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Updating on the Final Palaeolithic-Mesolithic transition in Trentino (NE Italy)[1]

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SUMMARY - *Updating on the Final Palaeolithic-Mesolithic transition in Trentino (NE Italy)* - This work offers an approach to the question of the transition phase between the Epigravettian and the Mesolithic in the Alpine area. The aim is to compare the techno-typological characteristics of diachronic lithic industries. Archaeological records that contribute to this issue come from the sites of Riparo Cogola (Trento), Palù Echen (Trento), Regole (Trento) and Galgenbühel/Dos de la Forca (Bozen/Bolzano). They cover the period from the Younger Dryas to the Boreal and are attributed to the Recent Epigravettian and to the Sauveterrian. Some changes in the lithic production that occurred between the beginning of the Younger Dryas and the Preboreal can be perceived: one of the most evident aspects of this development is the reduced necessity for the production of laminar products. A blade-bladelet production that exploits the maximum length of the core until its abandon (Cogola 19) changes into a more varied core management in the Sauveterrian finalised at extracting bladelets, laminar flakes and flakes. Taking into consideration the manufacture of the armatures, the use of the microburin technique becomes systematic in the Preboreal. Regarding the composition of the microliths, the following observations have been made: there is a numerical increase in some geometric microliths (crescents and triangles), a decrease in backed pieces with truncation and the disappearance of the trapeziums. Moreover, one of the key elements for analysing this transition is represented by the backed points that are characterised by a clear morpho-technical change together with a progressive microlithization.

RIASSUNTO - *Aggiornamento sulla transizione tra Paleolitico finale e Mesolitico in Trentino (Italia nord orientale)* - Questo lavoro affronta la problematica relativa alla transizione tra Epigravettiano e Mesolitico in area alpina. Lo scopo della ricerca è confrontare i caratteri tecno-tipologici di complessi litici diacronici. A questo tipo di analisi si prestano gli insiemi litici che provengono dai siti di Riparo Cogola (Trento), Palù Echen (Trento), Regole (Trento) e Galgenbühel/Dos de la Forca (Bozen/Bolzano) databili tra il Dryas recente e il Boreale e attribuiti all'Epigravettiano recente e al Sauveterriano. Grazie al confronto diretto degli insiemi litici è stato possibile osservare alcuni cambiamenti nella produzione litica tra l'inizio dello Younger Dryas e il Preboreale: uno degli aspetti più evidenti di questa evoluzione è rappresentato dalla minore necessità di ottenere supporti allungati. Da una scheggiatura (Cogola 19) che sfrutta la massima lunghezza del nucleo per una produzione lamino-lamellare nel Sauveterriano si passa a una gestione più varia, finalizzata a estrarre lamelle, schegge laminari e schegge. Nel confezionamento delle armature l'utilizzo sistematico della tecnica del microbulino si manifesta a partire dal Preboreale. Le armature vedono un aumento quantitativo di alcuni geometrici (segmenti di cerchio e triangoli), il calo dei dorsi troncati e la scomparsa dei trapezi. Infine, uno degli elementi chiave per analizzare questo passaggio è rappresentato dalle punte a dorso che sono caratterizzate da un netto cambiamento morfotecnico insieme a una progressiva microlitizzazione.

Key words: lithic industries, Epigravettian, Sauveterrian, transition, South-eastern Alps
Parole chiave: industrie litiche, Epigravettiano, Sauveterriano, transizione, Alpi sud-orientali

1. THE CHRONOLOGICAL AND PALAEO-ENVIRONMENTAL BACKGROUND

Since the 1970s, the process of human colonisation of the South-eastern Alps during the Late Glacial and the Early Holocene has primarily been studied by comparing the lithic industries, the ^{14}C dates and the palaeoenvironmental data gathered from numerous sites sampled and excavated in north eastern Italy, in order to correlate behaviour and culture with climatic and environmental modifications.

[1] The paragraph 1. THE CHRONOLOGICAL AND PALAEO-ENVIRONMENTAL BACKGROUND has been written by M. Bassetti, A. Cusinato and G. Dalmeri; the 2. SPECIFIC PURPOSE OF THE PROJECT by A. Cusinato, K. Kompatscher, M. Hrozny Kompatscher and U. Wierer; the 3. THE EXAMINED SITES by M. Bassetti, A. Cusinato, G. Dalmeri, K. Kompatscher, M. Hrozny Kompatscher and U. Wierer; the 4. THE LITHIC INDUSTRIES DURING THE YOUNGER DRYAS AND THE PREBOREAL by A. Cusinato, K. Kompatscher, M. Hrozny Kompatscher and U. Wierer; 5. CONCLUSIONS by A. Cusinato, K. Kompatscher, M. Hrozny Kompatscher and U. Wierer;.

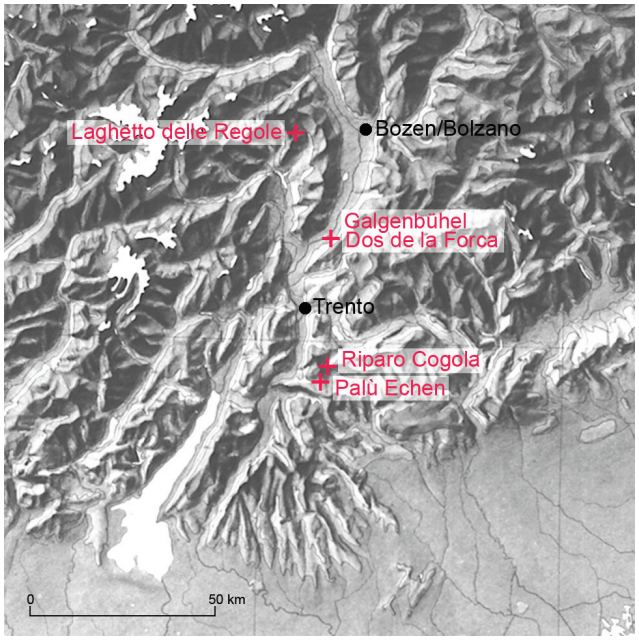

Fig. 1 - Localisation of the sites of Riparo Cogola (Trento), Palù Echen (Trento), Regole (Trento) and Galgenbühel/Dos de la Forca (Bozen/Bolzano).
Fig. 1 - Localizzazione dei siti di Riparo Cogola (Trento), Palù Echen (Trento), Regole (Trento) e Galgenbühel/Dos de la Forca (Bolzano).

The most important spread of human groups towards the Alpine environment occurred during the Bølling-Allerød Interstadials (GI-1 Greenland Interstadial 1). From the valley bottom sites, such as Riparo Soman (100 m a.s.l.), situated northwest of Verona near the Adige River (Battaglia *et al*. 1994), groups of Epigravettian hunter-gatherers moved on towards the mid-mountain environment.

The reforestation of the Alps from the eastern Prealps almost to the watershed has been reconstructed on the pollen sequences of three mountain peat-bogs. In the sequence of Viotte del Monte Bondone (1550 m a.s.l., Trento) the climatic improvement of the Bølling chronozone results in a vegetation increase and in a rise of the vegetation zones with a higher number of dwarf birches and pines (Kofler 1994). Forest expansion continued in the Allerød, as shown at Palughetto (1050 m a.s.l., Cansiglio plateau, Belluno) (Avigliano *et al*. 2000), with the stabilisation of the larch forest as evidenced at Totenmoos (1718 m a.s.l., Ulten Valley, Bozen) (Heiss *et al*. 2005). In this period timber line reached the Viotte del Bondone plateau (Kofler 1994).

During this stage, human groups frequented the Alpine plateaux as documented by many open-air sites and a number of rockshelters. A pattern for land use proposed by Broglio & Lanzinger (1990) suggests a seasonal migration of human groups between the valley bottom – where large rockshelters were occupied repeatedly during the year – and mid-mountain areas, frequented from spring to autumn. Altitudes above 1500 m were frequented sporadically, as documented by rare open-air sites.

Data recently gathered from Riparo Dalmeri (1240 m a.s.l.), radiocarbon dated to the Late Glacial Interstadial, indicate the use of resources from different environments. Hunting the ibex on the Alpine prairies was supplemented by the exploitation of forest ungulates and also by fishing (Bassetti *et al*. 2005; Cassoli *et al*. 1999; Castelletti & Maspero 1994; Fiore *et al*. 2001). These data, although being coherent with the proposed pattern for land use, suggest a more complex scenario, with frequent vertical movements by the human groups between the mid-altitude areas and the valley bottom during a single season. This latter hypothesis is corroborated by the fish remains attributed to species which do not live at high altitudes and therefore were most probably caught in the underlying River Brenta (today 200 m a.s.l.) (Fiore *et al*. 2001).

The cold and arid climate of the Younger Dryas

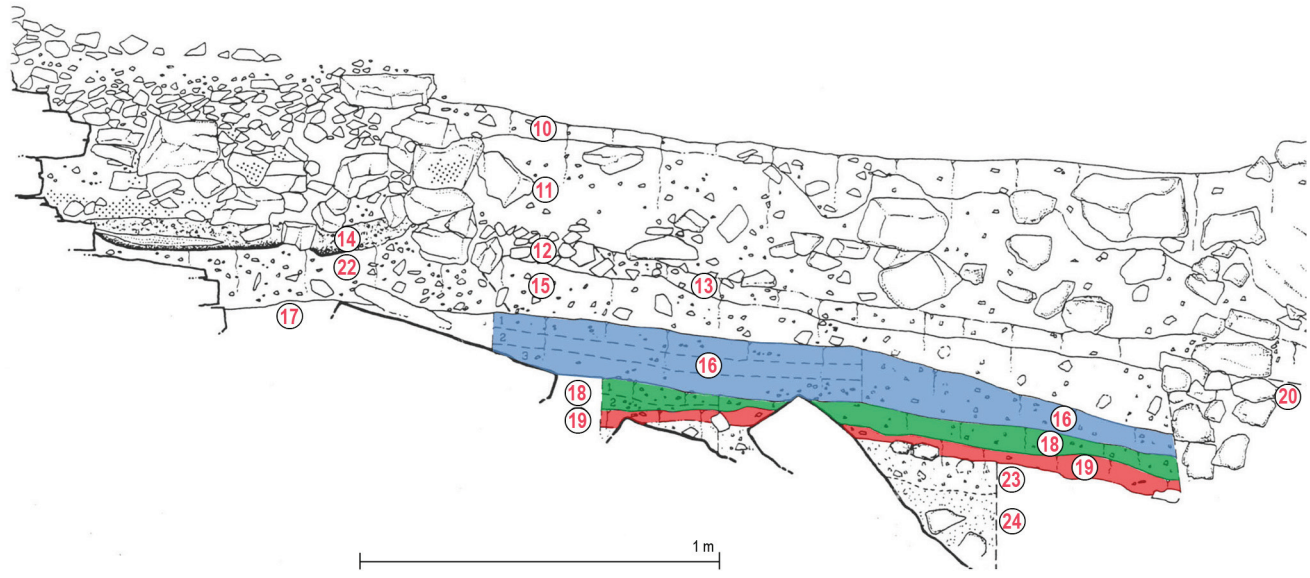

Fig. 2 - The stratigraphic sequence of Riparo Cogola (Trento).
Fig. 2 - La sequenza stratigrafica di Riparo Cogola (Trento).

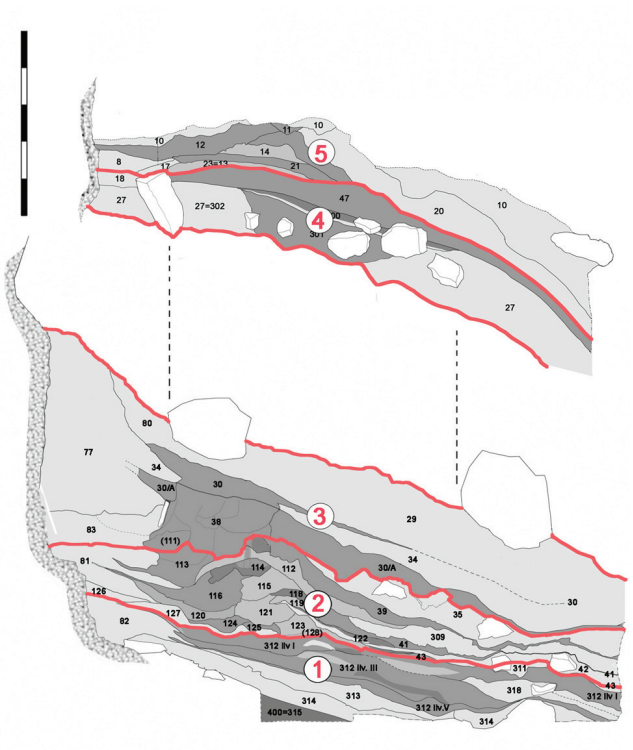

Fig. 3 - The stratigraphic sequence of Galgenbühel/Dos de la Forca (Bozen/Bolzano). In red the occupation phases.
Fig. 3 - La sequenza stratigrafica of Galgenbühel/Dos de la Forca (Bolzano). In rosso le fasi di frequentazione.

(Greenland stadial 1), interrupted by brief temperate periods, led to the retreat of the timberline (Kofler 1994; Heiss *et al*. 2005). This climatic change probably gave rise to the abandonment of sites frequented during the Allerød Interstadial. Nonetheless, recent radiocarbon dating carried out at Riparo Cogola (Bassetti *et al*. 2005), Regole sites (Dalmeri *et al*. 2002) and Bus de la Lum (Peresani *et al*. 1998) indicate that the mountain areas continued to be frequented during the Younger Dryas.

The climatic improvement at the beginning of the Holocene is shown by a lasting and progressive forest coverage that greatly reduces the dynamics of the geomorphologic degradation process.

In the Alps the brusque temperature increase between 11,550 and 11,350 years cal.B.P. saw the tree-line rise of about 800 m in only 200-300 years, reaching altitudes of 2200-2300 m (Seiwald 1980; Kofler 1994). During the Early Holocene, Mesolithic human groups frequented the valley bottom and the high altitudes, penetrating the innermost areas of the Alpine chain. Certain rockshelters of the Adige valley, such as Romagnano III (Broglio & Kozlowski 1984) and Pradestel (Bagolini *et al*. 1973), show a continuous occupation from the Preboreal to the Atlantic. The occupation of rockshelters was favoured by the greater stability of the valley bottom and the presence of small lakes, which enabled humans to intensify fishing, gathering of molluscs and hunting wetland mammals, as attested by the rockshelter of Galgenbühel/Dos de la Forca near Bolzano (Bazzanella *et al*. 2004; Wierer & Boscato 2006; Bazzanella *et al*. 2007). The majority of Mesolithic mountain Sauveterrian sites is distributed at altitudes between 1800 and 2300 m (Dalmeri & Pedrotti 1992; Broglio & Lanzinger 1996) and is primarily related to the exploitation of the mountain prairies and the uppermost belt of the woodlands, as demonstrated by the faunal remains found at Mondeval de Sora (Fontana & Guerreschi 1998). Rare Mesolithic sites at intermediate altitudes, such as Casera Lissandri (Peresani et al. 2007) on the Cansiglio Plateau at about 1000 m a.s.l., have been interpreted as intermediate stations along the ascent routes.

A mobility pattern (Kompatscher & Hrozny Kompatscher 2007), developed to reconstruct the main routes of Mesolithic human groups along the Alpine prairies, reveals the strong influence of geomorphology on the location of a camp. In fact, many of these sites are situated on ridges, saddles and near the shores of small lake basins. During the Mesolithic, the rise of the timberline led to the reduction of Alpine prairies and therefore to the decrease and the splitting up of hunting areas. This led to a greater mobility at higher altitudes, a movement further north to find new hunting grounds and a reduction in size of residential camps, around which many lookout posts or hunting bivouacs were established. Contacts between Mesolithic groups living north and south of the Alpine watershed is supported by artefacts obtained from southern Alpine raw materials found at several sites, such as at Ullafelsen (Tyrol, Austria) (Schäfer 1998).

2. SPECIFIC PURPOSE OF THE PROJECT

While the majority of authors concur on the fact that the Mesolithic was a period during which the Alpine region saw the appearance of new lithic assemblages (Guerreschi 1984), which originated in the local Upper Palaeolithic, specific studies on the technological changes have only just begun.

With this background, the research project under way is intended to pursue one principal objective: to draw the focus of the research towards the Upper Palaeolithic-Mesolithic transition, intending to compare the techno-typological characteristics of diachronic lithic industries.

Archaeological records that could contribute to this issue come from the sites of Riparo Cogola (Trento), Palù Echen (Trento), Regole (Trento) and Galgenbühel/Dos de la Forca (Bozen/Bolzano) (Fig. 1), which cover the period from the Younger Dryas to the Boreal and are attributed to the Recent Epigravettian and to the Sauveterrian.

3. THE EXAMINED SITES

3. 1. Riparo Cogola

Riparo Cogola (1070 m a.s.l.) is located in the Pragrande locality at the head of the Valdastico, near Carbonare on the Folgaria Plateau (Trento). The rockshelter opens in relation to a wide bank of the Rosso Ammonitico Formation (Dalmeri 2005).

The archaeological excavations, carried out in 1999 and 2002 by the Museo di Scienze Naturali and directed by G. Dalmeri, have revealed a series of anthropic levels in an area of about 13 m^2 (Fig. 2).

The well-preserved stratigraphic sequence is formed by a clast-supported cryogenic deposit ranging from the Final Upper Paleolithic (UUSS 19 and 18) to the Early Mesoli-

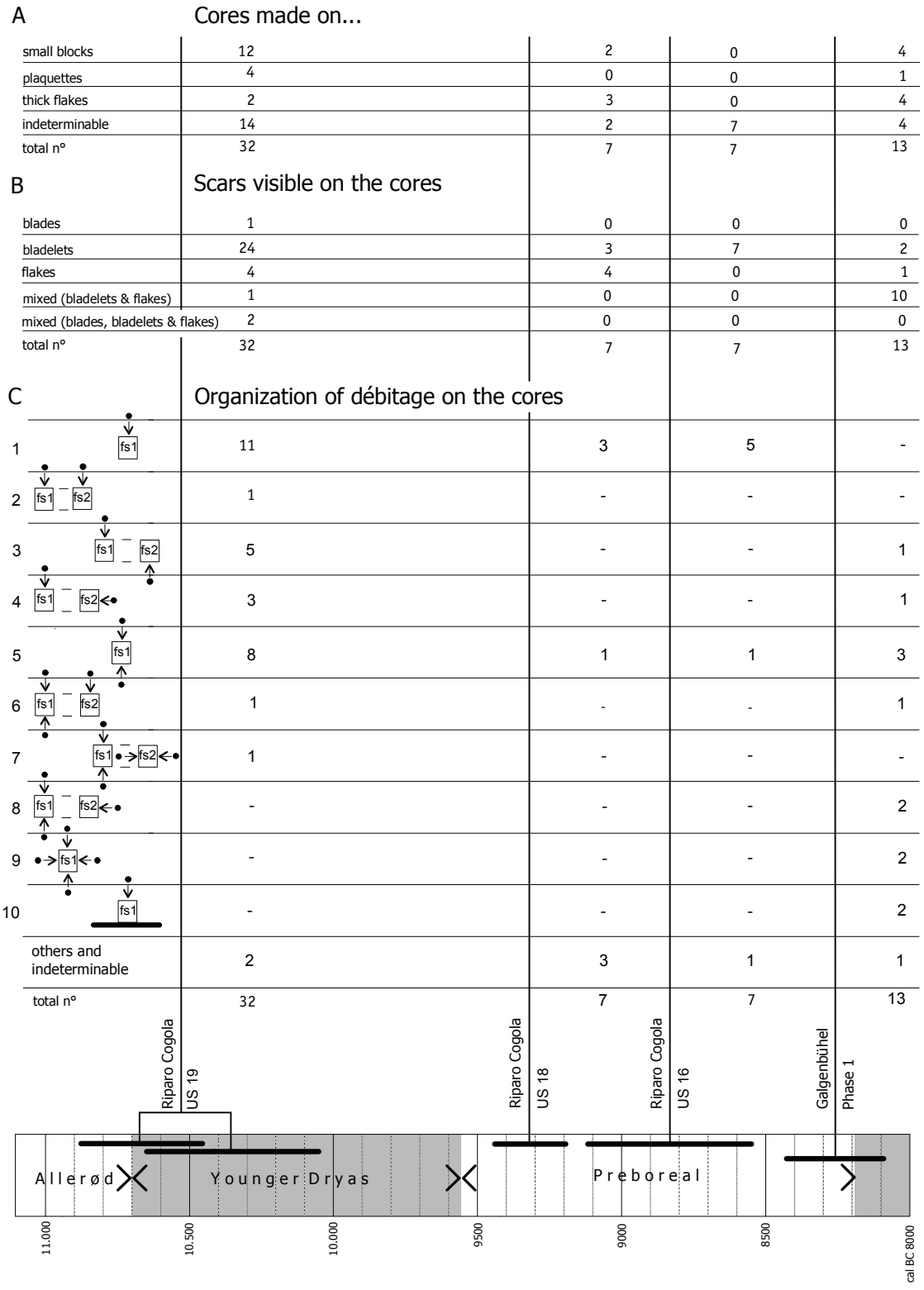

Fig. 4 - Comparison of the cores of Riparo Cogola, UUSS 19, 18, 16 and Galgenbühel, phase 1. A. Morphology of pieces used as cores; B. kind of scars visible on the cores; C. 1. core with single striking platform and single flaking surface, 2. core with single striking platform and 2 flaking surfaces, 3. core with 2 opposite ss.pp. and 2 ff.ss., 4. core with 2 ortogonal ss.pp. and 2 ff.ss., 5. core with 2 opposite ss.pp. and single f.s., 6-8. cores with 3 or 4 opposite and/or orthogonal ss.pp. and 2 ff.ss., 9. core with peripheric striking platform, 10. splintered core exploited with bipolar technique.

Fig.4 - Confronto tra i nuclei provenienti da Riparo Cogola, UUSS 19, 18, 16 e Galgenbühel, fase 1. A. Supporti dei nuclei; B. negativi visibili sui nuclei; C. 1. nucleo con unico piano di percussione e unica superficie di scheggiatura (=fs), 2. nucleo con unico piano di percussione e 2 superfici di scheggiatura, 3. nucleo con 2 pp.pp. opposti e 2 ss.ss., 4. nucleo con 2 pp.pp. ortogonali e 2 ss.ss., 5. nucleo con 2 pp.pp. opposti e unica s.s., 6-8. nuclei con 3-4 pp.pp. opposti e/o ortogonali e 2 ss.ss., 9. nucleo piano di percussione periferico, 10. nucleo scagliato sfruttato con tecnica bipolare.

A Core size

mean	41,8 mm	38,3 mm	25,0 mm	32,1 mm
minimum	27 mm	23 mm	20 mm	20 mm
maximum	58 mm	45 mm	31 mm	48 mm
total n°	18	7	3	12

B Reason for core abandonment

Size reduction	5	1	3	2
Loss of angle/convexity (hinge - fractures)	23	-	-	4
Raw material quality	1	-	-	1
Size reduction & loss of convexity	2	-	-	1
Raw material quality & loss of angle/convexity	-	-	-	1
Uncertain	1	6	4	4
total n°	32	7	7	13

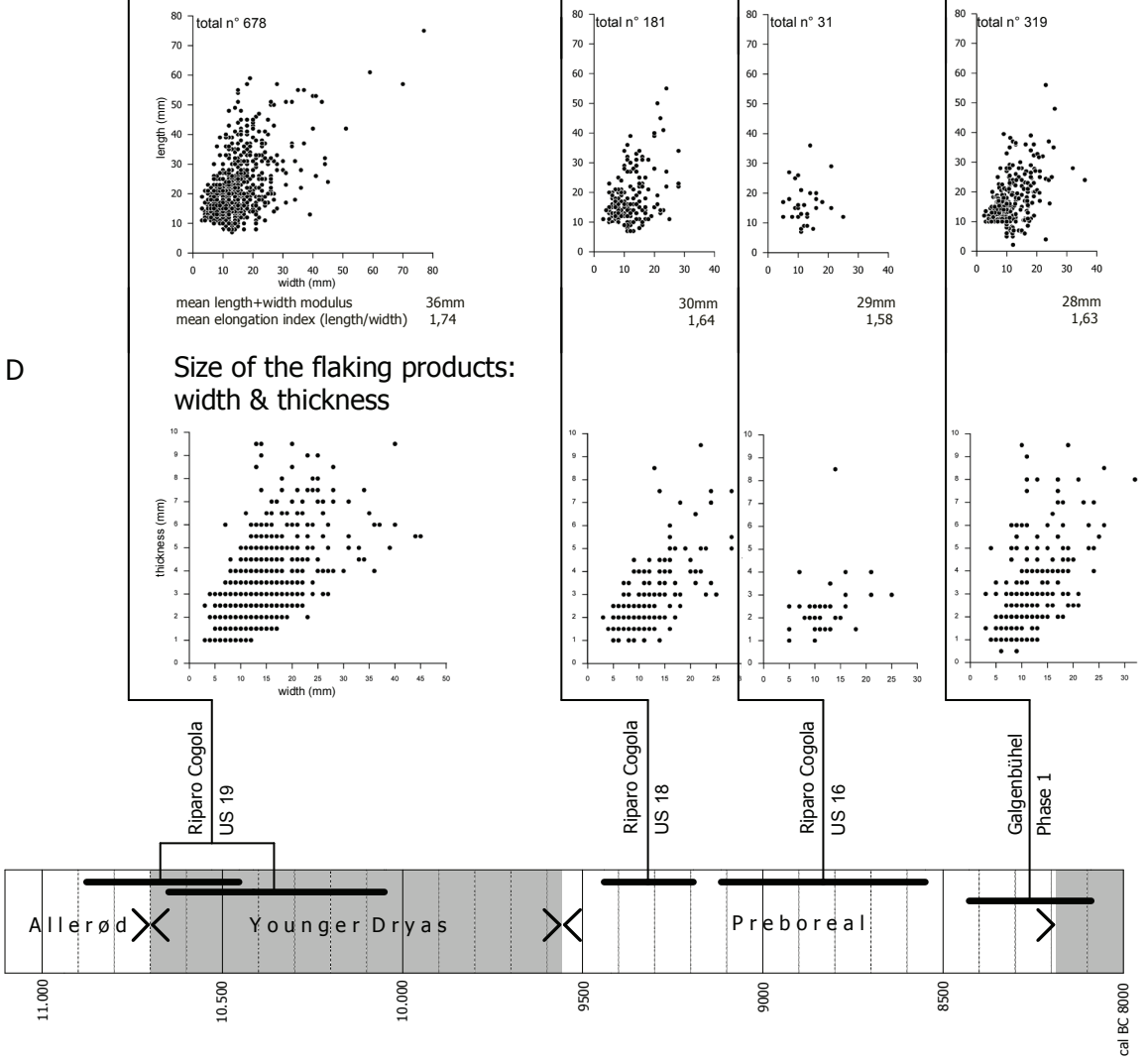

Fig. 5 - Comparison of the cores and the *débitage* products of Riparo Cogola, UUSS 19, 18, 16 and Galgenbühel, phase 1. A. Mean, minimum and maximum core size (measurements considered the greatest dimension among length, width and thickness of each core); B. reason for core abandonment; C. length and width of the whole unretouched products measuring between 10 and 80 mm in length; D. width and thickness of the whole unretouched products (length>= 10 mm).

Fig. 5 - Confronto tra i nuclei e i prodotti di scheggiatura di Riparo Cogola, UUSS 19, 18, 16 e Galgenbühel, fase 1. A. Dimensione media, minima e massima dei nuclei (è stata presa in considerazione la misura maggiore tra lunghezza, larghezza e spessore di ciascun nucleo); B. motivi di abbandono dei nuclei; C. lunghezza e larghezza dei prodotti non ritoccati con lunghezza compresa tra 10 e 80 mm; D. larghezza e spessore dei prodotti non ritoccati (lunghezza>= 10 mm).

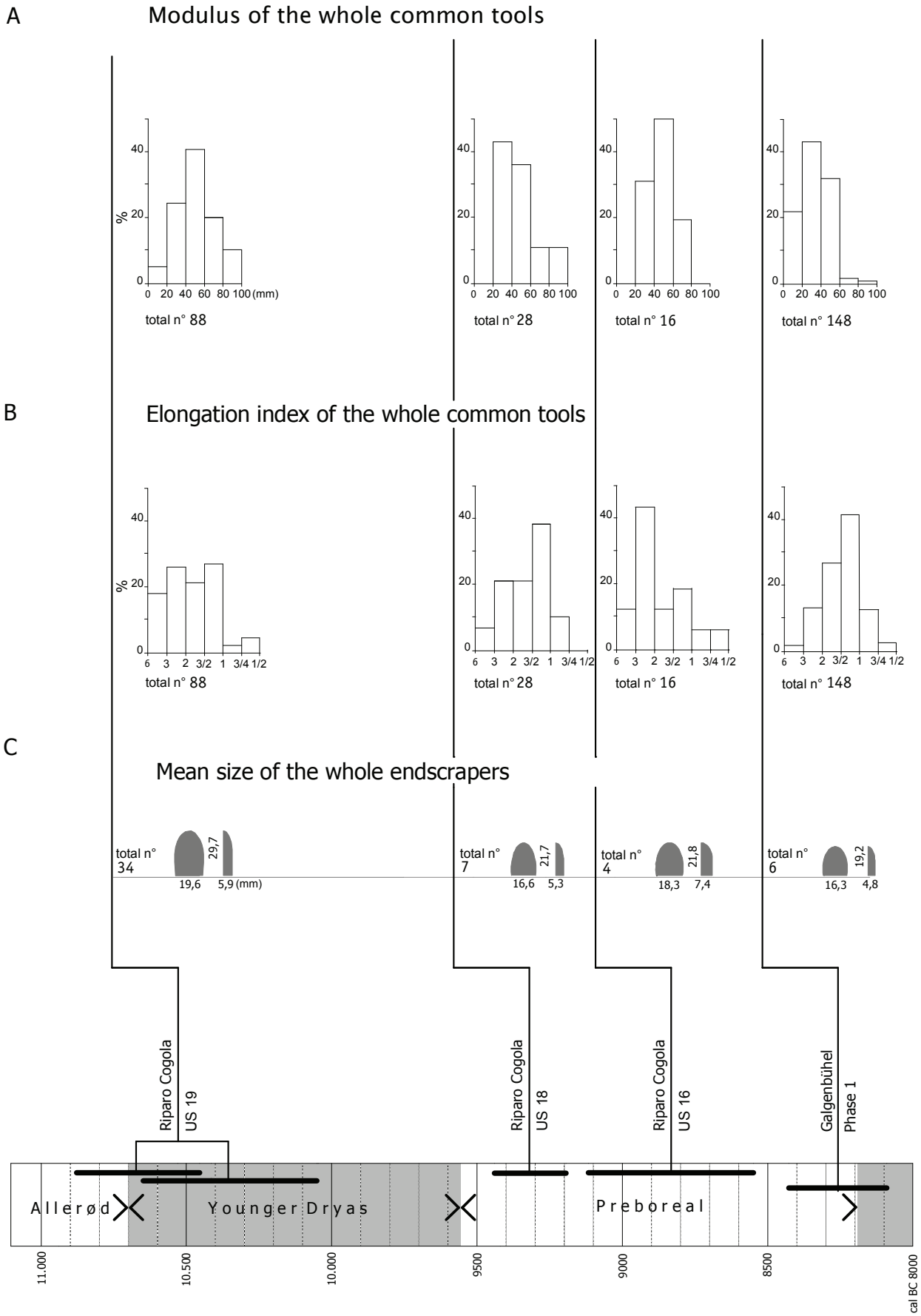

Fig. 6 - Comparison of the common tools and the endscrapers of Riparo Cogola, UUSS 19, 18, 16 and Galgenbühel, phase 1.
Fig. 6 - Confronto tra gli strumenti e i grattatoi di Riparo Cogola, UUSS 19, 18, 16 e Galgenbühel, fase 1.

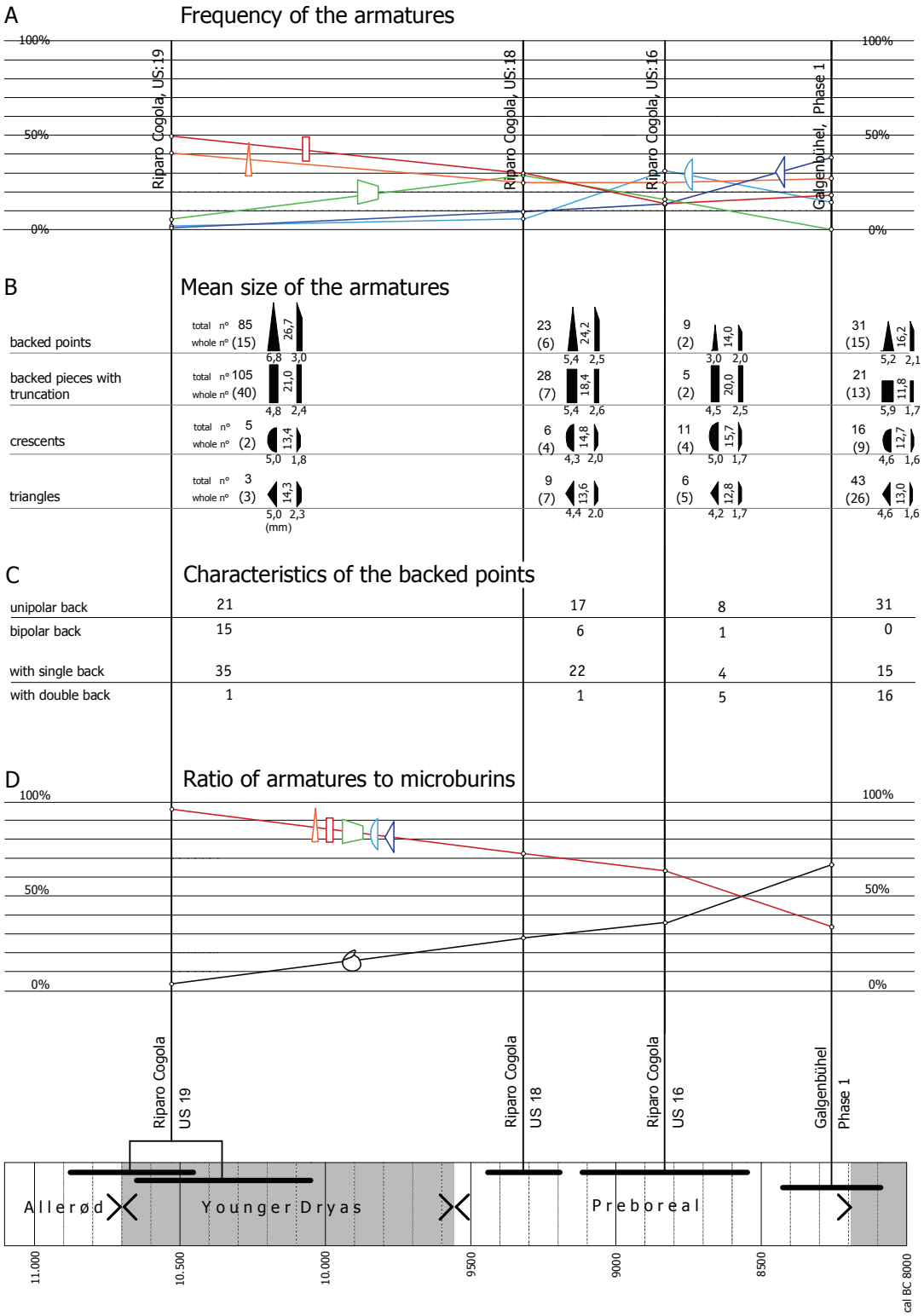

Fig. 7 - Comparison of the armatures of Riparo Cogola, UUSS 19, 18, 16 and Galgenbühel, phase 1. A. Frequency of the following determinable armatures: backed pieces with truncation, backed points and geometric pieces (trapezes, crescents and triangles); B. mean length, width and thickness of the armatures: the mean length has been calculated on the whole pieces, mean width and thickness on the whole and the fragmentary pieces; C. characteristics of the backed points; D. the quantity of armatures includes backed points, backed pieces with truncation, geometric pieces, backed bladelets and all backed fragments; the quantity of microburins includes only the ordinary ones (excluding "Krukowski"-microburins).

Fig. 7 - Confronto tra le armature di Riparo Cogola, UUSS 19, 18, 16 e Galgenbühel, fase 1. A. Frequenza delle seguenti armature determinabili: dorsi e troncatura, punte a dorso e geometrici (trapezi, segmenti e triangoli); B. dimensioni medie (lunghezza, larghezza, spessore) delle armature: la lunghezza è stata calcolata sui pezzi interi, mentre la larghezza e lo spessore su interi e frammenti; C. caratteristiche delle punte a dorso; D. la frequenza delle armature include punte a dorso, dorsi e troncature, geometrici, lamelle a dorso e tutti i frammenti di dorso; la frequenza dei microbulini include solo microbulini ordinari (escludendo microbulini "Krukowski").

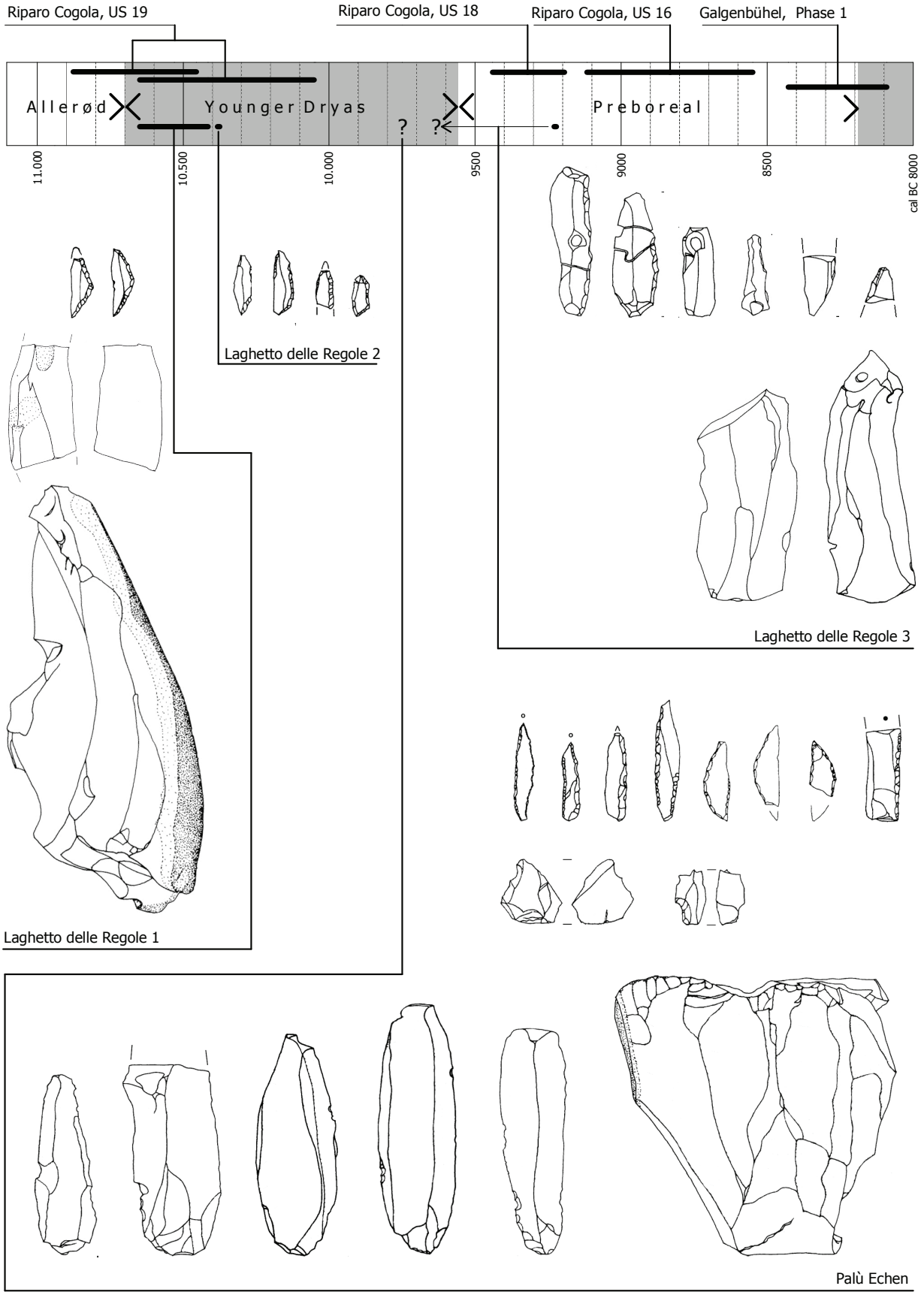

Fig. 8 - The lithic industries from the Regole and Palù Echen sites (drawn by Klaus and Maria Kompatscher).
Fig. 8 - Le industrie litiche dei siti delle Regole e di Palù Echen (disegni di Klaus e Maria Kompatscher).

thic (US 16) and is made up of sub-parallel levels.

US 19 is the base of the filling sequence and conserves an anthropic dwelling surface rich in lithic and faunal material. The level is dated to the Younger Dryas (10,660-10,050 cal BC and 10,880-10,450 cal BC, see Tab. 1). This dating is confirmed by lithic industry of the Recent Epigravettian.

The units 18 and 16, with paleosurfaces showing concentrations of lithic and faunal materials, in stratigraphic continuity with US19, are ascribable to the Preboreal chronozone (US 18: 9440-9190 cal BC, US 16: 9120-8550 cal BC, see Tab. 1). US 18 belongs culturally to the Recent Epigravettian that preludes the Early Mesolithic. US 16 is dated to the Early Sauveterrian.

In all three phases the hunting preys were principally ungulates (red deer, roe deer, ibex and chamois), while wild boar was present only in the first two phases and elk only in the Early Sauveterrian. The study of the skeletal portions shows that the ibex carcasses were taken whole into the shelter and were then butchered, as demonstrated by the *striae* on the lithic instruments and the traces of impact. However, a selection was carried out on the deer carcasses: only the anterior and posterior portions were taken inside the shelter. Studies on the hunting-season of ibex and chamois show that they were killed in summer-autumn, and this data indicate that humans used the shelter during the warmer season (Fiore & Tagliacozzo 2005).

3.2. Palù Echen

The open air site lies at 1260 m a.s.l. on the north east bank of the peat bog basin of Palù Echen, on the Altipiano di Folgaria (Folgaria, Trento). In the autumn of 2004 the Museo Tridentino di Scienze Naturali carried out an extensive stratigraphic investigation over 9 m^2 in sector 1 (P.ECH.1). On the same bank another four palaeoenvironmental sectors were identified. In order to better understand the peat bog stratigraphy, a coring campaign was carried out by the researchers of OLOAMBIENT project (Sezione di Paleoclimatologia, Limnologia e Algologia del Museo Tridentino di Scienze Naturali) . The peculiarity of the zone is in the contemporary presence of a settlement (excavation still in progress) attributed to the Recent Epigravettian on the base of the typological characters of the lithic industry and of a peat bog stratigraphy that includes the transition from the Late Glacial to the Holocene. The primary description of the peat bog stratigraphy and the first dating confirm that the lake already existed in the Late Glacial. The analyses aimed to compare the anthropic sequence with the peat bog/lake stratigraphy in order to correlate human frequentation with the climatic-environmental variations is still in progress.

From an archaeological point of view, it has not been possible to identify a stratigraphic sequence in sector 1 as a result of the post deposit processes (biodisturbance, cryodisturbance etc). The archaeological record, represented by lithic industry and carbon scraps, is impoverished by pedogenetic processes. Furthermore some fragments of prehistoric pottery were found in two excavation sectors.

The high percentage of artefacts in horizontal positions and with unaltered edges testifies that they are substantially in a primary position.

3.3. The Regole sites

In the Upper Val di Non (Trento) around the Laghetto delle Regole at 1240 m a.s.l., peat extraction has led to the identification of three archaeological sites frequented during the final stage of the Recent Epigravettian (Dalmeri *et al*. 2002; Cattani & Gosetti 2005). The excavations were carried out by the Museo Tridentino di Scienze Naturali in collabration with the Soprintendenza per i Beni Archeologici of Trento. The basin fill starts with moraine deposits from the Late Glacial Maximum and ends with the peat formation, reaching a maximum thickness of approximately 2 metres. Human occupation, dated to the Younger Dryas (site LR1: 10,650-10,410 cal BC; site LR2: 10,380 cal BC, see Tab. 1) and the beginning of the Preboreal (site LR3: 9220 cal BC) is concurrent with the regressive phase of the ancient lake. During the Preboreal and up to the Atlantic, the ancient shore deposit was pedogenised by a forested soil layer. At site LR1 the dating of roots in a living position provides a *terminus ante quem* for the development of the forest (6280±27 BP, 5316-5148 cal BC, KIA-14194). Peat formation began in the Mid Atlantic, with an *ante quem* date (5121±24 BP, 3975-3805 cal BC, KIA-14193) relative to ligneous remains found at the base of the peat.

This work primarily concerns the lithic assemblages of sites LR2 and LR3, whereas it will only make some remarks about site LR1 where artefact distribution has been altered by root system disturbances. In both LR2 and LR3 sites, the archaeological material consists exclusively of flint artefacts in undisturbed deposits and carbonaceous particles.

The site LR1, located on the southern shore of the lake, was excavated over an area of 13 m^2. The artefacts are not in a primary position.

At site LR2, located on the northern shore of the lake basin, an area of 6 m^2 was excavated, yielding stone artefacts almost exclusively obtained from flint of the Scaglia Variegata Cretaceous formation, with the majority originating from the same nodule. The analysis of raw material and the pedostratigraphic characteristics observed allow us to consider the lithic assemblage of this site as a uniform whole attributable to a single episode of occupation.

Site LR3 situated on the southern shore was excavated over 15 m^2. Artefacts are made from Cretaceous Scaglia Variegata and Scaglia Rossa raw materials. Artefact distribution shows operations of producing or repairing armatures.

3.4. Galgenbühel/Dos de la Forca

The rockshelter Galgenbühel/Dos de la Forca (225 m a.s.l.) is located at Salurn/Salorno (Bozen/Bolzano), on a detritic cone on the left-hand side of the Adige River Valley. Discovered during quarrying activities, the site was excavated from 1999 to 2002 by the Ufficio Beni Archeologici of Bolzano (Bazzanella & Wierer 2001; Bazzanella *et al*. 2004). The 2,5 m deep stratigraphic sequence is formed by debris alternating with a series of anthropogenic layers and hearth features (Fig. 3; for details see Coltorti *et al*. 2009). In order to grasp the diachronic changes of the archaeological complexes, the excavation units have been grouped into 5 occupation phases. Radiometric datings carried out by the ETH of Zurich show a occupation during the Preboreal and

Tab. 1 - Radiocarbon dates of the examined sites.
Tab. 1 - Datazioni al radiocarbonio dei siti esaminati.

Radiocarbon dates	Lab. Number	^{14}C BP	cal BC - 2 σ
La Cogola 19	Lacogola-RC4	10,640±60 ^{14}C BP	10,880-10,450 cal BC
La Cogola 19	Lacogola-RC3	10,380±70 ^{14}C BP	10,660-10,050 cal BC
Le Regole 2	KIA-14196	10,373±32 ^{14}C BP	10,380 cal BC
Le Regole 1	KIA-14195	10,445±32 ^{14}C BP	10,650-10,410 cal BC
La Cogola 18	Lacogola-RC2	9820±60 ^{14}C BP	9440-9190 cal BC
Le Regole 3	KIA-20343	9737±42 ^{14}C BP	9220 cal BC
La Cogola 16	Lacogola-RC1	9430±60 ^{14}C BP	9120-8550 cal BC
Galgenbühel 1	ETH-27173	9265±70 ^{14}C BP	8425-8089 cal BC

the Boreal chronozones: Phase 1: 8425-8089 BC cal; Phase 2: 8024-7690 BC cal; Phase 3: 7952-7583 BC cal; Phase 4: 7952-7583 BC cal, 7712-7483 BC cal. and 7326-7032 BC cal.; Phase 5 : 7705-7478 BC cal.

These dates, in accordance with the techno-typological characters of the lithic industry, attribute the site to the Middle Sauveterrian (Wierer 2007). First raw material analyses for phase 4 show the use of silex from the cretaceous formations of the Trento Plateau, Scaglia Rossa, Scaglia Variegata and Biancone. They originate from the nearby Non Valley and, probably, form the Folgaria Plateau near Rovereto (Bertola *et al*. 2006).

The particularity of the site lies in the exploitation of a wide variety of fauna, which includes numerous fish remains. Taxonomic identification, carried out by L. Betti, shows that Cyprinids, mainly Rudd (*Scardinius erythrophthalmus*), Roach (*Rutilus erythrophthalmus*) and Tench (*Tinca tinca*) were fished during the phases 1-3. The younger phases 4-5 display a specialization in Pike fishing *(Esox lucius*) (Bazzanella *et al*. 2007). Preliminary data about the season of fishing gathered on few scales would indicate a frequentation of the shelter from spring to late summer.

Among the hunting preys, ungulates are represented mainly by woodland and alpine species as wild boar, red deer and chamois (Wierer & Boscato 2006). Beaver hunting is well attested as well as the exploitation of other wetland fauna represented by otter, fresh water molluscs, mostly of the *Unio* genus, and marsh tortoise (*Emys orbicularis*). The present study considers the lithic complex of phase 1 dating to the final Preboreal.

4. THE LITHIC INDUSTRIES DURING THE YOUNGER DRYAS AND THE PREBOREAL

4. 1. The lithic industries

The lithic industries from the examined sites have been compared on the basis of techno-typological criteria. The numeric entity of the industries from both rockshelter sites, Riparo Cogola and Galgenbühel, has allowed a statistical evaluation (except for Riparo Cogola 16) (Tab. 2). The four open-air sites Palù Echen and Regole 1, 2 and 3 did not provide sufficient material (Tab. 3): they have here been considered on the basis of their diagnostic elements.

4. 2. The lithic complexes from the rockshelter sites Riparo La Cogola and Galgenbühel/Dos de la Forca

4. 2. 1. Observations of débitage based on the cores

In the absence of the complete reconstruction of the *chaines operatoires*, data about *débitage* are obtained by the observation of the cores.

Both at Cogola and at Galgenbühel the knappers exploited small blocks and plates originating frost or tectonic action (Fig. 4A). The blocks have distinguished by an approximately cubic or polyhedric form, while the plates are subrectangular and flat. The use of these supports is particularly frequent at Cogola 19, where they are all together half of the cores. Above all, the high number of plates represents a fact that distinguishes this complex from the other assemblages. At Cogola 18 and Galgenbühel 1 the situation changes, as the number of flakes exploited as cores increases. For this purpose knappers selected cortical flakes (apparently extracted from nodules) or flakes with natural fracture surfaces (taken from blocks).

The high number of undeterminable core-supports is due to the intense use and to the fragmenting of many cores.

The analysis of the removal negatives shows that in all the complexes bladelet extraction is well documented during the phase immediately before abandon (Fig. 4B). A generally exclusive production of bladets products can be seen at Cogola, whereas at Galgenbühel bladelets are generally extracted from mixed cores together with flakes and bladed flakes. Cores which were exploited only for flake production, though present in both assemblages, are notable only at Cogola 18 where they are predominant. The only blade-core was found at Cogola 19, and also the extraction of some blades from mixed cores is attested only in the same layer.

Starting from the work of Montoya (2004, see *Annexe n° 1 "Dynamiques de débitage"*). observations about the flaking dynamics were made considering the organisation of the striking platforms and the flaking surfaces (Fig. 4C).

It can be seen that the cores with only one striking

Tab. 2 - Structure of the assemblages of the rockshelter sites.
Tab. 2 - Struttura degli insiemi litici dei ripari sottoroccia.

	Cogola US 19	Cogola US 18	Cogola US 16	Galgenbühel 1
Cores	32	7	7	13
Flaking products>= 10mm	901	202	65	319 (sample)
Common tools	181	64	36	264
Armatures	375	202	80	198
Microburins	7	36	21	391

platform (Fig. 4C.1-2), generally with a single flaking surface, are quite numerous in the Cogola complexes, while they are completely absent at Galgenbühel. The cores with two opposite striking platforms and two independent flaking surfaces (Fig. 4C.3) are almost exclusive of the Epigravettian complexes (with the single exception of GB 1). The Cogola complexes are furthermore characterised by a good number of cores with two opposing platforms that exploit the same *débitage* surface (Fig. 4C.5, occasionally with other flaking surfaces: 4C.6-8). The bidirectional exploitation is well represented also at Galgenbühel 1. The opposite striking platforms, as far as it can be distinguished from the last detachments, seem to play different roles: they were exploited successively (n. 4 in C 19, n. 3 in GB 1), alternating (n. 2 in C 19, n. 1 in C 16, n. 1 in GB 1) or in a hierarchical way (secondary surface used for corrective operations (n. 1 in C 19, n. 1 in GB 1).

The opening of a striking platform orthogonal to the principal flaking axis appears more frequent in the Mesolithic assemblage (n. 3 out of 13; Fig. 4C.4 & 8). This clearly depends on the fact that the elongation of the blanks is not a priority of the Sauveterrian production. Also the cores with a peripheral striking platform (present only at GB 1) as well as the splintered cores (Fig. 4C.10), can be seen from this same point of view (Fig. 4C.9). The latter are the result of a percussion on anvil in order to extract some useful products before abandoning the core.

The metric analysis of the whole cores shows a clear decrease in size from the older to the younger assemblages (Fig. 5A). The only exception is the assemblage of Cogola 16 which however only contributed three measurable cores. The decrease in size of the other three complexes can be perceived observing the minimum and the mean size. It follows that, at Cogola 19, abandoned cores were on average bigger by almost 1 cm than those of Galgenbühel 1.

The principal cause of abandon in the Cogola 19 and Galgenbühel 1 complexes were the hinge fractures of the loss of the transverse and longitudinal convexity of the flaking surface both as a single cause as together with other factors (Fig. 5B). The reduced size of the cores as a cause for abandon seems to be more important in the two most recent complexes. A further cause (or aggravation) of abandon at C19 and at GB 1 is the bad quality of raw material (natural fracturing or non silicate inclusions).

4. 2. 2. Flaking products at Riparo Cogola and Galgenbühel

The metric comparison of the whole flaking products (unretouched products that come from all the knapping phases) shows a clear size reduction from the most ancient to the most recent complex. A brusque decrease between Cogola 19 and Cogola 18 can be seen from the modulus average and from the Cartesian length-width diagram (Fig. 4C). The decrease in width also corresponds to a reduction in thickness (Fig. 5D). The change is once again evident between Cogola 19 and 18.

The laminarity of the products, shown by the elongation index, decreases between US 19, with an average of 1.74, and the more recent levels, where it shows a slight oscillation between the average values of 1.64 and 1.58 (Fig. 5C).

4. 2. 3. The retouched artefacts and their waste products from Riparo Cogola and Galgenbühel

The retouched artefacts of Riparo Cogola and Galgenbühel have been examined on the basis of the Laplace typology (1964) (Cusinato *et al*. 2005; Wierer 2007, 2008) and, following a consolidated practise, have been further divided into two categories: common tools and microlithic armatures (Broglio & Kozlowski 1984; Battaglia *et al*. 1994).

The comparative analysis of the lithic instruments allowed the identification of some diachronic variations that are important from a dimensional and typological point of view.

On the whole, the common tools show a progressive decrease in their elongation index that goes from an average of 2.1 at C 19 to 1.5 at GB 1, with only C 16 not following the trend (2.1) (Fig. 6B). The histograms show a marked decrease in narrow blades (elongation index 3-6) in favour of the flakes (el. index 3/2-1). Leaving out the insufficient Cogola 16 data, the tendency continues with GB 1 being dominated by flakes and wide flakes (el. index 1-3/4).

The endscrapers, normally well characterised from a typological and functional point of view, have been chosen for detailed dimensional comparisons (Fig. 6C). A clear decrease in size (length and width) appears from US 19 and US 18.

Taking into consideration the composition of the microliths, the most characteristic retouched elements of the Epigravettian and Sauveterrian industries, the following observations have been made:

- The frequency of the **backed points** clearly decrease from US 19 to US 18 at Cogola and then remains stable in the more recent industries (about 25%) (Fig. 7A).
- The backed points show a decrease in length, with

Tab. 3 - Structure of the assemblages of the open-air sites.
Tab. 3 - Struttura degli insiemi litici dei siti all'aperto.

	Regole 1	Regole 2	Regole 3	Palù Echen (preliminary data)
Cores	1	0	0	3
Flaking products<10mm	188	58	1038	586
Flaking products>=10mm	109	147	94	
Retouched artefacts (armatures+common tools)	4	5	15	16
Microburins	0	0	0	2

a considerable decrease between UUSS 18 and 16 (Fig. 7B). The widths also register the same change, except for GB 1 where there are also some wide backed points. The thickness gradually becomes less from US 19 to US 16 and then stabilises during the passage to GB 1.

- The way of making the backed points changes: the bipolar retouching decreases in favour of unipolar retouching that becomes exclusive in GB 1 (Fig. 7C). This can certainly be connected to the decrease in thickness of the blanks selected for armature-manifacturing. In the same way a progressive increase in double backed points as against the single backed ones can be noted. The brusque increase appears at Cogola 16 (5 out of 9), with values comparable to the height of the Mesolithic (16 out of 31 at GB 1).
- The **backed pieces with truncation**, that represent 50% of the determinable microliths at Cogola 19, decrease in number in UUSS 18 and 16, while they increase slightly in GB 1 (Fig. 7A).
- In the three Cogola complexes, the backed pieces with truncation are more or less unchanged in size (length, width and thickness), while they show a considerable decrease in length and thickness and a notable increase in width in GB 1 (Fig. 7B).
- The **crescents**, present in small percentages in the older industries, show a peak of 30% in US 16 and then decrease notably in GB 1 (Fig. 7A). The **triangles**, almost absent in US 19, increase slightly up to US 16 (about 12%) and show then a considerable increase (38%) in GB 1.
- As far as size concerns, the geometrics (triangles and crescents, Fig. 7B) show oscillations in length and width that are almost negligible, while the thickness tends to decrease continuously (except for the crescents from C 19 and C 18).
- The **trapeziums**, microliths sporadically present in the Late Epigravettian sites in northern Italy, reach their highest level with 28% in Cogola 18, later decreasing to become completely absent in GB 1 (Fig. 7A).

An interesting fact about the technical behaviour in the production of microliths is shown by the quantitative comparison of the **microburins** in the different complexes. This precise technique of shortening (and shaping) the blanks was already known in the Epigravettian of Cogola 19 (Tab. 2) but it was used sporadically. Its use increases considerably in US 18 and again in GB 1. It is precisely in the passage between these latter two complexes that the inversion of the microburins/armatures ratio occurs.

4. 3. The lithic industry at the open air sites of Le Regole 1,2 and 3 and Palù Echen

In the Regole 1 site the lithic assemblage is made up of 302 elements (Tab. 3). The complex includes two common tools (a retouched flake and a large nucleiform burin) and three armatures: two isosceles triangles and a backed bladelet. Microburins are not present.

Blade *débitage* is attested by a broken blade. The cultural attribution of the site is based mainly on radiometric data as the typologic evidences are limited. The two isosceles triangles, even though frequent in the Sauveterrian assemblages, are also registered in Recent Epigravettian industries.

The Regole 2 site is made up of 210 artefacts (Dalmeri *et al*. 2002) (Tab. 3). The retouched items are represented by a truncation and by five microliths made on laminar flakes (a crescent, a long scalene triangle with a long base, a bi-truncated backed bladelet and a fragmented backed tool). The typological elements are not sufficiently diagnostic for a cultural attribution of the site which is therefore based on radiometric data. There are no microburins at this site. It has been interpreted as the result of a very short period of use, during which some small blanks for the production of microliths were obtained. From the refittings carried out, knapping seems to be finalised at the production of laminar flakes.

The Regole 3 site includes 1147 artefacts. The identified common tools are a burin, three endscrapers, a truncation, a retouched blade and three retouched flakes. Armatures are composed by three backed points (two are fragments), two backed bladelets and a backed bladelet with truncation. Microburins were also absent in this site. There is a considerable number of laminar and lamellar products among the flaking products. It is necessary to underline that the radiocarbon data 9224 cal BC has been obtained from a carbon scrap that is not of certain anthropic origin, but could come from a postdepositional fire as evidenced by a high percentage of burnt flint products (88%) scattered all over the excavation area. On the basis of the lithic assemblage a chronological position in the Epigravettian seems the most likely.

The lithic assemblage of the Palù Echen site is composed of 607 artefacts (Tab. 3). The retouched elements

include two endscrapers, three burins, a backed knife and a backed bladelet (Dalmeri *et al*. 2006, 150-151). The industry is made up of laminar and lamellar products, that are characterised by regular edges and arrises. The core shows two orthogonal flaking surfaces with lamellar scars. The typological structure of the microliths is not sufficiently diagnostic; we point out the presence of three crescents, four backed points and two backed bladelets. The backed points are small and show unipolar retouch. There are two microburins in the assemblage. The *débitage* seems to have the typical features of the Epigravettian, while the microliths seem to indicate the characters of the Ancient Mesolithic.

5. CONCLUSIONS

The Sauveterrian lithic industries developed gradually from the local Late Epigravettian, as Broglio had already hypothesised. The analysis presented in this work confirms this hypothesis and allows the transition between these two cultures to be observed in greater detail.

The analysis of the eight lithic complexes coming from sites located in a relatively limited area provides further indications about the diachronic development of the industries, even though unfortunately the assemblages from the four open-air sites have provided few diagnostic elements. These indications allow a preliminary interpretation of the techno-typological changes in anticipation of further data that could come from future research.

Some changes in the lithic production can be perceived in the direct comparison of the Cogola 19, 18, 16 (with reservations for the latter owing to the reduced quantity of items) and Galgenbühel 1, dated between the beginning of the Younger Dryas and the final phase of the Preboreal. One of the most evident aspects of the diachronic succession of the complexes is the reduced necessity for the production of long products. Flaking that exploits the maximum core length of the core by detaching blades and bladelets from one or two striking platforms (Cogola 19) evolves to a more varied core management in the Sauveterrian (orthogonal and peripheral exploitation as well as splintered cores) finalised at extracting bladelets, laminar flakes and flakes. The minor length can also be seen in the reduced size of the products. This change in the objectives of the *débitage* appears also from the size of the unretouched products and from the elongation index of the common instruments. Whereas at Cogola 19 more than 40% of the entire common instruments is on blades, the percentage decreases respectively to less than 30% and to less than 20% in the Cogola 18 and Galgenbühel 1 assemblages. According to this latter data the principal change seems to show up in the passage from Cogola 19 to Cogola 18 (Fig. 5).

There is a numerical increase in some geometric microliths (crescents and triangles), a decrease in the backed pieces with truncation and the disappearance of the trapeziums from the beginning of the Younger Dryas to the Preboreal. One of the key elements for analysing this passage is represented by the backed points that are characterised by a clear morpho-technical change together with a progressive microlithization. The manufacture of the backed points on large and medium sized bladelets producing a single back, normally rectilinear, opposite to a sharp edge can be observed in the older industries. In a number of cases, the relatively important thickness of the blank required bipolar retouching to break down the edge. In the Sauveterrian a stronger dimensional and morpho-technical variety of the backed points can be seen, with the appearance of a new item represented by the *Sauveterre* bilateral backed point. The retouch of the back is generally unipolar, owing to the reduced thickness of this particular mesolithic point.

Another salient aspect is the notable increase of the geometrics from the Holocene onwards, in particular of the crescents and triangles according to the various assemblages, while the trapeziums, attested in some Epigravettian sites, disappear. Parallel to this phenomenon there is a clear increase in microburins as the result of a particular shortening and shaping technique of blanks, which is almost absent at the beginning of the Younger Dryas (Cogola 19). The microburins gradually increase until they exceed the number of microliths in Galgenbühel 1. This technique, even if it is sometimes attested among the backed points and the backed pieces with truncation, is above all in relation to the production of the triangles and crescents. The adoption of the microburin technique, not suitable to thick blanks, also explains the progressive reduction in thickness among the triangles of the examined assemblages.

The open-air sites of Regole 1, 2 and 3 and Palù Echen also contribute, even though (at the moment) in a more limited way, to the definition of the transition from the Epigravettian to the Sauveterrian. The reservations expressed about the lithic complexes of these sites are above all based on the low number of the diagnostic elements (Regole 1, 2 and 3 seem to be briefly frequented sites and Palù Echen is still being excavated). The chronology of the Regole sites has been established by ^{14}C datings even though there are some doubts about the reliability of the data for Regole 3. At the moment there is no radiometric date available for Palù Echen.

The four open-air sites, that in this work have been placed in the transition phase of the Younger Dryas, show lithic assemblages of Epigravettian tradition, but with some characters that can be found in a systematic way in the Mesolithic industries. In fact, these sites include elements easily inserted in a context of Epigravettian flaking such as quite regular laminar products, large sized cores (Fig. 8) and some microliths as those coming from Regole 3 (backed bladelet with truncation) characteristic of Epigravettian industries. The microliths from the other sites show, on the opposite, morpho-technical and dimensional characteristics that are common in Sauveterrian industries (crescents, triangles, double backed unipolar points, see Fig. 8). Despite the presence of these Mesolithic characters, the microliths are not associated to a significant number of microburins. They are completely absent in the Regole sites and there are two examples at Palù Echen. Evidently this technical manufacturing characteristic of the microliths was used systematically only later, in the Preboreal. It is possible to hypothesise that in the long and cold phase of the Younger Dryas survival required two completely different tool sets: on one hand, common tools made mainly on blades and on the other, microlithic armatures necessary for new hunting techniques that developed at the end of the Pleistocene.

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