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RESEARCH ARTICLE

# Prehistoric nests of Mud Dauber Wasps (Hymenoptera: Sphecidae) discovered in Transylvania, Romania

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## Abstract

Fragments of mud dauber wasp's nests dating from the Bronze Age (Noua culture, about 1500–1200 BC) from a Romanian archaeological site are described. The present discovery represents, to our knowledge, the first reported fragments of mud dauber nests recuperated from an archaeological site in Romania and probably among the rare ones from Europe. The archaeological site called Zoltan-"Nisipărie" is placed in the Covasna County, south-eastern Transylvania. The five fragments belong to two nests made by *Sceliphron* sp. wasps genus and they were described in terms of general and detailed morphology and morphometry. Two nest fragments preserve *in situ* secondary cells, showing evidence of nest reoccupation by other insects. Another important aspect of this discovery is the opportunity to extract and analyse a whole secondary cell from the original nest fragment. Various impressions of vegetal material (grass, straws etc.) and a seed on the nest fragments' surface were observed using microscopic techniques. The preserved pieces recovered from archaeological investigations provide important data regarding the local environmental conditions during the recent period of Bronze Age in an anthropized environment of the Noua culture.

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**Keywords**
archaeology, Bronze Age, mud dauber wasp nest, Noua culture, prehistory, Sceliphron, Transylvania-Romania, Zoltan.

## Introduction

Zoltan is a village (included in Ghidfalău commune) placed at 8 km of Sfântu Gheorghe, Covasna County, Romania. The archaeological site called "Nisipărie" is placed in the Olt Meadow at the northern side of the village. In 1970 the archaeological site was accidentally discovered by the local inhabitants and the specialists from Covasna County Museum (the former director Székely Zoltán) were announced. During 1971–1972, Dr. Zoltán carried out extensive archaeological research from which he recovered important archaeological materials. In 1996, the research was re-taken by Valerii Kavruk, the manager of the National Museum of the Eastern Carpathians. During 1996–2001 the archaeological excavations were carried out in the southern area of the site. Non-invasive research was carried out in 2005 and between 2015–2018. The archaeological excavations were restarted in 2021 (Cavruc 1997; Popa 2016; Ștefan 2016; Kavruk 2022).

The nest fragments retrieved from the Zoltan-"Nisipărie" site were identified as belonging to the *Sceliphron* wasp species (mud dauber wasps), possibly to *S. destillatorium* (Fig. 1), the native species nowadays in Romania. Mud dauber wasps (Hymenoptera: Apoidea: Sphecidae) are found in all biogeographical regions of the world, in all of the temperate and tropical continental areas (Pham 2016). Adults are diurnal and active starting from late spring and during the summer in temperate regions (Coville 1987). The females build interesting nests out of mud, often attached to various surfaces (e.g., the walls of buildings, under eaves, in the attics, under bridges) and which resist over time due to mineralization. The nests petrify after abandonment and can survive in open shelters for tens of thousands of years (Roberts et al. 1997; Finch et al. 2019). Regarding the Sphecidae fossil record, it should be mentioned that the oldest fossilized forms (preserved in Baltic amber) date from the Oligocene and can be found in the collections of the Massachusetts Museum of Comparative Zoology, United States (Bohart and Menke 1976). Mud wasps of the genus *Sceliphron* Klug, 1801 are solitary wasps that are morphologically and behaviourally uniform (Bokart and Menke 1976). The genus *Sceliphron* currently comprises 35 species globally (Pulawski 2020). Seven species are reported from Europe, four of them native (Barbier 2013) and three introduced (Ćetković et al. 2011). At the moment, there are three *Sceliphron* species reported for Romania: the native *Sceliphron destillatorium* (Illiger, 1807) and the invasive *Sceliphron curvatum* (F. Smith, 1870) (Popescu 2014) and *Sceliphron caementarium* (Drury, 1773) (Gagiu 2012). *S. destillatorium* is present in all Romanian regions, with the oldest mention made by Mocsáry in 1874 (Mocsáry 1874, 1897, 1900; Szilády 1914; Müller 1930; Lehrer and Scutaru 1963).

**Figure 1.** A female of *Sceliphron destillatorium*, Romania (Photo: Irinel Eugen Popescu).

The nesting biology of wasps in the genus *Sceliphron* is well studied. All species build their nests by moulding separate cells in which they store food (spiders) for the young. The nest cells are built from mud transported to the nest by the female (Bokart and Menke 1976). Nests are usually composed of several tubular cells arranged side by side, where the female lays the eggs (Park et al. 2022). The cells are concentrically built around the lumen (Polidori et al. 2005). Each tubule-shaped cell is constructed from mud and a local source of water or even dew. The female uses mud collected from the ground that is shaped in the form of a spherical ball which is carried to the nest with the help of its front legs and mandible (Bohart and Menke 1976; Nachtigall 2001; Polidori et al. 2009). Afterwards, the female spreads the mud into a thin layer along the cell wall (Shafer 1949). At the same time, the plastered mud layer is compacted with the aid of the first pair of legs and mandibles by repeatedly striking it, an activity that creates a specific noise (Camillo 2002; Fink et al. 2007). The time for finishing a cell varies according to the availability of construction material (mud), water supply, and environmental disturbances. Finalizing each cell can vary from 20 minute to several hours, or even a whole day, sometimes 30 to 40 trips for collecting the mud being necessary (White 1962; Ferguson and Hunt 1989; Matthews 2010; Peckham and Peckham 2011).

After a cell is completed, a period of inactivity of at least one hour and up to two days is required to allow the clay to dry (White 1962). After this interval, the cell is supplied with paralyzed spiders as food for the developing larva. Studies have shown

that depending on the wasp species, each nest cell can be stocked with up to 25 spiders (Obin 1982; Matthews 2010). It should be noted that the cells are built and supplied one after the other, not all at the same time. After oviposition, the female covers the cell opening with mud, subsequently starting the construction of the next cell (Shafer 1949). After building several cells, a thick layer of mud is sometimes added to cover them, with the role of conferring additional protection against predators and preventing nests from disintegrating under the action of rain (Polidori et al. 2005).

Considering that this type of archaeological discovery is very rare in Romania and the excellent preservation conditions of the pieces, along with some quite interesting entomological elements, we aim to analyse these objects trying to highlight the information exclusively preserved by these nest fragments that are related to prehistoric habitation - entomological environment relationship within an anthropized landscape dated from 3300–3500 years ago.

## Material and methods

### Context – study area

The surface of the settlement (about 18 ha, 1,000 × 200 meters) has been identified and the stages of site habitation were highlighted (Aeneolithic – Ariușd-Cucuteni culture; Final Aeneolithic – Coțofeni I culture), Bronze Age: early period (Gornea-Foeni-Iernut-Zoltan cultural aspect); middle period (hybrid cultural aspect Zoltan – unknown in Transylvania – which combines elements from Wietenberg, Tei, Monteoru and Costișa-Ciomortan cultures); late period, about 15$^{th}$ – 12$^{th}$ centuries BC (Noua culture with Wietenberg elements). Zoltan-"Nisipărie" is the most important settlement for the last above-mentioned culture within the intra-Carpathian region (due both to its extent and results of the research) (Cavruc and Cavruc 1997; Popa 2016; Ștefan 2016; Beldiman 2002a; Beldiman 2002b; Kavruk 2021).

In the excavated area, traces of a burnt rock construction and more than 50 pits with rich and diverse archaeological inventory (potsherds, objects made from bronze, bone, antler, animal bone fragments, fragments of wattle and daub walls) were discovered. During the first archaeological campaign (1996), Pit no. 10 was discovered. It contained three fragments of mud wasp nests. Other two fragments were discovered in 1999 within the archaeological layer dated from Noua culture. This scientific material has not been previously published.

The present description of nest fragments proposes a series of conventions and abbreviations to be used in this paper in order to make the exact identification, description and definition of each fragment and detail possible (Table 1). These abbreviations are hierarchically assembled in a taxonomy that facilitate the exact location of the items, starting from the nest to each detail specific for a fragment (cells, secondary cells, clay lids, impressions of plant stems, seeds). The five fragments were

**Table 1.** Conventionally defined elements of description – abbreviations.

| Abbreviation | Meaning |
|---|---|
| A_1, A_2 etc. | Impression(s) |
| a) - b), b) - c) etc. | Margins of the sides (of the fragment of mud dauber nest) |
| C_1, C_2 etc. | Cell(s) |
| CB_I, CB_II | Mud dauber nest |
| CP | Clay lid (of the cell) |
| CS | Secondary cell(s) |
| Einf | Inferior extremity (of a cell, impression) |
| Esup | Superior extremity (of a cell, impression) |
| F_A, F_B etc. | Side(s) (of the fragment of mud dauber nest) |
| FC_I, FC_II etc. | Fragment (of mud dauber nest) |
| S_1 | Seed |

described in terms of general morphology and other details (Tables 1–2), to which morphometric data is added (Tables 2–3).

All pieces are fragments of clay/mud nests. They are conserved in the archaeological collection of the National Museum of Eastern Carpathians, Sfântu Gheorghe, Covasna County. CB_I / FC_I (inventory number 25837) and CB_I / FC_II (inventory number MNCR_25838) fragments come from the first nest (CB_I) (Figs 2–11), and CB_II / FC_III (inventory number MNCR_27535a), CB_II / FC_IV (inventory number MNCR_27535b) and CB_II / FC_V (inventory number MNCR_27535c) fragments come from second nest (CB_II) (Figs 12–15).

The pieces were systematically examined with a magnifying glass (magnifier, 5×) and with a stereomicroscope (Leica M80 stereomicroscope, Leica Microsystems, Germany) with a standard magnification of 7.5× – 60×, equipped with a digital camera DFC290HD. The aim was to highlight and identify (in order to define and analyse) all the morphological details of the wasp nest fragments, which would allow


**Figure 2.** Mud dauber wasp nest fragment (CB_I / FC_I) from Zoltan – "Nisipărie": general view on the five sides.

**Table 2.** Conventional elements of description – quantitative status.

| Nest | Fragment | Impressions | Inventory number | Cells | Secondary cells | Clay lid(s) | Seed | Dimensions (L/W/T) (in mm) |
|---|---|---|---|---|---|---|---|---|
| CB_I | FC_I | A_1 – A_9 | MNCR_25837a MNCR_25837b | C_1 – C_8 | CS_1 – CS_2 | CP_1 | - | 39.38/32.32/31.35 |
| | FC_II | A_1 – A_2 | MNCR_25838 | C_1 – C_13 | CS_1 – CS_3 | - | S_1 | 41.78/34.52/33.49 |
| CB_II | FC_III | A_1 – A_3 | MNCR_27535a | C_1 – C_7 | - | - | - | 45.95/30.73/32.81 |
| | FC_IV | - | MNCR_27535b | C_1 – C_2 | - | CP_1 | - | 25.82/20.11/10.95 |
| | FC_V | A_1 – A_5 | MNCR_27535c | C_1 – C_4 | - | - | - | 35.98/31.82/15.84 |

an exact comprehension of the way in which they were shaped, how the impressions were generated and how they were fractured.

The basic elements used in the description were identified: cells; secondary cells; cell lids; impressions of plant stems; seeds fixed on the surface of a fragment; the surfaces of the nests which were attached on the supports (wooden and clay constructions - walls, roof) and the specific impressions produced by them; the impressions of the plant elements of the fixing structures embedded in the clay mass (straw, blades of grass). These details allowed the proposal to reconstruct the way of fixing the nests.

All the observed details of each fragment were recorded in digital images (general views, details, macrophoto, microphoto), some of which were used to create the illustration of this article.

The five wasp nest fragments come from two different archaeological contexts; according to their general as well as detailed morphology (cells, clay composition, traces of accidental burning in prehistory) we may advance the idea that they belonged

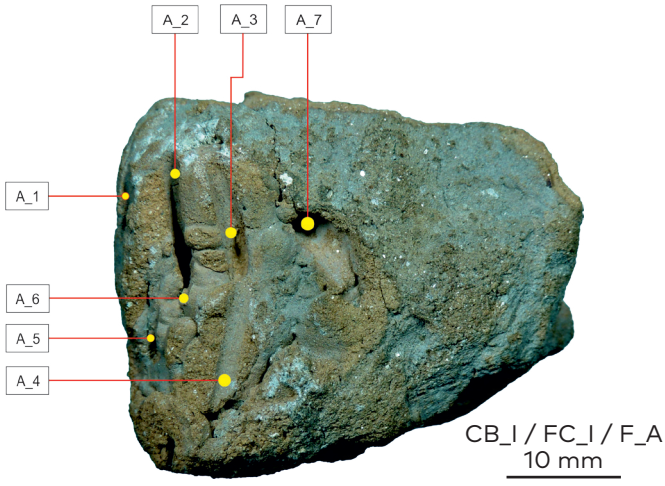


**Figure 3.** Mud dauber wasp nest fragment (CB_I / FC_I / F_A) from Zoltan – "Nisipărie": details (impressions).

**Table 3.** Morphometry/Dimensions of the elements of description (cells, secondary cells, clay lids, impressions, seed) (in mm).

| Parameter | CB_I | CB_II |
|---|---|---|
| Length of cells | 21–30 | 21.27–25.75 |
| Diameter of cells | 7.12/6.82–10.45/8 | 11.35/7.80–13.60/12.75 |
| Thickness wall of cells | 2–2.25 | 1.60 |
| Length of secondary cells | 25–27 | - |
| Diameter of secondary cells | 7.50/8.80 | - |
| Thickness wall of secondary cells | 1.50–1.75 | - |
| Diameter of clay lids | 6.70/6.62 | 9.27/8.70 |
| Length of impressions | 3.75–21.30 | 23.75 |
| Diameter of impressions | 2–4 (grass, straw), 11 (reed, branch) | 17 (reed, branch) |
| Diameter of seed | 2 | |

to a number of two nests with different morphologies and dimensions; two fragments are from nest I and three fragments from nest II. The first two fragments do not allow the reconstruction of the original shape of the nest, while the other three can be juxtaposed/set side by side and thus, offer the possibility of reconstructing the original shape of the nest in a proportion of over 80%. The old nests were compared with contemporary mud dauber nests from "Grigore Antipa" National Museum of Natural History collections.


**Figure 4.** Mud dauber wasp nest fragment (CB_I / FC_I / F_B) from Zoltan – "Nisipărie": details (impressions).

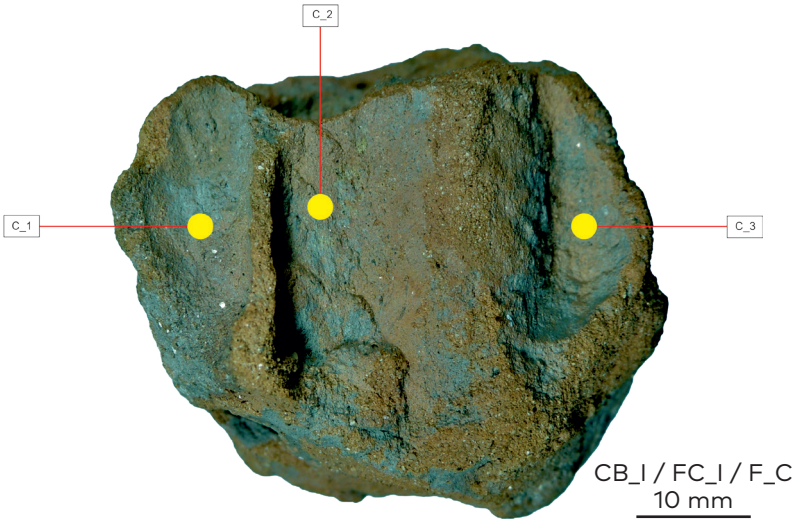


**Figure 5.** Mud dauber wasp nest fragment (CB_I / FC_I / F_C) from Zoltan – "Nisipărie": details (cells).

## Results

The nest fragments identified at Zoltan – "Nisipărie" were built by *Sceliphron* wasps. The confirmation is given by the specific relief pattern present on one side of the nest, while the opposite surface is flat and smooth (Fig. 3) because the nest is usually fixed to a vertical substrate, with the cells adjoined one another along the nest's long axis (Bown and Ratcliffe 1988). The similarity between contemporary (Figs 16, 18) and archaeological (Figs 6, 10) mud dauber nests is also obvious.

The initial nests were most likely medium in size (about 150 mm in length), semi-circular or half-oval in shape, and fixed with two sides on the surface of wooden buildings, walls made out of clay mixed with vegetal stems (grass, straw) applied on wood (wattle and daub), roofs probably made of materials such as reed, bulrush or branches with bark. The nests were probably located in the upper part of the walls and at the interior side of the roof, under the eaves (one contemporary example in Fig. 18). For the morphometry of each fragment see Tables 1–2.

The fragments were broken in prehistory (intentionally or accidentally) but also at archaeological excavation, only partially on small areas. The fragments have the general shape of an asymmetrical polyhedron of various dimensions, with triangular, trapezoidal, pentagonal, and hexagonal sides; the colours are light grey, brown-orange and red (CB_I), grey or brown-grey with uneven burning traces (CB_II). Burning could have occurred in prehistoric times after nest's break, in the pit or at the surface of the soil at the same time with the building or after being thrown in the pit. Fragments are moulded in hard compact clay, with a different composition than the one at the discovery place. Those belonging to CB_I nest contain sand with microscopic fragments of limestone, molluscan shells, rocks, mica, while those from nest CB_II

contain microscopic rock fragments (Fig. 11). The construction of the cells resorted to the economic solution of completing (at least 1/4) of the circumference of a new cell with that of a pre-existing cell, on which a new one was modeled (sharing a common wall). Secondary cells are moulded in friable clay with a composition of microscopic rock fragments, limestone included (Fig. 8). The cells and the spaces between them preserve the specific wavy aspect resulted from successive addition of mud balls and their shaping (Figs 5–7).

The nest fragments preserve a various number of cells which are whole or fragmented, long and narrow, with curved walls, circular, oval or triangular in section with rounded corners and concave ends, N = 21 (CB_I) (Fig. 7) or short, oval and wide, oval sections and concave ends, N = 13 (CB_II) (Figs 12, 15). Some of them preserve at an end the opening done by the adult by chewing when emerging. Two cells preserve the clay/mud lid, circular/oval which covered the cell, N = 2 (Figs 6, 14): one clay lid is entire, but still fixed on a fragmentary cell; some details observed, it suggests that the young adult chewed not the clay lid, but a small adjacent area to emerge (CB_II, Fig 14). The other mud lid is whole, and still *in situ*, fixed on a sealed cell, suggesting the adult didn't emerge (Fig. 6). The X-rays investigation (in progress) will provide further details in this respect. Some of CB_I cells preserve *in situ* secondary cells (parasite or not), N = 5, which are whole or fragmented, cylindrical, long and narrow, with curved walls, circular/oval in section, with one end concave and the other one open (Figs 6–7); exceptionally, one of the secondary cells (CB_I / FC_I / CS_2), a whole one (inventory number MNCR_27835b), was extracted from

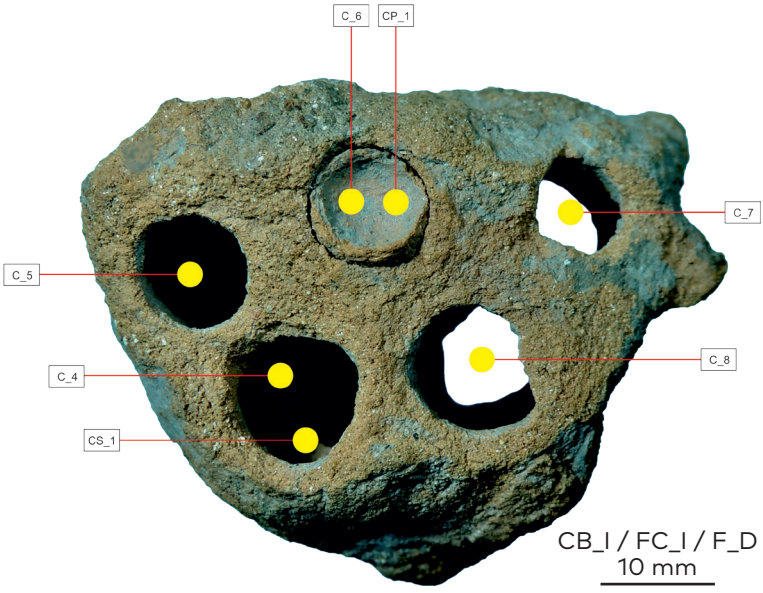


**Figure 6.** Mud dauber wasp nest fragment (CB_I / FC_I / F_D) from Zoltan – "Nisipărie": details (cells, secondary cells and clay lid).

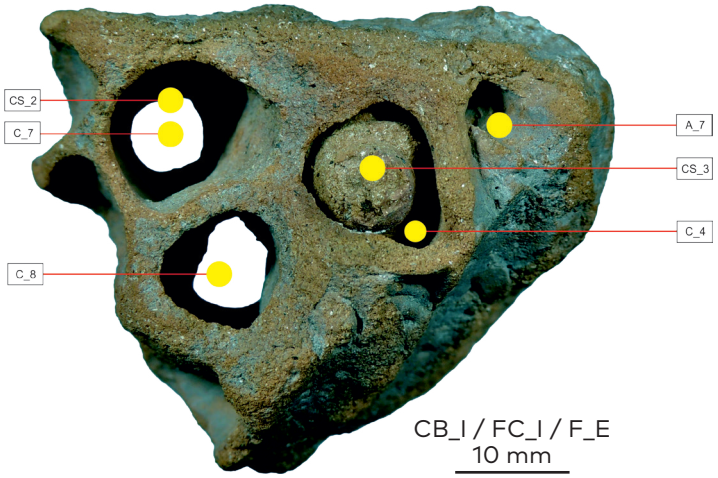


**Figure 7.** Mud dauber wasp nest fragment (CB_I / FC_I / F_E) from Zoltan – "Nisipărie": details (cells, secondary cells and impression).

the original cell and further analysed (Fig. 8). Similar secondary cells were observed also on the contemporary *Sceliphron* nests (Fig. 17).

Soil characteristics affect the lifting dynamics of wasps and their load-carrying capacities. For example, for *S. destillatorium* the dry mud ball mass weighs about 0.07 g (Polidori et al. 2009). Supposing that the nest fragments belong to this species, we can approximate the total number of mud balls used to make the prehistoric nest fragments from Zoltan-"Nisipărie". Fragments from CB_I weigh 42 g, being made of about 600 mud balls. Fragments from CB_II weigh 20 g and were made of about 285 mud balls. The number of mud balls corresponds to round trips taken by the wasp between the nest and the clay source.

The mud ball formation activity in *Sceliphron* wasps is similar among species and comprises four different phases: I) patrolling the ground in search of a suitable place for mud-ball building; II) removing twigs, leaves or small pebbles from the selected area; III) forming the mud balls; and IV) flying off with the mud balls. There are different time indices for these phases depending on the species. For example, for *S. destillatorium* the total time spent in mud ball construction, considering that the maximum registered values are 26.83 seconds on average (Chatenoud et al. 2012). Taking into account this optimal value and the possibility that the nest fragments belong to *S. destillatorium*, the estimated effective work time for the CB_I is about 3 hours. Similarly, the estimated effective work time for the CB_II fragments is about 1 hour 50 minutes.

On the fragments' surface, various impressions of plant stems (probably reed, bulrush, branches with bark, grass, straws) (CB_I, N = 9; CB_II, N = 5) (Figs 3–5, 12, 15) have been produced by the structure on which the nests were fixed (wood walls, clay with grass and chopped straws applied on wooden walls – wattle and clay,

roof made from reed/bulrush); some of this vegetal material has also been integrated in the nest's clay walls between the cells (CB_I) (Figs 3, 7, impression A_7). The impressions are sometimes on different sides of the nest fragment and the initial numbering on first side was kept on the next one in order not to generate confusion in the identification and description processes. On CB_I surface an area with a spherical seed is preserved (Fig. 10, S_1). The seed is possible to have been fixed accidentally or carried out (covered by clay) by the mud dauber wasp during the nest building process The impressions and the seed are currently the subject of archaeobotanical investigations for establishing the plant species (in progress).

## Discussion

### The entomological and archaeological value of this discovery

The present discovery represents, to our knowledge, the first reported fragments of mud dauber nests discovered in a Romanian archaeological settlement and probably among the rarest in Europe. At this stage of our study, we have not identified other


**Figure 8.** Mud dauber wasp nest fragment (CB_I / FC_I / F_E and CS_2) from Zoltan – "Nisipărie": general views of CS_2.

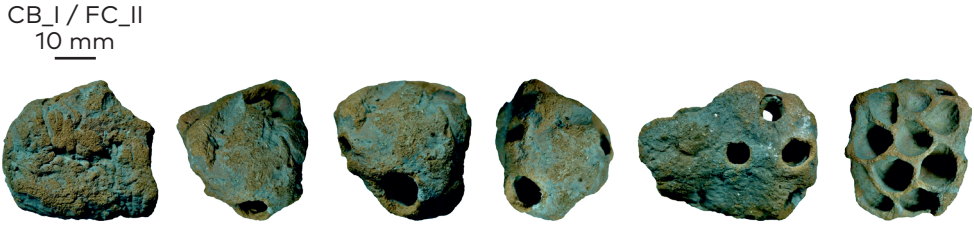


**Figure 9.** Mud dauber wasp nest fragment (CB_I / FC_II) from Zoltan – "Nisipărie": general view on the five sides.

wasp nests recovered from archaeological environments in Romania, regardless of age, culture etc. Similar discoveries were reported from Australia on the walls of rock shelters used by human groups as habitation or sacred places (rock art) (Hansell 2007) and from the Americas, where burning structures from late prehistoric and historic sites are preserved (Freimuth and LaBerge 1976). The remains of prehistoric mud wasp nests were also discovered in other archaeological researches in North America, until 1973 a total of 60 nests having been identified and examined from archaeological sites in the Mississippi area (Freimuth and LaBerge 1976). Krakker reported black and yellow mud dauber nests associated with human habitation in the middle Holocene

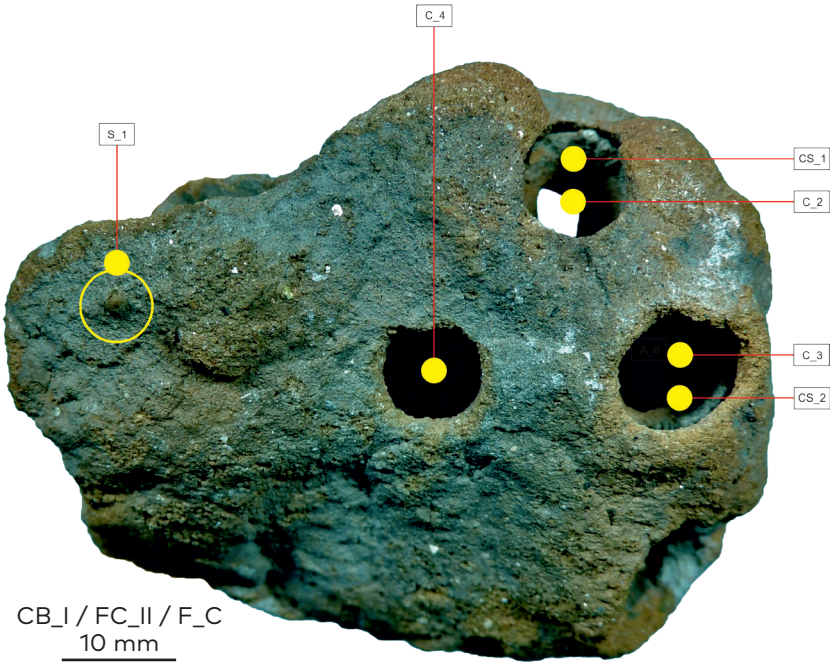


**Figure 10.** Mud dauber wasp nest fragment (CB_I / FC_II / F_C) from Zoltan – "Nisipărie": details (cells, secondary cells, seed).

in Missouri. The study mentions the importance of prehistoric wasp nests, describing them as eloquent archaeological markers for the presence of human communities and dwellings characteristic of the mid-Holocene period (Krakker 2012).

For now, the discovery from Zoltan-"Nisipărie" seems to be a quite rare discovery for Romania and, perhaps, for Europe. It is remarkable because it dates from 3300–3500 years ago (according to the general chronology of habitation vestiges, Noua culture) and due to the excellent state of conservation of the fragments which enabled the systematical, detailed analysis of the surfaces using a stereomicroscope.

The presence of nests in the archaeological site suggests a safe environment for wasp life and the proximity of clay and food sources for wasps and larvae (spiders). Thus, the mud dauber nests discovered at Zoltan-"Nisipărie" indicate a specific anthropogenic environment from the Bronze Age in Transylvania. The nest fragments also represent archaeological evidence for a sequence in the life cycle of wasp species in the genus *Sceliphron*. Their life cycle is simple and linked to environmental resources. After the nest is built, a single egg is laid on the abdomen of one of the spiders in each cell, usually on the first introduced spider (Smith 1979). Other paralyzed spiders are added to the cell which is sealed afterwards. The egg hatches after a few days (depending on external temperature) (Fowler 1987; Smith 1979) and the larva feeds on the paralyzed spiders. After the consumption of the entire available food, the fully grown larva makes an oblong brown cocoon covered in sparse webby white

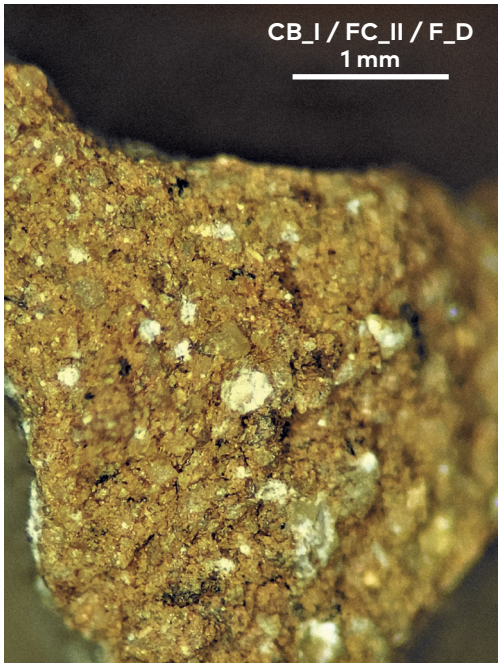


**Figure 11.** Mud dauber wasp nest fragment (CB_I / FC_II / F_D) from Zoltan – "Nisipărie": microscopic view of a transverse section of a cell wall – compozition of clay.

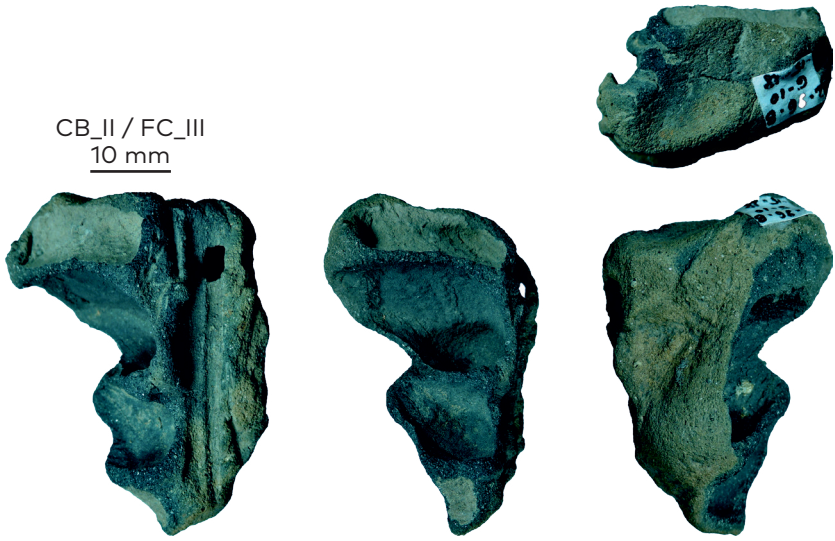


**Figure 12.** Mud dauber wasp nest fragment (CB_II / FC_III) from Zoltan – "Nisipărie": general view on the three sides.

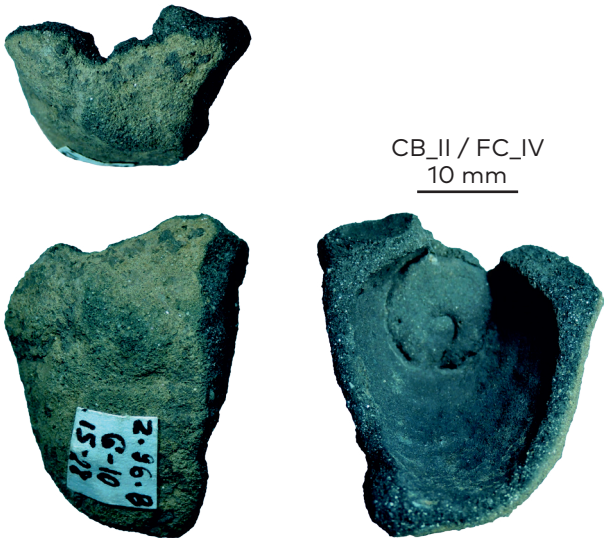


**Figure 13.** Mud dauber wasp nest fragment (CB_II / FC_IV) from Zoltan – "Nisipărie": general view on the three sides.

silk. Within this cocoon, its development is finishing and it emerges as an adult wasp. It depends on the species and oviposition moments if the species go through hibernation or not. Generally, larvae from eggs laid early in the summer (June–July) do not hibernate in the larval stage and develop constantly, emerging in 19 to 25

days (Rau and Rau 1918). The length of the larval stage is of considerable interest since larvae that hatch late in the season (August–September) hibernate in this stage, thus they do not develop during cold periods (Bodine and Evand 1932). The larva remains in this prepupal stage until the beginning of the following summer, when it will pass into pupal stage by moulting. After this stage, the adult characteristics are acquired gradually over a period of weeks. *Sceliphron* adults with already expanded


**Figure 14.** Mud dauber wasp nest fragment (CB_II / FC_IV / F_B) from Zoltan – "Nisipărie": detail.

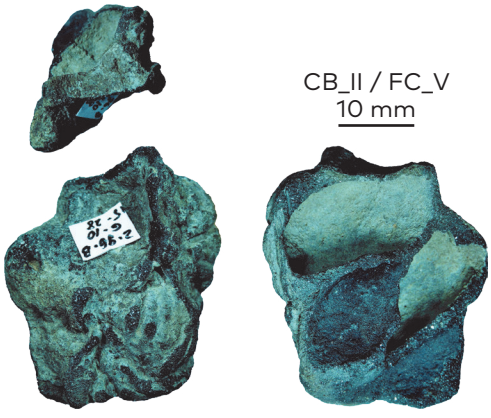


**Figure 15.** Mud dauber wasp nest fragment (CB_II / FC_V) from Zoltan – "Nisipărie": general view on the three sides.

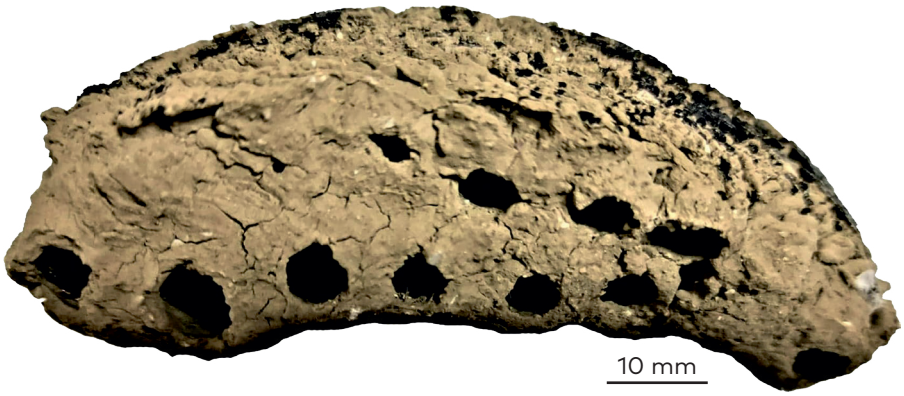


**Figure 16.** Contemporary mud dauber wasp nest - front view with open cells (Collection of "Grigore Antipa" National Museum of Natural History, Bucharest).

wings emerge from the cells in which they developed by chewing their way out of the cocoon and the mud cell (Smith 1979). After emergence, they leave behind cavities with hard walls and different diameters depending on the species that built them. For example, in the case of *S. destillatorium*, the open cell size varies between 6.5 × 22 mm and up to 12 × 36 mm (Fateryga and Kovblyuk 2014).

The synanthropic character of *Sceliphron* species (Bilanski et al. 2014) is an important aspect of the discovery of Zoltan-"Nisipărie" settlement. The presence of mud dauber nests could indicate that durable structures (such as human dwellings) existed for a long enough period of time in summer months for the wasps to build nests. However, the occupancy of this type of structures was not necessarily limited only to the warm season (Krakker 2012).


**Figure 17.** Mud dauber wasp nest - front view with open cells and secondary cells (Collection of "Grigore Antipa" National Museum of Natural History, Bucharest).

Although no species of *Sceliphron* is known to reuse its own cells (Fateryga and Kovblyuk 2014) or conspecific cells (made by other species in the same genus) (Starr et al. 2018), there are still other species that "take advantage" of such already made cavities left by mud wasps, behaviour commonly known as "renting" (Iwata 1964; Spurway et al. 1964). The nest fragments discovered at the Zoltan-"Nisipărie" settlement show some secondary cells (Figs 6–7) which are probably not part of the original nest, but most likely belong to a species that builds its own cells inside other abandoned nest cells. The species that reuse empty *Sceliphron* nests may be parasitic or ones that just reuse other abandoned nests (inquilines or re-users) (Pham et al. 2021). This behaviour is well documented. Fateryga and Kovblyuk have observed that out of 250 abandoned *S. destillatorium* nest cells, 215 were occupied by other "tenants" such as bees and wasps belonging to 17 species in 8 genera. The most common such "tenants" are solitary bees from the *Megachilidae* family, as well as some species in the genus *Osmia* Panzer, 1806, while the second most common are species from the *Vespidae* family (Fateryga and Kovblyuk 2014).

From an entomological point of view, the data presented here increase the knowledge on the capacity of some other insect species to use pre-existing nests. Certain studies (Michener 1974) suggested that reoccupation of nests is important in the evolution of social systems, especially for certain taxa that are less advantaged


**Figure 18.** Mud dauber wasp nest *in situ* on wooden structure (Collection of "Grigore Antipa" National Museum of Natural History, Bucharest).

(Bonito et al. 2011). Prehistoric nests are sometimes treated as curiosities by archaeologists (when they are recuperated). However, arthropods (spiders or wasps) can be excellent environmental indicators and mud nests are among the few preserved remains containing such macroscopic arthropods (Harris and Connaway 2018).

The preserved plant impressions also document the placement of nests on wooden structures with clay walls, at the intersection of vertical wooden wall + clay with the oblique roof made of plant elements (stems). The morphological details of the pieces, identified through the systematic microscopic analysis of the surfaces, revealed details (indirect evidence) regarding the existence on the site of some building-type structures (residential, other destination) with wooden walls with or without a reed or bulrush roof.

## Conclusions

The old mud dauber nest fragments (from 1500–1200 BC) from Zoltan-"Nisipărie" site represent an important discovery from an archaeological site. We also present for the first time in Romania the case of empty prehistoric mud dauber nest cells with several secondary cells preserved *in situ*, some of them whole, others fragmented. Therefore, we had the rare opportunity to document a case of other species reusing *Sceliphron* sp. nests. More methods (radiography, computed tomography, OSL - optically stimulated luminescence, SEM - scanning electron microscopy) are needed to elucidate the composition of nest fragments (organic content, physical properties of the soil, distribution and concentration of nest elements) and establish the correct relationship between the nest itself and the secondary cells.

The present work represents a starting point for further research on the relationship between two fundamental fields: biology (entomology) and archaeology. Mud wasp nests are often built on man-made structures such as roofs, eaves, bridges or building walls. The present discovery illustrates an anthropogenic environment in Romania during the Bronze Age. On the other hand, burnt wasp nest fragments represent a clear archaeological marker of house construction, as during the Bronze Age, houses burned very often so it is very probable that this type of objects would be present (Krakker 2012). Mud dauber nests contain some vegetal impressions (branches with bark, spores, grass) from which important and sometimes unique information on the Bronze Age environment (vegetation) can be achieved.

This paper highlights the importance of such entomological structures and aims to stimulate the interest for other eventual not published or not yet signalled similar materials from other archaeological sites from Romania and/or from abroad. The present study also wants to draw attention to this type of archaeological objects located, and sometimes forgotten, in museum repositories, in research institutes or are still undiscovered.

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