Blade and Levallois technology in western Australian prehistory

by Charles Dortch, Perth and François Bordes, Bordeaux

The western australian stone industrial sequence, as shown by recent discoveries, can be separated into an earlier and a later phase, resulting from the introduction of a whole series of stone working techniques and tool forms. This transition, which occurred between three and about six thousand years ago, according to radiocarbon dates for regional sequences (Dortch, in press), is parallel to the stone industrial sequence in the eastern half of mainland Australia, where the earlier industrial complex is replaced by more technologically evolved industries as early as five to six thousand years ago (Jones, 1973; Lampert, 1971; Mulvaney, 1969, 1975).

In western Australia, the more recent industrial phase comprises two major regional complexes defined by the differences in flaked stone tools (Dortch, in press). The first of these, with an important component of unifacially or bifacially flaked points, is in the Kimberley district in the tropical north, and extends east and south into Arnhem Land and the northern desert regions (fig. 1). The second regional complex, with several local variants, extends over the whole of the southern two thirds of western Australia. It is notable for geometric microliths and microlithic backed points.

There is some overlapping in the distribution of the key tool types which characterise these two complexes. Unifacially flaked points extend to the southern coast of central Australia (Mulvaney, 1975, fig. 41) and a very small number of microlithic backed points have been collected in Kimberley and other northern districts.

The northern (or Kimberley) and the southern late phase industries (but not all of the later's regional variants) share many of the same kind of stone tools, including long pointed blades and points of the "leilira" category (McCarthy, 1967; Mulvaney, 1969, 1975; Spencer and Gillen, 1899, 1904, 1927), small blades and bladelets, pecked or polished axes, bifacially flaked edge-ground axes, and grindstones. They also share various forms of flake scrapers, horsehoof cores (McCarthy, 1967), adze flakes (Gould, 1973; Gould, Koster and Sontz, 1971; Mulvaney, 1969, 1975), choppers and chopping-tools, denticulated and notched pieces, tool forms which also occur in one or other of the early phase assemblages identified at Miriwun in Kimberley (Dortch, in press), Puntutjarpa in the central desert region (Gould, 1971, 1973) and at Devil's Lair in the south west (Dortch, 1974; Dortch and Merrilees, 1973). Several authors (cf. Gould, 1973; Jones, 1973; Lampert, 1971; Mulvaney, 1969, 1975) have recently pointed out this continuity within the industrial sequences of various regions in mainland Australia. Nevertheless the influx of new tool types which marks the begining of the late phase industries gives them their special, though regionally varying character.

Clear prototypes for geometric microliths, microlithic backed points and points with invasive retouch have not been identified in the earlier industries in Australia. These tool types occur variously in post-Pleistocene industries in Sulawesi (Celebes), Java and other parts of Indonesia (Glover, 1973b; Mulvaney and Soejono, 1970; van Heekeren, 1957), and it is likely, as suggested by Glover (1973b) and Mulvaney (1969, 1975) that they were introduced into Australia from Indonesia.

There are also marked differences in the stone working methods of the earlier and later stone industries in western Australia. There is no certain evidence for blade technology in the earlier industries

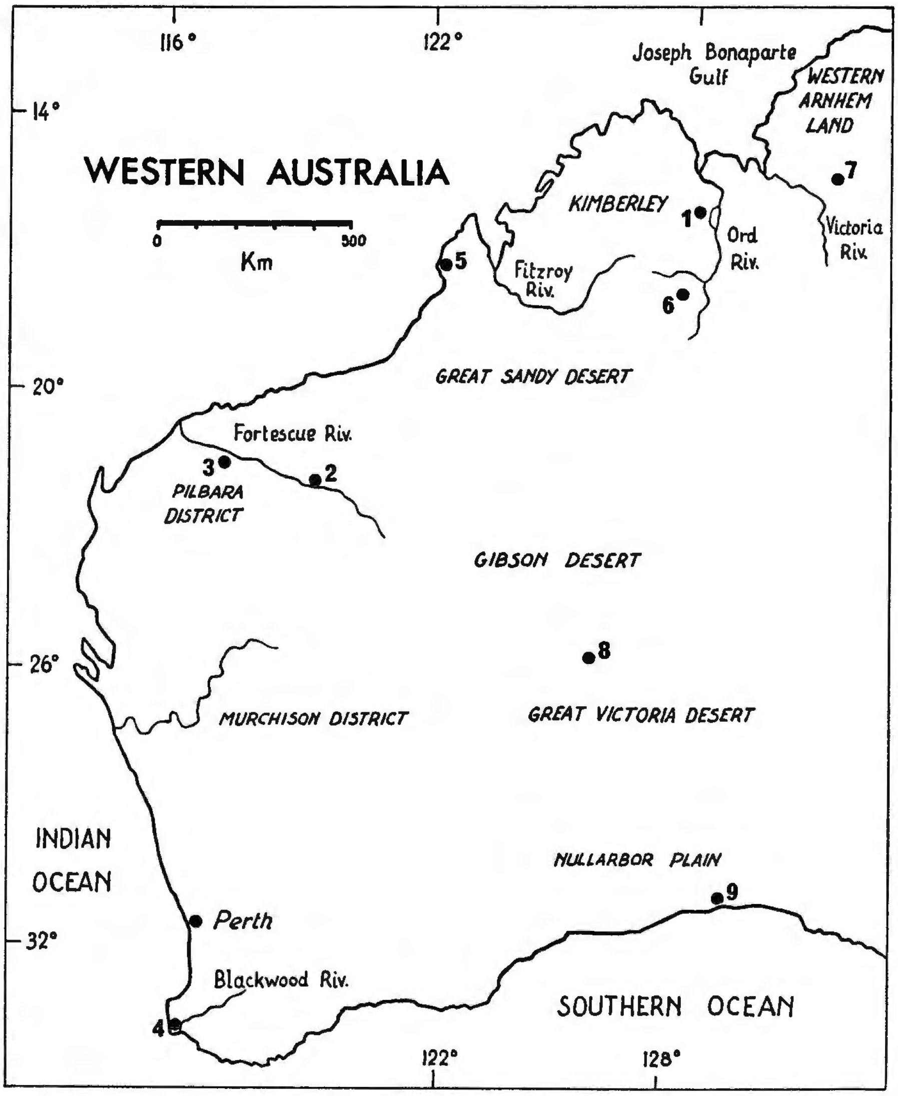

Fig. 1: Map of Western Australia, showing sites and localities mentioned in the text. 1, Ord River and Lake Argyle. 2, Chichester Range. 3, Millstream Station. 4, Devil's Lair. 5, Dampier Land. 6, Halls's Creek, Bedford Downs. 7, Ingaladdi. 8, Puntutjarpa. 9, Koonalda.

whereas during the later phase blade techniques were used in all districts where suitable stone was available. In parts of the Kimberley and the Pilbara (fig. 1), Levallois techniques were important, and appear to be confined to the later phase. However, despite the presence of blade and Levallois techniques in the later industries, a basic flake technology prevails through both earlier and later phases. Cores are simple and include those of the "horsehoof" category (McCarthy, 1967; Mulvaney, 1969, 1975), bipolar cores (Dortch and Merrilees, 1973; Mulvaney, 1975; White, 1968), cores with multiple flaking faces, and various forms of pebble cores. Discoidal cores are common in some regional late phase industries, and these were probably used in the early assemblages at Devil's Lair (Dortch and Merrilees, 1973).

Point and blade technology

In Australia, large, typically pointed blades are usually called "leilira" blades (McCarthy, 1967; Mulvaney, 1975). The term, originaly "lialira" or "lalira" (Spencer and Gillen, 1899) and then "leilira" (Spencer and Gillen, 1904) is a central Australia word referring to the large stone knives Spencer and Gillen saw made by the men of the Arunta (Aranda) tribe. These authors stated: "What the native aims at is the making of a blade, which for the main part of its length, shall be trigonal [in section], tapering to a sharp point" (1899, p. 592). Roth (1904, p. 17), describing similar blades he had seen manufactured by Aborigenes in Northern Queensland wrote: "The two main desiderata for [blades] are length combined with thinness, and a main ridge running to the extreme apex".

Leilira blades are thus typically pointed even though Spencer and Gillen (1904, p. 641) and Roth (1904, p. 17) note that sometimes these blades may be square-ended, depending upon the length and configuration of the flake scar ridges on the dorsal face of the blade. Bordes (1967, p. 28) identifies pointed blades of the leilira type illustrated by Spencer and Gillen (1927, figs. 192–200 and 202–209) as *"pointes Levallois allongées ou des lames pointues"*. Bordes' observation has been substantiated by recent descriptions of western Australian point and blade assemblages (Dortch 1972, in press).

Ressources of stone suitable for the manufacture of large blades and points are relatively poor in most districts in western Australia. However, in the Ord and Fortescue valleys (fig. 1), there are quantities of fine grained lithic sandstones, quartzites, cherts or metasediments and fine grained basalts which are easily available and can be used for making blades or points. In both the valleys, stone was quarried form cliffs, gorges or outcrops, or collected as pebbles from gravel beds in the rivers and streams. Similar stone, and also chalcedony is available in many other districts in the Pilbara and Kimberley, and in some of the desert regions of the interior. Flint of good quality occurs in abundance in parts of the Nullarbor Plain (fig. 1) where at Koonalda Cave (Wright, 1971) extensive flint quarrying dating back to the Late Pleistocene took place. In the south west dolerite can be used to make large blades and points, though very few tools classifiable as leiliras are known from there. Nor does it seem that leilira blades or points were made in the Nullarbor Plain. So the apparent lack of large blades and points in some areas cannot be explained simply by the lack of suitable raw material.

The Ord Valley, East Kimberley

The only comprehensive data for blade and point production in western Australia comes from the Ord valley in east Kimberley where one of us (C. D.) is engaged in an area study. Most of the Ord valley material comes from open air sites or undated quarry-factories. Assemblages excavated from rock shelter deposits (Dortch, in press) show that Levallois point and prismatic blade technology dates back at least three thousand years, this being the likely age for the early-late phase transition in this area.

The presence of both prismatic blade and Levallois point techniques in this area may in part be largely a function of the raw material. Most of the typical prismatic blade cores are made on angular quartzite blocks quarried from cliff faces or outcrops, whereas typical Levallois point cores are often made on chert and fine grained quartzite or basalt river pebbles.

Levallois points (fig. 2, n° 1–15) are found in most Ord valley late phase assemblages, up to 10 % of the tools in some assemblages excavated from archaeological deposits (Dortch, in press). The most typical specimens (fig. 2, n° 3, 4, 6, 10, 13, 15) are usually small and have been produced on cores made on small chert pebbles (fig. 3, n° 4). Ord valley Levallois points have plain or facetted butts, and the elongated form (Bordes, 1961, p. 18) is most common (fig. 2, n° 1, 10). In some cases one or both lateral margins are retouched and in a few cases one of the lateral edges may be backed. Typical Ord valley Levallois points have three principal flake scars on their dorsal faces; the last produced removes the proximal part of the central ridge formed by the adjacent facets of the two initial preparatory flakes, so preparing a "*pointe de deuxième ordre*" (Bordes, 1961, p. 18), and producing a "pointe de premier ordre".

Ord valley Levallois point cores range from classic forms (fig. 3, n° 2, 3, 4, 5, 6) from which one or two points were removed (pointes du premier et du deuxième ordre, Bordes, 1961, p. 18) to transitional forms between Levallois point cores and pyramidal cores (fig. 4, n° 1), prismatic blade cores (fig. 6, n° 8) and Levallois blade cores (fig. 4, n° 3). Perhaps the most common of these transitional forms are those intermediate between Levallois point cores and prismatic blade cores. These have flaking faces which are often flat and generally triangular in plan with flake scar configurations suggesting that blades as well as points, probably indistinguishable from elongated Levallois points, have been removed.

There is also evidence that in the Ord valley typical Levallois point cores were flaked after the principal Levallois point or points had been removed. This is borne out by the configuration of the flake scars of several Levallois point cores and is clearly demonstrated in the specimen illustrated in fig. 3, n° 1. Fig. 3, 1 a, shows the core as it was found and in fig. 3, 1 b, it is shown with one of the flakes struck from it replaced. This replacement reveals a central flake scar which forms the outline of an elongated Levallois point. The parts of the outline of this principal flake scar facet, indicated by dotted lines, show: 1, where the replaced flake has been notched after being removed; 2, where a flake was misstruck after the principal point has been removed; and, 3, where a small triangular flake was struck off from the other end of the core, subsequent to the removal of the principal point, but prior to the removal of the flake shown replaced.

Quantities of blades and blade cores and some Levallois points and point cores (figs. 2, 3, 4, 5, 6) have been collected from several cliff face quarryfactories where the Ord valley stone workers flaked blocks of quartzite fallen or perhaps prized from the cliff walls. Blades from these sites have either parallel or slightly convergent edges (fig. 6, n° 1–3). Distal extremities are usually pointed. Butts are generally broad and are typically plain. Blades with punctiform butts, such as the chert specimen from Miriwun rock shelter (fig. 6, n° 1) are uncommon in any Ord valley site.

The blade cores from the cliff face quarry- factories comprise typical prismatic forms including those with single or opposed striking platforms (fig. 6, n° 7), pyramidal cores and multiple platform cores. These sites are the source of most of the cores which we have already regarded as transitional in form between Levallois point and prismatic blade cores.

True crested blades (Barnes and Cheynier, 1936; Bordes and Crabtree, 1969) seem to be rare in the Ord valley, with only a few atypical specimen (fig. 7, n° 3) known from the cliff face quartzite quarry-factories. Generally when working with angular quartzite fragments such as those used at the cliff face sites, the stone worker chose an acutely angled corner on a block or fragment for the flaking face. He prepared this face by simply removing the edge of the block with a first blade. Number of blades with such trihedral section have been collected from the cliffs face sites, and we interpret these as having been struck off to prepare the flaking face of the core for a succession of blades to follow. Thus, these first blades would have had the same function as true crested blades which have been prepared by bilateral, or less typically, unilateral flaking, before being struck off. Bordes and Crabtree (1969, p. 3–4) discuss the preparation of core flaking faces and point out that with angular blocks it is not always necessary to prepare a ridge to guide the first blade.

The gravel bed factory sites along the Ord river and its larger tributaries also contain quantities of Levallois points, prismatic blades and cores, most of which are heavily rolled. The pebbles used there are made of quartzite, chert, basalt and eruptive rocks.

Blade cores made on elongated river pebbles were usually prepared by removing one end, the resulting fracture face serving as the striking platform. One side of the pebble was then prepared as a flaking face by removing two adjacent flakes, thereby leaving a ridge or crest which guides the first blade to be removed. This technique is more in keeping with the Levallois point technique than the prismatic blade technique in which the crest or ridge is created by bilateral flaking of the face (Bordes and Crabtree, 1969).

In this region there is a marked gradation between the prismatic blade technique, in which a number of blades with parallel sides are produced successively, and the Levallois point technique, in which one or two principal points were produced from specialy prepared cores (Bordes, 1961). These transitional forms between Levallois point cores and prismatic cores are known from other contexts where Levallois point technique was used. Cores of transitional form are known from Pleistocene sites such as Ksar Akil or Jerf Ajla in the Middle East, and also from France. Bordes (1961, pl. 102, n° 3 and 5) illustrates two cores which he calls *"nucléus Levallois à pointes passant aux nucléus à lames"* (1961, p. 72). These two cores, respectively from Abou Sif in Jordan and Mesnil-Esnard, (Seine maritime), France, are very similar to the Ord valley cores illustrated in fig. 4, n° 1. Bruce Schroeder (1969, p. 221 and figs. 48, 2 and 49) has proposed that these be called Jerf Ajla cores.

The Pilbara district

Levallois points and prismatic blades assemblages are known from several open air sites in the Fortescue valley, Pilbara (fig. 1). Detailed data are not available, and the paucity of cores from sites in the Chichester Range (Dortch 1972) on the north side of the Fortescue valley hampers our interpretation of the stone working techniques used. However, a number of cores have been recovered from a quarry-factory on Millstream Station (fig. 1) where a kind of lithic sandstone (sub-greywacke; personal communication, Mr. J. Clarke) was used in the production of pointed prismatic blades with parallel sides some of which resemble elongated Levallois points. There are numbers of large blade cores of pyramidal form at that site as well as cores intermediate in form between prismatic blade cores and Levallois point cores. Some of them (fig. 7, n° 5) are very similar to the Ord valley cores in fig. 4, n° 1. It is not certain whether a true Levallois point technique occurs here, for, as one of us (F.B.) has demonstrated experimentally, it is possible to produce pointed blades resembling elongated Levallois points on pyramidal cores or on cores of intermediate form such as the one in fig. 7, n° 5.

The raw material at the Millstream site is found angular blocks which requires little preparation to be readied for blade production. Bordes and Crabtree state (1969, p. 3): "Angular material often has natural longitudinal ridges which may, after slight modification or unifacial trimming, suffice as a ridge to guide the first blade". No crested blades have been found at this quarry-factory and very few are known from other blade factories in the Pilbara district. Thus it seems that in the Fortescue valley, as in the Ord valley, blades were produced on unprepared or almost unprepared cores.

Silicified shale was also quarried extensively from tabular strata exposed along the Fortescue river a few kilometers south of the sandstone quarry. Thousands of bladelets, flakes, chips and cores are strewn over the eroded slopes, colluvial fans and alluvial terraces in this part of the Fortescue valley. The silicified shale does not appear to occur in sufficiently large blocks for the manufacture of large blades and points. Near the surface, the stone is internally fractured by thermal alternation and dehydration, and is thus of poor quality for blade or point production. Recently, Aborigenes with local knowlegde informed Mr. K. Palmer (personal communication) that the surface stone was useless for flaking, and that "cool" stone could only be obtained by digging down a few centimeters into the eroded bedrock.

The main product at these sites are flakes and bladelets ("lamelles" Tixier, 1963, p. 35–39) which were made on small cores with single flaking face. The striking platforms of these cores were not usually elaborately prepared. Some of the bladelets and flakes have facetted butts, and some of the cores have facetted striking platforms: Many of the cores' flaking faces were probably prepared by cresting. However, only three bilaterally retouched crested blades (fig. 8, n° 6) have been recovered from here. Unilaterally retouched crested blades are present in small numbers, and it seems clear that the tabular raw material could be readied for bladelet production without preparation or with only "slight modification or unifacial trimming", as noted by Bordes and Crabtree (1969, p. 3).

Bladelets at the Millstream silicified shale quarry-factories were also produced by a form of bipolar technique. The cores (fig. 8, n° 4 and 5) are very small and have bipolar flake scars facets showing that bladelets were removed from both faces and both ends. Experimentation shows that bladelets obtained by bipolar percussion from such cores are usually irregular with relatively thick triangular or quadrilateral sections. It is likely that these cores were on occasion hand held, and flaked by direct percussion.

The material used in the Chichester Range sites, 120 km upstream from Millstream is a black cherty siltstone of tabular form found in abundant outcrops. Many prismatic blades (fig. 7, n° 1, 2) have been recovered from this area but only two typical blade cores. One of these is pyramidal (fig. 6, n° 7), the other has opposed striking platforms. One of the striking platforms in this later piece has been prepared by flaking, the other consists of cortex. No bilaterally retouched crested blades have been collected from the Chichester Range and only one unilaterally flaked specimen is known from there.

The Chichester Range sites are notable for their abundant Levallois points (fig. 6, n° 4, 5, 6; fig. 8, n° 1), the majority of which are of the elongated form. Most of these points have cortex butts, and facetted butts are uncommon. No typical Levallois point cores have yet been collected from the Chichester Range sites, and a core previously described as such (Dortch, 1972, fig. 5 d) we consider here to be atypical.

The quantity of typical Levallois points in the Pilbara district, and the presence of cores intermediate between Levallois point cores and prismatic blade cores suggest that the Levallois point technique, or at least some variant of it, was practiced here. Clover, in his description of the Newall collection of artifacts from Millstream Station illustrates two pointed blades of the leilira catergory (1967, figs. 3, 191 and 4, 758) and states: "They appear to have been struck from prepared cores of the sort illustrated by Spencer [1928]" (1967, p. 423). We interpret Glover's term "prepared core" as referring to the Levallois point technique, or perhaps a variant of it.

We feel that the apparent rarity if not absence of typical Levallois point cores in the Pilbara district, where typical Levallois points are abundant, and from other areas such as Dampier Land (fig. 1) where there are very typical Levallois points (fig. 8, n° 3), can perhaps be best explained in two ways. First of all, symmetrical pointed blades, as we have seen, can be produced on pyramidal cores and on cores of intermediate form, and it is likely that these cores are common in the Pilbara. Secondly, as in the Ord valley, Levallois point cores may have been flaked on after the removal of the point, and it is possible that some of the cores we have described as intermediate or transitional in form are the result of such a practice.

Levallois flake technology

Until now, the Ord valley is the only region in western Australia where Levallois flake technology is demonstrable. Most of the Levallois flake cores from this valley are made on small chert pebbles (fig. 5, n° 1–5, 16, 19). Levallois flake cores are not nearly as numerous as discoidal cores made on similar chert pebbles (fig. 5, n° 17). Levallois flakes (fig. 5, n° 6–15,18) are also much more common than corresponding cores, and considering the similarity of the discoidal and Levallois flake cores, we think that in many cases, following the removal of the principal flake (*éclat Levallois*) Levallois flake cores were often further worked as discoidal cores. Bordes (1961, p. 72–73) describes this practice as identified in Mousterian assemblages, and it is probable that it was the same in the Ord valley.

Ord valley Levallois flakes are generally small (2.5 to 4 cm as maximum dimensions) with plain (fig. 5, n° 18) or facetted butts (fig. 5, n° 7) or sometimes cortex butts (fig. 5, n° 8). Most are unretouched and some have chipped or nibbled edges which in some cases may be the result of use. Similar small Levallois flakes, with the corresponding cores, have been found in layer J–3 at the shelter of Pech de l'Azé IV, in Dordogne (France) (Bordes, 1975), in a Mousterian context.

A few Levallois blades (fig. 5, n° 14) and some Levallois blade cores (fig. 5, n° 4) have been collected in the Ord valley. They are more variable in size than the flakes and flake cores. They are made on small chert pebbles or larger quartzite pebbles and blocks.

Some flakes and cores of Levallois technique are known from other parts of east Kimberley. Two of the most typical specimen are the Levallois flake core from Bedford Downs (fig. 8, n° 7) and the Levallois flake from Hall's Creek (fig. 8, n° 8). Both these specimen are surface finds collected along with other typically late phase artefacts (for the location of these two sites, see fig. 1).

Few flakes or cores of Levallois type are known from the southern two thirds of western Australia. A few Levallois flakes (fig. 8, n° 2) and a single misstruck Levallois flake core (fig. 7, n° 4) have been found in the Chichester Range in the Fortescue valley. One of us (C. D.) picked up a flake of Levallois morphology (fig. 8, n° 10) on the banks of the Blackwood River, about 10 km east of the cave of Devil's Lair (fig. 1).

There is no clear evidence of Levallois flake technology in any south western assemblages, and only one flake resembling those struck from Levallois cores has been identified in the Late Pleistocene assemblages at Devil's Lair. Discoidal cores occur in many south western assemblages, and further field work may show that the Levallois flake technique was used in conjunction with the discoidal core technique, as it was in the Ord valley.

Discussion

It is probable that Levallois point technology was used in many of the areas in northwestern and central Australia where leilira blades and points were made. The Levallois point in fig. 8, n° 3, and the pyramidal blade core in fig. 8, n° 9, come from Dampier Land in northwestern Kimberley (fig. 1). Mr. K. Akerman (personal communication) reports that in Dampier Land symetrical points were sometimes made in a true Levallois technique, in which three preparatory flakes were removed in order to produce a "second order Levallois point", as defined and shown schematically by Bordes (1961, p. 18–19). Professor Mulvaney (personal communication) inform us that some symmetrical pointed blades from the more recent horizons at Ingaladdi rock shelter to the east of the Victoria River (fig. 1) are reminiscent of elongated Levallois points.

Blade cores are known from many regions in mainland Australia though there is very little detailed description (e. g. McCarthy, 1967) of blade making techniques. Blade assemblages from southern regions in western Australia, and the stone industries excavated at Puntutjarpa rock shelter by Gould (1971, 1973) still await detailed publication. There are some blades and bladelets in assemblages collected at open air sites in the desert, but we have not identified any Levallois type in desert material we have examined in the Western Australian Museum collection.

Horsehoof cores (McCarthy, 1967; Mulvaney, 1969, 1975) are found in many Ord valley assemblages which contain blades, Levallois points and blade and point cores, and they occur in assemblages from other parts of northwestern Australia which have important blade and point components. However, horsehoof cores, which are generally interpreted not only as cores, but also as scraping or chopping tools (McCarthy, 1967; Mulvaney, 1969, 1975) were probably used for the production of flakes, but not points or blades. We base this opinion on our examination of horsehoof cores in the Western Australian Museum collection: all those examined were typical flake cores, and none had flake scar facets showing where blades or points may have been removed.

It is not possible with existing data to define fully blade and point technology in western Australia.

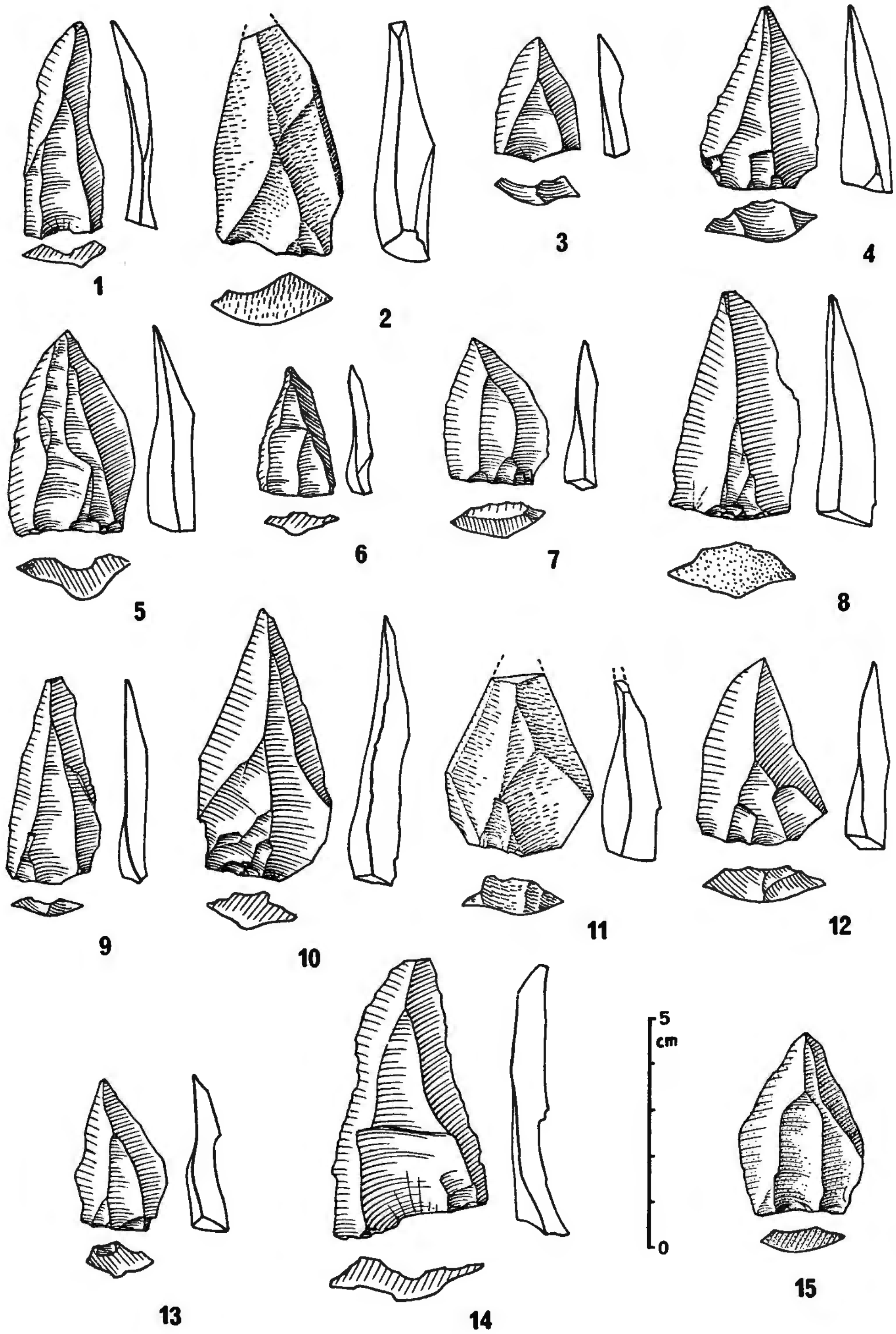

Fig. 2: Ord Valley, eastern Kimberley. Levallois points and elongated Levallois points. N° 3 can be called "classic".

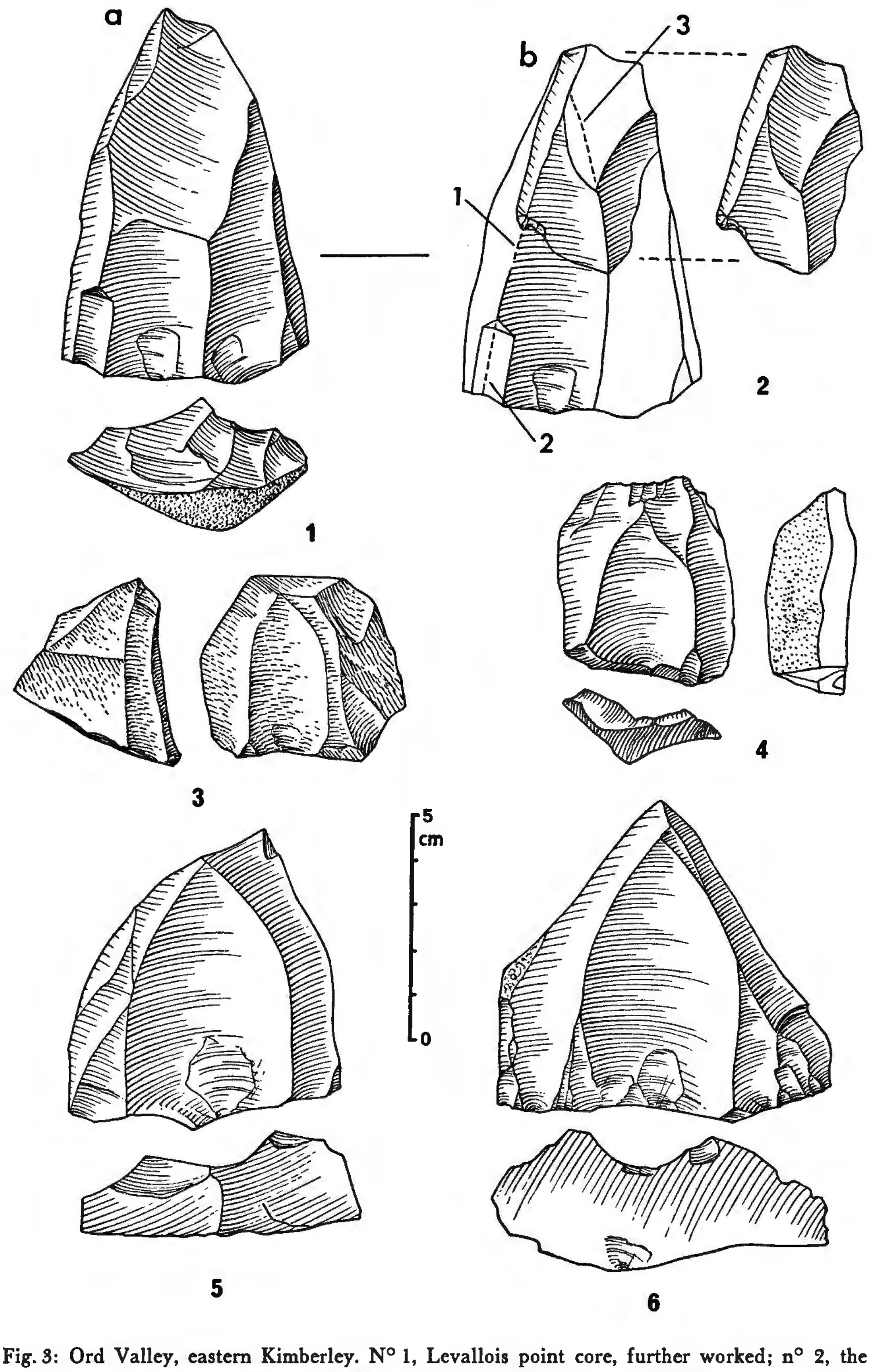

Fig. 3: Ord Valley, eastern Kimberley. N° 1, Levallois point core, further worked; n° 2, the same, with one of the further flakes replaced; n° 3 to 6, Levallois point cores.

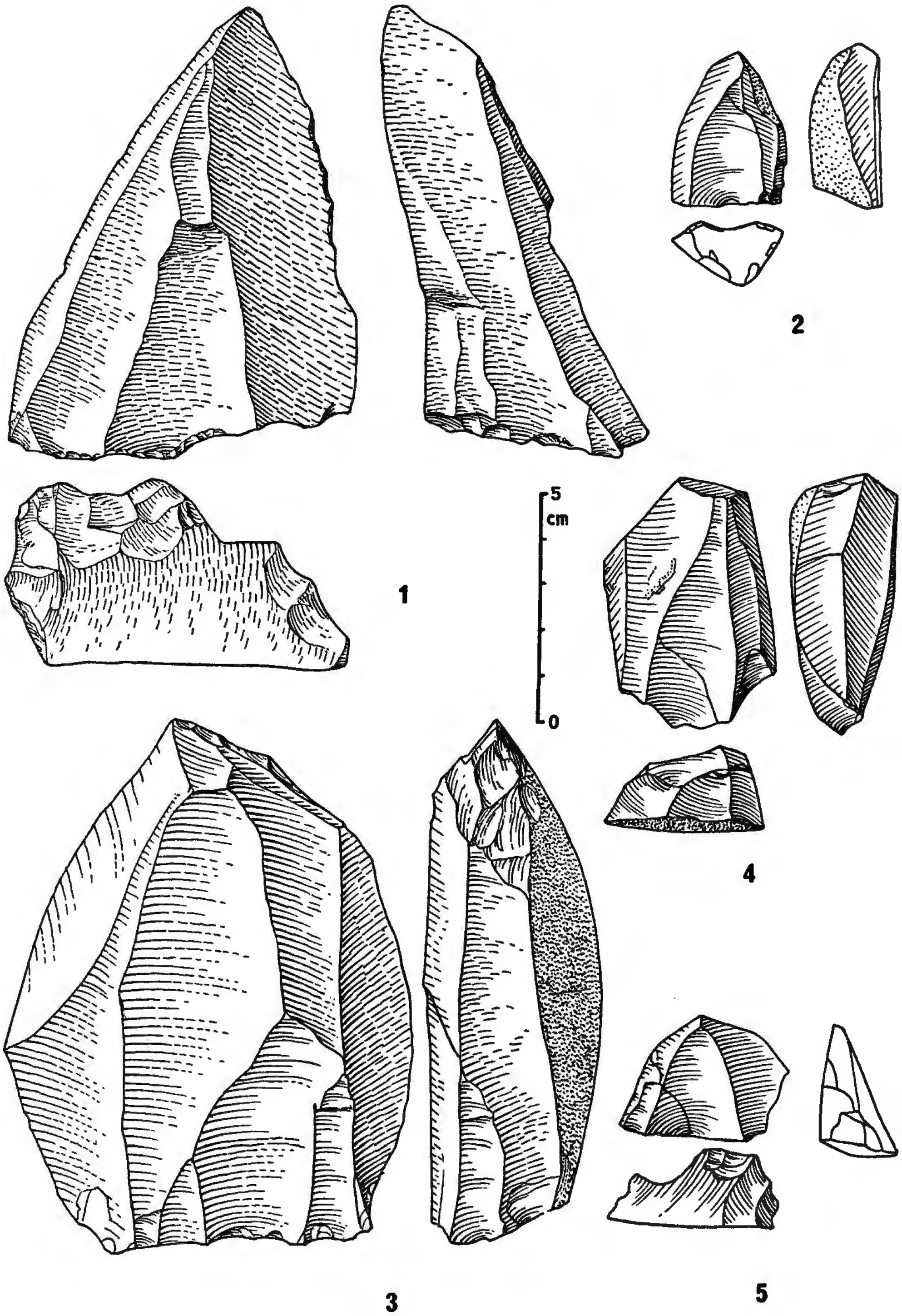

Fig. 4: Ord valley, eastern Kimberley. N° 1, Levallois point core passing to a prismatic core; n° 2, 4, 5, Levallois point cores; n° 3, Levallois blade core.

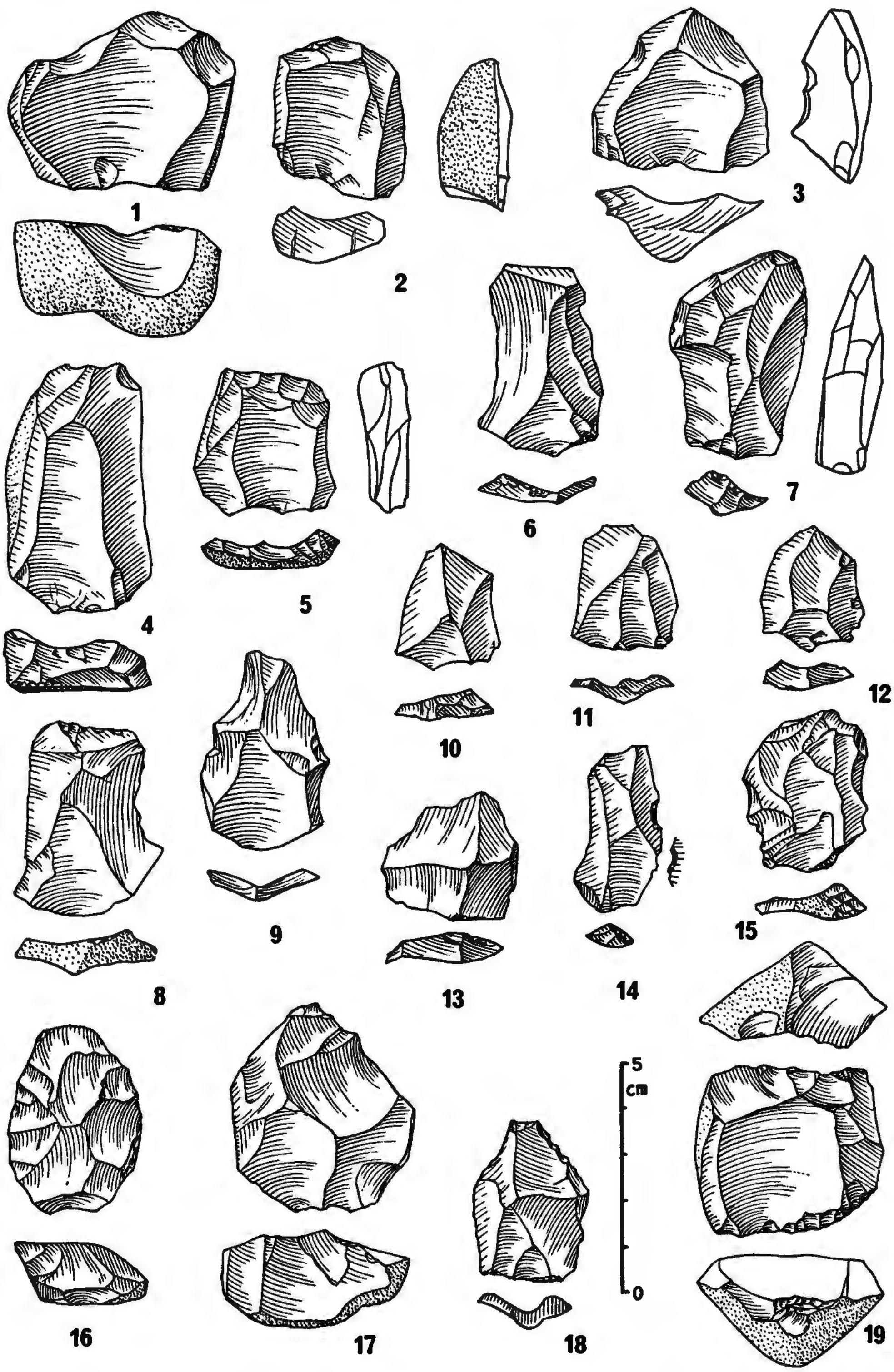

Fig. 5: Ord valley, eastern Kimberley. N° 1, 2, 3, 5, 19: Levallois flake cores; n° 4, Levallois blade core; n° 6 to 15, n° 18, Levallois flakes, typical and atypical; n° 16, unstruck Levallois core or discoïdal core; n° 17, discoidal core.

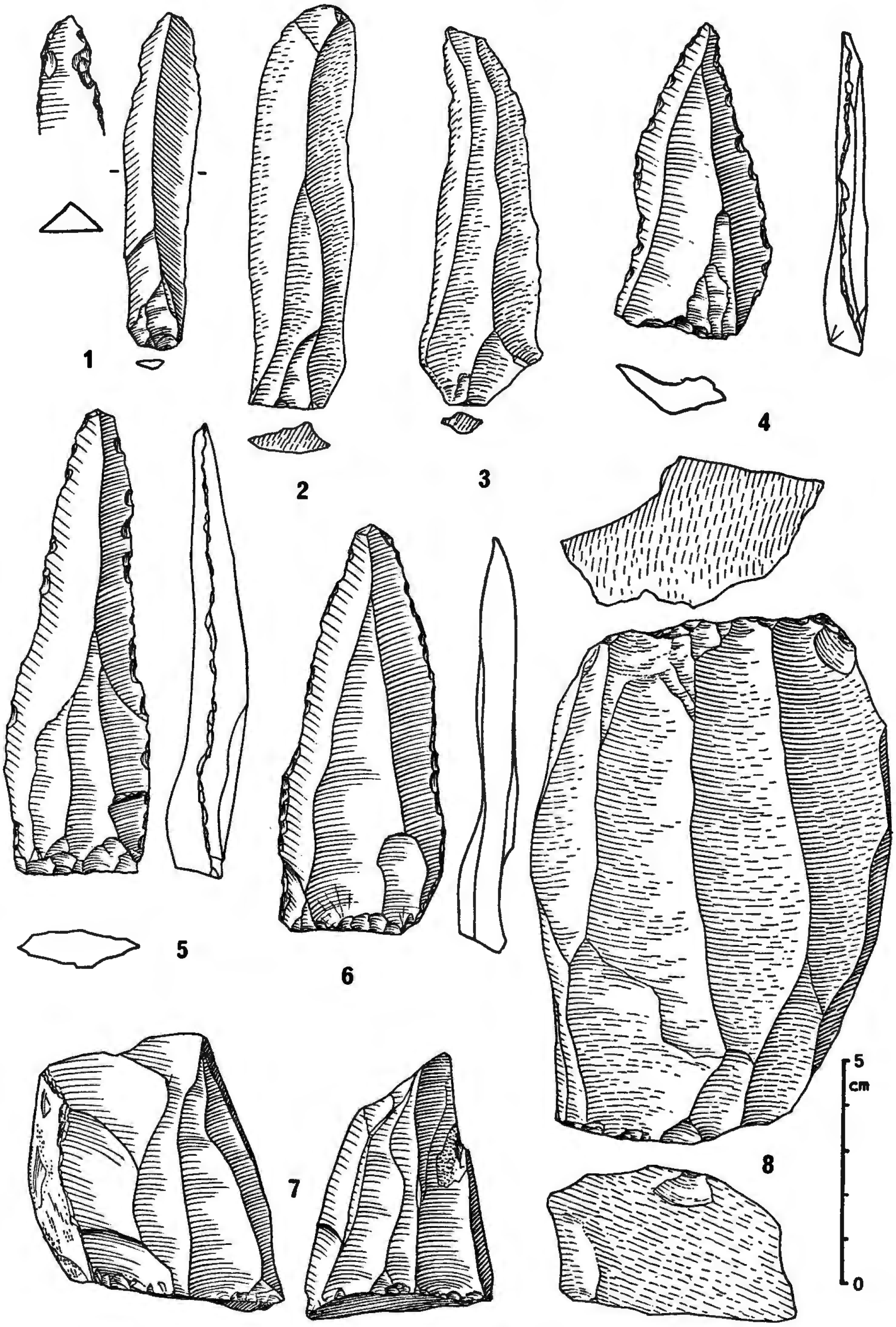

Fig. 6: Ord valley, eastern Kimberley. N° 1, blade with punctiform butt; n° 2, 3, prismatic blades; n° 8, double ended prismatic blade core.
Chichester Range. N° 4, elongated Levallois point; n° 5, very elongated Levallois point passing to a prismatic blade; n° 6, elongated Levallois point; n° 7, pyramidal core or prismatic core passing to a Levallois point core.

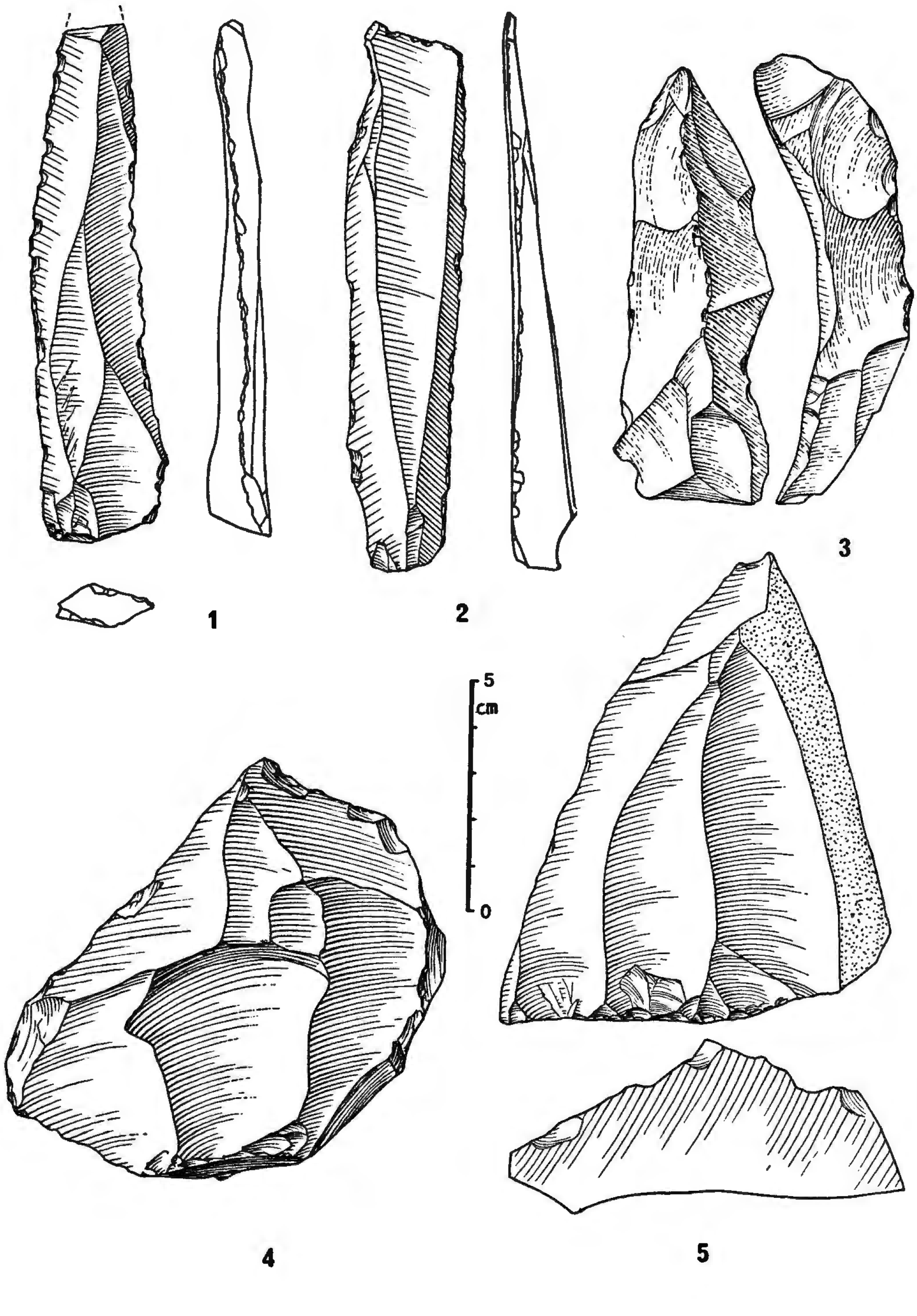

Fig. 7: Chichester Range. N° 1, 2, prismatic blades; n° 4, misstruck Levallois core.
Ord valley. N° 3, crested blade.
Millstream Station. N° 5, core intermediate between prismatic blade core and Levallois point core.

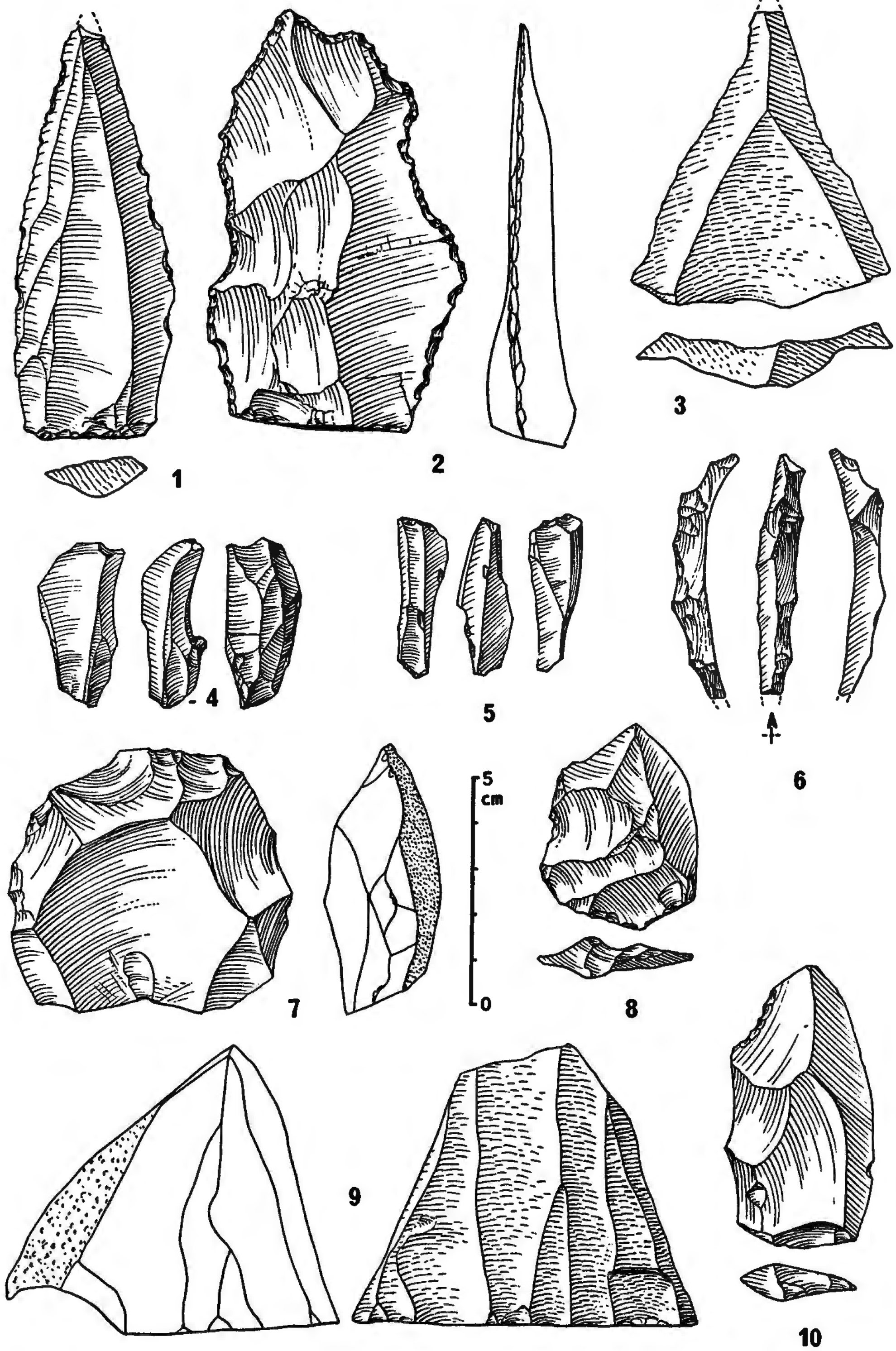

Fig. 8: Chichester Range. N° 1, elongated Levallois point; n° 2, Levallois flake. Dampier's Land. N° 3, typical Levallois point; n° 9, pyramidal blade core. Millstream Station. N° 4, 5, small bipolar bladelet cores; n° 6, crested blade. Blackwood River. N° 10, Levallois flake. Bedford Downs. N° 7, typical Levallois flake core. Hall's Creek. N° 8, Levallois flake.

For the present we suggest that in this region points and blades of the leilira category were made by the following techniques:

1: The prismatic blade technique, with the following methods of preparing the core flaking face for successive blade production.
   a) by removing a natural ridge from the edge of an angular block of stone.
   b) by creating or improving a natural crest or ridge by unilateral or bilateral flaking, and then removing a crested blade.
   c) by removing adjacent flakes in order to form a central ridge as in the Levallois point technique.

2: The Levallois point technique, often on cores which were flaked or reprepared after the removal of the principal point or points.

The identification of the products of these two basic techniques is complicated by the existence of cores of intermediate form, and by the extensive use of pyramidal cores to obtain pointed symmetrical blades resembling elongated Levallois points, along with asymmetric non-pointed blades. Further analysis should show which of these techniques was predominant, and how they merge into one another. It should also clarify the correlation which may exist between the technique used and the different kinds of raw material.

The only indication of early phase blade manufacture in western Australia comes from Miriwun rock-shelter in the Ord valley (fig. 1) where several bladelets and small blades were recovered from a layer dated at 17 980 $\pm\,^{1170}_{1370}$ years B.P. (ANU 1008) Dortch, in press). No blade cores have been identified from this layer and it is possible that the blades and bladelets were produced fortuitously. This layer at Miriwun also contains a few flakes resembling those produced on Levallois cores. The earlier assemblages at Ingaladdi (fig. 1; Mulvaney, 1975) and Puntutjarpa (Gould, 1971, 1973) do not appear to contain blade tools or Levallois technology. At Devil's Lair in the south west (Dortch and Merrilees, 1973) the whole of the industrial development extending from about 25 000 years B.P. until the mid-recent period is based on a flake technology.

Gallus (in Wright, 1971, p. 101) describes two of the flint artifacts of Late Pleistocene age which he excavated from Koonalda Cave as Levallois forms. However, one of us (C.D.) was not able to identify any Levallois types in the artifacts from Koonalda which he briefly examined in the South Australian Museum. Wright (1971, p. 56–57) does not mention the presence of any Levallois technology in his summary of the Koonalda flint assemblages, and we conclude that there is no evidence for either Levallois or true blade technology at that site.

There is almost no record of Levallois technology from eastern Australia, Tasmania or New Guinea. McCarthy (1964, p. 240) mentions the presence of Levallois technique in the Capertee valley, New South Wales, but he refers only to the facetting of flake butts, a feature which is not diagnostic (Bordes, 1961, p. 14). However, one of us (F.B.) picked up on a deflation surface at Lake Mungo site several flakes which may be called Levallois, albeit they are thick and crude most of the time, owing to the rather poor raw material. Until now, no prismatic blade technology has been identified in the earlier assemblages from eastern Australia, though blades were manufactured in many regions of mainland Australia during later prehistoric times (McCarthy, 1967; Mulvaney, 1969, 1975). It seems likely that some variation of the Levallois point technique was used in most areas where leilira blades and points were made, and it is possible that Levallois flake technology exists in districts where suitable stone is abundant and easily available, such as flint or chert occuring in parts of the Nullarbor Plain. On the whole, the apparent absence of Levallois technology in some areas seems as much due to the scarcity or unsuitability of raw material as to cultural differences or technological preferences.

In several Ord valley archaeological deposits, prismatic blades, Levallois points and Levallois flakes are associated with objects of european origin such as bottle glass and cattle bones, indicating that these techniques continued to be in use some time after *circa* 1885 A.D., the time of effective european contact in this region. Unfortunately, recent inquiries among Ord valley Aborigenes have failed to produce any information on these manufacturing techniques.

However, one of us (C.D.) recently showed the Ord valley Levallois flake core (fig. 5, n° 19) to a Kimberley man, Mr. Wattie Karawarra of the Unambal tribe, whose territory lies in northern Kimberley to the west of the Ord valley. This man recognized the specimen as a core, saying that "someone took off those little pieces" (the preparatory flakes around the margin of the flaking face) in order to "get a good stone (the principal flake) out of there". He demonstrated this technique by holding the core, flaking face downwards and with the previously struck striking platform towards his body. He then showed how the principal flake has been removed with a single blow of the hammerstone. The implication of Wattie Karawarra's demonstration is that there was a good "stone" (flake) within the small chert pebble on which the core was made, but that it had to be prepared in a certain way in order to get this flake "out of there". Thus this man's obvious understanding of the principles of Levallois flake technology, like the stratigraphical association of Ord valley Levallois material with european artifacts, shows how recently Levallois technology was practiced in parts of the Kimberley district.

Fortunately, Roth's (1904) and Spencer's and Gillen's (1899, 1904, 1927; Spencer, 1928) early ethnographic studies record the function and to some extent the methods of manufacturing prismatic blades and Levallois points which can be classified under the leilira group. They observed that pointed leilira blades served as spearheads, daggers, knives and, among some tribes, as the heads of fighting picks. K. Akerman reports (personal communication) that prismatic blades and Levallois points were not used in Dampier Land as spears or daggers, but as knives in butchering turtles and dugongs. He states that, even though most of these knives taper to a point, an acute cutting edge and not a point was the chief requisite in these tools. However, one may observe that modern steel butchering knives and kitchen knives are pointed most of the time.

Spencer's and Gillen's description (1904, p. 641–643) of the manufacture of those pointes and blades accords with the essential steps of Levallois point technique (Bordes, 1961, p. 18–19). At the same time, these authors make it clear that the core was often used in the production of a series of blanks, and not just one or two points. Thus their description is consistent with an intermediate form of blank manufacture rather than with the Levallois point technique in the strictest sense. Technically the blades these authors describe correspond to either prismatic blades, pointed or not, or Levallois points *"du premier ordre"* (Bordes, 1961, p. 18–19). Some at least, however (Spencer and Gillen, 1904, figs. 179 and 195) clearly are "second order" points. And contrarily to what these authors wrote, this was certainly not "simply a matter of chance" (p. 642).

Roth (1904) and Spencer and Gillen (1904) also record that stone working was done by means of direct percussion with a hammerstone. There is no record of the punch technique of indirect percussion being used in Australian stone industries, though, interestingly enough, Spencer (1928, fig. 242, 243) illustrates the use of punch and hammerstone in human incisor evulsion by people of the Kaitish tribe of the Northern Territory.

A final question here is that of the connection between the western Australian Levallois technology and that occuring in other parts of the world. Levallois technology of Middle to Upper Pleistocene age is know from southern Britain to southern Africa, and eastwards to India and China (Bordes, 1968). It also occurs in Vietnam (Boriskovsky, 1966) and in Indonesia (Ghosh, 1971; Movius, 1944). Levallois technology of post-Pleistocene age is uncommon, but is known in the Neolithic industries of Grand Pressigny in France (Brézillon, 1968) and it may be present in mid-Holocene stone industries in Timor (Glover, 1972, p. 125). There is no published reference for Levallois technology in the so-called Toalian industries of Sulawesi though van Heekeren (1957, plates 28, 29 and 45) illustrates material excavated on Sulawesi which includes a number of typical Levallois points. Professor Mulvaney (personal communication) states also that symmetrical pointed blades of Levallois form occur in Toalian assemblages excavated by him and Dr. Soejono on their joint expedition to Sulawesi (Mulvaney and Soejono, 1970). The Toalian industries are old enough (Glover 1973b, p. 60–61) to be the source for some of the important features of the Australian late phase industries, and as Glover (1973, p. 51) suggests, it is likely that there is a connection between the two. Likely, but not altogether certain, since one of us (F. Bordes, 1949) pointed out long ago convergence in the flaking technique for the square-section axes in Denmark and Java, which is a much more elaborate technique than the Levallois.

Unfortunateley, there is little detailed information on the Upper Pleistocene industries of Indonesia (for available references, see Glover, 1973a, 1973b) and it is not completely clear whether Levallois techniques were used in Indonesia during this period. Nevertheless, the flakes of Late Pleistocene age from Tabon Cave, Palawan, illustrated by Fox (1970, fig. 7), and van Heekeren's figures of implements from the probable Upper Pleistocene site of Berru near Tjabengè in southern Sulawesi (1958, fig. 3) include specimens which resemble those made by the Levallois flake technique. However, Glover (1973a, p. 118) states that there is no evidence for Levallois technology in the Tjabengè material and he does not mention the presence of Levallois technique in any probable Middle or Upper Pleistocene assemblages from Timor or Flores (Glover, 1973a). On present data then it cannot be determined whether the western Australian Levallois technology outlined here has an ultimate Pleistocene origin in Indonesia.

The western Australian Levallois techniques may be a purely indigenous development occuring in the late phase during the latter half of the Holocene, or they could have developped in the early phase industries of Early Holocene and Late Pleistocene age. As we have shown, the latter possibility cannot be demonstrated though it should be emphasized that the present sample of western Australian early phase material is relatively speaking very small, and that further field investigations may yet reveal clear evidence of Levallois techniques or blade manufacture in the early phase. Alternatively an indonesian origin for these techniques is possible by means of diffusion from the Toalian or other indonesian industries of Holocene age, or from one of the indonesian Pleistocene industries.

The actual events of the origin, dispersal and evolution of these stone working techniques are undoubtedly much more complicated than the outlined possibilities suggest. Nevertheless, it is clear that stone working techniques and stone industries in the Indonesian Archipelago have undergone an extremely long and complex evolution which probably includes numerous cases of independant or convergent development and diffusion. Diffusion would certainly have been at times seaborne, and thus capable of affecting the evolution of Australian stone industries. This is not to discount the significance of indigenous development within Australia where there were certainly sufficient stimili, both ecological and cultural, to produce a number of innovations in stone working methods, just as in other aspects of Aboriginal culture. However, the question of the extent and of the age of probable diffusion from Indonesia is intriguing, when we consider how near north western Australia is to Java, one of the great centres of human evolution and cultural development, and where Levallois techniques are of great antiquity (Gosh, 1971; Movius, 1944).

We feel that more detailed analyses of stone working techniques in Australia can be particularly useful in two ways. First, assuming that diffusion to a greater or lesser degree did occur, they can provide significant clues for tracing the dispersal of cultural traits through eastern Indonesia and into Australia. Second, these studies help to make explicit the view that it is beneficial to regard Australian prehistory as an integral part of Old World prehistory, and not simply as a case of isolated cultural development in a new or a lost world.

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