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Bifacial reduction sequences observed on the Solutrean large 'laurel leaves' from Volgu (Rigny-sur-Arroux, Saône-et-Loire)

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Abstract: This paper follows up our previous contribution on the 'laurel leaves' from the Volgu site (Inada, 2014), and further enriches the attempt of reconstructing realistic images of the final phase of bifacial point production through two approaches: analyzing the chronological contexts of removal groups on the central ridges and marginal edges of the fifteen 'laurel leaves', and then establishing as hypothesis the technological concepts of working procedures such as unifacial and bifacial removal stages, and 'analog' and 'digital' reduction sequences.
Three types of removal position shifts (A: alternate, B: bifacial, O: opposite) can be used for reducing the four sides of a bifacial piece. However, in order to complete the four sides, two of these three types must be generally combined as six working procedures (OB, AB, AO, BO, BA and OA—except for the case of overshot flaking), that can further be apprehended in a hypothetical general diagram arranging a total sum of twenty-four working procedure aspects. By comparing the results of chronological analysis of removal groups of the pieces with the procedure aspects of this diagram, we were able to discern that the Volgu 'laurel leaves' were produced respectively along the bifacial removal stages according to their specific regularized working procedure aspects. The digital reduction sequence (consisting of this regularized working procedures recognized especially on central ridges), certainly hold a main role in achieving symmetry both in outline and in section of Volgu pieces, a role enabled by the support of the analog reduction sequence (including all phases of reduction observed generally on edges such as visible or hidden normal removals, provisional or complementary removals and even platform preparations).
We hope the proposed concepts and diagrams concerning working procedures and removal stages will serve to promote comparative studies among the results of analysis of finished objects, researches into refitted pieces and experimental replications.

Keywords: Solutrean, Volgu, 'laurel leaf' point, bifacial reduction sequence, chronology of removals, typology, technology.

Résumé : Cette contribution fait suite à notre article précédent sur les « feuilles de laurier » de Volgu (Inada, 2014), et vient enrichir notre réflexion sur les deux grands types d'étapes d'enlèvement prises en compte dans nos tentatives de reconstruction d'une image – la plus réaliste possible – de la phase ultime d'amincissement de ces grandes « feuilles de laurier » : 1) les étapes unifaciales des groupes de négatifs d'enlèvement (en bref, étapes d'enlèvement unifaciales) distinguées principalement sur les « crêtes » centrales et longitudinales résultant de la rencontre des nervures distales des enlèvements de retouche issus des bords gauches et droits de la feuille, et qui ne présente une chronologie des opérations de taille que sur une face de la feuille ; 2) les étapes bifaciales des groupes de négatifs d'enlèvement (étapes d'enlèvement bifaciales) déchiffrées sur les crêtes centrales et les bords marginaux de la feuille, et qui peuvent permettre de reconstituer une chronologie des opérations de taille sur les deux faces. Les étapes unifaciales ayant déjà fait l'objet de notre attention dans notre précédente contribution, ce seront les étapes bifaciales qui nous occuperons cette fois-ci.
Dans un premier temps, nous avons prêté attention à la relation entre les quatre côtés qui ont permis le façonnage des feuilles de laurier (les côtés gauches et droits sur les deux faces) et les trois changements de la position d'enlèvement (position alterne : signe A, position bifaciale : B et position opposée : O). Dans le cas de « feuilles de laurier » de Volgu et en assumant que les enlèvements ont effectivement été réalisées en séries au long des quatre cotés, ces deux ensembles et leurs corrélations ont pu être théorisés et appréhendés en un schéma général arrangeant, en vingt-quatre aspects de procédés, six procédés de façonnage (OB, AB, AO, BO, BA et OA) à la colonne gauche, et quatre aspects (signes a, b, c et d : différences du côté d'opération initial facultatif d'un cycle des étapes d'enlèvement bifaciales) à la ligne supérieure (fig. 2). Dans un second temps, il nous est apparu important de déterminer l'aspect du procédé de façonnage de chaque « feuille de laurier » (tabl. 2) par le contexte chronologique de ses groupes de négatifs sur les crêtes et les bords (fig. 3 à 10), et par sa correspondance typologique avec le schéma général (fig. 2). Il résulte de ces essais analytiques et hypothétiques que tous les aspects des cinq pièces appartenant aux procédés de façonnage OB et BO peuvent être identifiés (nos 1, 2, 4, 8 et 10).
En se référant à ces cinq derniers exemples, il est possible de dire que la production de chaque « feuille de laurier » a cheminé suivant les étapes d'enlèvement bifaciales en accord avec la répétition continuelle de son aspect spécifique

de procédé de façonnage (fig. 11). Il est raisonnable de supposer que les autres pièces, qu'elles relèvent de deux ou de quatre aspects de procédé, ont été produites de la même manière systématique (fig. 12 et 13). L'utilisation continuelle du procédé de façonnage régularisé est considérée comme une tendance générale dans la production des pointes de Volgu, bien qu'il existe une pièce échappant à cette règle, produite suivant différents aspects entre le premier et le deuxième cycle des étapes d'enlèvement bifaciales (n° 9). Cette tendance générale pourrait être la raison fondamentale, ou à tout le moins la plus plausible, qui viendrait expliquer le caractère symétrique du plan et de la coupe des grandes « feuilles de laurier » de Volgu.
Si la posture du tailleur demeurait la même durant toute la durée du travail, c'est la main opposée à celle qui tenait le percuteur, qui devait assurer le choix du côté d'opération suivant et faire pivoter la pièce pour achever les façonnages sur les quatre côtés. Il serait donc logique de donner davantage d'importance qu'elle n'en a reçue au rôle de la main opposée, dans la mesure où c'est elle qui marquait le rythme des processus de la production des feuilles de laurier, en contrôlant l'avancement des étapes d'enlèvement bifaciales en accord avec l'aspect de procédé de façonnage régularisé.
Nous avons essayé de comparer les étapes bifaciales d'enlèvement observées sur les pointes de Volgu avec celles d'une réplique expérimentale de la pointe bifaciale rapportée par B. Bradley (Bradley, 2013). Les différences notables entre ces deux pointes sont bien naturelles puisque la réplique avait pour but la reconstruction d'une séquence de réduction asymétrique d'une pointe semblable à celle du site des Maîtreaux où seules les premières phases de mise en forme de préformes de grandes « feuilles de lauriers » sont présentes. Nous inspirant de ces différences et de quelques exemples d'enlèvements observés sur les pointes de Volgu, nous sommes parvenus à distinguer une progression double, constituée en séquences de réduction « analogique » et « numérique ». La première implique une séquence complète de réduction, irrégulière en apparence, comprenant des enlèvements normaux, des enlèvements provisoires et complémentaires, ainsi que des enlèvements d'échec et de correction, accompagnés même de la préparation des plans de frappe. La seconde est une séquence de réduction bien contrôlée par la main opposée et réalisée suivant la répétition continuelle du procédé de façonnage régularisé observable sur les pointes de Volgu.
Comment ces séquences doubles de réduction ont-elles progressé, en réalité, au cours de la fabrication ? Peut-on également trouver quelque séquence de réduction numérique dans la séquence de réduction asymétrique ? La seule observation des « feuilles de laurier » achevées ne suffit pas à résoudre ces questions. C'est par conséquent au moyen d'études comparatives qu'il nous faut désormais avancer, en employant les résultats obtenus par l'analyse des pièces finies, la recherche sur les remontages et les expérimentations. Il nous semble que le schéma général figurant les variétés des procédés de façonnage et des étapes d'enlèvement (fig. 2) devrait pouvoir servir de premier élément de fondations communes à ces études. Ce schéma peut être utilisé aussi bien au point de vue statique (*i. e.* typologique) que dynamique (technologique). Ce deuxième usage envisageable n'a d'ailleurs pas encore été suffisamment exploité dans notre présente contribution, mais pourrait montrer toutes ses potentialités lors de travaux comparatifs à venir.

Mots-clés : Solutréen, Volgu, « feuille de laurier », séquence de réduction bifaciale, chronologie des négatifs d'enlèvement, typologie, technologie.

The Volgu site was discovered in 1874, producing a number of 'laurel leaf' points buried as a cache (Chabas, 1874; Arcelin, 1875). Because of their exceptional dimensions (23 cm to 34 cm long and less than 1 cm thin), regularity of their removals and symmetrical outlines, the laurel leaves of Volgu were regarded as one of the most important Solutrean lithic objects and studied from different points of view (Bonnet, 1905; Déchelette, 1908; Cabrol, 1940; Patte, 1944; Smith, 1964 and 1966; Aubry et al., 2003, 2007 and 2009; Peyrouse et al., 2013). After the 1990s, excavations carried out at other Solutrean open sites such as Maîtreaux (Aubry et al., 1998, 2004 and 2008; Almeida, 2005), Cantalouette (Bourguignon et al., 2004) and Ormesson (Bodu et al., 2014) encouraged to develop researches to study 'laurel leaf' production nearby flint outcrop, based on refitting as well as experimental replicating approaches aiming at the reconstruction of reduction techniques (Aubry et al., 1998 and 2009; Almeida, 2005; Pelegrin, 2007 and 2013; Bradley, 2013). (1)

In our previous contribution on the fifteen 'laurel leaves' from Volgu, we discussed the flake removal stages of each single one of them, and came to illustrate our findings by means of both a chronological diagram of removals, and a diacritical diagram of different removal stages and the progression of removal stages (Inada, 2014). These stages were distinguished in two groups : removal groups flaked from the left (or the right), then the right (or the left) sides of one face ('unifacial removal stages'). The reconstruction of the removal stages divided among the removal groups located on the four sides of the two faces of a point ('bifacial removal stages') was left for later studies. In early 2015, visits to the related museums and access granted to the collections needing further examination enabled us to further consider the chronological contexts of removal groups on both faces.

Marginal zones of the Volgu 'laurel leaves' are broadly covered by small removals or minute retouches for platform preparation. Back at the time of our first observations, in 1993 and 1994, we recognized at once these aspects as constitutive obstacles preventing a straightforward understanding of the chronological contexts of a number of removals on both edges.

Though the conditions remain as inappropriate as they were, we resumed this time-demanding research, strengthened by the new results exposed in our previous paper, embodied in the recognition that the numerous and complicated removals can be brought together in several

removal groups, that can be arranged in an order of unifacial removal stages distinguished on the central ridges along longitudinal midlines of both faces. Following this approach, we only needed to determine the chronological context between two or so removals belonging to two removal groups of different faces, and not among all the removals distributed on edges. The reliability in determining a chronological context between two removal groups was increased when we could find the chronological sequences among more than two removals or at two or more spots on edges. In addition, it was possible to take hold of more long series of removal stages when we could establish the chronological contexts of more than four removal groups on four sides of a point.

This is how it was possible for us to come to an understanding of the overall correlations between the removal groups overlapping each other on faces and edges. The aim of this paper consists to show the evidences of chronological decisions among the removal groups, and clarify the existence of systematic reduction sequences based on regularized working procedures and continuous removal stages for the final phase of 'laurel leaves' from Volgu.

HYPOTHETICAL UNDERSTANDING OF THE WORKING PROCEDURES AND REMOVAL STAGES FOR COMPLETING A BIFACIAL POINT

Removal position shifts

Generally speaking, it is necessary to work on the four sides of a point in order to complete a bifacial 'laurel leaf', and the four removal groups occurring on the four sides form one cycle of operation. The removal group constitutes a unit of work in space and time, actually performed by the knappers that we will use as a basic concept for analyzing removals. Accordingly, determination of the chronological context between these removal groups is essential to clarify the sides operating order, that is to say, to define removal stages.

There are, as stated above, two ways of interpreting removal groups as removal stages. The first relies on the unifacial removal stages—as already explained in our previous paper—that are distinguished mainly on the central ridge of each face of a 'laurel leaf' (fig. 9 in Inada, 2014). These stages are numbered in Roman numerals. The second is based on the bifacial removal stages that can be defined both on the two central ridges and the two marginal edges of a 'laurel leaf'. Those stages will be expressed in Arabic numerals. To put it in other words, the earliest four removal groups observed on the four sides of a 'laurel leaf' correspond, on the one hand, with the unifacial removal stages I and II of each faces, and, on the other hand, with the first cycle of the bifacial removal stages 1 to 4 (see fig. 11 as a reference). The focus of the present research is, needless to say, placed on the latter.

In order to consider removal position shifts in relation to the four sides of a bifacial 'laurel leaf', one cannot ignore previous defining studies grasping with retouches on blade tools. Michel Brézillon gave the designations of 'inverse retouch' (*retouche inverse* in French) to retouches observed on a side of the ventral face of a blade, and of 'alternate retouch' *(retouche alterne)* to the two retouches occurring on left (or right) side of the dorsal face and on the left (or right) side of the ventral face (Brézillon, 1977, p. 109). Jacques Tixier extended this terminology by using the term of 'bifacial retouch' *(retouche bifaciale)* for what could be observed on the two sides of the two faces along an edge (Tixier et al., 1980, p. 99). In addition to these two effective designations of alternate position (abbreviated code A in this paper) and bifacial position (code B), it is useful and logical to talk of an 'opposite position' (*retouche opposée*, code O). In the case of position O, removal positions occur on the two opposite sides of a face (fig. 1, no. 1).

If the knapper sustains the same working posture all along to completion of a point, the shifts in the removal position A, B or O are directly responsible of changes in the posture of the point itself :

1) firstly, the position shift A (alternate) can be performed by turning a face to another along a semi-rotation (at a 180 degrees angle) on longitudinal axis (i.e. along transversal axis) of 'laurel leaf';

2) then, the position shift B (bifacial) is achieved by turning faces, and, at the same time, a turn of the distal end to the proximal end, along a semi-rotation on the transverse axis (i.e. along the longitudinal axis);

3) finally, the position shift O (opposite) is performed by a horizontal turn of the distal end to the proximal end along a semi-rotation on the center of a face (fig. 1,no. 2).

However, as we will see, when two removal positions are combined in order to complete a cycle of operation, the real posture changes of the leaf during its fabrication do not necessarily correspond with the apparent removal positions observed on the resulting piece.

Working procedures and removal stages

For completing the operations on the four sides of the two faces of a 'laurel leaf' point, it is necessary to change the operational sides, at least, three times and combine two of these three position shifts. The resulting six combinations of the three removal positions are as follows: AB (ABA for completion of a cycle, with a possible omission of the last code), BA (BAB), AO (AOA), OA (OAO), BO (BOB) and OB (OBO). These combinations will be referred to as 'working procedures' *(procédés de façonnage)*.

Unlike the unifacial removal stages distinguishable on the central ridges of the faces, following the bifacial removal stages on the marginal edges proves to be an uneasy task. Worse, even when all the removal stages can be reconstructed, the determination of working procedures has to face other complicated subject: some cases simply cannot be related to by assigning them a unique procedure to each 'laurel leaf'. Indeed, other procedures show the

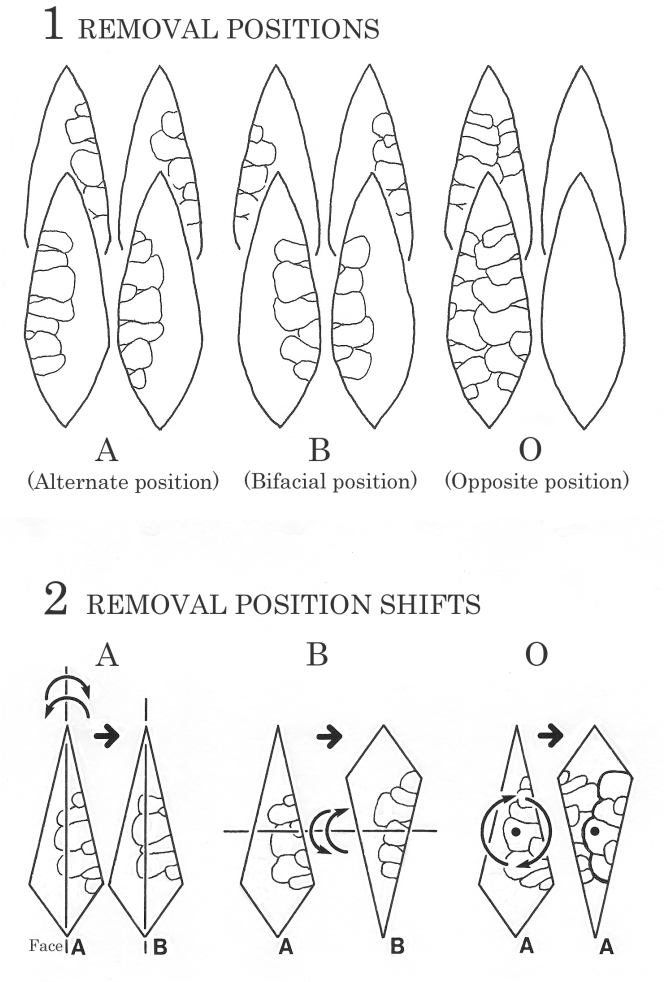


Fig. 1 – Removal positions and removal position shifts on the four sides of a bifacial point. 1: removal positions; 2: turns of 'laurel leaf' for realizing removal position shifts in the case of operational side fixed to right side of face A. A (alternate): turning a face to another along a semi-rotation (at a 180 degrees angle) on longitudinal axis; B (bifacial): turning faces and, at the same time, a turn of the distal end to the proximal end, along a semi-rotation on the transverse axis; O (opposite): horizontal turn of the distal end to the proximal end along a semi-rotation on the center of a face.

Fig. 1 – *Positions d'enlèvement et changements de position d'enlèvement sur les quatre côtés d'une pointe bifaciale. 1 : positions d'enlèvement ; 2 : retournements des feuilles de laurier pour réaliser le changement de position en cas de côté d'opération fixé au côté droit de face A. A (alterne) : retournement d'une face à l'autre selon une demi-rotation sur un axe longitudinal ; B (bifaciale) : retournement d'une face à l'autre et de l'extrémité distale à l'extrémité proximale selon une demi-rotation sur un axe transversal ; O (opposée) : retournement horizontal de l'extrémité distale à l'extrémité proximale selon une demi-rotation sur un point central d'une face.*

same chronological context of removal groups on ridges and edges. It is, therefore, of the highest importance to be theoretically prepared, by having a general grasp of the working procedures based on the different chronological contexts of removal groups on ridges and edges.

In a diagram (fig. 2) that we will propose here, the six procedures (OB, AB, AO, BO, BA and OA) line up from top to bottom on the left side. The former three procedures differ from the latter three in inverted order of the positions. Four sets of diagrams of section and plan of a 'laurel leaf' are placed in a row, toward the right side of each procedure and according to signs a, b, c and d on top row. The sections of the 'laurel leaf' itself are omitted at the single exception of the one included in the top left corner. In the lozenge-shaped section, an arrow indicates one removal group operation and its striking direction from edge to ridge. The lozenge-shaped section composed of four crossing arrows represents a cycle of removal stages that corresponds with the chronological context of removal groups illustrated in plan. Arrows crossing both on ridges and edges in section also illustrate chronological contexts of removal groups: arrows interrupted at distal or proximal end point up earlier removal stages than those illustrated as prolonged arrows, which correspond to bold lines in plan. The lozenge-shaped sections are pictured from the view of the proximal (basal) end of 'laurel leaf'. The top of section corresponds, consequently, with the outline of left side (face A) in plan, and the bottom of section outlining the right side (face B).

Consecutive numbers are assigned to the removal groups in plan and the arrows in section according to bifacial removal stages. In the case of top left corner (OBa),

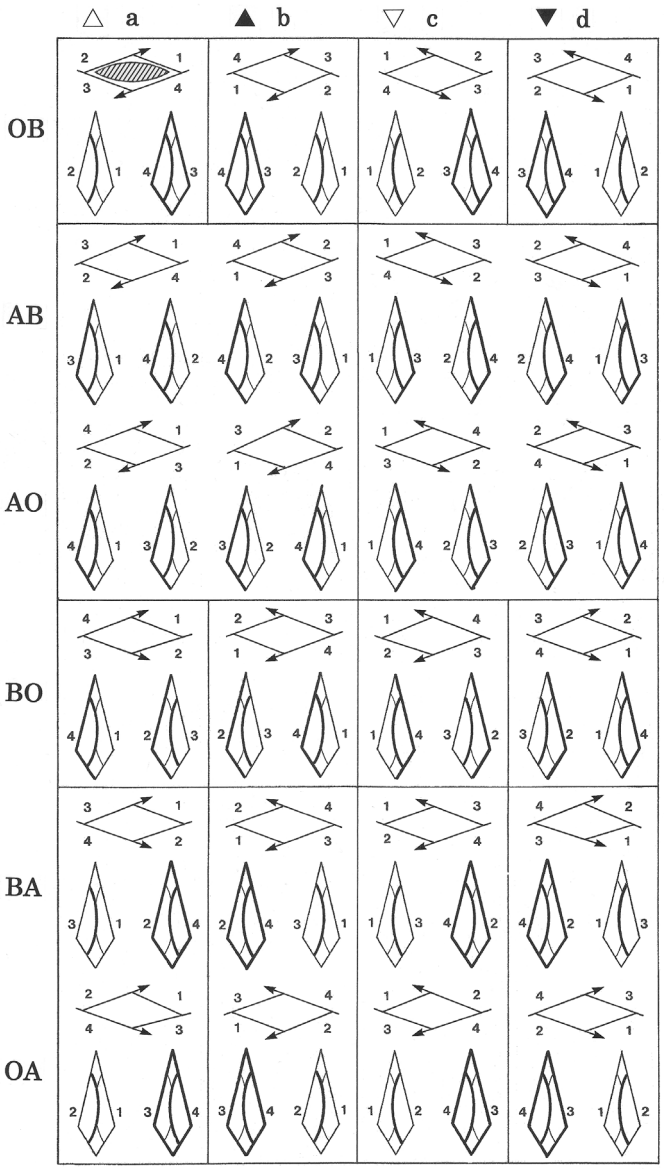


Fig. 2 – General diagram of working procedures and removal stages for the fabrication of a bifacial point. The twenty-four working procedure aspects are composed of six working procedures (OB to OA; positions O, B and A referred to fig. 1) in left line and four aspects (a to d: difference of starting operational side) in top row. In lozenge-shaped section, an arrow indicates one removal group operation and its striking directions. The lozenge-shaped section composed of four crossing arrows represents a cycle of removal stages that corresponds with the chronological context of removal groups illustrated in plan. Arrows crossing both on ridges and edges in section illustrate chronological contexts of removal groups: arrows interrupted at distal or proximal end point up earlier removal stages than those illustrated as prolonged arrows, which correspond to bold lines in plan. The numbers in Arabic numerals indicate bifacial removal stages. Checkered framework shows fourteen aspect groups integrated typologically. The triangle marks on top row relate only to dynamic viewpoint of the diagram and the variation of its shapes shows the posture shift of the face A of ‘laurel leaf’ according to signs a, b, c and d. White and black triangles indicate respectively face A (superior face) and B (inferior face).

Fig. 2 – *Schéma général des procédés de façonnage et des étapes d’enlèvement pour la fabrication d’une pointe bifaciale. Les vingt-quatre aspects des procédés de façonnage sont composés des six procédés de façonnage (OB à OA) de la colonne gauche et des quatre aspects (signes a, b, c et d : différences du côté d’opération initial d’un cycle des étapes d’enlèvements bifaciaux) de la ligne supérieure. Dans les coupes en losange, une flèche indique le groupe des négatifs d’enlèvement et sa direction de percussion. La coupe en losange composée de quatre flèches croisées montre le cycle des étapes d’enlèvement qui correspond au contexte chronologique des groupes des négatifs d’enlèvement illustré dans le plan. Les flèches croisées sur les crêtes centrales et les bords marginaux dans la coupe présentent le contexte chronologique des groupes de négatifs : les flèches interrompues sur leurs extrémités distales ou proximales soulignent l’étape d’enlèvement antérieure à celle de flèches prolongées, lesquelles correspondent aux groupes d’enlèvement figurés par les lignes en gras dans le plan. Les numéros en chiffre arabe indiquent les étapes d’enlèvement bifaciales. Le cadre de la grille montre les quatorze groupes intégrés typologiquement des aspects de procédés de façonnage. Les signes triangulaires situés à la ligne supérieure ne renvoient qu’au schéma compris du point de vue dynamique (c’est-à-dire technologique), et la variété de leurs formes correspond avec la changement de posture de la face A de la feuille de laurier suivant les signes a, b, c et d. Les triangles blancs et noirs indiquent respectivement les faces A (face supérieure) et B (face inférieure).*

for example, the advance of bifacial removal stage 1 to 2 shows the position shift O (opposite), the stage 2 to 3 presents the position shift B (bifacial), and stage 3 to 4 is characterized by the position O (fig. 2). Although a cycle of bifacial removal stage is a three times set of position shift i.e. three codes OBO, the combination of two codes OB would be enough to define its specific working procedure, considering the first code must be repeated once again for concluding a cycle.

Twenty-four working procedure aspects and fourteen aspects groups

The four sets of section and plan marked as a, b, c and d in figure 2, differ from one another in the side on which the first removal stage is carried out: stages 1 of line a are located on upper right side in section and on right side of face A in plan; those of line b on lower left side in section and on right side of face B in plan, and so on. The shift of the starting side of a working procedure results in different chronological contexts of removal groups on the central ridges and marginal edges. Hence, the working procedures codes combined with signs a, b, c or d may be named working procedure aspects. The diagram of figure 2 presents the variation of twenty-four procedure aspects from OBa on left top corner to OAd on right bottom corner. The six working procedures themselves are mere technological concepts, but each 'laurel leaf' were actually produced by following one of these procedures, and must have been realized according one of these procedure aspects.

However, more than half the procedure aspects shows the same chronological context on ridges and edges between two or four aspects (fig. 2). The twenty-four procedure aspects—established technologically by mean of the six procedures and the shift of four starting sides of removal stages—are integrated typologically into fourteen groups of aspects on basis of chronological contexts of removal groups on ridges and edges. The fourteen aspect groups are specified in a checkered framework in figure 2.

The procedures OB and BO present respectively four separate aspects. On the contrary, procedures AB and AO are integrated into only two aspect groups, and procedures BA and OA into four aspect groups partitioned from a to d. The partitions dividing the different procedure aspects shows evidence that they are removed by mean of the position A—used one or twice—included in a cycle of removal stage. It is thus possible to estimate a distinguishable extent of the various working procedures or procedure aspects in the finished 'laurel leaves'. Ultimately, the working procedures or procedure aspects can probably be discussed simply on the basis of the typological correspondence between this hypothetical general diagram (fig. 2) and the other respective diagrams of 'laurel leaves' showing their different chronological contexts of removal groups on ridges and edges (fig. 3 to 10). Let us now explain the relationships of the actual samples of Volgu with our general diagram.

Static and dynamic understanding of the general diagram of working procedures

The general diagram of working procedures (fig. 2) can be understood from both a static and dynamic viewpoints, i.e. from both the typological and technological viewpoints. Our demonstration so far resulted mainly from the static viewpoint. First of all, let us say that the static understanding of the diagram is a prerequisite in order to build a comparative approach toward 'laurel leaves' as archaeological remains. The fact is there never were such things as removal numbers written on each side of those artifacts, and we have no idea of the posture Solutrean knappers might have performed, or even whether if they were right-handed or left-handed. However, one can say without a shadow of doubt that the 'laurel leaves' could not have been worked in a resting posture, but rather were produced, turning and rotating, in a dynamic posture. Now that we have achieved our typological identification of the working procedures or procedure aspects, we have to advance to a more vivid reconstruction of these working procedures, utilizing the same diagram, but through a technological viewpoint.

In the static apprehension of the diagram, all the 'laurel leaves' of twenty-four procedure aspects are figured with distal end on top and proximal end on bottom (let us temporarily call this the 'right posture'), and operational parts are shifted from one face to the other or one side to the others (fig. 2). This viewpoint postulates that the position of the 'laurel leaf' remains fixed and knapper moves around it following or changing the operational side needed. In a dynamic viewpoint of the diagram, the posture of the knapper remains unchanged and the 'laurel leaf' is turned following operational side. It appears that the dynamic viewpoint is the better suited to give a more real to life reconstruction of a 'laurel leaf' production process.

The detailed explanations of the diagram as seen dynamically are as follows (fig. 2). The triangle beside a to d on top row corresponds with the outline of face A of the 'laurel leaf' point, and white and black triangles indicate respectively face A (superior face) and B (inferior face). The four variations of triangle show the posture shifts of face A from a, to d. When △ of face A of a means the superior face of right posture of a leaf, ▲ of face A of b indicates a position shift A (alternate) from aspect a (fig. 1, no. 2). Then ▽ of face A of c presents a position shift B (bifacial) from b (or position shift O—opposite—from a). Finally, ▼ of face A of d shows a position shift A from c (or position shift O from b).

From a static standpoint, we followed the removal stages 1 to 4 along the four sides of a leaf as illustrated in each procedure aspect. The same removal stages, seen from a dynamic viewpoint, progress through the four procedure aspects of the same working procedure. The operational side of aspect a is systematically located on side 1 of aspect a. The numbers 2, 3 and 4 mentioned along the same sides in the three other aspects indicate a progressing sequence of the removal stages of aspect a with 1, and naturally, a range of position shift of the 'laurel leaf' identified with aspect a.

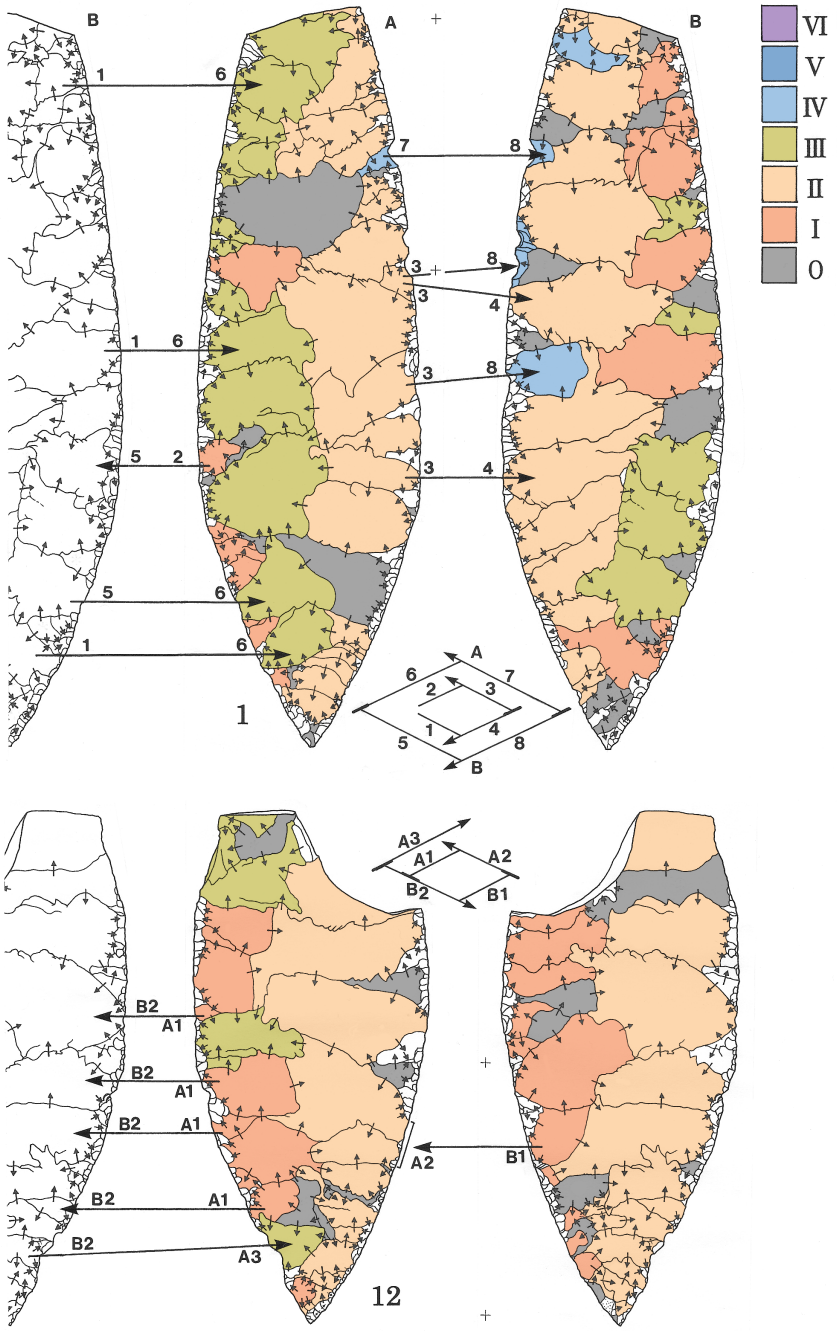


Fig. 3 – Removal groups and removal stages of Volgu ‘laurel leaves’ (nos. 1 and 12). In the diacritical diagram of the different removal stages, small arrows on arrises indicate the chronological contexts between two neighboring removals, and colors correspond to the unifacial removal stages numbered in Roman numerals. The revised parts of removal stage are indicated by dotted lines with alphabetical small letters, and small arrows resulted in or related to these revisions are marked ●. The horizontal long arrows indicate the chronological context of removals or removal groups between faces A and B. The resulting chronological contexts are illustrated as sections similar to those of figure 2. The long arrows are numbered by simple sequential numbers in Arabic numerals of bifacial removal stages or by Arabic numerals composed with large alphabetical letters A or B (face A or B).

Fig. 3 – *Groupes des négatifs d’enlèvements et étapes d’enlèvement des « feuilles de laurier » de Volgu (nos 1 et 12). Dans le schéma diacritique des différentes étapes d’enlèvement, les petittes flèches sur les nervures indiquent le contexte chronologique entre les deux négatifs voisins, et les couleurs correspondent aux étapes d’enlèvement unifacial indiquées en chiffres romains. Les parties révisées des étapes d’enlèvement unifacial sont indiquées par les lignes pointillées avec les lettres minuscules alphabétiques, et les petites flèches se rapportant à ces révisions sont marquées ●. Les flèches longues et horizontales indiquent le contexte chronologique des négatifs ou des groupes de négatifs entre les deux faces A et B, et ces résultats chronologiques sont montrés dans les coupes en losange pareilles à la figure 2. Les flèches longues sont numérotées par la série des chiffres arabes des étapes d’enlèvement bifacial ou par une combinaison des chiffres arabes et des lettres capitales A ou B (face A ou face B).*

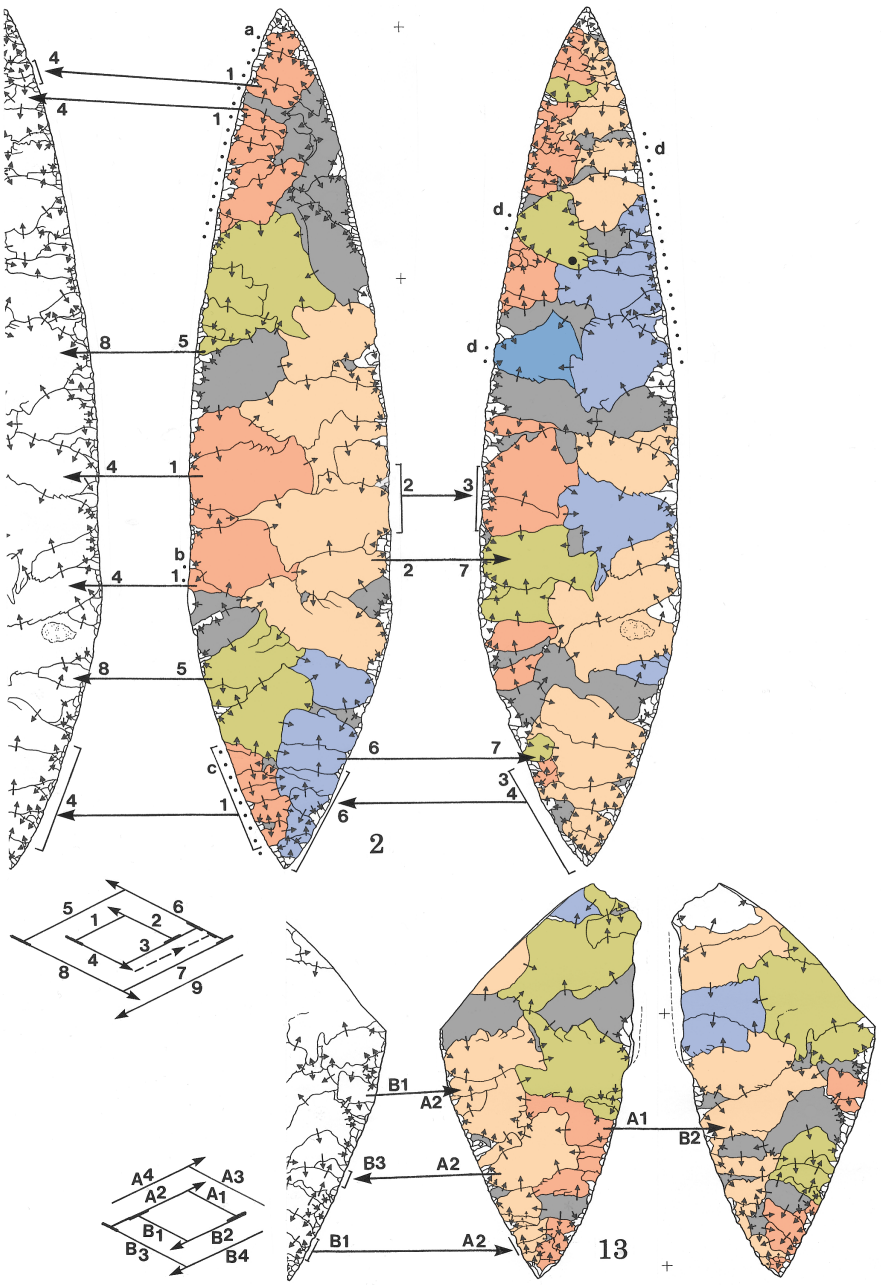


Fig. 4 – Removal groups and removal stages of Volgu 'laurel leaves' (nos. 2 and 13).

Fig. 4 – *Groupes des négatifs d'enlèvements et étapes d'enlèvement des « feuilles de laurier » de Volgu (nos 2 et 13).*

Let us take an example. In the procedure aspect ABa's case of procedure AB, the right side 1 on face A is a fixed operational side of the aspect. The same sides are numbered 2 in aspect ABb, 3 in aspect ABc and 4 in aspect ABd. We arbitrarily chose to arranged the position shift of triangles illustrated on the top of figure 2 accordingly to the removal stage of the procedure aspect ABa. Hence, the progress of removal stages conforms completely with the order of a to d. Consequently, the removal stages of all the five other procedures do not conform with the order of triangle marks beside a to d. The relations between the removal stages (in Arabian number) of procedure aspects of line a and the orders of their position shifts—i.e. triangle marks of signs a to d (alphabetical small letters)—are as follow:

Procedure aspect OBa: 1(a) → 2(c) → 3(b) → 4(d)
Procedure aspect ABa: 1(a) → 2(b) → 3(c) → 4(d)
Procedure aspect AOa: 1(a) → 2(b) → 3(d) → 4(c)
Procedure aspect BOa: 1(a) → 2(d) → 3(b) → 4(c)
Procedure aspect BAa: 1(a) → 2(d) → 3(c) → 4(b)
Procedure aspect OAa: 1(a) → 2(c) → 3(d) → 4(b)

In case of the aspect OBa, firstly, when removal stage 1(a) progresses to stage 2(c) along the position shift O (opposite), the distal end of face A on top of the leaf is rotated horizontally (at a 180 degrees angle) around the central part of the face (fig. 1, no. 2). Then, when stage 2(c) progresses to stage 3(b) along the position shift B (bifacial), the proximal end on top of the piece is turned to bottom, then, in the meantime, the face A of the piece is turned to face B along a semi-rotation on the transverse axis (i.e. along the longitudinal axis). Finally, the shift of

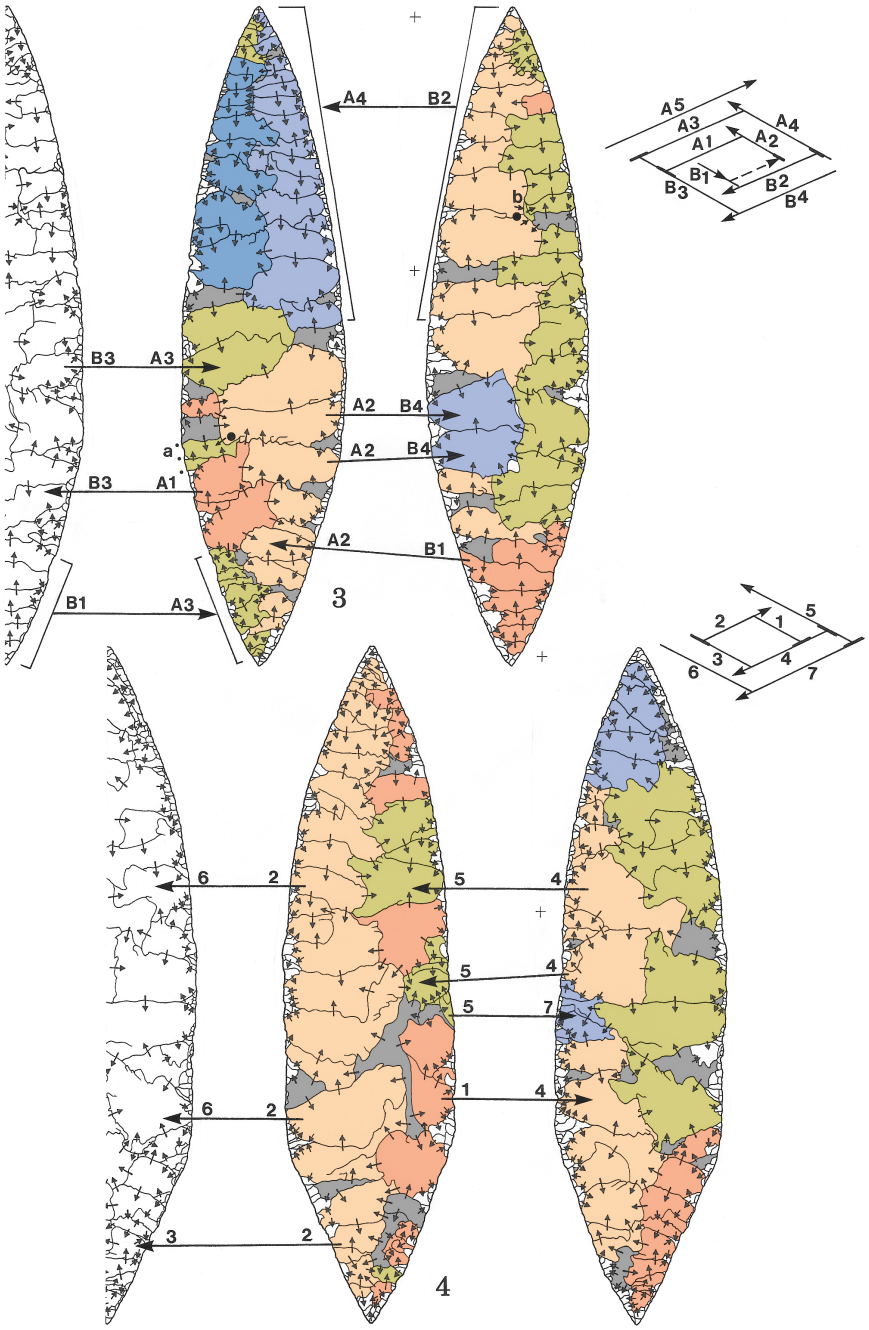


Fig. 5 – Removal groups and removal stages of Volgu 'laurel leaves' (nos. 3 and 4).

Fig. 5 – *Groupes des négatifs d'enlèvements et étapes d'enlèvement des « feuilles de laurier » de Volgu (nos 3 et 4).*

the leaf posture along the position O is repeated in order to proceed to stage 4(d). To be precise, when removal stage 3(b) progresses to stage 4(d) along the position shift O (opposite), the distal end of face B on top is turned horizontally to bottom along a semi-rotation on the facial center without altering faces.

Close attention must be paid to two different facts: the posture for the face A of a 'laurel leaf' in each removal stage can be changed in correspondence with the triangle of the line where the stage belongs; the numbers as they are illustrated remain, however, unchanged in each procedure aspect. In order to follow the bifacial removal stages, in the general diagram, from a dynamic viewpoint, numbers fixed for each aspect have to be combined with the changing of postures emphasized by the triangles (i.e. pieces). The posture of face B of each removal stage is changed, needless to say, according to the changed posture of face A.

Furthermore, in all of the four aspects of procedure OB, the chronological contexts of removal groups on the central ridges are similar between faces A and B. At first sight, it would be only natural to interpret this analogy between two faces as a result of the use of position A. Nevertheless, procedure OB do not include the position A. It would be dangerous to surmise the used procedure without examining the chronological contexts of removal groups, both on central ridges and on marginal edges.

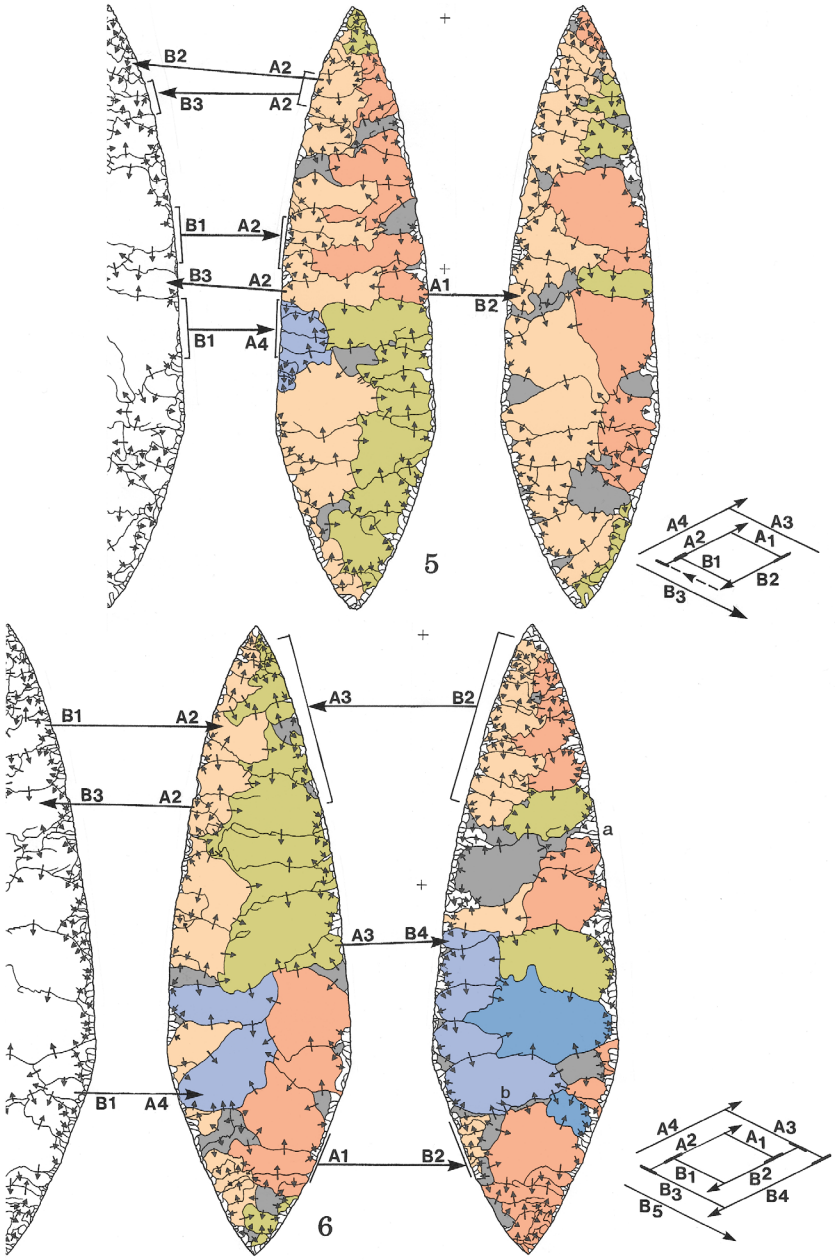


Fig. 6 – Removal groups and removal stages of Volgu 'laurel leaves' (nos. 5 and 6).

Fig. 6 – *Groupes des négatifs d'enlèvements et étapes d'enlèvement des « feuilles de laurier » de Volgu (nos 5 et 6).*

The removal stage 1 of the six aspects of line b is always placed on the right side of face B, which is used as a fixed operational side through the progress of removal stages of each procedure.

Procedure aspect OBb: 1(b) → 2(d) → 3(a) → 4(c)
Procedure aspect ABb: 1(b) → 2(a) → 3(d) → 4(c)
Procedure aspect AOb: 1(b) → 2(a) → 3(c) → 4(d)
Procedure aspect BOb: 1(b) → 2(c) → 3(a) → 4(d)
Procedure aspect BAb: 1(b) → 2(c) → 3(d) → 4(a)
Procedure aspect OAb: 1 (b) → 2(d) → 3(c) → 4(a)

Concerning the other procedure aspects belonging to lines c and d, we are also able to get hold, following these two cases explained above, on the relationships between the progress of removal stage and the orders of removal position shifts. The removal stage 1 of these aspects begins with an upside_down inverted posture, but leaving stage numbers as they are illustrated in each procedure aspect.(2)

UNIFACIAL AND BIFACIAL REMOVAL STAGES OBSERVED ON THE 'LAUREL LEAVES' FROM VOLGU

Chronological contexts of the removal groups between faces A and B on marginal edges

Further study of the chronological contexts of the removal groups analyzed in our previous paper (fig. 4 to 6 *in* Inada, 2014), lead us to perform mainly minor revisions of our

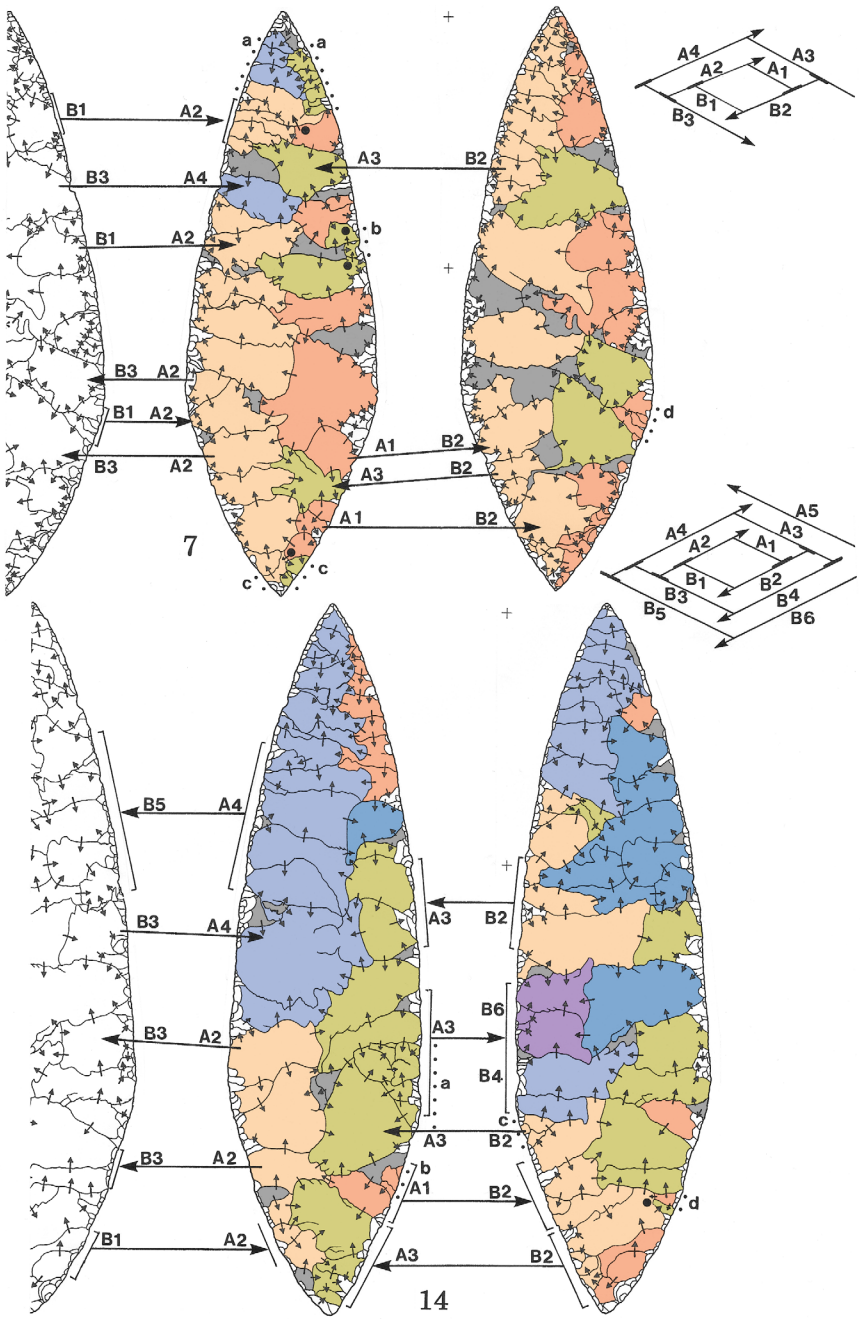


Fig. 7 – Removal groups and removal stages of Volgu ‘laurel leaves’ (nos. 7 and 14).

Fig. 7 – *Groupes des négatifs d’enlèvements et étapes d’enlèvement des « feuilles de laurier » de Volgu (nos 7 et 14).*

interpretative model on the unifacial removal stages of seven ‘laurel leaves’ (table 1).(3)

Let us now reconstruct concretely the working procedures and bifacial removal stages along which the fifteen ‘laurel leaves’ from Volgu were made, using two kinds of diagrams: one already referred to for phasing the unifacial and bifacial removal stages (fig. 3 to 10); another showing the continuous progression of bifacial removal stages in relation with their removal position shifts (fig. 11 to 13).

In figures 3 to 10, the face A of ‘laurel leaf’ is placed at the center of each diagram, and its face B is disposed both at right side (full face) and at left side (half face) of face A. The horizontal long arrows indicate the chronological context of removals or removal groups between faces A and B. The results of its chronological context are presented as sections similar to those of figure 2. In this lozenge-shaped section, arrows indicate removal directions from right or left edge to the ridge of face A (superior face of section) or B (inferior face). Arrows interrupted at distal end or proximal end are chronologically anterior to prolonged arrows.

Unifacial and bifacial removal stages’ arrows have their respective numbering. Where the first or second cycles of the bifacial removal stages correspond precisely to a unique procedure aspect presented in figure 2, sequential numbers in Arabic numerals are assigned to the arrows on both faces. This case is limited to five ‘laurel

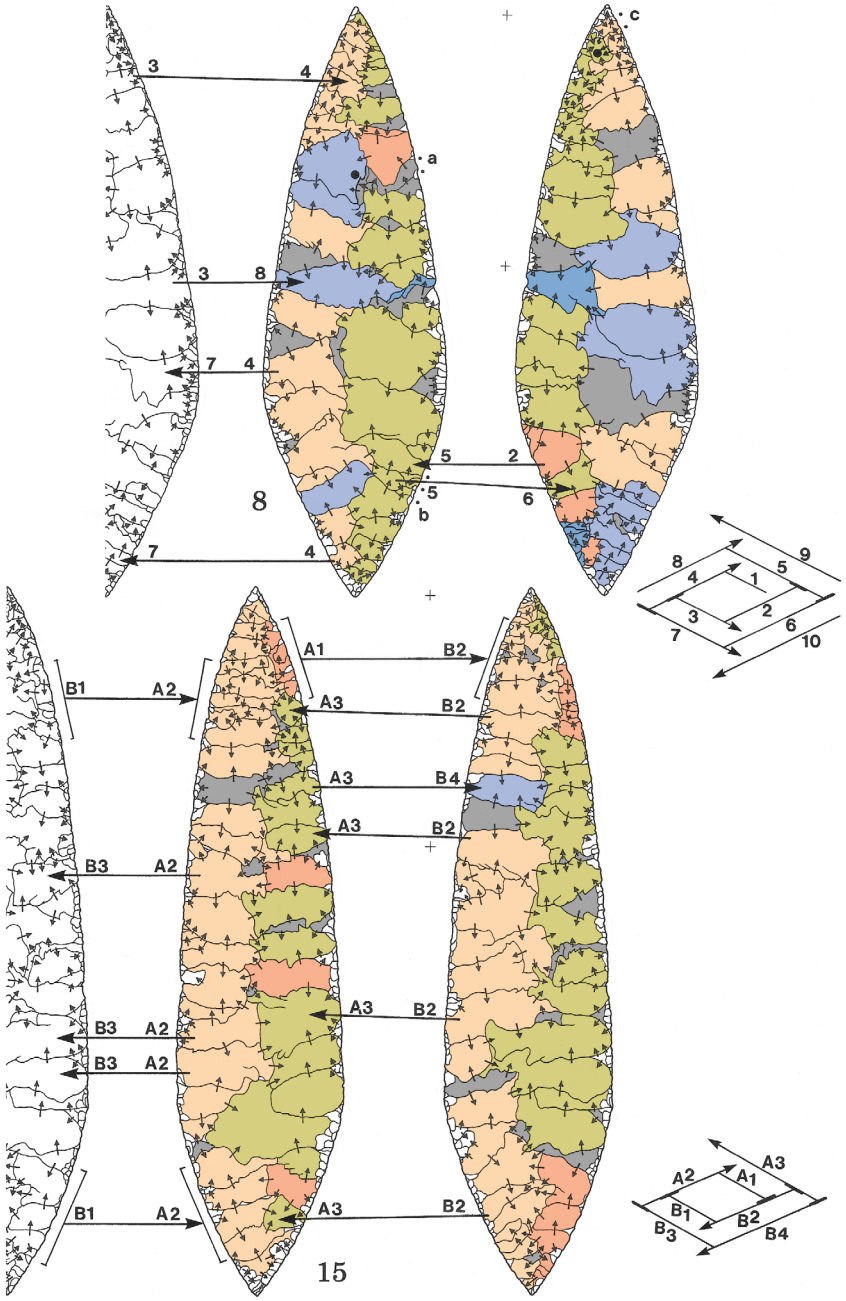


Fig. 8 – Removal groups and removal stages of Volgu 'laurel leaves' (nos. 8 and 15).

Fig. 8 – *Groupes des négatifs d'enlèvements et étapes d'enlèvement des « feuilles de laurier » de Volgu (n^os^ 8 et 15).*

leaves' belonging to procedures OB and BO (nos. 1, 2, 4, 8 and 10). Where the reconstructed cycle of the bifacial stage corresponds to multiple procedure aspects—i.e. aspect group in figure 2—or when the reconstruction of the cycle is not sufficient to determine its procedure aspect, the arrows are numbered respectively by Arabic numerals composed with large alphabetical letters A or B (face A or B). The numbers correspond to the plans and sections. Long arrows showing self-explanatory chronological contexts are mostly omitted from the plans of diagram, and the main chronological contexts valuable for reconstructing the cycle of removal stage are preferentially presented as arrows in sections. The broken arrows illustrated in sections of pieces nos. 2, 3, 5, 10 and 11 indicate the chronological contexts of removals derived from over-shot flaking.

In order to distinguish, on edges, the chronological contexts of removal groups between two faces, we came by four promising clues:

1) the first clue is a direct chronological context, where an anterior removal of a removal group on a face was used as a striking platform for producing a posterior removal of the other face's removal group. The posterior removal retains its full negative bulb and the proximal part of the anterior removal is damaged;

2) the second is an intermittent context, where a platform preparation was inserted between two flake removals on two faces—the proximal part of an anterior removal

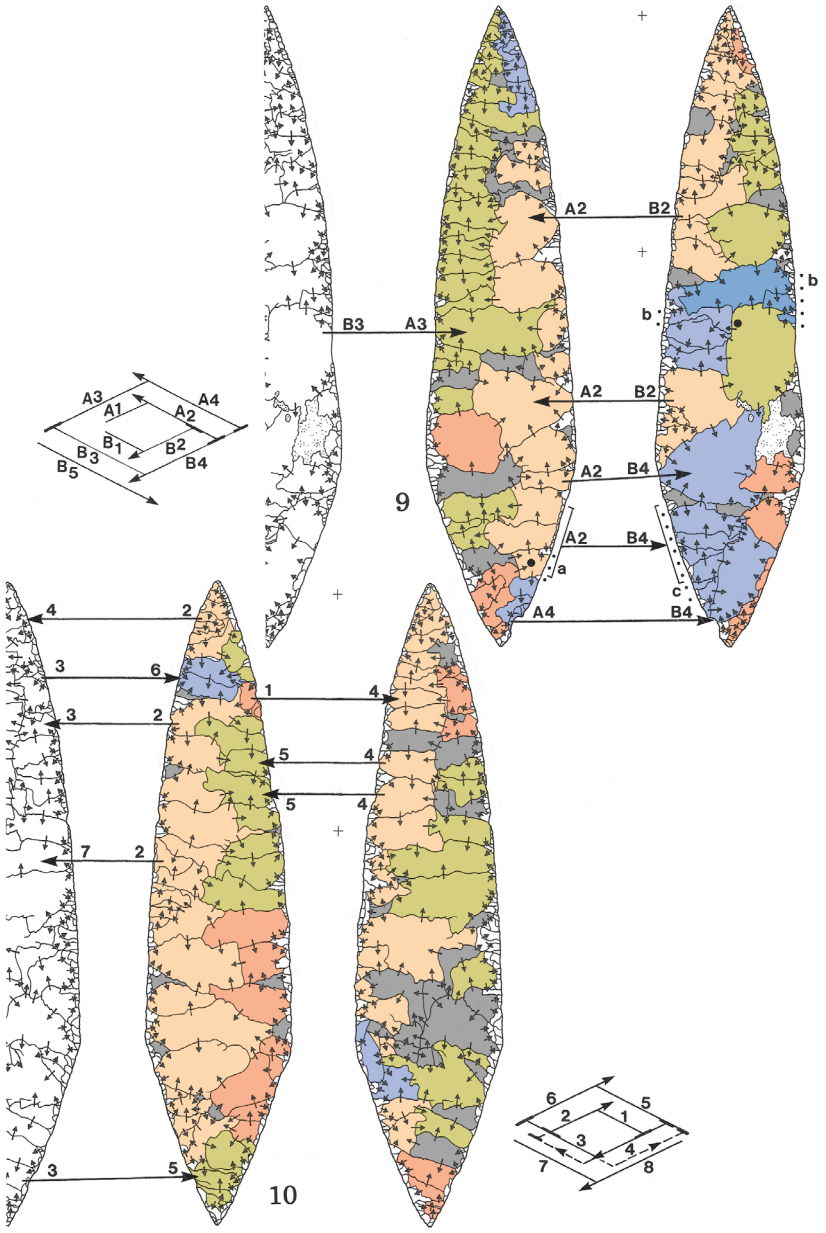


Fig. 9 – Removal groups and removal stages of Volgu 'laurel leaves' (nos. 9 and 10).

Fig. 9 – *Groupes des négatifs d'enlèvements et étapes d'enlèvement des « feuilles de laurier » de Volgu (nos 9 et 10).*

belonging to a removal group on a face—retouched and then used as a striking platform for producing a posterior removal belonging to the other face's removal group. The posterior removal retains its full negative bulb and the proximal part of the anterior removal is retouched and damaged;

3) the third is an indirectly recognizable context, where we can follow the chronological contexts of two removals of the two faces over a narrow edge covered with retouches such as platform preparations or edge regularizations posterior to these two removals. The one relatively depressed removal on a face, retaining a part of its negative bulb closer to edge, should be posterior to the other flat removal without negative bulb on the other face;

4) a fourth, rare, case occurs in order to define chronological context of two removals on two faces by over-shot removal, whose distal end on a face is anterior or posterior to the proximal end of the other removal formed on the other side of the other face.

The figures 11 to 13 present the unifacial and bifacial removal stages of Volgu 'laurel leaves' from the static viewpoint of figure 2. The piece no. 1 presented in figure 11, for example, was reconstructed pointing at the fact it must have been actually worked according to the procedure aspect BOb in figure 3. Hence, its bifacial stage 1 is located at the right side of face B, and its stage 2 is shifted to the left side of face A along position shift B.

We were not able to narrow down the procedure aspect involved in six pieces (nos. 5, 7, 11, 13, 14, 15 but no. 6 omitted) but we came to the conclusion that it must have been any one (or possibly two) of the four aspects

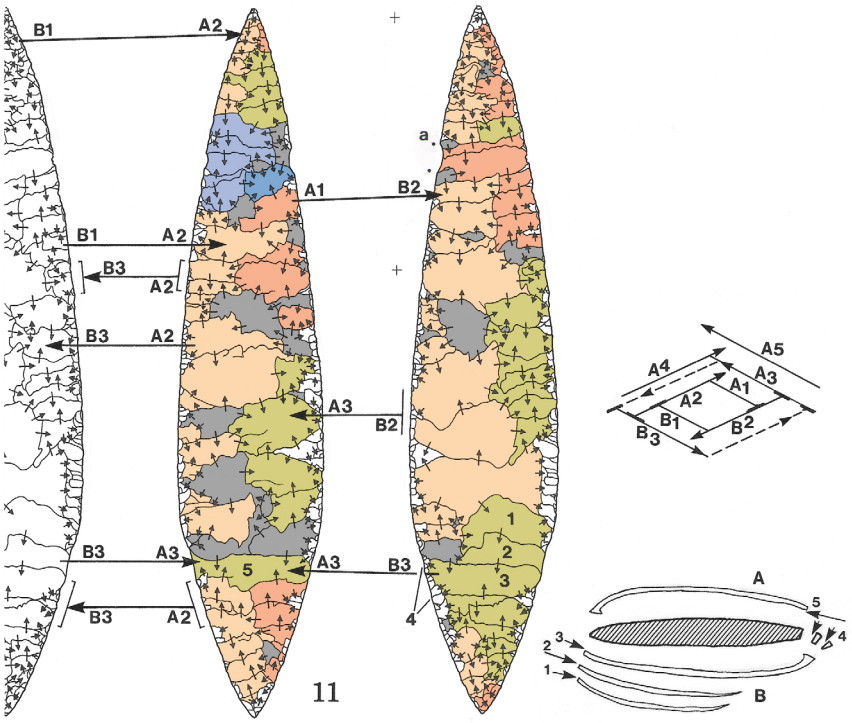


Fig. 10 – Removal groups and removal stages of Volgu 'laurel leaves' (no. 11).

Fig. 10 – *Groupes des négatifs d'enlèvements et étapes d'enlèvement des « feuilles de laurier » de Volgu (n° 11).*

Nb. of pieces	Part of corrections	From original to corrected removal stages	Grounds for correction
No. 2	a	III → I	Chronological relation with face B
	b	marginal retouch → I	Chronological relation with face B
	c	III → I	Chronological relation with face B
	d	II → IV, III →V, IV → II, V → III, VI → IV	Misread of an allow indicated by mark ●
No. 3	a	I → III	Confirmation of an allow indicated by mark ●
	b	0→ III	Confirmation of four allows indicated by mark ●
No. 7	a	0→ II, I → III, II → IV	Revision of direction of an allow indicated by mark ●
	b	I → III	Confirmation of two allows indicated by marks ●
	c	0→ II, I → III	Confirmation of an allow indicated by mark ●
	d	III → I	Chronological relation with face A
No. 8	a	I →0	Confirmation of a removal categorized as stage 0 indicated by mark ●
	b	marginal retouch → III	Chronological relation with face B
	c	IV → II	Confirmation of three allows indicated by mark ●
No. 9	a	0 → II	Misread of an allow indicated by mark ●
	b	0 → IV, III → V	Confirmation of an allow indicated by mark ●
	c	II → IV	Chronological relation with face A
No.11	a	II → 0, II → 0	Misread of two allows
No. 14	a	marginal retouch → III	Chronological relation with face B
	b	marginal retouch → I	Chronological relation with face B
	c	marginal retouch → II	Chronological relation with face A
	d	III → I	Confirmation of an allow indicated by mark ●

Table 1 – Partial revisions of unifacial removal stages of Volgu 'laurel leaves'. Unifacial removal stages presented in the previous paper (figs. 4 to 6 *in* Inada, 2014) are revised to those in this table and in figures 3 to 10.

Tabl. 1 – *Révisions partielles des étapes d'enlèvement unifaciales des « feuilles de laurier » de Volgu. Les étapes d'enlèvement unifaciales présentées dans l'article précédent (fig. 4 à 6* in *Inada, 2014) sont remplacées par celles de ce tableau et des fig. 3 à 10.*

ABa, ABb, AOa or AOb, collected in figure 12. In figure 13, three pieces (nos. 3, 9, 12) fabricated according to the other procedure aspects are presented in the same way as the figure 11, but the applicable aspects are multiple.

Procedure aspect and bifacial removal stages of each 'laurel leaf'

Up to now, we have examined, mainly as generalities or analytic principles, the chronological contexts of removal groups on the central ridges and marginal edges of the 'laurel leaves', the method of identifying working procedures and procedure aspects and the correlation between unifacial and bifacial removal stages. To conclude this chapter, we must determine clearly the working procedures and procedure aspects of each 'laurel leaf' (table 2), and the mostly regularized but occasionally irregular progressions of their bifacial removal stages. We will be also adding some additional explanations on the usefulness of overshot flake removals for defining these working procedures, procedure aspects and removal stages.

Leaf 1. The procedure aspect is flagged as BOb on the basis of the second cycle of removal stage (exterior lozenge-shaped section of fig. 3, no. 1) and because of the incomplete lozenge of the first cycle (interior lozenge in section). It seems that the removal stage advanced regularly alternating between O and B until the final eighth stage (fig. 11, no. 1).

Leaf 2. The two-hold lozenge-shaped sections, resulting from the first and second cycles of removal stages, represent the procedure aspect OBc (fig. 4, no. 2). The stage 4 located at left side of proximal end on face B is a distal end of overshot removal knapped from the right side of the same face. This overshot flake removal and the small removals of stage 3 flaked at left side preceded together the stage 6 at right side on face A. In terms of progression of the removal stages (fig. 11, no. 2), the final stage 9—i.e. termination of removal sequence—presents a variant O instead of the regular position B. However, this may have happened due to an isolated removal.

Leaf 3. The chronological contexts of removal groups on the central ridges on both faces (fig. 5, no. 3) indicate aspects b and c of procedures BO, BA and OA (fig. 2). In addition, because the stage B3 is anterior to stage A3 during the second cycle, we can assume that this piece was produced according to any one (or possibly two) of the procedure aspects BOb, BAb or OAb (table 2). A removal numbered B1 located at left side of face B (fig. 5, no. 3) is the distal end of overshot removal (broken arrow illustrated in interior lozenge-shaped section) knapped from right side, and preceded the stage A2 of opposite face. The terminations of removal sequences according to these three aspects present together irregular variants though the final removal stage 9 consist of an extensive removal group (fig. 13, no. 3).

Leaf 4. The first cycle of removal stage shows clearly aspect OBa (fig. 5, no. 4). However, the stage 6 presents a variant A (alternate) due to the omission of operation on face A of unifacial removal stage IV (fig. 11, no. 2).

Leaf 5. By reference to the first cycle of removal stage, this piece belongs to any one (or possibly two) of procedure aspects ABa, ABb, AOa and AOb. These aspects can further be narrowed down to either of ABa or AOb (table 2) because the distal end of overshot removal belonging to stage B2 is posterior to the removals of stage A2 (fig. 6, no 5). These two removal stages regularly advanced together until the final seventh stages (fig. 12, no. 5).

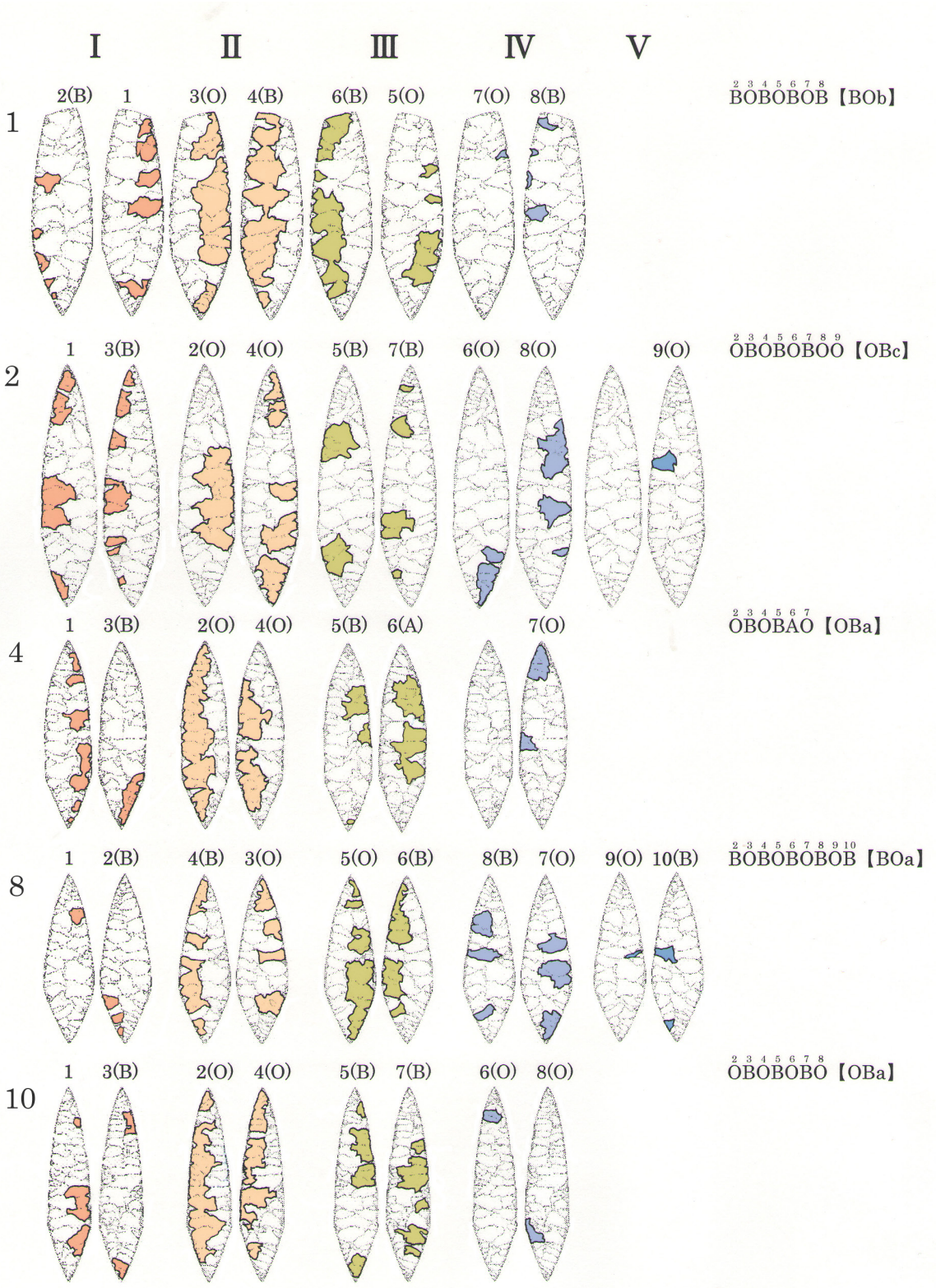
Leaf 6. The unifacial and bifacial removal stages of this piece remain undetermined, as stated above, and the division of unifacial removal stages attempted in the previous paper remains as is in figure 6, no. 6 of this paper. However, there is a good probability that the working procedure aspect of this piece belongs to any one (or possibly two) of the aspects ABa, ABb, AOa and AOb.

Leaf 7. The first cycle of removal stages shows that the procedure aspect belongs to any one of ABa, ABb, AOa or AOb (fig. 7, no. 7). The two aspects ABa and AOb present their specific regular terminations of removal stage (fig. 12, no. 7).

Leaf 8. Neither one of the first and second cycles of removal stage do not serve for defining the specific procedure aspect (fig. 8, no. 8). Assuming that these two cycles complement each other, the piece may be worked according to the aspect BOa. A regular repeat of positions B and O continued till the termination of removal stage (fig. 11, no. 8).

Leaf 9. This piece presents an exceptional case of a procedure aspect replaced by another during the progression of removal stage. Concerning the first cycle, the chronological contexts of removal groups on the left edge of face A are unknown, and so, the procedure aspect corresponds typologically to any one of aspects BOc, BAb or OAb (fig. 9, no. 9). On the other hand, the second cycle belongs clearly to aspect BOb. There are two solutions to this rare event. The first would be that the procedure BO was continued to be utilized from the beginning to the end of removal stage for finishing this piece, although the stage 5 presents an irregular variant i.e. position A (fig. 13, no. 9, top series of signs of no. 9). In accordance with this solution, the procedure aspect BOc of the first cycle should have been replaced by the aspect BOb of the second cycle. The second solution is the idea that the used working procedure itself was different between the two cycles, and so, the aspect BAb or OAb of the first cycle was changed into the aspect BOb of the second. It is necessary to further examine which one is the suitable interpretation.

Leaf 10. The first cycle of removal stage indicates the aspect OBa, that can be consistently applicable to the second cycle (fig. 9, no. 10). The stage 4 marked at right side of distal end on face B (see half face of the diagram) and the stage 5 at left side of proximal end on face A are the distal parts of removals derived from overshot flaking. A regular repeat of positions B and O continues till the termination of removal stages (fig. 11, no. 10).



Leaf 11. The first cycle of removal stage corresponds to any one of the aspects ABa, ABb, AOa or AOb (fig. 10, no. 11). The progressions of these four removal stages concluded together showing terminations of variant O (fig. 12, no. 11).

This 'laurel leaf' provides a very rare and interesting evidence based on which we can discuss about the correlations between the six regularized working procedures and the other irregular removal sequences during the fabrication of 'laurel leaves'. The evidence consists of two overshot flaking removals located at the proximal end on both faces. These removals are illustrated in a section of more pictorial diagram than the lozenge-shaped section of removal stages (fig. 10, no. 11). Numbers 1 to 5 in plan indicate a chronological context of removals and accord with those in pictorial section. The removals 1 and 2 were firstly formed by normal thinning flakes. Then, two times of overshot flaking produced the removals 3 and 5, and between these two flaking, retouches 4 were inserted and car-

Fig. 11 (left page) – Progression of unifacial and bifacial removal stages and their removal position shifts on the four sides of Volgu 'laurel leaves' (nos. 1, 2, 4, 8 and 10). Roman numerals on top row indicate unifacial removal stages. Arabian numerals and parenthesized capital letters on top of each 'laurel leaf' show, respectively, bifacial removal stages and the corresponding removal positions shifts according to the working procedure aspect reconstructed in the diagrams of figures 3 to 10. These removal stages and removal position shifts are rearranged in numeral order to the right-hand of the same row and concluded by parenthesized signs of related procedure aspect.

Fig. 11 (page de gauche) – *Déroulé des étapes d'enlèvement unifacial et bifacial ainsi que leurs changements de positions d'enlèvement sur les quatre côtés des « feuilles de laurier » de Volgu (nos. 1, 2, 4, 8 et 10). Les chiffres romains à la ligne supérieure indiquent les étapes unifaciales. Les chiffres arabes et les lettres capitales entre parenthèses en haut des pièces indiquent respectivement les étapes d'enlèvement bifaciales et leurs changements de positions (O : opposée ; B : bifaciale ; A : alterne) suivant les aspects de procédé reconstruits dans les figures 3 à 10. Ces étapes bifaciales et changements de positions sont réarrangées selon l'ordre des numéros des étapes à droite et sur la même ligne, et conclues par les signes de l'aspect concerné entre parenthèses.*

ried out on the distal end of removal 3 as platform preparation for following removal 5. Finally, the distal end of removal 5 cut slightly a proximal part of removal 2 away.

This flaking succession reminds us that not only four sides of a 'laurel leaf' can be worked by only two times of detaching flakes (even though such case seldom happened), but also that one unifacial or bifacial removal stage realized by position A (alternate position) allows to include the frequently repeated semi-rotations on the longitudinal axis of a leaf. This matter will be discussed again in the following chapter.

Leaf 12. This piece is a basal half fragment of 'laurel leaf'. The first cycle of removal stage accords with any one of the aspects ABc, ABd, AOc and AOd (fig. 3, no. 12). The aspects ABc and AOc show regular terminations of removal stage progression (fig. 13, no. 12).

Leaf 13. The piece is also small basal fragment, the first lozenge-shaped section presents any one of the aspects ABa, ABb, AOa and AOb (fig. 4, no. 13). All these aspects show regular terminations of removal stages (fig. 12, no. 13).

Leaf 14. The bifacial removal stage of this piece extents to stage 11 and its first and second cycles presents any one (or possibly two) of the aspects ABa, ABb, AOa or AOb (fig. 7, no. 14). The aspects ABb and AOa have regular terminations (fig. 12, no. 14).

Leaf 15. This piece has the same length as leaf no. 14, but the progression of its bifacial removal stage ended at stage 7, forming lozenge-shaped section corresponding with any one (or possibly two) of the aspects ABa, ABb, AOa and AOb (fig. 8, no. 15). Two aspects ABb and AOa show regular terminations although the final stage is an isolated removal (fig. 12, no. 15). The shorter series of bifacial removal stage of this piece suggests skills highly superior to those shown in leaf no. 14.

DISCUSSION

Continuous use of regularized procedures for fabricating 'laurel leaves'

We have examined the production processes of the Volgu 'laurel leaves' on the basis of the general diagram of working procedures and removal stages for fabrication of bifacial point (fig. 2). We also used other diagrams reconstructing unifacial and bifacial removal stages (fig. 3 to 10) and their progression (fig. 11 to 13). This work brought to light the fact that at least a majority of six working procedures could be used to produce 'laurel leaves', but their frequencies were concentrated on a certain number of procedure aspects (table 2). Eight of fifteen pieces were produced according to procedures AB or AO and seven of those eight pieces belong to any one (or possibly two) of the aspects ABa, ABb, AOa or AOb. The procedures AB and AO include two time of position A in a cycle of bifacial removal stage. It seems probable that the preferential use of position A resulted in a dominance of procedures AB and AO. Contrary to this tendency, there are evidences that not only the procedures BA and OA including one time of position A in a cycle were used for producing only two pieces, but also that five pieces were worked according to the procedures OB and BO never including position A. On balance, we can say that it is incorrect to presume that frequent use of position shift A alone should have resulted in large symmetrical 'laurel leaves'. If so, what have let Solutrean knappers produce them?

Concerning procedures OB and BO, we are able to distinguish respectively their four separate aspects, and so to know precisely on which side of piece the first or final removal stage have been performed. The piece no. 2 is a good example that total reconstruction of all stages of finishing process was achieved on the basis of chronological contexts observed both on ridges and edges (fig. 4, no. 2). This piece was fabricated according to procedure aspect OBc, showing a regular repetition of procedure OB during two cycles of removal stage (fig. 11, no. 2). The piece no. 8 presents also an exact repeat of procedure OB till the final stage (fig. 8, no. 8).

Contrary to these solider bases supporting the repeated use of regularized procedures, the only one piece to be made according to different procedure aspects between first and second cycles of removal stages is the leaf no. 9, as stated above. Its rarity may suggest rather an importance of continuous use of regularized procedure aspect than an emphasis on arbitrary use of different procedure aspects.

Irregular terminations of a final removal stage are widely observed no matter what procedure aspect may be. Three (nos. 1, 8 and 10) of the five pieces belonging to procedure OB and BO show regular terminations,

I		II		III		IV		V		VI		
1	2(A)	3(B)	4(A)	5(B)	6(A)	7(B)	8(A)	9(B)	10(A)	11(B)	12(A)	【ABa】
2(A)	1	4(A)	3(B)	6(A)	5(B)	8(A)	7(B)	10(A)	9(B)	12(A)	11(B)	【ABb】
1	2(A)	4(A)	3(O)	5(O)	6(A)	8(A)	7(O)	9(O)	10(A)	12(A)	11(O)	【AOa】
2(A)	1	3(O)	4(A)	6(A)	5(O)	7(O)	8(A)	10(A)	9(O)	11(O)	12(A)	【AOb】

$^{2\,3\,4\,5\,6\,7}$ABABAB【ABa】, $^{2\,3\,4\,5\,6\,7}$AOAOAO【AOb】

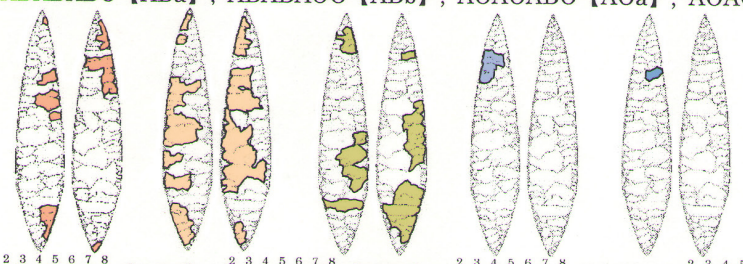
5

$^{2\,3\,4\,5\,6\,7}$ABABAB【ABa】, $^{2\,3\,4\,5\,6\,7}$ABABAO【ABb】, $^{2\,3\,4\,5\,6\,7}$AOAOAB【AOa】, $^{2\,3\,4\,5\,6\,7}$AOAOAO【AOb】

7

$^{2\,3\,4\,5\,6\,7\,8}$ABABABO【ABa】, $^{2\,3\,4\,5\,6\,7\,8}$ABABAOO【ABb】, $^{2\,3\,4\,5\,6\,7\,8}$AOAOABO【AOa】, $^{2\,3\,4\,5\,6\,7\,8}$AOAOAOO【AOb】

11

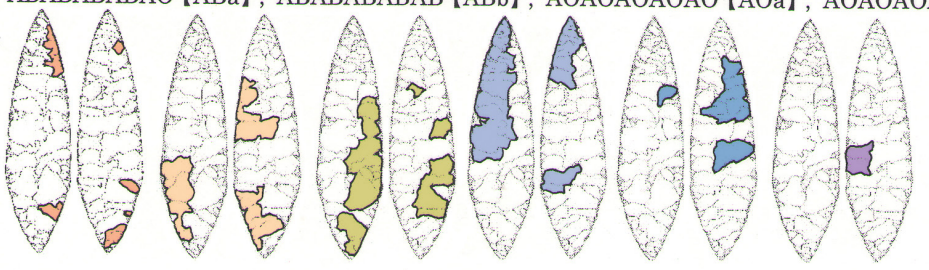


$^{2\,3\,4\,5\,6\,7\,8}$ABABABA【ABa】, $^{2\,3\,4\,5\,6\,7\,8}$ABABABA【ABb】, $^{2\,3\,4\,5\,6\,7\,8}$AOAOAOA【AOa】, $^{2\,3\,4\,5\,6\,7\,8}$AOAOAOA【AOb】

13

$^{2\,3\,4\,5\,6\,7\,8\,9\,10\,11}$ABABABABAO【ABa】, $^{2\,3\,4\,5\,6\,7\,8\,9\,10\,11}$ABABABABAB【ABb】, $^{2\,3\,4\,5\,6\,7\,8\,9\,10\,11}$AOAOAOAOAO【AOa】, $^{2\,3\,4\,5\,6\,7\,8\,9\,10\,11}$AOAOAOAOAB【AOb】

14



$^{2\,3\,4\,5\,6\,7}$ABABAO【ABa】, $^{2\,3\,4\,5\,6\,7}$ABABAB【ABb】, $^{2\,3\,4\,5\,6\,7}$AOAOAO【AOa】, $^{2\,3\,4\,5\,6\,7}$AOAOAB【AOb】

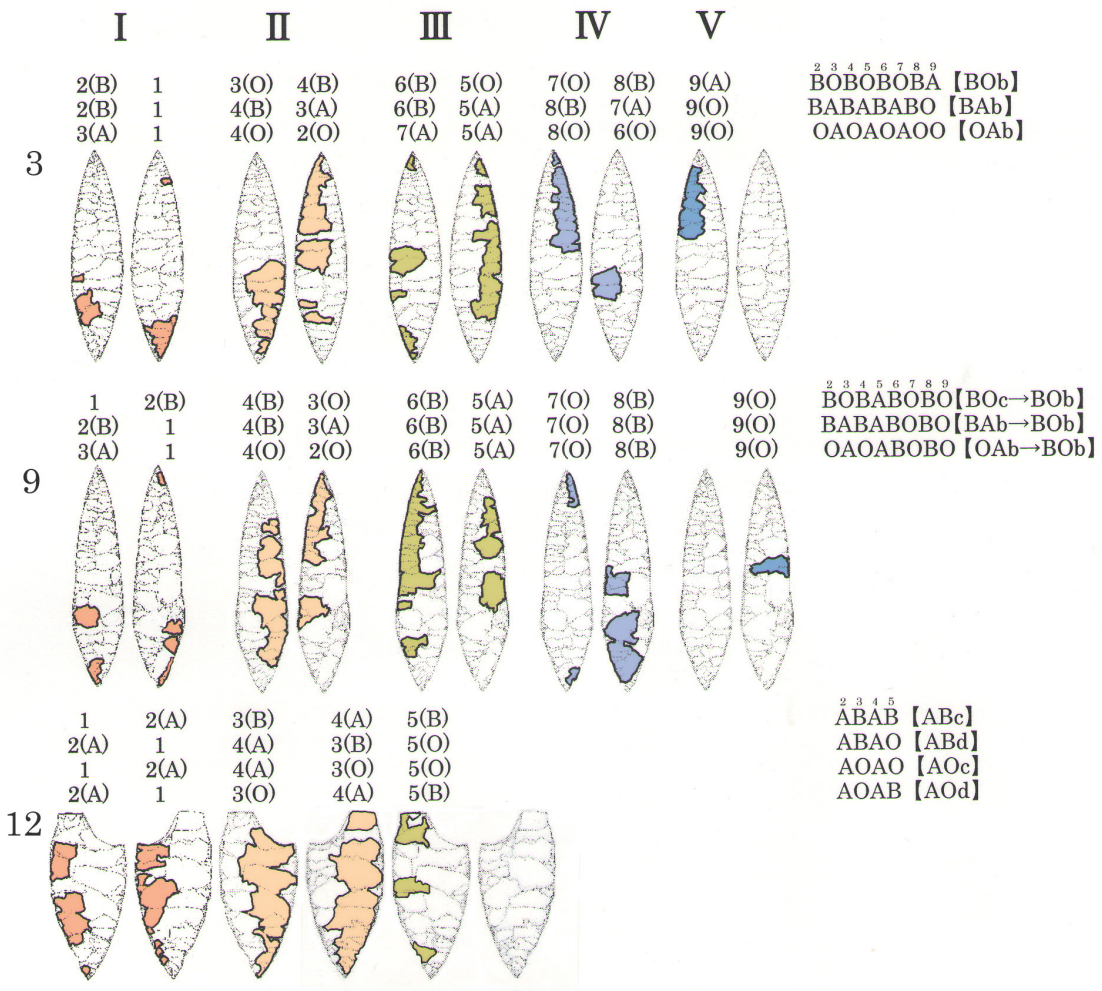
15

Fig. 12 (left page) – Progression of unifacial and bifacial removal stages and their removal position shifts on the four sides of Volgu 'laurel leaves' (nos. 5, 7, 11, 13, 14 and 15). These are not defined by a unique procedure aspect but can be narrowed down to any one (or possibly two) of four aspects ABa, ABb, AOa and AOb. The correlations between bifacial removal stages and their position shifts according to these four aspects are presented as a norm on the top of the diagram, and specific removal progressions of each piece according to two to four possible procedure aspects are mentioned just above the 'laurel leaves'.

Fig. 12 (page de gauche) – *Déroulé des étapes d'enlèvement unifacial et bifacial ainsi que leurs changements de positions d'enlèvement sur les quatre côtés des « feuilles de laurier » de Volgu (nos 5, 7, 11, 13, 14 et 15). Ces pièces ne peuvent faire l'objet d'une définition selon un seul et unique aspect. Elles ont toutefois, pu être restreintes à un (ou éventuellement deux) des aspects de procédé de façonnage ABa, ABb, AOa et AOb. Les corrélations entre les étapes d'enlèvement bifaciales et les changements de position suivant ces quatre aspects sont présentées cmme un standard aux lignes supérieures. Les progrès des étapes d'enlèvement de chaque pointe suivant les deux ou quatre aspects possibles sont notés en haut de cette pièce.*

Fig. 13 (below) – Progression of unifacial and bifacial removal stages and their removal position shifts on the four sides of Volgu 'laurel leaves' (nos. 3, 9 and 12). This diagram is presented in the same way as the figure 11, but the applicable aspects are multiple.

Fig. 13 (ci-dessous) – *Déroulé des étapes d'enlèvement unifacial et bifacial ainsi que leurs changements de positions d'enlèvement sur les quatre côtés des« feuilles de laurier » de Volgu (n^{os} 3, 9 et 12). Ce schéma est présenté de la même manière que la figure 11, mais les aspects possibles sont multiples.*



and the others (nos. 2 and 4) irregular ones. Pieces of the other procedures seem to present the same tendency. The irregular terminations are concerned, for the most part, with one or a few isolated removal(s) except for more extensive removal groups such as pieces nos. 3 and 4. Anyway, it is possible to consider that these irregular terminations of removal stage have resulted from one or a few complementary removals, eventual error removals, error correction removals and provisional needs of shaping or thinning on the extensive removal groups (Inada, 2014, p. 448). These facts also, on the contrary, shed a spotlight on the importance of continuous repetitions of regularized procedure aspects before the final removal stages.

	a	b	c	d
OB	4, 10		2	
AB	6, 7, 11, 13, 14, 15 (ABa, ABb, AOa or AOb),		12 (ABc, ABd, AOc or AOd)	
AO	5 (ABa or AOb)			
BO	8	1		
BA		3 (BOb, BAb or OAb),		
OA		9 (from BAb, OAb or BOc to BOb)		

Table 2 – Identification of Volgu ‘laurel leaves’ (nos. 1 to 15) with working procedure aspects. Alphabetical capitals, small letters and checkered framework are referred to fig. 2

Tabl. 2 – *Identification des « feuilles de laurier » de Volgu (nos 1 à 15) avec les aspects des procédés de façonnage. Les lettres majuscules et minuscules alphabétiques et le cadre de grille renvoient à la fig. 2.*

The most remarkable fact obtained from the analysis of the Volgu ‘laurel leaves’ in this paper is the solid tendency consisting in each of the pieces being made according to a regularized procedure aspect from the first stage to nearly final stage, as far as observed on two faces and marginal edges of the pieces. Consequently, we can say that the continuous use of regularized working procedures should be a true reason, or at least, one of the reasons why and how the symmetry in outline and section observed on the Volgu ‘laurel leaves’ was produced. It is also probable that this tendency could bring about two apparent incidents of removal groups: a near resemblance of the location and extent of removal groups at unifacial removal stage II between two faces (nos. 10, 11 and 15); certain similarities of the mutually complementary extent of removal groups at stages I and III between two faces (nos. 2, 14 and 15; Inada, 2014, p. 447). The symmetrical outline of ‘laurel leaves’ may be considered as effects originated rather from the creative potential of regularized working procedure itself than from imitating some natural symmetrical forms like foliate shapes.

It is probable that the continuous use of regularized working procedures was related to a need for fixing operational sides in a certain position convenient for knappers. The work for holding the leaves and rotating them for changing operational sides during fabrication would be generally attributed to the role of knapper’s opposite hand. The previous experimental studies told us a great deal about the importance of handedness for striking, thinning, shaping and retouching, but little about the opposite hand. T. Aubry put, for example, emphasis on how to maintain pieces for avoiding propagation of parasite vibrations at the moment of percussions (Aubry et al., 2007, p. 42).

In addition to this hand’s rather subsidiary contribution, we have to take notice of the crucial role the opposite hand has assumed in fabricating ‘laurel leaves’. It is not knapper’s handedness, but opposite hand of handedness that led and controlled all stages of working process of the ‘laurel leaves’, indicating following operational side to be flaked by rotating the piece on its longitudinal or transversal axis or on its facial center, and allotting a roughly equal quantity of work to each of four sides and more work to unifacial stages II and III than to later stages. In minor cases where knapping skills of the handedness cannot cooperate well with leading motions of the opposite hand, operations affecting more extensive removal groups would be continued to the unifacial stage IV and later (nos. 3, 9 and 14). Even though all the knappers who worked Volgu pieces were skillful in lithic tool making, differences in virtuosity between the two hands might have resulted in slight variations in knapping ability such as the case of the knappers of pieces no. 14 and no. 15 (Inada, 2014, p. 448), apart from the other conditions like quality of raw material.

So far, we have discussed about the working procedures and procedure aspects used for producing ‘laurel leaves’ and identified specific procedure aspect(s) to each piece (table 2). This argument, however, rest on the condition that the finishing phase of a ‘laurel leaf’ production was clearly divided from its earlier phase—i.e. preform production process—which might be carried out at different sites, and the beginning of the finishing phase corresponding with the first bifacial removal stage of each finished piece. Indeed, T. Aubry pointed out many times the preforms of ‘laurel leaves’ exported from the atelier site for finishing elsewhere (Aubry et al., 2007, p. 42; 2008, p. 50 and 2009, p. 54). This recent leading tendency in Solutrean research may add probability to the coincidence between the beginning of finishing phase of ‘laurel leaf’ production and the first bifacial removal stage of each finished piece of Volgu.

We can presume, at the same time, another situation with no distinction between preform production phase and finishing phase, or inter-sites discontinuity of these two phases. In this case, the removal groups observed on the finished pieces should have covered the other removal groups produced in a series of reduction sequence and anterior to the existing first bifacial removal stage. As a result, the identified procedure aspects of the pieces in table 2 may be changed to the other aspects, because the

beginning side of the existing bifacial removal stages may be changed to the other sides.

Considering the latter case, the continuous use of the regularized working procedures remains, for the meantime, should remain interpreted as a general tendency for making 'laurel leaves'. It goes without saying that the essential characteristics of regularized working procedures do not change, no matter the aspect. However, we cannot know, by the sole observations of finished pieces, which of these two cases—finishing phase alone or all phases of production—corresponds with the 'laurel leaves' from Volgu. To actually ascertain whether these two phases of production used to be separated or not, it should be essential to promote closer collaborations among researches into refitted pieces, experimental replications and chronological analysis of removal groups on finished objects.

Comparison of the results between chronological analysis of removal groups and experimental replications

Researches into refitted pieces and experimental replications yielded the most reliable and promising clues for the study on Solutrean 'laurel leaves' production. New results keep emerging since the beginning of this century (Aubry et al., 1998, 2003, 2007, 2008 and 2009; Bradley, 2013; Pelegrin, 2007 and 2013).

Experimental replications undertaken by B. Bradley are especially interesting (Bradley, 2013) because they enable us to build comparisons with the chronological analysis of removal groups described above. The production of the 'laurel leaf' point 'replica 018' was achieved with a large transversal flake as a blank, and adjusting the position of striking platform and bulb on the ventral surface of a blank to the left side of the finished 'laurel leaf'. According to the diagram in figure 14 (fig. 14 cited from fig. 13 in Bradley, 2013), the sum of ninety-nine flaking motions (at the exclusion of non-thinning flakes) was divided into nineteen phases by the shifts of operational sides. This very term of 'phase' is closer to the concept of bifacial removal stage in my paper. The working phases and flaking occurrences of each side are as follow: twenty-four flaking motions divided into five phases located on *left* side of dorsal face of the blank (this *left* side indicates the same side as the *left* side of ventral face in his paper and as the right side of face B in my paper. In the case of citing his terms *'left'* and *'right'*, letters are italicized); sixteen flaking motions divided into four phases on *right* side of dorsal face; seventeen flaking motions divided into four phases on *right* side of ventral face (this *right* side means right side of face A in my paper); forty-two flaking motions divided into six phases on *left* side of ventral face.

The sum of sixty-six flaking motions belonging to eleven phases located on *left* side dominates evidently the sum of thirty-three flaking motions belonging to eight phases located on *right* side. This clear contrast between two sides was explained by the fact that it derived from a remarkable thickness of *left* side of the original blank, and indirectly, from author's intention of fabricating replica 018 according to the asymmetrical reduction sequences similar to those attested firstly at the Maîtreaux site in France (Aubry et al., 1998), which are certainly different from "the standard symmetrical approach where the biface plane is in the centre of the nodule" (Aubry et al., 2008, p. 57) such as Volgu 'laurel leaves'.

According to the same way of expression as figures 11 to 13 in my paper, the progression of bifacial removal stages and the removal position shifts of replica 018 can be expressed as follows:

2	3	4	5	6	7	8	9	10	
B	A	A	A	O	B	A	O	A	(first cycle)

11	12	13	14	15	16	17	18	19	
O	O	A	B	O	A	A	O	A	(second cycle)

The sum of nineteen phases is divided only into two cycles of four sides operations (two cycles of bifacial removal stages in my way of expression) by the tenth and

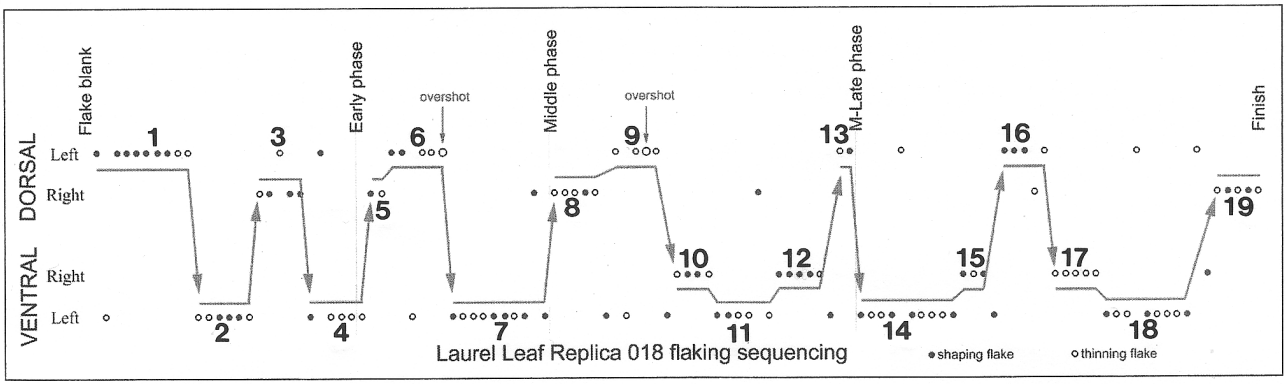


Fig. 14 – Production sequence of replica 'laurel leaf' 018 (diagram cited from fig. 13 in Bradley, 2013). Phase numbers are added by the quoter.

Fig. 14 – *Séquence de production d'une « feuille de laurier » de réplique 018 (fig. 13, in Bradley, 2013). Les numéros des étapes des groups d'enlèvement sont ajoutés par nos soins.*

nineteenth removal shifts. This series of position shifts quite differs from that of Volgu pieces: firstly, there is no continuous use of regularized working procedure; then, each of the two cycles includes many phases i.e. many times of position shifts. To what extent can we say that these two characteristics of replica 018 came from the use of an asymmetrical reduction sequence? What phase of replica 018 does correspond to the beginning of a removal stages' series on a Volgu leaf? To solve these questions, we could compare the reconstruction diagram of unifacial and bifacial removal stages of finished replica 018 with those of Volgu 'laurel leaves' (figs. 3 to 10). Let's leave this problem for future observation. The most important matter for technologically comparative studies among finished 'laurel leaves', refitted pieces and experimental replicas would lie in preparing as common basis the reconstruction diagrams of unifacial and bifacial removal stages.

In relation to the results of experimental research, let us carry on furthermore toward derivative but interesting two subjects: position shift A (alternate) and overshot flaking. In fabrication of the replica 018, nine iterations of position A dominate six iterations of position O (opposite) and three of position B (bifacial). This tendency of position A corresponds, to a certain extent, with numerical dominance of working procedures AB and AO in Volgu pieces. On the other hand, it is essential to take notice that the consecutively three times repeated position A of phase 3, 4 and 5 of replica 018 may be as well interpreted as a doubled position shift A on the finished replica for the following reason.

In a bifacial point fabrication, one unifacial or bifacial removal stage can include multiple repeats of position A. Indeed, two removals or removal groups located at alternate position on two faces can be produced without overlapping together both on central ridges and marginal edges of a point, in different expressions, both on distal and proximal ends of removals themselves. The shift of position A means a semi-rotation (at a 180 degrees angle) on the longitudinal axis (i.e. along the transversal axis) of the 'laurel leaf". The repetition of position shifts A can be realized easily on knapper's opposite hand and seems effective to a certain extent to form the symmetrical outline of the pieces. The case of the piece no. 11 of Volgu does not prove directly this kind of repeated position shift but gives us some hints.

The concept of unifacial or bifacial removal stages described in this paper rests on the analysis of removals left as traces of knapping operations on the faces and edges of 'laurel leaves'. For this reason, we have to sufficiently pay attention to the existence of invisible or hidden removal stages, using the results of refitted pieces researches and experimental replications as a reference.

Analog and digital removal stages

What can be observed on the surfaces of the finished 'laurel leaves' is, mainly, larger removal groups and some complementary removals, and partially or completely hidden earlier removals and removal groups. If some of the removal groups have disappeared, why then could regularized working procedures and well-ordered bifacial removal stages be reconstructed in Volgu pieces? Such regularized characteristics of reduction sequence are neither exceptional nor accidental, but extremely common among these pieces. The meaning of this two rather paradoxical facts that consist of regularized working procedures on the one hand, and of possible existence of invisible or hidden removal stages on the other hand, must be addressed.

All large and small removals observed on the both faces of 'laurel leaves' were produced by detaching flakes from both edges. On the marginal edges of the pieces, there are different types of removals such as normal thinning removals, platform preparations for normal removals, eventual error removals and error correction removals, and other removals provisionally needed for retouching. However, we cannot say that all these removal operations constituted an equal contribution to the completion of 'laurel leaves'. The operations forming larger removal groups dominate effectively over the length, width and thickness of the resulting pieces, though the platform preparations served to only arrange the knapping conditions for following main percussions, and the provisional flaking complements partially the previous removal operations.

After all, we come to the conclusion that there are two kinds of removals or removal groups realized according to two types of reduction sequences. The first produces all kinds of removal observed on marginal edges of a piece, including existing or hidden removal groups, provisional or complementary removals and platform preparations. This can be called 'analog' reduction sequence in terms of continuous range of real number, according to which Solutrean knappers actually carried out tool making. It is difficult and useless for us, however, to account one by one the retouching occurrences of platform preparation, and so, virtually more useful to examine the analog reduction sequence without platform preparations and non-thinning removals, such as the experimental research B. Bradley has undertaken (fig. 14).

The second type of reduction sequence to be recognized, using the chronological context of normal removals, or removal groups mainly on central ridges and slightly on marginal edges, shows the continuous use of regularized working procedures such as the Volgu leaves'. This type can be named 'digital' reduction sequence in terms of discontinuous range of integer number. It renders a real image of the production process of the Volgu 'laurel leaves', in which the digital reduction sequence acted as a basic framework for the process, where the other visible or hidden removals and provisional or erred removals consisting of a part of analog reduction sequence were added.

We can assume that knappers who made Volgu pieces would have understood the effectiveness of the digital reduction sequence probably, both in his knowledge and in his hand skills, and got their handedness to proceed the force-demanding analog reductions, engaging their opposite hand in role of rational controls of the digital

reduction sequence. This analog reduction sequence may correspond more or less with the "chaînes opératroires machinales" (Leroi-Gourhan, 1965, p. 27) and the digital reduction sequence with "pratiques opératoires lucides" (p. 27) or "chaînes opératoires périodiques ou exceptionnelles" (p. 32).

According to a saying of A. Leroi-Gourhan's, "les opérations périodiques, surtout à longue échéance, dépassent la fixation machinale et constituent l'un des traits qui séparent le plus radicalement la société humaine de tout le reste du monde zoologique" (p. 32). The anthropogenic periodic operation would be proved by its endurance through not only long-term life, but also relatively short-term complicated activities like 'laurel leaf' productions, where many irregular events and conditions may hinder periodic operation from working. The analog reduction sequence as 'mechanic operational sequence' should have advanced along the frequently irregular removals due to the partially bad quality of raw materials, troubles with the lithic or organic hammer and suchlike inconvenient conditions. Contrary to this or owing to this, the digital reduction sequence as 'periodic or exceptional operation sequence' has realized the symmetrical and thin enough masterpieces of the Solutrean culture, surpassing these irregular removals and retaining the regular reductions procedure. It may be supposed that the analog reduction sequence dominated relatively in earlier production phases influenced heavily from natural form of raw material such as nodules or angular pieces and from flaked blank shapes. Then, the digital reduction sequence played the leading role gradually toward final production phases. Anyway, we can find the human potential for an enhancement materializing itself in the digital reduction sequence and the resulting symmetrical shape of Volgu 'laurel leaves', overcoming different human or natural accidents.

Leroi-Gourhan suggested also that the 'periodic or exceptional operational sequences' could be reflected more easily in social organisms (Leroi-Gourhan, 1965, p. 34). It seems reasonable to think that more abstract concept such as periodic operational sequence, language and memory are closely related to social organisms. What were the relationships between the regularized working procedures or procedure aspects and Solutrean social groups? It is a question that should be addressed in the future, on the basis of comparative studies among the refitted pieces researches, experimental replications and analysis of removal groups of finished objects, and furthermore, widening our horizon over different archaeological evidences and environmental factors.

CONCLUSION

We took notice of the relationship between four operational sides of a bifacial piece and three types of removal position shifts (alternate position shift: abbreviated code A, bifacial position: code B and opposite position: code O). These two factors and their relationships were amplified in a general diagram arranging theoretically twenty-four working procedure aspects, that are composed of six working procedures (OB, AB, AO, BO, BA and OA) in a left side line and four aspects (a, b, c and d: difference of starting operational side) in a top row (fig. 2). Then, we attempted to determine the specific working procedure aspect of every Volgu piece (table 2) judging from its chronological contexts of removal groups both on ridges and edges (fig. 3 to 10), and from its typological correspondence with that of the general diagram (fig. 2). All the procedure aspects of five pieces belonging to the procedures OB and BO could be respectively distinguished.

Using these five aspects as a reference, we can say that the production of each 'laurel leaf' progressed along the bifacial removal stages according to the continuous repetition of its specific regularized working procedure aspect (fig. 11). Other pieces belonging to any one of two to four working procedure aspects may be assumed to have been produced in the same systematic way as the five pieces (figs. 12 and 13). The continuous use of regularized working procedures can be considered as a general tendency in the production of Volgu pieces, whereas there was the only one case of the piece nos. 9 to be produced according to different procedure aspects between first and second cycles of bifacial removal stages. This general tendency alone should be a basic reason, or at least one of the most reliable reasons why and how the symmetry in profile and section of Volgu 'laurel leaves' have been realized.

In the case of a knapper's fixed posture during knapping, it is his opposite hand that assumed the work of changing operational sides by rotating the piece for completion of its four side operations. We should put more emphasis on the role of the opposite hand of handedness that led the rhythm of 'laurel leaves' production, controlling the progress of the bifacial removal stages according to the regularized working procedure.

Working procedures and their bifacial removal stages observed on Volgu pieces were compared with those of a 'laurel leaf' replica reported by B. Bradley. It seems logical to conclude that the bifacial removal stages were quite different between these two because the replication aimed at the reconstruction of the asymmetrical reduction sequence opposite to the symmetrical reduction sequence of Volgu pieces. However, we gained useful hints from this difference—and some overshot removals observed on a piece of Volgu (no. 11)—, about the double progressions of the 'analog' and 'digital' reduction sequences during bifacial point production. Analog reduction sequence consists in all kinds of removals observed on marginal edges of a piece, including visible or hidden removals, provisional or complementary removals and even platform preparations, and so, it shows more or less irregular sequence contrary to the digital reduction sequence such as regularized working procedure of Volgu, probably controlled by knapper's opposite hand of handedness.

How did these double progressions of the analog and digital reduction sequences actually proceeded during all stages of symmetrical biface production? Can we observe any digital reduction sequence during asymmetrical biface production? Analysis of finished objects alone is not sufficient to solve these questions. From now on, we will have to promote comparative studies among analysis of finished objects, researches into refitted pieces and experimental replications.

The proposed general diagram concerning working procedures and bifacial removal stages (fig. 2) would serve those studies as a common basis, and can be understood from both static and dynamic viewpoints. The latter viewpoint was not yet fully discussed in this paper, but should widely develop in comparative studies.

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NOTES

(1) Despite their different cultural contexts from the Solutrean industies, it is useful for us to know the results of experimental replications conducted on the various bifacial points of the Paleo-Indian culture and Archaic culture in the New World (Callahan, 1979; Flenniken, 1985; Hester, 1985; Pavesic, 1985; Shafer, 1985; Tindale, 1985; Young and Bonnichsen, 1985; Bradley, 1993; Whittaker, 1994; Alejandro and Hirth, 2003; Hirth et al., 2003). E. Callahan explained, for example, the basics of biface production following the nine stages from phase of obtaining blanks to phase of final retouching. M. Pavesic's analysis of the large bifacial points called 'turkey-tail' and cahe blade are especially valuable to compare the reduction sequences of bifacial point between the Old and New Worlds. However, Callahan's manufacture stages distinguished on a replica (Callahan, 1979, p. 138) and Pavesic's reduction sequence analyzed on an archeological specimen (Pavesic, 1985, p. 71) are not 'bifacial removal stages' that this paper aims to pursue, but remain related to 'unifacial removal stages' that my previous paper has argued.

(2) There would be other ways, in the general diagram, of combining the six procedures and four aspects. Indeed, we could illustrate directly, instead of the four aspects stated above, a range of posture changes of each 'laurel leaf' turning from obverse to reverse, or from distal end on top to that on bottom according to its respective working procedure. After all our trial and error process, we reached to the solution represented by the diagram in figure 2, which is especially valuable to allow us to look at the six working procedures from both the static and the dynamic viewpoints at the same time, as well as to compare their various and distinctive progress of removal stages on the basis of a standardized condition like four aspects. Parenthetically we may add that it is useful that each procedure aspect group congregates respectively in one section of this diagram.

(3) These modifications are indicated, in the figures 3 to 10, by dotted lines with alphabetical small letters, and ● emphasize on the arrows that were subject of revision on the diagram of removal groups. Furthermore, relatively more important alterations on their removal stages were made to two 'laurel leaves' (nos. 2 and 9), and the removal stages of leaf no. 6 are yet to be defined, and will be subject for further investigations. We also added several arrows in order to better materialize the chronological context of the removals. Though far from being a definitive take on the chronological contexts of removals or removal groups, and the removal stages, the diagrams embodies the most up to date vision of these aspects one can have on the 'laurel leaves' from Volgu.
The revisions of our take on the removal stages were brought about by some uncovered errors as well as new data.
– 1) The reconstructions of removal stages were influenced by the wrong chronological contexts of removal groups contrary to the direction of illustrated arrows. Misreading the direction of an arrow caused relatively broad extent of modification on the upper part of face B of no. 2 (fig. 4, d of no. 2), and its removal stage VI was canceled. The same problem resulted in limited modifications on the face A of no. 9 (fig. 9, a of no. 9) and on the face B of no. 11 (fig. 10, a of no. 11). In order to prevent this sort of errors, synthetized in one both the chronological diagrams with arrows and the diacritical diagrams of removal stages (figs. 3 to 10).
– 2) Wrong direction was applied on an arrow in the previous paper, accordingly reversing the chronological context. This case affected only one revision on face A of apical end of no. 7 (fig. 7, a of no. 7) and its related arrow is marked by sign ●.
– 3) New data lead us to revise our take on the removal stages, conducing us to add new arrows, and resulting in revisions on five 'laurel leaves' (nos. 3, 7, 8, 9 and 14). An new arrow on the medial part of face B of no. 9 compelled us to replace former stage 0 with new stage IV and a part of former stage III with new stage V (fig. 9, b of no. 9).
– 4) The removal stages were revised through a new formulation of their chronological context on edges and their relation on both faces, resulting in nine modifications of our readings concerning five 'laurel leaves' (nos. 2, 7, 8, 9 and 14). In the previous paper, the distinction of unifacial removal stages was based on two postulates that a series of removals with arrows in the same direction are a) brought together in a removal group i.e. removal stage, and are b) classed as earlier stage as possible (Inada, 2014, p. 444). To this definition, we must now add a condition to these terms: that the removal stages on a face (i.e. unifacial removal stages) do not contradict those through two faces (i.e. bifacial removal stages).
In the case of leaf no. 2, a removal group on the left side of the upper part of face A (fig. 4, a of no. 2), formerly classified as an unifacial stage III, is now identified as stage I because of its anteriority on an unifacial stage II of face B. Similar recognition caused another revision of stage III to I of a removal group at left side of lower part of face A (fig. 4, c of no. 2). The size of each removal of these groups changed to new stage I tends to be significantly smaller than that of their neighboring groups left as stage III. These clear, observational facts justify these revisions.

The unifacial stage IV at lower part of face B of no. 9 (fig. 9, c of no. 9) is modified from the former stage II in order to avoid a contradiction between the two clear chronological contexts observed at medial part between stages II of face A and B. The distinction of removal stages of no. 6 remains, unfortunately, undetermined because we could not confirm two chronological contexts of the removals located at the upper and lower parts of face B (fig. 6, a and b of no. 6). Therefore, the division of its removal stages remains, for the time being, the same as is in the previous paper, and we will rightfully persist in not using this unifacial removal stages as a basis for reconstructing its bifacial removal stage in relation to both faces.

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