitable morphologies and convexities are chosen as cores, as to reduce the need for long phases of core configuration. This strategy represents a diffused technological expedient that makes easier the exploitation of rocks with grainy texture and rich in internal cleavage planes (Mourre 1996). These technological expedients are clear for the Levallois method, attested in the preferential and recurrent centripetal modalities. Vein quartz Levallois cores have one production phase, with natural and not prepared striking platforms; flint Levallois cores have long phases of core configuration and after a first Levallois production the cores are reconfigured for a new production phase.

A further observation must be made regarding the laminar component of the Trino hill lithic assemblages. Regardless the issues related to the chronological attribution, among the 257 artefacts belonging to laminar reduction sequences, 28 are cores and 110 are flakes issued from core configuration and management while the production phases are barely represented. In our opinion this aspect cannot be ascribed to a selection made during the collection of the lithic artefacts: if this were the case, it would be reasonable to expect the exact opposite, *i.e*., a better representation of blades and bladelets and of retouched tools. Even if speculative, some hypothesis can be made: the technological composition of the laminar assemblage suggests a significative difference between the Middle Palaeolithic and the subsequent frequentations of the Trino hill. During Middle Palaeolithic the frequentation of the area was based on the exploitation of local lithic resources (*i.e*., vein quartz) and on the limited introduction of other rocks (*i.e*., radiolarite and flint), probably collected during recurring movements. Tools were produced, used, and discarded at the Trino hill, suggesting a probable use of the area as a residential place. Starting from Upper Palaeolithic, local lithic resources are not exploited anymore, and flint is introduced in the area as natural blanks or as cores partially configurated; cores were exploited in the site, but the final products were transported in other places, probably following short or long-range movements linked to subsistence activities and seasonal displacements. The frequentation of the area now assumes the character of sporadic occupations, perhaps short stopovers along broader routes.

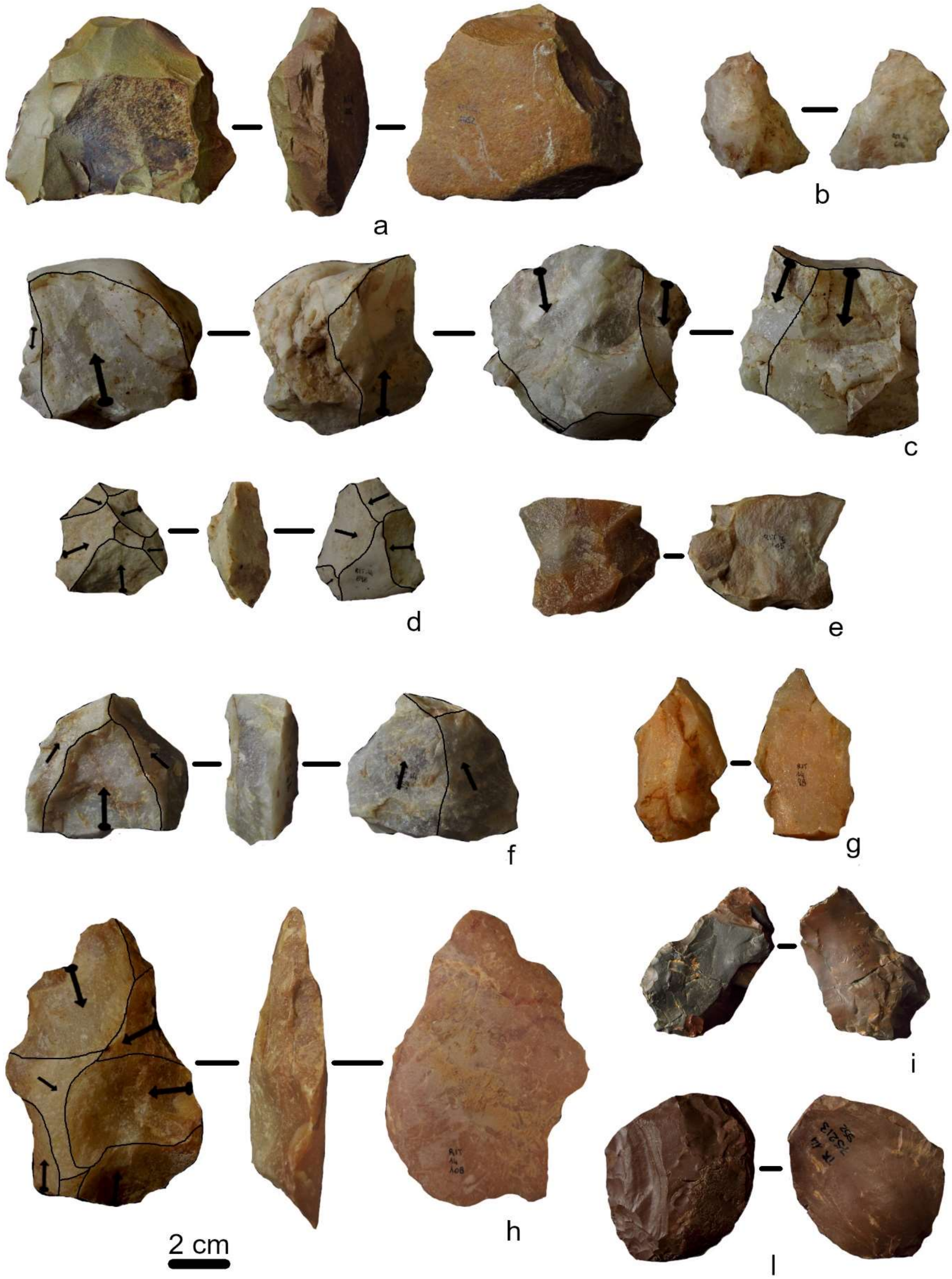

Figure 11. Middle Palaeolithic lithic artefacts from the RIT 14 area. Preferential Levallois core on chert (a); discoid flake (b); opportunistic core on a vein quartz pebble (c); bifacial discoid core (d); preferential Levallois flake (e); preferential Levallois core on vein quartz (f); opportunistic flake with unipolar removals on the dorsal face and lateral neocortical surface (g); recurrent centripetal Levallois core (h); jasper (i) and radiolarite (l) sidescrapers on opportunistic flakes, the jasper flake was glued by the discoverers to fix a post-depositional fracture.

5. Discussion and Conclusions

There are many data attesting to the Palaeolithic of Piedmont; however, still today it is very difficult to propose an exhaustive and clear reconstruction of the dynamics of the regional population between Middle and Upper Palaeolithic. The reasons are evident if we consider that most of the Palaeolithic contexts of the region correspond to lithic assemblages found occasionally outside of specific research projects (D'Errico & Gambari 1983; Gambari & Piccinini 1984; Guerreschi & Giacobini 1998). The two sites of Ciota Ciara for the Middle Palaeolithic and Castelletto Ticino for the Upper Palaeolithic are an exception. And it is precisely in consideration of this situation that the study of surface lithic assemblages assumes importance, since the few technological data and the raw materials used can give general indications, although always within the limits of data without any stratigraphic context. Putting together the data obtained from the technological study of the lithic assemblages considered here, it is indeed possible to propose a scenario of the Palaeolithic population of Piedmont.

Concerning Middle Palaeolithic, the point of reference is the Ciota Ciara cave, where the technological study completed in the last years highlights an articulated technological behaviour (Arzarello *et al.* 2012; Daffara *et al.* 2014; 2021a). All the archaeological layers show the predominant use of local rocks, and in particular of vein quartz, for the production of lithic tools. Other local rocks (*i.e.*, spongolite) have been important resources during all the phase of site frequentation. For these local rocks, knapping activities took place in the cave while allochthonous raw materials (*i.e.*, radiolarite and rhyolite) were introduced at Ciota Ciara just as finished tools that were used and sometimes discarded in the site (Daffara *et al.* 2019; 2021a). The most important information that these tools bring with them is their provenience: rhyolite comes from outcrops located at about 2 km in a straight line from Ciota Ciara, and it could have been collected and knapped during short-term movements linked to subsistence activities during the periods of frequentation of the Monte Fenera area; radiolarite comes from outcrops and secondary deposits located at about 30 km in a straight line from the site and it was probably collected and knapped during seasonal movements towards east (Daffara *et al.* 2019). This information is pivotal to propose a first hypothesis about the direction of the seasonal movements that took place during Middle Palaeolithic. The Middle Palaeolithic lithic assemblages from Trino (1555 artefacts) shares several elements with the Ciota Ciara cave. It sees the almost exclusive exploitation of local rocks, among which vein quartz is strongly predominant (75.6%): together with limestone and different kind of volcanic and metamorphic rocks, vein quartz pebbles are easily available in the fluvial deposits forming the Trino hill. A dark red radiolarite is also well attested at Trino, and its characteristics are consistent with a provenience from the same outcrops located on the east side of the Maggiore Lake that were exploited by the Neanderthal groups from the Ciota Ciara cave. At Trino the importance of radiolarite in the Middle Palaeolithic assemblage could have been underestimated since almost exclusively Levallois and discoid cores and flakes have been placed in this assemblage but radiolarite is intensively exploited also through laminar reduction sequences; flakes issued from opportunistic methods or from phases of core configuration, in the absence of diagnostic techno-typological features, have been considered as indeterminate for what concerns their chronology; indeed, it is realistic to suppose a Middle Palaeolithic exploitation of radiolarite through opportunistic reduction strategies, but in the absence of a stratigraphic context, this component cannot be recognized and evaluated. This kind of problem do not concern vein quartz, as not any laminar core or products has been found; it can therefore be hypothesized that vein quartz was used only during Middle Palaeolithic, while starting at least from the Upper Palaeolithic its importance as a lithic resource decayed and just a marginal use of vein quartz for the production of blades is known in the region, at the Neolithic site of Lago Pistono (Padovan *et al.* 2019).

The same can be said concerning the vein quartz Middle Palaeolithic assemblage from Vaude Canavesane where opportunistic, Levallois and discoid reduction sequences have been carried out using the same technological expedients and the use of vein quartz as main lithic resource seems to be limited to Middle Palaeolithic (Rubat Borel *et al.* 2013). From Colline Novaresi and Baragge Biellesi the Middle Palaeolithic lithic artefacts are very reduced in number, so it is hard to propose hypothesis about the development of the different reduction strategies. Even though, we can observe that once again vein quartz is present and preponderant among the raw materials and at Colline Novaresi its use is not attested starting from Upper Palaeolithic. As already mentioned concerning Trino, also in the Colline Novaresi area the exploitation of radiolarite is attested both concerning the Middle Palaeolithic industries and the Upper Palaeolithic ones (Biagi 1988; Daffara *et al.* 2022; Gambari 1982; Gambari & Piccinini 1984). In the Middle Palaeolithic assemblages, Levallois and discoid reduction strategies are well represented and show technological characteristics comparable to those observed at the Ciota Ciara cave. Vein quartz Levallois and discoid cores are exploited through short reduction sequences, and in most cases just one exploitation phase is completed before the core is discarded. The striking platforms are often neocortical and pebbles with suitable morphologies and convexities are chosen as cores, as to reduce the phases of core configuration. Opportunistic production is based on the exploitation of cores through a unipolar series of removals; after that the cores are discarded and just rarely the production proceeds with a new series of removals. In the considered Middle Palaeolithic assemblages, the production of tools is based on the exploitation of vein quartz as main lithic resource, from time to time accompanied by other local lithic resources with technological adaptation to the quality and mechanical properties of the raw materials employed. In the context of the Alpine and sub-Alpine region, Piedmont represents a particular case-study in the field of lithic technology. A first aspect concerns the lack of reliable data about Middle Palaeolithic frequentations along the southern margin of the central and western Alps (*i.e.*, Piedmont and Lombardy), while in the nearby Liguria and in the eastern side of the Southern Alps archaeological sites are numerous and well documented (Cauche 2007; Delpiano et al. 2018; Holt et al. 2019; Peresani et al. 2014; Picin et al. 2013).

It is difficult to identify the causes of this absence, but one of them is certainly the lack, in the last decades, of specific studies aimed at investigating these issues. Another factor is the lithic raw materials availability at a regional scale. Flint is very abundant in the eastern part of the Alpine arc and many formations provide excellent quality lithic resources that were systematically exploited by the Middle Paleolithic human groups. In Piedmont, the most diffused rock is vein quartz, while Monte Fenera (north-eastern Piedmont) is the only area where chert can be easily accessible. The data available for the western part of the alpine arc are in our opinion still too scarce to propose a detailed contextualization at a large scale. Proposing comparisons with the well-known contexts of Liguria appears risky at the moment as the lack of precise chronological, technological and stratigraphic data does not allow for accurate and detailed comparisons. However, it will be an interesting starting point for research, once an exhaustive picture of the Middle Palaeolithic of Piedmont has been obtained, to investigate the differences and the reasons for the differences between these two neighbouring territories. The ongoing research will certainly provide a more precise placement of Piedmont even in the context of the European Palaeolithic.

The Upper Palaeolithic is even more difficult to define in Piedmont. Castelletto Ticino represents an intense Epigravettian frequentation but for the previous Upper Palaeolithic phases no data are available at a regional scale. Epigravettian elements have been recognized at Colline Novaresi and at Trino but just on a typological basis and through the comparison with the technological characteristics observed at Castelletto Ticino (Daffara *et al.* 2021b; 2022) and at other important Epigravettian sites in northern Italy like Riparo Tagliente (Fontana *et al.* 2015), Riparo Dalmeri (Montoya 2008), Grotta del Clusantin (Peresani *et al.* 2008) and Palù Echen (Duches *et al.* 2014). From a technological point of view, these artefacts share with these sites some characteristics, as the frequent use of direct percussion by soft hammer for the production of blades and bladelets, the use of flat striking platforms and the strategies of core exploitation with the clear preponderance of unipolar production sequences (Berruti *et al.* 2017; Daffara *et al.* 2022).

If from a technological perspective data about Upper Palaeolithic are very scanty, some consideration can be made looking at the lithic raw materials. In all the lithic assemblages of Piedmont, when laminar reduction sequences appear, a relevant change in the raw materials exploited is observed. Radiolarite from Lombardy becomes predominant in the assemblages while vein quartz and all the other local rocks from time to time attested become marginal or are not exploited at all. Different kinds of flint of allochthonous provenience and probably from outcrops located in Lombardy (Berruti & Viola 2011), appear, and are intensively exploited to produce blades and bladelets. The presence at Trino of flint cores and of flint flakes issued from phases of cores management and configuration let us suppose that these rocks were brought in Piedmont as natural blanks, to be exploited in the sites or during movements on the territory.

More data and studies are needed to fully understand these changes and to define Upper Palaeolithic in Piedmont, but a hypothesis can be proposed. Looking at the characteristics of the considered lithic assemblages and on the regional availability of knappable rocks, the origin of this change could be due to purely technological reasons. Vein quartz and all the other local rocks available in the region do not consent a complete control on the results of knapping activities due to the presence of inner cleavage planes that the more knapping activities continue, the more they affect the results in terms of fragmentation of the final products and occurrence of knapping accidents (Daffara *et al.* 2021a; de Lombera-Hermida 2009; Tallavaara *et al.* 2010). The laminar method needs an accurate configuration of the cores and the maintenance of a precise geometry during the productions (Pelegrin 2000); the technological constraints of vein quartz can be probably the factor determining the different choices made starting from Upper Palaeolithic. These technological changes must have also entailed important changes in the dynamics of the regional population and in the ways of sites frequentation, but these aspects must be clarified and discussed in the light of more reliable and consistent data.

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Data statement

The authors confirm that the data supporting the findings of this study are available within the article.

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Tecnologia ed economia delle materie prime litiche in Piemonte (Italia nord-occidentale). Un primo scenario realistico

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Abstract:

Le conoscenze e i dati sul popolamento, sulle dinamiche insediative, sulla tecnologia e sull'economia delle risorse durante il Paleolitico sono molto scarsi per quella porzione della penisola italiana che corrisponde al margine sud-occidentale dell'area alpina. In questi territori, la mancanza di ricerche scientifiche mirate e la limitata disponibilità di materie prime, hanno contribuito a diffondere il pregiudizio che aree come il Piemonte non siano state frequentate durante il Paleolitico. Nel 2009, la ripresa di scavi archeologici sistematici presso la grotta Ciota Ciara ha portato all'attenzione nuove questioni e problematiche, incentivando l'elaborazione e lo svolgimento di progetti di ricerca a scala regionale. La grotta Ciota Ciara è a oggi l'unico sito della regione riferibile al Paleolitico medio oggetto di ricerche multidisciplinari. Lo studio tecnologico dell'insieme litico e la definizione delle aree di approvvigionamento delle materie prime hanno permesso di comprendere a un buon livello di dettaglio sia le scelte tecnologiche messe in atto dai gruppi neanderthaliani, sia la loro mobilità sul territorio a livello locale e sub-regionale.

In Piemonte sono poi noti altri insiemi litici riferibili al Paleolitico medio ma tutti provengono da raccolte di superficie non sistematiche se non da ritrovamenti fortuiti o da ricerche non autorizzate. Si tratta di industrie litiche provenienti dalla porzione settentrionale del territorio regionale e in particolare da Vaude Canavesane, Trino, Baragge biellesi e Colline novaresi. Lo studio tecnologico condotto su questi insiemi litici, sebbene con tutti i limiti legati alla mancanza di un contesto stratigrafico certo, ha portato a evidenziare importanti similitudini con l'industria litica delle Ciota Ciara. Pare infatti di cogliere scelte e comportamenti tecnologici che accomunano tutti i contesti del Paleolitico medio a oggi noti: la produzione tecnologica si basa sullo sfruttamento del quarzo, roccia diffusa ampiamente su tutto il territorio regionale e facilmente reperibile presso terrazzi fluviali, letti di torrenti, fiumi o corsi d'acqua stagionali; al quarzo si affiancano altre rocce di provenienza locale quali spongolite, riolite, rocce metamorfiche, diaspro, la cui presenza e le cui proporzioni nei diversi insiemi dipendono dalla loro disponibilità nelle vicinanze del sito. Risorse litiche di provenienza alloctona quali selce e radiolariti sono attestate in proporzioni diverse a seconda dei contesti. In tutti gli insiemi litici si nota la messa in atto di espedienti e adattamenti

tecnologici volti a far fronte alle diverse caratteristiche fisiche e meccaniche delle rocce impiegate nella produzione dello strumentario litico; questo risulta evidente sia nel caso di metodi di scheggiatura caratterizzati da una certa predeterminazione, quali i débitage Levallois e discoide, sia nel caso di sequenze di produzione a carattere speditivo.

Per quanto riguarda il Paleolitico superiore, l'unico insieme litico del Piemonte proveniente da uno scavo sistematico, e dunque da un contesto stratigrafico certo, è quello del sito Epigravettiano di Castelletto Ticino. Da Trino e dalle Colline novaresi provengono alcuni manufatti litici riferibili su base tecno-tipologica al Paleolitico superiore. Nonostante la scarsità dei dati noti per questa fase di occupazione della regione, lo studio effettuato mostra come alla presenza di débitage laminare corrisponda un significativo cambio nelle risorse litiche sfruttate: le radiolariti lombarde diventano predominanti mentre il quarzo e tutte le altre rocce reperibili sul territorio regionale e ampiamente attestate nel Paleolitico medio diventano marginali se non completamente assenti negli insiemi litici esaminati. D'altra parte si assiste a una maggiore presenza di selci importate e provenienti con tutta probabilità da affioramenti localizzati nella vicina Lombardia. Il fattore determinate di questo cambiamento potrebbe essere di natura tecnologica e potrebbe essere ricercato nello scarso controllo degli esiti della scheggiatura determinato dalla natura stessa del quarzo. Il cambiamento di natura tecnologica potrebbe infine aver comportato importanti mutamenti nelle dinamiche del popolamento della regione e nelle modalità di frequentazione dei siti; tuttavia, questi aspetti dovranno necessariamente essere chiariti e discussi alla luce di dati certi, circostanziati e maggiormente significativi.

Parole chiave: Paleolitico medio, Paleolitico superiore, Piemonte, quarzo, tecnologia