Late Pleistocene to Early Holocene Lithic industries in the southern fringes of the Himalaya

Claire Gaillard a,*, Mukesh Singh b, Anne Dambricourt Malassé a

a UMR 7194 CNRS, Département de préhistoire du Muséum national d’Histoire naturelle, Paris, France
b Society for Archaeological and Anthropological Research, Chandigarh, India

1. Introduction

In the sub-Himalaya region, all along the highest mountain range of the world (Fig. 1), late Pleistocene and early Holocene human settlements are poorly known. The Neolithic begins around 5 ka BP in the Swat Valley, with hand-made pottery associated with human settlements are poorly known. The Neolithic begins around 5 ka BP in the Swat Valley, with hand-made pottery associated with human settlements. Besides, this region was not severely disturbed during the last glacial maximum and could have been a refuge for many animal and vegetal species. It has certainly favoured "latitudinal" circulation (precisely circulation along the geomorphological features) of human and animal populations despite the global climatic changes. However, lithic artefacts occur in plenty, especially in the western Siwaliks.

The earliest of these artefacts are represented by a few flakes in the Soan valley (Indus basin) dated to ca. 2 Ma (Dennell et al., 1988). At the time of the first surveys in the Potwar, in the 1930s, two types of lithic assemblages had been identified. The Acheulian, often rolled and in a lower stratigraphical position, was considered as older, while the Soanian (further sub-divided into two stages) was considered as later (Teilhard de Chardin, 1936, 1937). In synthesising the data regarding the Lower Palaeolithic of South and East Asia, Movius (1944, 1948) considered the early Soanian and the Acheulian of the western Siwaliks as belonging to the same time period; in his conclusions he proposed a sketch of the Old World distinguishing two Lower Palaeolithic cultural areas: "handaxe culture" and "chopper-chopping tool culture". Subsequently this concept was oversimplified and became "the Movius line". Although the Acheulian is acknowledged even by Movius himself in both cultural areas, this famous line is still a matter of debate (Keates, 2002; Corvinus, 2004; Petraglia and Shipton, 2008), recently leading to the "Movius line sensu lato" (Norton et al., 2006; Norton and Bae, 2008) that actually matches well with the original proposition of Movius.
Acheulian. Moreover, in central Nepal assemblages mostly comprising cobbles tools are dated between 24 and 20 ka (Kadereit et al., 2007), and in eastern Nepal a rich site yielding cobbles tools along with adzes/axes akin to Hoabinhian types dates back to Early Holocene (Corvinus, 1987, 1989). This latter site known as Patu is a key for understanding the cobble tool industries of the western Siwaliks (Soanian), and probably also those of the Irrawaddy terraces (Anyathian) in Myanmar (Movius, 1944, 1948). Looking in a broader perspective, it appears that comparable industries are common further east in late Pleistocene and early Holocene contexts, for instance in Thailand and Vietnam. They precede the Hoabinhian tradition and progressively merge into it. At places they already include some of the characteristic Hoabinthian tool types, which are much more significant than the time-transgressive and universal cobbles tools.

Recent studies of the early Soanian artefacts in the western Siwaliks lead to the identification of these tool types, suggesting that the “early” Soanian in many cases if not all probably belongs to this later phase of the Pleistocene. The abundance of cobbles as raw material along the Himalayan rivers might have prompted prehistoric populations to use them with minimal modification, just as cobbles tools and flakes. As well, the particular landscape in the hilly environment of the Siwaliks and its frequent modifications due to continuous tectonic activity might have been one of the reasons for the originality of this tradition when compared to the sharply different contemporaneous industries in peninsular India.

2. Western Siwaliks

From the 1930s, the Western Siwaliks became well known for their rich assemblages of prehistoric industries, especially in the Potwar plateau and Soan Valley (Teilhard de Chardin, 1936; Terra and Paterson, 1939). Two technical groups were identified: “Sohan/Soanian” (Soanian) and Acheulian. The former was the richest one and was first found at the base of the Potwar loess, assigned to the Upper Pleistocene, and therefore was regarded as the youngest. It was considered as a local Middle Palaeolithic, especially rich in cobbles tools. The latter was usually occurring in the form of rolled but very typical specimens in the basal gravel of the Potwar loess and was considered as belonging to the underlying Boulder Conglomerate, the last formation of the Upper Siwaliks (Teilhard de Chardin, 1936, 1937).

Since then many assemblages of different facies have been collected in the Western Siwaliks (Rendell et al., 1989; Dennell, 2004, 2007, 2009; Chauhan, 2007, 2008), especially between Indus and Sutlej (Mohapatra, 1966, Mohapatra and Singh, 1979a,b). The Acheulian, characterised by handaxes and cleavers, fits well to the Acheulian’s variability known in Africa and Eurasia (Gaillard et al., 2008; Singh, in press). The Soanian has been sub-divided into different evolutionary stages according to the stratigraphical origin and state of preservation (Terra and Paterson, 1939; Paterson and Drummond, 1962). However, the stratigraphical context was severely questioned by later field studies (Rendell et al., 1989) and only two Soanian stages are now referred to (Early and Late Soanian), apart from a very rare Final Soanian (Mohapatra, 1974). The late Soanian mostly including flakes and cores (sometimes well organised), along with cobbles tools, is technologically related to the Middle Palaeolithic (Teilhard de Chardin, 1937; Movius, 1948; Paterson and Drummond, 1962; Sankalia, 1974; Karir, 1985; Lycett, 2007). It is dated to between >57 ka and 20 ka in the Sirsa valley (Fig. 2; Suresh et al., 2002).

The Early Soanian is represented by numerous assemblages mainly composed of cobbles tools (choppers and chopping tools), flakes and cores being occasional. This industry, like the Late Soanian, is made from the well silicified quartzite cobbles, usually of dark colour, transported by the Himalayan rivers from the inner mountain ranges. It displays simple technical features and therefore has for long been assigned to the Lower Palaeolithic like the
Acheulian. It was then suggested that people bearing different “cultures” or technical traditions were alternatively “invading” the region (Terra and Paterson, 1939; Movius, 1944, 1948; Sankalia, 1974). However, the early Soanian appears to be later than the Acheulian (Gaillard and Mishra, 2001; Chauhan, 2003, 2008; Mishra, 2007; Gaillard and Dambricourt Malassé, 2008). On the one hand this latter tradition is dated to between 0.7 and 0.4 Ma in the Jhelum valley, at Dina and Jalapur (Pakistan: Rendell and Dennell, 1985) and it is probably older than 0.6 Ma at Atharapur (Punjab, India; Gaillard et al., 2008, 2010a,b), on the other hand the

Fig. 2. Map of the sub-Himalayan sector between Beas and Ghaggar Rivers, focussing on the Janauri Anticline of the Siwalik Frontal Range and showing the sites where tools with transversal trimmed cutting edge occur (small circles: 1 tool; medium: 2–5 tools, large: 6–10 tools; very large circles: 11 tools or more).
abundant assemblages of cobbles tools representing the early Soanian mainly occur on the 2nd and 3rd terraces of the Himalayan rivers, which formed after the post-Siwalik tectonic phase in the second half of the Middle Pleistocene. Besides, field observations show that the cobbles tools are usually much better preserved than the Acheulian cleavers or handaxes, and at places they occur in dense clusters in a very fresh condition suggesting they have been made on the spot and have not been disturbed afterwards. Recent reassessment of the early Soanian assemblages collected between the Beas and Sutlej Rivers, in association with new field work by the authors (Singh et al., 1999, 2008), resulted in the identification of several specimens looking more standardised than the choppers; with their rectangular, square or sometimes triangular shape, they may recall the adze/axe-like tools of the early Hoabinhian of South-East Asia (Colani, 1936; Forestier, 2000; Forestier et al., 2008; Zeitoun et al., 2008), or of the Sonvian (pre-Hoabinhian) of North Vietnam (Hà Van Tan, 1997, 2001), which are attributed to the Late Pleistocene and Early Holocene. In the Western Siwaliks these adze/axe-like tools, or at least tools with a transversal trimmed cutting edge (Figs. 3–5), usually occur along with typical Soanian choppers and chopping tools, in different localities of the Siwalik Frontal Range between Sutlej and Beas River and a sector forming the Janauri Anticline. Their concentration is observed in the area which is facing the Sutlej deflection zone downstream of Nagal, i.e. when the Sutlej encounters the anticline and turns from NE-SW to NW-SE (Fig. 2). In this area the final uplift occurred quite late in the Pleistocene and even possibly in the Holocene, as the Janauri anticline results from the junction of two segments that have been growing towards each other (Delcaillau et al., 2006). As long as they were not connected, the Sutlej continued flowing southwest, at 90° to the tectonic structure (Malik and Mohanty, 2007). The top of the ridge is broader and flatter in this junction area, forming a sort of plateau, wherein at places the landscape is littered with quartzite cobbles deposited by the ancient Sutlej. These were selected by the prehistoric craftsmen for making their tools, mostly choppers of early Soanian type, but sometimes also thinner tools with one or two transversal cutting edge(s). These assemblages are not dated, but they are definitely later than the deposition of the cobbly gravels by the Sutlej, during a high energy (tectonic rather than climatic) phase. In the Sirsa-Soan dun (longitudinal valley along the north-eastern flank of the Janauri and Chandigarh Anticlines; Fig. 2) the last aggradation phase ended around 20 ka (Kumar et al., 2007). It would have been the same in the Sutlej Valley, to where these two rivers merge upstream the Siwalik crossing, and this date may correspond to the period when the river was blocked by the emerging Janauri Anticline. It is difficult to know whether the populations who were using the cobbles as raw material had settled in this sector at a time when the river was still flowing “straight” through the Siwalik structure, or whether they came later, probably for encampments of short duration only, in the absence of a close source of water.

Within the assemblages dominated by choppers, these tools with transversal trimmed cutting edge look significantly more refined. Most are made on flakes (nearly 40%) and otherwise on flat cobbles or on split cobbles. They are trimmed on 2–4 of their edges by unifacial or bifacial flaking, the transversal edge being generally bifacially trimmed. The shaping never hides the original shape of the blank support, whose selection or initial production (by flaking or splitting) therefore strongly determines the final tool morphology. The contour is mostly trapezoidal (Fig. 3(1) and (3)), square, rectangular (Figs. 3(2) and 4(2)) or pentagonal (Fig. 4(1)) tools are also common. The only 3 triangular tools (Fig. 3(1)) along with some of the trapezoidal ones, clearly resemble the “primitive axe/adze” identified by Colani (1929) in North Vietnam and the “axes/adzes” found by Corvinus (1987, 1989, 2007) in Eastern Nepal (see below).

It is interesting to note that some of these tools show a polished facet on one or two lateral side(s), perpendicular to the preferential cutting edge (Fig. 6(1)). However, no gloss is observed except on one of the rectangular tools, whose surface is almost entirely glossy. Similarly the flakes do not show any gloss on the edge, unlike those from the Nangal-Barmla sites on the left bank of the Sutlej, on the lower terrace dated to 6.2 ± 0.8 BP (Soni et al., 2008; G.C. pers. observation 2009) or from Ampapur in Nepal (Corvinus, 2007).

Close scrutiny of the cobbles tools also shows severe abrasion of some of the edges, comparable to small polish facets (Fig. 6(2)), while some others have been heavily chipped as if they had been used for battering or pounding. Many choppers present this type of wear on one part of their edge only, while the other part looks unworked for a large flake scar having re-sharpened it. The corresponding flakes do occur in the field at places: they are characterised by frequent step-retouch on the striking platform’s dorsal ridge. The cobbles tools therefore appear as evolving tools, recurrently re-sharpened by a large removal that affects one part of their cutting edge only. In general the early Soanian collections actually include all the stages of modification, from the cobbles only showing a few removals to the intensively reduced cobbles.

3. Nepal

During her 20 years work in Nepal, Gudrun Corvinus laid the foundations of the prehistory in the central sub-Himalayas, in close relation with the Quaternary stratigraphy. Not only did she discover the first Acheulian elements (Corvinus, 1990, 1995) in this part of the central Siwaliks (dun and frontal range), and excavate a rich Middle Palaeolithic site belonging to MIS 5 or early MIS 4 (Corvinus, 1994, 2007), but also she found many cobbles tool assemblages and showed that they came from Late Pleistocene deposits. Moreover, at Patu site in Eastern Nepal she discovered a unique “macrolithic Mesolithic” assemblage and compared it to the Hoabinhian of South-East Asia, thus suggesting a technical link between the Siwaliks and the South-East Asia (Corvinus, 1987, 1989, 2007).

Her contribution regarding the cobbles tool industries is especially interesting when related to the comparable assemblages found in the Western Siwaliks. In Nepal this techno-cultural phase is abundantly represented in the dun as well as in the top of the river terraces and hill wash deposits (Fig. 1); given such a prominence, she named it the “Brakuti industry”. It is characterised by various types of cobbles tools but the main component are flakes, apparently resulting from the shaping of the cobbles tools; a few adze/axe-like tools are also noted within these assemblages. This type of industry is usually found in the upper part of the yellow silts in the upper Babai formation, dating to 25–15 ka BP (MIS 2). In the lower part of the same silts, dating to 34–33 ka BP, an assemblage characterised by end-choppers occurs at Sanpmarg on a buried paleosol. Corvinus never compared these industries to the early Soanian assemblages from the Western Siwaliks, probably for the latter being known as Lower Palaeolithic largely dominated by cobbles tools and practically devoid of flakes. Actually sites yielding large quantities of flakes are extremely rare in the Janauri Anticline, but they do exist as shown by recent field work (Dambricourt Malassé, 2008; Singh et al., 2008). Salient features in both the Brakuti industry and the so called “early” Soanian from the Janauri Anticline are the “rejuvenation flakes” as Corvinus also interpreted them. These flakes bear a characteristic “step-flaking or step-retouch at their platform edges on the dorsal face” (Corvinus, 2007: 93).

In Eastern Nepal, the site of Patu (Fig. 1) covers an area of 2 × 3 km on the higher terrace along the Rato Khola. It has yielded
Fig. 3. Tools with transversal trimmed cutting edge (adze/axe-like tools) from the Janauri anticline, Western Siwalik Frontal Range (drawings).
a rich (2590 artefacts) “macrolithic Mesolithic” industry mainly composed of flakes (80%) along with unifacial and bifacial “adzes”, choppers and core-scrapers. It also includes 6 “sumatraliths”, which are typical tools of the Hoabinhian. These artefacts are imbedded in a red soil developed in the upper part of the alluvial silt capping the terrace. Originally they might have been abandoned on the surface of the silt and later buried in it by bioturbation. A charcoal found in the same horizon as the artefacts provided a date of 7 ka BP and therefore a minimum age for the industry. Nearly half of the 83 “adzes” show a very distinct gloss on their transversal edge. This assemblage made from quartzite cobbles and boulders by splitting and flaking is interpreted as mainly oriented towards wood or bamboo working (Corvinus, 1987, 1989, 2007).

4. South-east Asia

The Hoabinhian was identified by Madeleine Colani in the late 1920s on the basis of lithic assemblages from the region of HoaBinh, east of Hanoi in North Vietnam (Fig. 1; Colani, 1927, 1929). It has been recognised in most parts of Mainland South-east Asia to South China, Myanmar, and Malaysia (Zuraina Majid, 1990) and in Sumatra (Forestier et al., 2005), where the “sumatraliths” had first been described. These large oval tools, unifacially shaped are the most typical stone artefact of this “industry” rather than “techno-complex” or “material culture” (Bowdler, 2008) but in most of the sites the lithic assemblages are mainly composed of cobbble tools, core tools and flakes. Some triangular “primitive axes” (Colani, 1927, 1929) and rectangular tools are also reported from North Vietnam (especially from the Xom Trai cave, near HoaBinh; Hà Van Tan, 1997) and from Northern Thailand (Zeitoun et al., 2008). The various studies on these lithic assemblages (reviewed by Marwick, 2007) usually conclude that they were mainly used for working wood and various vegetal matters.

In Northern Vietnam, the Xom Trai cave providing a typical Hoabinhian industry is dated by 14C to between 18 and 17 ka BP (Hà Van Tan, 1997). In Huang Cho rockshelter, the first occupation occurred around 30 ka BP (Yi et al., 2008), but the first stages may include only cobbble tools and flakes without the typical large unifacial tools known as “sumatraliths”. In several Vietnamese sites the industries preceding the Hoabinhian are identified as Sonvian (Hà Van Tan, 1997). In Thailand, especially in the rich province of Kanchanaburi, the Hoabinhian covers the time range of about 32 – 7 ka BP (Santoni et al., 1990; Shoocongdej, 2000). In the north, the lower levels in Tham Lod rockshelter are dated TL to 35 ka (Shoocongdej, 2006) but it is not clear whether Hoabinhian tools are from these lower levels. Similarly in South Thailand, the Hoabinhian starts around 35 ka BP at Lang Rongrien (Anderson, 1990), while at Moh Khiew, the lower level yielding a local facies of the Hoabinhian (Moser, 2001) is dated to 25 ka BP (Pookajorn, 2001). However, unlike in Vietnam, it is not sure in South Thailand and Malaysia that...
there is continuity between the earlier technical stages and the typical Hoabinhian (Bellwood, 1997).

Hoabinhian settlements are found both in caves or shelters and in the open. The former provide good information regarding the environment and subsistence behaviour of people who made and used such tool kits. These people were foragers and moving according to the seasons; they probably had different strategies during the wet and dry seasons. Their sites are usually located in forested environments and the stone artefacts are associated with large quantities of fresh water or sea shells (often boiled or burned at Moh Khiew; Pookajorn, 2001) and bones from small to medium sized animals (Shoocongdej, 2000; Auetrakulvit, 2004). Some sites, as in Vietnam, also yield abundant nuts, provided by an environment that was forested even during the colder but not dry Last Glacial Maximum (Viet, 2008). Open-air sites are especially characterised by huge accumulations of shells. A large number of such

Fig. 5. Tools with transversal trimmed cutting edge (adze/axe-like tools; triangular and elongated shapes) from the Janauri antcline, Western Siwalik Frontal Range.

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shell middens occur along the north-east coast of Sumatra and in the Malay Peninsula. They attest a human occupation from 12 to 3 ka (McKinnon, 1990; Forestier, 2007). More than the cave sites, they indicate an intensive exploitation of the marine or river food resources, but game from the forest is also found.

Wood and especially bamboo were probably used as main raw materials, as they are nowadays, for all the activities of the day to day life (Pope, 1989; Forestier, 2003). This might have given its specificity to the "Hoabinhian", which has to be better defined, not only on technological terms but also in relation to the climatic variations, subsistence strategies and territories (Zeitoun et al., 2008).

5. Discussion

All the industries presented here, mainly composed of unretouched flakes, cobbles tools and a few tools with transversal trimmed cutting edge (adze/axe-like tools), occur in sites located in the sub-Himalayan belt (between the Main Boundary Thrust and the Himalayan Frontal Fault) and its eastern continuation in northern South-east Asia. They belong to a geographic area occupied, nowadays, by the monsoon forest (clearly visible on satellite views such as Fig. 1), of which bamboo is a typical component. This forest grades into the tropical rain forest towards the south-east and to the mountain forest on the Himalayan slopes; it is bordered by the Alpine and savannah biomes and may be replaced by them according to the climate fluctuations.

It is difficult to reconstruct the exact landscape and environment associated to these particular lithic industries, all the more as they encompass several climatic phases including the end of the MIS 3, then the entire last glacial cycle as well as the subsequent warming and cooling phases of the first part of the Holocene. During this period the stone tool kit did not change much, apart from an increasing number of tools with a transversal trimmed cutting edge.

In the Nepali sub-Himalayas, these industries date back to 25 ka BP. They are even earlier (34–43 ka BP) at Sanpmarg, where the artefacts are lying on a red soil indicating milder conditions (Corvinus, 2007). They probably last till the beginning of the Holocene, as observed at Patu site, where they are also associated to a red soil. In the Janauri Anticline of Western Siwaliks, between Beas and Sutlej, they may date back to 20 ka or older, and in Northern South-east Asia, the Hoabinhian (and Sonvian in Vietnam) cover the same time period. In the North-West, comparable assemblages have been observed in the aceramic Neolithic of Srinagar valley (Pant et al., 1982) or in the upper Yarkhun Valley of Northern Pakistan (Gaillard et al., 2002; Dambricourt Malassé and Gaillard, this issue). These industries did not change much till the mid-Holocene, despite the global climatic alternation of cold and warm phases.

However, the sub-Himalayan belt provides specific conditions during the climate changes, which may be favourable to continuous (or nearly continuous) human occupation. The strong gradient of the mountain slopes offers refuges for the vegetation, which remains quite stable despite the climatic changes, since slight upwards or downwards shifts allows the biomes finding again their specific climatic conditions. This is observed for instance on the slopes of Tibetan Plateau in Eastern China (Qiu et al., 2009). Moreover the last glacial maximum (LGM) was not as severe as in most parts of the world. In the Himalayas, the maximal extension of...
the glaciers occurred during MIS 3, earlier than the global maximum (Owen et al., 2002). In the Kumaun Himalaya and Ladakh, for instance, the lake deposits have recorded detailed climatic alternations. Many lakes in this sector have formed as a consequence of a regional tectonic event that happened around 40 ka. At that time the climate was rather dry and cold; then it became more humid between 35 and 30 ka (Kotlia et al., 1997, 2000). This latter phase may be in relation with the paleosol at Sanpmarg in Nepal with cobble tool industry lying on it. After a short alternation (cold and dry, then warm and humid), the major glacial phase is recorded between 29 and 21.7 ka cal. BP in Kumaun (Kotlia et al., 2000) or between 28 and 21 ka BP in Ladakh (Bhattacharya, 1989), while only a short cold event is observed around 18 ka BP (Sharma, 1995), at the time of the global LGM. In North Thailand the late Pleistocene vegetation is forested with pine and oak as characteristic taxa (White et al., 2004). In North Vietnam charred plant remains and especially walnut trees indicate that during the LGM the conditions were rather cool but not dry (Viet, 2008). Therefore, the global LGM (18 ± 2 14C ka BP, corresponding to 21 ± 2 cal ka BP) was not the harshest period of the late Pleistocene in the Himalayas: due to dryness and snowfall decrease, the ice cover could not spread. The glaciers did not extend beyond 10 km from the present day ice margin (Owen et al., 2002) and among all the tropical and sub-tropical glaciers of the Himalaya the Hima-
layan glaciers show the smallest equilibrium-line altitude drop (100 m) from the present day altitude (Mark et al., 2005). Moreover, it appears that the climate variations are less abrupt in the Asian monsoon zone (Shakun et al., 2007). In the Andaman Sea the temperature during the LGM is estimated to be about 3 °C less than during the late Holocene (Rashid et al., 2007).

The relative stability of the forested environment and the abundance of perennial rivers and other water sources such as lakes, possibly linked to the constant tectonic activity, have certainly favoured a particular way of life that remained more or less the same throughout the late Pleistocene and early Holocene, until the Neolithic. The use of bamboo, wood and various types of vegetal raw materials may have induced the particular aspect of the lithic tool kit; some other tasks may also be involved. For example the cobble tool and flake industry from Votaw site on the Snake River (Washington State, USA) is supposed to be associated with fishing activities (Andrefsky, 2007). The abundance of shellfish in the Hoboinhan sites supports the idea of a subsistence strategy closely linked to the water foods. Why not apply this pattern to the Western Siwaliks, as the Soanian sites are mostly settled along the rivers? To date, the cobble tool assemblages have not been shown to be associated with shells; the absence of faunal remains in these open-air sites prevents any approach of the subsistence pattern (large or small game, shellfish, fish, etc.) and strategies (hunting, trapping, vegetal food collection, etc.). There is no possibility either to know how long the settlements lasted at each place, whether they were seasonally recurrent, and how wide were the territories of these foraging populations. The continuity of the forested environment all along the sub-Himalayan belt and its south-eastern extension was certainly favourable to population movements, especially as the upland regions (above 400 m) have been shown to be particularly rich in resources during the entire Paeleoolithic, providing opportunities to people to migrate eastwards (Schepartz et al., 2000) and probably westwards too. This "lithatudinal" circulation, or rather circulation along the geological structures in following similar geomorphological features, might have been forced by the marked contrast between the hilly forested envi-
ronment, rich in quartzitic or other siliceous raw material (as far as stone is concerned), and the indus-gangetic plain lacking such material (Dennell, 2007) and therefore implying other behaviours. The sharply different lithic industries in peninsular India, where blade and bladelet technology is widely applied in the same time period, confirm that this vast plain was a barrier, or at least a border separating two types of behaviours. As the Movius line is slowly vanishing from the concepts regarding the Asian Lower Pae-
leoolithic, this new line, partly superimposed to the former one, appears as clearly related to the late Pleistocene and early Holocene environment.

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