# THE MOLLUSCS OF THE DWELLING MOUND GOMOLAVA, YUGOSLAVIA

## AN ENVIRONMENTAL INVESTIGATION ON AND NEAR GOMOLAVA

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## CONTENTS

# 1. INTRODUCTION*

Gomolava, in Yugoslavia, is a dwelling mound on the left bank of the river Sava near Hrtkovci, a small village about 60 km north-west from Belgrade (fig. 1). The mound shows eight periods of habitation, the oldest belonging to the Vinča culture that, with the aid of C14, may be fixed at c. 4000-3800 B.C. (Clason, 1977). The most recent traces, including a burial-ground, date from the early Middle Ages (table 1).

After trial excavations during the fifties, it was decided in 1970 to excavate the tell, as systematically as possible, in its entirety. The location of Gomolava along the outside bend of the river Sava, has largely contributed to this decision. For, owing to erosion, portions of the tell disappear into the river every year. Its original surface area has no doubt been bigger than what now remains (about 230 x 45 metres) (fig. 2). In the earliest periods of its habitation, the tell may possibly have been situated at some distance from the Sava. It is more than 5 metres high.

The excavations that still continue are being carried out by the Vojvodjanski Muzej of Novi Sad and the Universities of Belgrade and Novi Sad, under the direction of Dr. B. Brukner, Dr. B. Jovanović and Dr. N. Tacić.

Staff-members of the Biologisch-Archaeologisch Instituut at Groningen take part in the Gomolava-excavations in pursuance of a co-operation between this institute and the Vojvodjanski Muzej, as provided for in the Yugoslav-Dutch Cultural Treaty.

The mollusc material, which is the subject matter of this research, was excavated in 1976, 1977 and 1980. Material excavated in 1980 was collected by myself in co-operation with Drs. D.C. Brinkhuizen of the Biologisch-Archaeologisch Instituut at Groningen.

Object of the present research was to examine whether conclusions may be drawn from mollusc material found in dwelling mounds. It was mainly focused on a reconstruction of the environment of the tell Gomolava and, under supervision of Dr. A.T. Clason, carried out as an optional part of a university course in biology, following a staff-membership of the Archaeozoological Department of the Biologisch-Archaeologisch Instituut at Groningen.

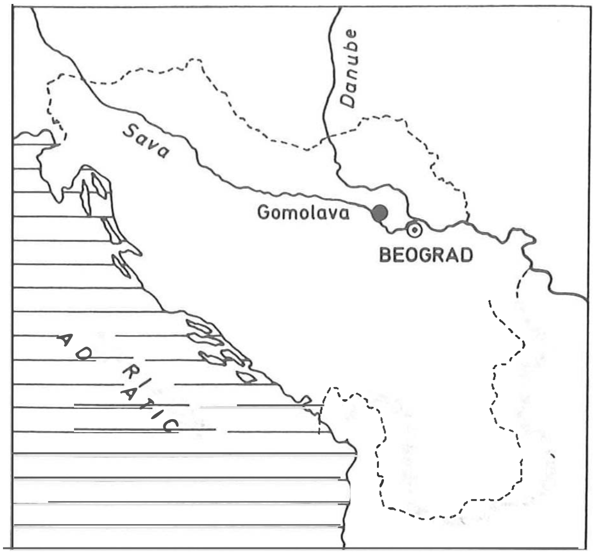


Fig. 1. The geographic location of Gomolava, Yugoslavia.

# 2. THE HISTORY OF MOLLUSC RESEARCH IN ARCHAEOLOGY*

As a hunter and a food-gatherer man has always affected his surroundings more or less. But when the domestication of animals began and farms came into being where crops were grown, his influence increased considerably. Forests were cut and the resulting clearings used for various purposes. Investigations of the environment of such farms is therefore most interesting and data derived from it may afford some insight into the way in which these early dwellers lived and how they used their land.

Following the development of pollen analysis it became possible to recognize the re-

* Tables 4, 5, 7-13 and the Appendix have been reproduced as microfiches (1:A1-B6) in an envelope attached to the rear of this volume.

* In part after Evans (1972: p. 3 ff.).

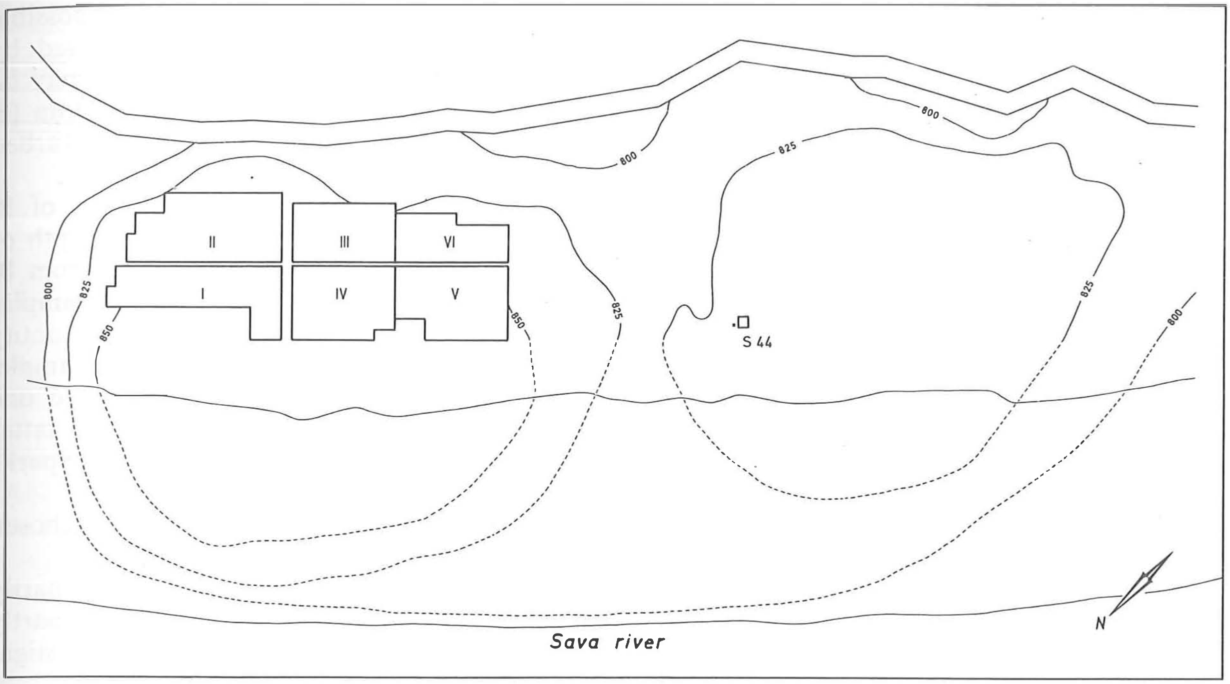


Fig. 2. The dwelling mound Gomolava. Schematic lay- out.

gional vegetation of certain areas. At first the local structure of the vegetation could only be determined by macroscopic plant fossils. Now, with the use of three-dimensional pollen diagrams, local aspects, such as big clearings in woods, can also be distinguished (Turner, 1975).

As pollen grains can not be preserved quite so well in a basic as in an acid environment, one was, when examining settlements in calcareous areas, forced to look for other means. Therefore, the generally large numbers of molluscs in these areas seemed, together with the local information they may divulge about their earlier environment, eminently suitable for further study.

In the beginning of this century, much research on mollusc material of late prehistoric periods in the calcareous countryside of South-east England was done by A.S. Kennard and B.B. Woodward.

B.W. Sparks introduced for the first time a classification of mollusc species in ecologically related groups. He made use of histograms in which, on a similar basis as in pollen analysis, the occurrence of these groups is shown in percentages (Sparks, 1961). He spent a great part of his investigation on molluscs contained in fresh-water deposits from the Pleistocene, in which period climatic factors may also play an important role in the diffusion of snails (Sparks, 1964).

On the basis of the same techniques, M.P. Kerney and J.G. Evans studied Late-Glacial deposits in South-east England (Kerney, 1963).

Outside England the investigation of snail material from Pleistocenic deposits was carried out mainly in Central Europe. Calcareous loess deposits in Czechoslovakia were thoroughly examined by Lozek. Successive cold and warm periods could be defined by means of the mollusc material found (Lozek, 1964).

In a great many places shells from recent archaeological excavations have been collected, for instance the sediment in ditches, post-holes, pits, deposits on slopes at the foot of walls and banks, dump-hills, *etc.* Mollusc investigation of dwelling mounds in order to reconstruct the local environment has not yet taken place (Evans, 1978a).

The construction and interpretation of mollusc diagrams is to a great extent hampered by lack of information concerning the exact recent distribution of a great number of mol-

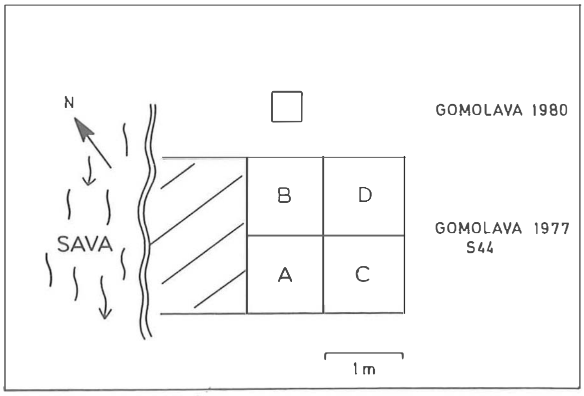


Fig. 3. Gomolava 1977 and 1980.

luscs. Only when more quantitative data about recent snail and mussel associations would become known, more questions about earlier environments may be answered by means of mollusc diagrams.

## 3. MATERIAL AND METHODS

### 3.1. Material

The investigation is directed at shells of animals belonging to the class of Gastropoda and the class of Bivalvia, both Mollusca.

The material collected is twofold. Firstly the shells sampled by myself in 1980 (3.2.1.1.), and secondly the material from pits excavated in 1976 and 1977 (3.2.1.2.).

In addition to this, mollusc material sampled at Gomolava by Dr. B.S. Ottaway of the University of Edinburgh (5.2.3.) will be considered summarily.

### 3.2. Methods

#### 3.2.1. *Sampling*

##### 3.2.1.1. *Material sampled in 1980*

In August 1980 I visited Gomolava during the excavation campaign. Object of my visit was to take a successive series of samples.

About half a meter north-east of a trench, resulting from an earlier excavation in 1977 by Ottaway, and fixed on the tell by the coordinates S44 (Jovanović, 1965), a column of soil with a surface of 40 x 40 cm and a depth of c. 5 m was cut away (figs. 3, 4). A possible disturbance within this column, caused by infiltration of recent snail material, may be ignored. The upper layer of the column (c. 10 cm) was removed because of its disturbed character.

The column was cut away in layers of 10 cm each, whereby the layer with a depth of 0 to 10 cm was numbered sample 1, from 10 to 20 cm sample 2 and so on. The samples were sifted in their entirety, so that the quantity of soil sifted amounted to 16 litres per sample.

Mesh size of the sieves amounted to one and a half and half a millimetre, the latter being the smallest that Kerney (1963), Sparks (1964) and Evans (1972) also used.

Only odd-numbered samples were chosen for analysis.

Dating of each single layer was done partly by means of pottery that was found, partly by the use of data collected at the investigations by Ottaway in 1977.

Some observations concerning the stratigraphy:

— At a depth of 3.00 to 3.10 m the so-called 'Eneolithic humus' formed in a period when the mound was uninhabited, was found. In this layer practically no remains of pottery were met with.

— The last two samples (47 and 49) contained no pottery fragments.

##### 3.2.1.2. *Material from pits, excavated in 1976 and 1977*

In the study of molluscs a few pits were included that were found next to the remains of houses dating from the Vinča period.

The width of these houses was c. 7 m, and their length sometimes over 20 m. The walls were probably a wattle and daub construction. The floors may also have been made of loam, quarried in the direct vicinity of the house, whereby pits remained. Loam was also removed from the banks of the Sava, and possibly from other sources. The pits next to the houses were used for the disposal of garbage: most of the bones from these pits are broken and show carving marks (Clason, 1979). In these garbage pits layers are found consisting of shells of the genus *Unio*, as well as of *Helix pomatia*.

The measurements of the pits vary. At a width of 1 to 3 m, the length may be between

Fig. 4. The column of soil dug up in 1980.

1 and sometimes more than 7 m. Their depth is never more than two and a half metres.

The pits, excavated in 1976 and 1977, were identified by means of letters. In 1976 pit A, B, C, D and H were excavated; in 1977 pit K, L, M, O, P, R and X. All were excavated in blocks I-VI (fig. 2).

Fully 100 litres of soil from each pit were sifted. How much precisely can not be ascertained. Mesh sizes of the sieves were 3 and one and a half millimetres.

3.2.2. *Identification*

On the identification of subfossil and recent Yugoslav shell material no standard-work is available. A great support at the identification was Lozek's study (1964), in which also the regional spread of molluscs in Czechoslovakia is recorded.

Moreover, the following textbooks that are based on recent material, were consulted: Adam (1960), Ehrmann (1937), Ellis (1969),

Table 1. Habitation periods of the dwelling mound Gomolava (after Clason, 1979)

Gomolava I
a) Older dwelling horizon of Vinča group
b) Younger dwelling horizon of Vinča group

Gomolava II
a) Horizon with Lengyel pottery
b) Horizon with prototiszapolgar and Tiszapolgar pottery

Gomolava III
a) Horizon of pits of Baden group
b) Dwelling horizon of Kostolac group
c) Horizon with Vučedol pottery

Gomolava IV
a) Horizon Omoljica-Vatin group
b) Dwelling horizon of group Belegiš I
c) Dwelling horizon of group Belegiš II

Gomolava V
Horizon of Bosut group (Basarabi complex)

Gomolava VI
a) Older dwelling horizon of La Tène settlement
b) Younger dwelling horizon of La Tène settlement
c) La Tène-Early Roman dwelling horizon

Gomolava VII
Dwelling horizon of Roman-provincial settlement

Gomolava VIII
Horizon of Middle Age settlement and necropolis

Gittenberger *et al.* (1970), Janssen & de Vogel (1965), Janus (?), Riedel (1980), Kerney & Cameron (1979) and its slightly more extensive translation by Gittenberger (1980).

For the identifications use was made of recent mollusc material collected in 1980 in the surroundings of Gomolava (see Appendix).

On some identifications Gittenberger, Backhuys and Ripken were personally consulted.

A few notes on some of the identifications:
Landsnails.

*Succinia/Oxyloma.* Separation of species of *Succinia* and *Oxyloma* is, particularly where juvenile material is involved, extremely difficult. From a few adult specimens it may be inferred that *Succinia* is, within the scope of this investigation, only represented by *Succinia oblonga* and *S.putris*, which are both included in recently collected material (Appendix). Specimens of *Oxyloma* could not be identified to within the species.

In view of these problems of identification, and of the fact that *S.oblonga, S.putris* and *O.* sp come within the same ecological group (3.2.5.), all specimens belonging to these genera were classified in group *Succinia/Oxyloma.*

*Granaria frumentum frumentum.* Identification to within the sub-species *frumentum* was done by Dr. E. Gittenberger.

Clausiliidae. To this group belong apices of sinistrally coiled shells, that could not be more closely identified.

Limacidae. Small internally asymmetric shells of slugs were, at the investigations in 1980, found on the half millimetre sieve. Neither in 1980, nor in 1977 were these shells found on the one and a half millimetre sieve. Closer identification to within the species is impossible.
Water-molluscs.

*Viviparus* sp. Material of this group consists of apices of young specimens of the genus *Viviparus.* Most probably these are of the species *acerosus* (Bourguignat, 1862). Recently this species has been found along the Sava (see Appendix).

Opercula. At both investigations a great number of opercula were found in the samples. These are mainly belonging to *Bithynia tentaculata* and only occasionally to *B.leachi.*

### 3.2.3. *Counting*

To count fragments of shells I applied the following rules:

Identifiable apertures (f.i. of *Chondrula tridens*) are added to the total number of intact shells of the species or genus in question.

Apices of identifiable shells (f.i. of Clausiliidae) are added to the species, genus or family in question. However, if of one group the apices and apertures are singly identifiable, only one of both is counted. Thus, of *Chondrula tridens* and *Granaria frumentum* only the apertures are counted.

Like Sparks (1961) and Evans *et al.* (1978b) I count the valve of a bivalve's shell for one individual.

Fragments of shells of *Unio* and *Pisidium* may, when more than half of the hinge is discernable, be counted as individuals.

At none of the investigations the opercula of *Bithynia* are included in the calculations, as its counts are open to discussion and might show an over-representation of the species (Sparks, 1964).

Table 2. Species and families found at the 1980 and pit investigations.

| land | water |
|---|---|
| *Pomatias elegans* (Müller 1774) | *Theodoxus danubialis* (C. Pfeiffer 1828) |
| *Succinea oblonga* Draparnaud 1801 | *Theodoxus transversalis* (C. Pfeiffer 1828) |
| *Succinea putris* (Linnaeus 1758) | *Viviparus* sp. |
| *Oxyloma* sp. | *Valvata piscinalis* (Müller 1774) |
| *Cochlicopa lubrica* (Müller 1774) | *Valvata macrostoma* Mörch 1864 |
| *Cochlicopa lubricella* (Porro 1838) | *Valvata cristata* Müller 1774 |
| *Truncatellina cylindrica* (Férussac 1807) | *Lithoglyphus naticoides* (C. Pfeiffer 1828) |
| *Orcula dolium* (Draparnaud 1801) | *Bithynia leachi* (Sheppard 1823) |
| *Granaria frumentum frumentum* (Draparnaud 1801) | *Bithynia tentaculata* (Linnaeus 1758) |
| *Pupilla muscorum* (Linnaeus 1758) | *Lymnea stagnalis* (Linnaeus 1758) |
| *Vallonia excentrica* Sterki 1892 | *Lymnea truncatula* (Müller 1774) |
| *Vallonia pulchella* (Müller 1774) | *Planorbis planorbis* (Linnaeus 1758) |
| *Chondrula tridens* (Müller 1774) | *Planorbis corneus* (Linnaeus 1758) |
| *Ena montana* (Draparnaud 1801) | *Anisus leucostomus* (Millet 1813) |
| *Punctum pygmaeum* (Draparnaud 1801) | *Anisus septemgyratus* Rossmässler 1835 |
| *Vitrea contracta* (Westerlund 1871) | *Anisus vortex* (Linnaeus 1758) |
| *Aegopinella ressmanni* (Westerlund 1883) | *Bathyomphalus contortus* (Linnaeus 1758) |
| *Oxychilus inopinatus* (Uličný 1887) | *Gyraulus albus* (Müller 1774) |
| *Daudebardia brevipes* (Draparnaud 1805) | *Armiger crista* (Linnaeus 1758) |
| *Cochlodina laminata* (Montagu 1803) | *Segmentina nitida* (Müller 1774) |
| *Clausilia pumila* Pfeiffer 1828 | *Fagotia acicularis* (Férussac 1823) |
| fam. Clausiliidae | *Amfimelania holandri afra* (Rossmässler 1839) |
| *Bradybaena fruticum* (Müller 1774) | *Unio crassus crassus* Philipsson 1788 |
| *Euomphalia strigella* (Draparnaud 1801) | *Unio pictorum* (Linnaeus 1758) |
| *Perforatella rubiginosa* (Schmidt 1853) | *Unio tumidus* Philipsson 1788 |
| *Monacha cartusiana* (Müller 1774) | *Pisidium* sp. |
| *Cepaea vindobonensis* (Férussac 1821) | |
| *Helix pomatia* Linnaeus 1758 | |
| fam. Helicidae | |
| fam. Limacidae | |
| *Cecilioides acicula* (Müller 1774) | |
| *Cecilioides jani* (De Betta & Martinati 1855) | |

### 3.2.4. *Frequency of land and water-molluscs*

When calculating the frequency of land and water-molluscs per layer or per pit no individuals of the genus *Cecilioides* were considered. *Cecilioides acicula* can burrow to depths of c. 2 m (Evans, 1972: p. 201). It is, like *C.jani*, as such of minor importance for stratigraphic investigation. In the tell Gomolava *C.acicula* was found alive to a depth of c. 70 cm.

### 3.2.5. *Ecological groups*

If all species would be singly represented in a mollusc diagram, its interpretation would become virtually impossible. In order to get a clearer view a classification in ecological groups is being used. Water-molluscs are grouped according to the system adopted by Sparks (1961); land-molluscs according to Evans (1972: p. 194 ff.). For the present study Lozek's classification (1964; 1965) was used as well. Molluscs that could not be identified to within the species, were not classified in ecological groups (Helicidae, Clausiliidae, *Viviparus* sp, *Lymnea* sp, *Segmentina* sp, *Pisidium* sp). The exception is fam. Limacidae which, in accordance with Evans (1972), are classified into the group 'Catholic land species'.

The following ecological groups are being distinguished:

Land: woodland species,
catholic species,
open country species,
marsh species.
Water: slum species,
catholic species,
ditch species,
moving water species.

When classifying the various species in ecological groups, it is assumed that the present distribution is identical to what it was in the past. However, the interference of man may have caused a change in the distribution of certain species (Sparks, 1964).

Concurrently with the classifications mentioned above, data on the distribution of molluscs derived from Kerney & Cameron (1979), Riedel (1980), Janssen & de Vogel (1965), Janus (?), Boycott (1936), Gittenberger *et al.* (1970) and Jaeckel (1954) were used.

Table 3. Classification in ecological groups of the species found at the present investigation, as well as of the species of live mollusc material collected round Gomolava in 1980 (see Appendix).

| land | water |
|---|---|
| A:woodland species<br>B:catholic species<br>C:open country species<br>D:marsh species | E:slum species<br>F:catholic species<br>G:ditch species<br>H:moving water species |
| A: woodland species<br>*Vitrea contracta*<br>*Aegopinella ressmanni*<br>*Daudebardia brevipes*<br>*Carychium tridentatum* (Risso 1826)<br>*Ena montana*<br>*Acanthinula aculeata* (Müller 1774)<br>*Punctum pygmaeum*<br>*Perforatella incarnata* (Müller 1774)<br>*Helix pomatia*<br>*Bradybaena fruticum*<br>*Cochlodina laminata*<br>*Clausilia pumila*<br>*Orcula dolium*<br><br>B: catholic species land<br>*Euomphalia strigella*<br>*Cochlicopa lubrica*<br>*Cochlicopa lubricella*<br>fam. Limacidae<br>*Cepaea nemoralis* (Linnaeus 1758)<br>*Cepaea vindobonensis*<br>*Pomatias elegans*<br><br>C: open country species<br>*Vallonia excentrica*<br>*Vallonia pulchella*<br>*Pupilla muscorum*<br>*Truncatellina cylindrica*<br>*Monacha cartusiana*<br>*Chondrula tridens*<br>*Granaria frumentum frumentum*<br>*Helicella obvia* (Menke 1828)<br>*Oxychilus inopinatus*<br><br>D: marsh species<br>*Succinea oblonga*<br>*Succinea putris*<br>*Oxyloma* sp.<br>*Vertigo antivertigo* (Draparnaud 1801)<br>*Zonitoides nitidus* (Müller 1774)<br>*Perforatella rubiginosa*<br><br>land-snails, not classified<br>fam. Clausiliidae<br>fam. Helicidae | E: slum species<br>*Lymnea truncatula*<br>*Anisus leucostomus*<br><br>F: catholic species water<br>*Armiger crista*<br>*Bathyomphalus contortus*<br>*Gyraulus albus*<br>*Bithynia leachi*<br>*Bithynia tentaculata*<br><br>G: ditch species<br>*Valvata cristata*<br>*Planorbis planorbis*<br>*Anisus septemgyratus*<br>*Anisus vortex*<br>*Segmentina nitida*<br>*Planorbis corneus*<br><br>H: moving water species<br>*Valvata piscinalis*<br>*Lithoglyphus naticoides*<br>*Unio crassus crassus*<br>*Unio pictorum*<br>*Unio tumidus*<br>*Valvata macrostoma*<br>*Fagotia acicularis*<br>*Amfamelania holandri afra*<br>*Theodoxus transversalis*<br>*Theodoxus danubialis*<br>*Viviparus acerosus*<br><br>water-molluscs, not classified<br>*Viviparus* sp.<br>*Lymnea* sp.<br>*Segmentina* sp.<br>*Pisidium* sp. |

Recent distribution data drawn from mollusc material collected in the vicinity of Gomolava (1980) were used as well (Appendix).

The species found at the mollusc investigation (Gomolava 1980 and pit-exploration) are listed in table 2. For the classification in ecological groups of these species and of the species found recently in Gomolava, see table 3.

### 3.2.6. *The mollusc diagram*

In a mollusc diagram the number of molluscs per ecological group or per family or genus may be presented in terms of either absolute or relative abundance. Both methods of presentation have their pros and cons.

One disadvantage of the use of the latter is that, in case of an increase in absolute numbers of one species, another species which in absolute numbers remains constant, shows a decrease in percentage on a relative scale. Another disadvantage of this method would be that, when the total numbers are small, the percentages might be statistically unreliable.

Kerney (1963) gives four reasons why, in his analysis, histograms are best constructed in terms of absolute abundance. He presents the results of his investigation at Dover Hill in terms of both absolute and relative abundance.

Evans (1978a) points out that particularly the relative differences from period to period are important for the investigation of the earlier environment.

When considering the number of molluscs, found in dwelling mounds, the rate of speed at which the level of the mound was raised as a result of man's depositing all sorts of material on it, plays an important role. It will, during periods of intensive habitation, rise faster than when a few people choose it for their dwelling place. The deposits may contain land as well as water-molluscs. Owing to the varying speeds at which the mound rose, the total number of molluscs per sample (and thus per period) may vary to a great extent. To compare the ecological groups as to their abundance layer by layer, it seems to be best to consider their relative numbers. The absolute numbers may vary to an extent that makes them hardly suitable for comparison. As the size of the samples taken at the exploration of the pits is unknown, the absolute number of molluscs per sample cannot be used for drawing a comparison between the pits.

After considering the foregoing arguments, presentation in terms of relative abundance has been chosen for this investigation.

The construction of a mollusc diagram is comparable to that of a pollen diagram. In the case of this investigation, the vertical axis represents the depth from the top of the tell (measured after removal of the disturbed top-layer). At the investigation of the pits, this axis represents the identification of the various pits (figs. 6 and 9). The horizontal axis shows the percentage of the ecological groups as well as of not-classified groups. The percentages of the groups of land-molluscs at the left side of the diagram, are calculated as percentages of the total number of land-molluscs. A similar calculation was separately made in respect of water-molluscs. Alongside the vertical axis of the diagram Gomolava 1980, a sketch of the profile is given, i.e. the north-eastern profile with a width of 40 cm (fig. 3). For Gomolava 1980 dating of the layers is, with an occasional note, given to the right of the land-water frequency.

In figure 6, the frequency of the genus *Cecilioides* is expressed as a percentage of the total number of land-molluscs, contained in a particular sample.

## 4. TABLES AND DIAGRAMS

The results of the investigation of 1980 are to be found in tables 4 to 8 inclusive. The first two tables show the species found and their numbers per sample: table 4 land-molluscs, table 5 water-molluscs. A$^{+}$ sign means that the species in question is represented in a sample. Owing to deficient preservation it is, however, impossible to distinguish individuals separately. In the calculations a$^{+}$ sign was counted as 1 individual. Table 6 gives the abundance, absolute and relative, of land and water-molluscs per sample. The uppermost rows indicate the combined results of either of the sieves used. Under it the results are split up in material found on the half millimetre and one and a half millimetre sieves, respectively. The absolute and relative numbers of the various ecological groups are plotted in tables 7 and 8.

Tables 9 to 12 inclusive show the results of the pit investigation. The absolute numbers of the collected species are shown in tables 9 and 10. In table 11 the various groups are listed in absolute, in table 12 in relative terms.

The mollusc diagrams are plotted in figure 6 (Gomolava, 1980) and figure 9 (the pits). Figure 5 is a graphic presentation of the land-water frequency per layer, concerning the investigation of 1980. The results are split up in material found on the half millimetre and one and a half millimetre sieves, respectively. The total result of both sieves (one and a half plus half millimetre) is shown in between.

## 5. DISCUSSION

### 5.1. General aspects of the mollusc investigation

Before considering the tables and diagrams concerning the various investigations, it will be wise first to discuss shortly some general aspects of mollusc investigation. The question will be raised of what may be the cause of

Table 6. Gomolava 1980. The absolute and relative number of land and water-molluscs per sample, specified in totals trapped on both sieves (½ mm + 1½ mm) and per sieve

| Sample number | 1 | 3 | 5 | 7 | 9 | 11 | 13 | 15 | 17 | 19 | 21 | 23 | 25 | 27 | 29 | 31 | 33 | 35 | 37 | 39 | 41 | 43 | 45 | 47 | 49 | + |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | 73 | 120 | 51 | 63 | 43 | 83 | 47 | 29 | 57 | 64 | 32 | 86 | 36 | 51 | 89 | 139 | 59 | 59 | 78 | 374 | 783 | 452 | 234 | 128 | 122 | 3353 |
| ½ mm + 1½ mm | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Water absolute | 0 | 24 | 10 | 21 | 21 | 16 | 14 | 6 | 17 | 25 | 11 | 57 | 28 | 35 | 35 | 75 | 37 | 42 | 71 | 356 | 742 | 419 | 212 | 94 | 28 | 2396 |
| Water % | 0 | 20 | 20 | 33 | 49 | 19 | 30 | 21 | 30 | 39 | 34 | 66 | 78 | 69 | 39 | 54 | 63 | 71 | 91 | 95 | 95 | 93 | 91 | 73 | 23 | 71 % |
| Land absolute | 73 | 96 | 41 | 42 | 22 | 67 | 33 | 23 | 40 | 39 | 21 | 29 | 8 | 16 | 54 | 64 | 22 | 17 | 7 | 18 | 41 | 33 | 22 | 35 | 94 | 957 |
| Land % | 100 | 80 | 80 | 67 | 51 | 81 | 70 | 79 | 70 | 61 | 66 | 34 | 22 | 31 | 61 | 46 | 37 | 29 | 9 | 5 | 5 | 7 | 9 | 27 | 77 | 29 % |
| ½ mm | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Total | 4 | 32 | 22 | 47 | 32 | 73 | 38 | 20 | 44 | 55 | 25 | 74 | 26 | 41 | 77 | 114 | 45 | 45 | 74 | 357 | 768 | 432 | 216 | 112 | 104 | 2877 |
| Water absolute | 0 | 5 | 4 | 16 | 16 | 13 | 10 | 2 | 14 | 22 | 6 | 50 | 23 | 28 | 30 | 67 | 33 | 38 | 68 | 343 | 732 | 405 | 199 | 85 | 25 | 2234 |
| Water % | 0 | 16 | 18 | 34 | 50 | 18 | 26 | 10 | 32 | 40 | 24 | 68 | 88 | 68 | 39 | 59 | 73 | 84 | 92 | 96 | 95 | 94 | 92 | 76 | 24 | 78 % |
| Land absolute | 4 | 27 | 18 | 31 | 16 | 60 | 28 | 18 | 30 | 33 | 19 | 24 | 3 | 13 | 47 | 47 | 12 | 7 | 6 | 14 | 36 | 27 | 17 | 27 | 79 | 643 |
| Land % | 100 | 84 | 82 | 66 | 50 | 82 | 74 | 90 | 68 | 60 | 76 | 32 | 12 | 32 | 61 | 41 | 27 | 16 | 8 | 4 | 5 | 6 | 8 | 24 | 76 | 22 % |
| 1½ mm | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Total | 69 | 88 | 29 | 16 | 11 | 10 | 9 | 9 | 13 | 9 | 7 | 12 | 10 | 10 | 12 | 25 | 14 | 14 | 4 | 17 | 15 | 20 | 18 | 17 | 18 | 476 |
| Water absolute | 0 | 19 | 6 | 5 | 5 | 3 | 4 | 4 | 3 | 3 | 5 | 7 | 5 | 7 | 5 | 8 | 4 | 4 | 3 | 13 | 10 | 14 | 13 | 9 | 3 | 162 |
| Water % | 0 | 22 | 21 | 31 | 45 | 30 | 44 | 44 | 23 | 33 | 71 | 58 | 50 | 70 | 42 | 32 | 29 | 29 | 75 | 76 | 67 | 70 | 72 | 53 | 17 | 34 % |
| Land absolute | 69 | 69 | 23 | 11 | 6 | 7 | 5 | 5 | 10 | 6 | 2 | 5 | 5 | 3 | 7 | 17 | 10 | 10 | 1 | 4 | 5 | 6 | 5 | 8 | 15 | 314 |
| Land % | 100 | 78 | 79 | 69 | 55 | 70 | 56 | 56 | 77 | 67 | 29 | 42 | 50 | 30 | 58 | 68 | 71 | 71 | 25 | 24 | 33 | 30 | 28 | 47 | 83 | 66 % |

the differences between the proportions in which the various species originally occurred in living nature, and those in which they are found in the sediment. The method of extracting molluscs from the sediment will be critically viewed, and the causes of fluctuations in numbers of molluscs from layer to layer examined.

### 5.1.1. *Abundance of molluscs in nature*

The numbers in which snails can occur in a certain community depends on hereditary factors (f.i. the reproductive rate), and on environmental factors. The latter may be regional, such as climate and lime-content of the soil, or local, such as sloping country, exposure to sun, humidity, shade, *etc.* These local factors are generally of importance for archaeological mollusc investigation. About the regional factor 'climate' but little can be concluded from mollusc investigation into the past 6000 years (Evans, 1972: p. 17).

### 5.1.2. *Alterations owing to disturbance of the soil*

After death, snails will initially land on the ground, or stay in the ground when being there already. The proportional abundance of the various species immediately after death, which we equate with that within the living community may, however, be altered by all kinds of processes. Shells may be displaced horizontally, for instance by moving water, as well as vertically. The latter displacement is of great importance for the investigation of dwelling mounds. The ground may be stirred up by worms and other animals — also man —, whereby recent and older material becomes mixed.

Cameron (1978) reports on a recent investigation in which recent mollusc material, collected on the surface, appeared to be mixed with older shells. Mollusc diagrams plotted on the basis of recent material only on the one hand, and of mixed — recent and older — material on the other, showed appreciably different results. From this it may be concluded that, if recent and older shells cannot be sorted out, which is always the case with archaeological excavations, a correct interpretation can be very difficult to achieve.

At pollen analysis burrowing animals present great problems as well. Thus burrowing bees impede the interpretation of pollen diagrams at the investigation of prehistoric settlements, like Gomolava (Bottema, 1975).

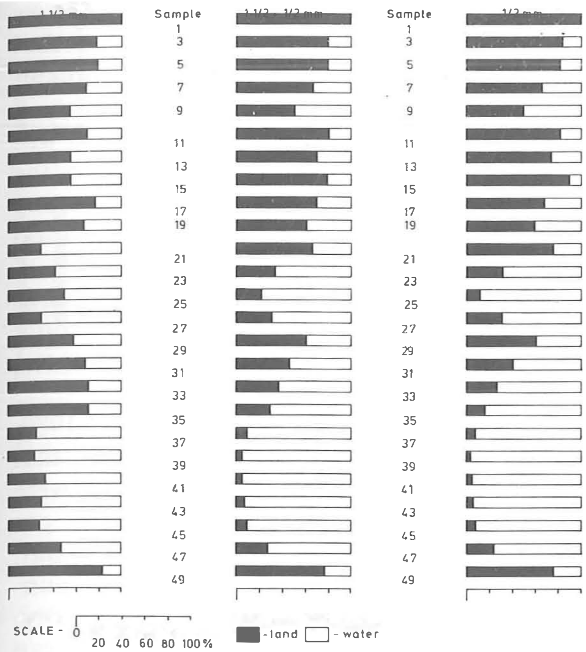


Fig. 5. The land-water frequencies of Gomolava 1980.

5.1.3. *Weathering and fracture of shells*

Other factors that may alter the proportional abundance of the various species after death are weathering and fracture of shells. Generally, shells stay best preserved in calcareous regions. Fracture of material may occur in the sediment as well as be a result of the method of extraction of the shells from the sediment.

However, whether the results shift in a certain direction as a result of such weathering and fracture, remains questionable. Among land as well as water-snails, some species are more vulnerable than other species, where their shells are concerned. When the original abundance of species is unknown, as always in archaeology, it is difficult to trace whether, and to what extent the results are shifted through weathering and fracture.

5.1.4. *Mesh size of the sieves*

At the extraction of shells from the sediment, the mesh size of the sieves plays an important role. The smallest mesh size used indicates the order of magnitude of the smallest individuals from the material collected. Practically, no adult snails will pass the half millimetre sieve (Kerney & Cameron, 1980), so that a smallest mesh size of half a millimetre seems allright for optimal extraction of the smallest, identifiable, mollusc material from the sediment. In most cases, juvenile molluscs of less than half a millimetre are very hard to identify.

Table 6 shows, that of 3353 identified molluscs, 86 % (2877) were trapped by the half millimetre sieve and 14 % by the one and a half millimetre sieve. When examining the land-water frequency in these totals, it appears that the percentages of land and water-molluscs, trapped by the half millimetre sieve are 22 % and 78 % respectively; of these trapped by the one and a half millimetre 66 % and 34 %. These results make it clear that, when no smaller sieve than one and a half millimetre mesh size is used as happens at the pit investigation, a very great number of molluscs is not extracted from the sediment. The molluscs that are washed through such a sieve show a totally different land-water frequency in comparison with the material trapped by it.

By using a half millimetre sieve next to f.i. a one and a half millimetre sieve, the total number of extracted shells per volume of sediment increases. The percentages are, as a result of these greater numbers, statistically more reliable.

Figure 5 shows that, sample by sample, the changes in land-water frequency of the half millimetre sieve and half millimetre plus one and a half millimetre sieves are practically identical. This similarity can be largely explained by the fact that the number of molluscs, trapped by the half millimetre sieve, amounts, during the whole investigation, to 86 % of the material collected in total (half millimetre plus one and a half millimetre). The differences per sample between the percentages of land and water-molluscs of the one and a half millimetre sieve and of the half millimetre plus one and a half millimetre sieves are much more pronounced.

From these results it may be concluded that percentages of land and water-molluscs per sample may vary with the use of a smallest sieve of half millimetre or one and a half millimetre. In many cases the percentage of shells of water-snails per sample will increase when both types of sieves are used, instead of using only the one and a half millimetre one. Whether the numbers would show comparable differences, if the one or the other sieve were used at excavation on other sites, will only appear after more will have been published about the method of extraction at mollusc investigations.

### 5.1.5. *Fluctuations from sample to sample*

The relative numbers of various species, families, ecological groups *etc.* may fluctuate from sample to sample. The cause could be the different distribution of certain species in time. The proportional abundance of the species in the living community is reflected in the proportions immediately after death. These proportions may, as already mentioned, undergo changes as a result of horizontal displacement, stirring up of the soil, weathering and fracture. Import of material from elsewhere (in the present investigation f.i. material from the surroundings of the tell) may change these proportions as well.

To obtain statistically reliable percentages, the number of molluscs extracted per sample should be as great as possible. Evans (1972: p. 83) demonstrates, by means of a test sample of 500 snails comprising 11 species, that a total number of 150 to 200 snails is sufficient to obtain the proportional abundance (5 % more or less) of the species in the original sample.

As, at both investigations now under discussion, the total number of molluscs amounted often less than 100, it should be realized that some of the fluctuations in the diagrams may be caused by statistically unreliable percentages.

### 5.1.6. *The build-up of the dwelling mound*

The build-up of a dwelling mound takes place through the import by man of material from the countryside to his dwelling place. When habitation is concentrated in the same place for a long time, dwelling mounds may reach a considerable height (sometimes over 15 m; Evans, 1978a). Generally, the material consists mostly of clay from the surroundings, imported for house-building.

In many places of the tell Gomolava, remainders of houses have been found, in most cases consisting of burnt clay from houses destroyed by fire. Remainders of houses that were not burned down are much more difficult to mark.

In Gomolava, for house-building use was made of clayish soil dug away next to the houses. Accordingly, in the tell a great many pits dating from the Vinča and Baden period were found.

It is expected that on the tell Gomolava mainly land-snails lived. Water-snails could only have lived in pits, partly filled with water, and possibly watertanks, basins, *etc.*

As to the analysed layers of Gomolava 1980, no pits were apparent in the profile, so that it may be assumed that all water-molluscs were imported by man. Possible exceptions are *Lymnea truncatula* or *Anisus leucostomus*, which can be found in very moist surroundings, such as puddles that are running dry. The imported land- and water-molluscs can be of different origin. Land-snails may have been brought up with building-material, branches for the construction of walls, grass, herbs and other vegetable food.

Water-snails and fresh water mussels may have come along with loam from the river, or may originate from neighbouring marshes or other pools. When water was drawn for f.i. drinking and washing, water-molluscs and possibly land-molluscs, living alongside water ('marsh species') may have been carried off also.

Great quantities of *Unio* sp and *Helix pomatia*, which served as food for man, are found in layers in the pits. Pigs also eat them, but then the shells are crunched. As the shells from the pits are hardly ever crushed, they are considered to be human refuse. Probably, the pigs will have rooted for *Unio* and *Helix* themselves, just as they do nowadays.

## 5.2. Mollusc diagrams

### 5.2.1. *Local and regional information*

When an attempt is made to obtain, by means of mollusc diagrams, data concerning the occurrene of land-snails that have not been imported from elsewhere, the information about the environment, derived from these data, is local. The local character is, however,

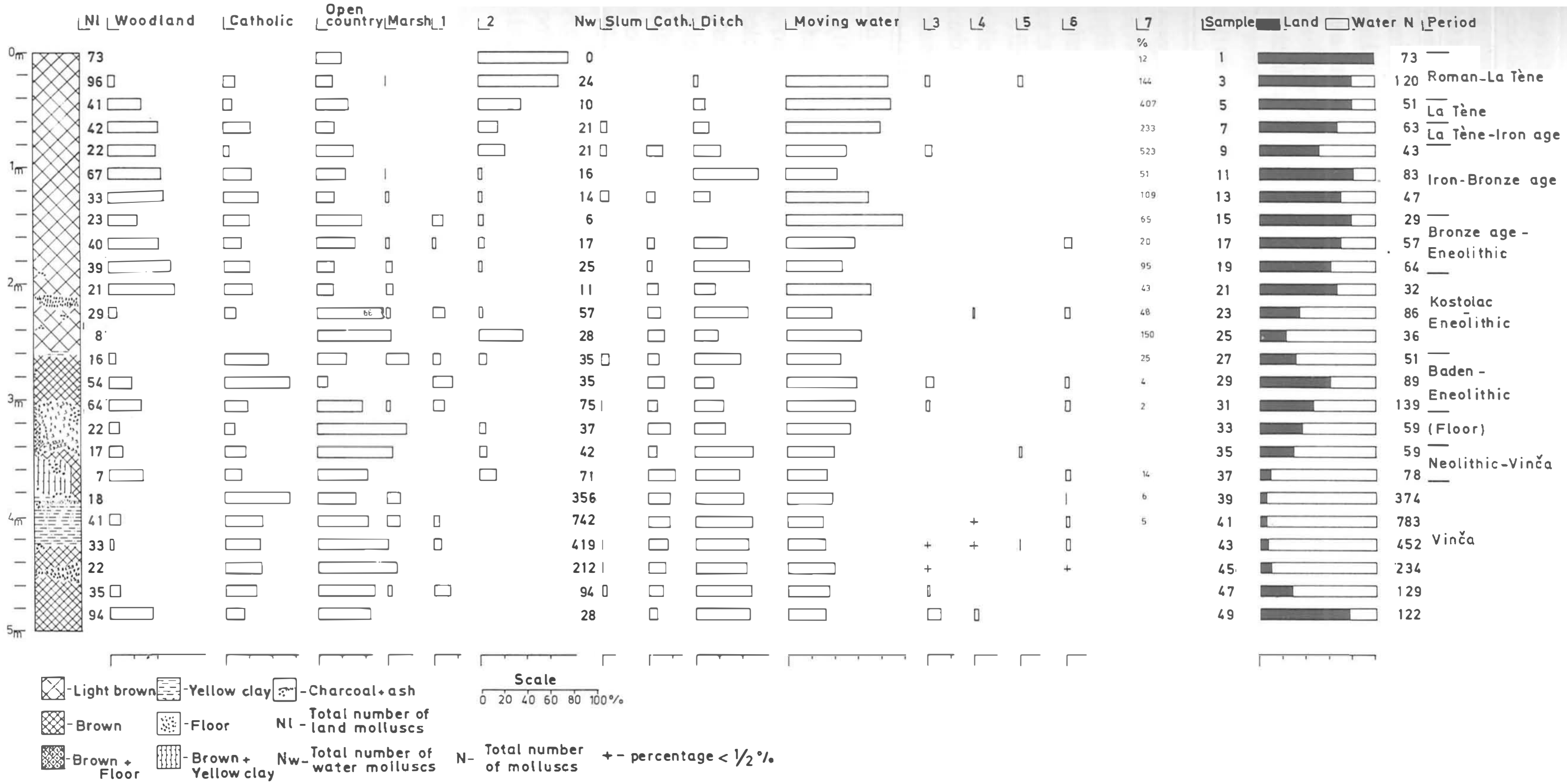


Fig. 6. The mollusc diagram of Gomolava 1980.

not limited to a mere square metre.

Snails move continually from one micro-habitat to another. This, and the fact that in one sample several generations of snails are represented, may cause the obtainable data to contain information about the neighbourhood of the spot where the sample was taken (Evans, 1972: p. 112 ff.).

### 5.2.2. *The diagram of Gomolava 1980*

#### 5.2.2.1. *The humus layers*

In the stratigraphy of Gomolava 3 humus layers can be distinguished: primeval humus, Eneolithic humus, and contemporary humus (Jovanović, 1965). These humus layers were formed in periods when the tell was not inhabited. As a result of this a vegetable cover could develop.

As man's influence in these periods is smallest, the interpretation of the diagram presents the fewest problems. These humus layers and the layers immediately on top and beneath, will be discussed first.

The primeval humus was formed before there was any habitation in Gomolava. The Eneolithic humus lies on top of the Lengyel layer (table 1); thereafter dwellers of the Baden group were the first to settle again on the mound (Tasić, 1965). The contemporary humus was formed after the last inhabitants had left Gomolava.

At the formation of humus from dead vegetable material, the influence of worms and other burrowing organisms that feed on this material, may have become greater. It is possible that, as a result of this, shells have been wormed up from deeper layers, or that they have been moved from the humus downwards. The roots of plants may change the original stratigraphy as well.

In the mollusc diagram the humus is characterised by a relative increase in the number of land-molluscs: as there is no habitation, there is no import of water-molluscs.

In the diagram Gomolava 1980 (fig. 6), the effect of primeval humus on the land-water-frequency is evident in the bottom samples. Of samples 45 to 49 inclusive, the relative number of land-snails increases. When examining the ecological groups, it appears that the relative number of woodland-molluscs decreases from sample 49 to 45. In this sequence of samples the percentages of catholic and open-country land-snails increase. This change in percentages may point to the first occupation of the dwelling mound, whereby the site assumes a more open character, influenced by man. Evans *et al.* (1978b) also deduces habitation and cultivation from an increase in the number of open country species.

The Eneolithic humus is found at a depth of 3 to 3.10 m. The diagram clearly shows that the relative number of land-snails in it is, when compared with the nearest samples, great. The considerable percentage of water-snails may be caused by (increased) activity of worms and other burrowing organisms. By disturbance of the soil, shells of water-snails from deeper layers — occurring in relatively great numbers during the Vinča period — are being worked up. As a result of this, shells of land-snails can be moved downwards. Hence, the slow relative increase in the number of land-snails in the samples from beneath the humus up to the humus layer is evident in the diagram (see also Evans, 1972: p. 210).

The relative increase in number of woodland-snails in the samples beneath the Eneolithic humus is not very clearly noticeable in figure 6. When compared with the nearest samples however, sample 31 shows a relatively greater number of woodland-snails. The high percentage in sample 37 may be a chance fluctuation, owing to a low total number (7) of land-snails.

Next to *Vitrea contracta, Aegopinella ressmanni* is found in the samples from the soil around the humus layer. The latter species occurs almost only in leaf litter in damp woods (Kerney & Cameron, 1979), and may as such point to a humid environment at the time the humus was formed.

From sample 29 upwards, it may be concluded that, on top of the humus layer, the mound has been inhabited once more. Thereby, the site obtained a more open character as a result of which the relative number of catholic molluscs increased. Thereafter, the percentage of open country snails, which is relatively low in sample 29, became higher again.

The contemporary humus can be found in the upper layers of the dwelling mound. It appears that in these layers the percentage of land-snails increases. In sample 1, only land-snails occur. In the upper layers, chiefly open country snails and snails of the family Helicidae are found. As the latter cannot be more closely identified, it is difficult to give a definite answer to the question of which environment existed during the later periods on and about the mound. The fact that no woodland-snails and practically no catholic land-snails were found any more in the samples of the upper layers of the mound, may indicate that the tell has, in recent times, been but sparsely wooded. One cause of this may be the great height of the mound, which allowed water to flow off, and wind and sun to exert their drying influence. It is also possible that man, living round the mound, has, through f.i. his grazing cattle, left his mark on the mound's vegetation.

Today the mound is covered with low grass. Great numbers of *Helicella obvia* and *Monacha cartusiana* (both Helicidae) were found living on its surface (see Appendix).

5.2.2.2. *The phases of habitation of the tell*
In figure 6, the diagram of the land-water frequency shows that during the Vinča period a relatively high percentage of water-molluscs has been imported onto the mound. The percentage of land-snails herein is low, but it increases in the neighbourhood of the Eneolithic humus. In the Early Eneolithic the percentage of water-molluscs is lower than in the Vinča period. In the Bronze Age, the Iron Age and in even more recent periods, the percentage of water-molluscs decreases per sample.

*The ecological groups of water-molluscs.* When considering the ecological groups of the water-molluscs, it appears that the percentages may widely differ from sample to sample. The cause may be a low total number of molluscs per sample (f.i. sample 15, fig. 6). Another very important factor is the influence of man. Except in very rare cases, all water-molluscs have, along with water, loam or vegetable material, been brought up to the mound by man. The proportional abundance of the ecological groups in a given sample may, provided N-water is sufficient, indicate in what proportion man made use of various types of water in the neighbourhood during a certain period.

In both cases of low and high total numbers,

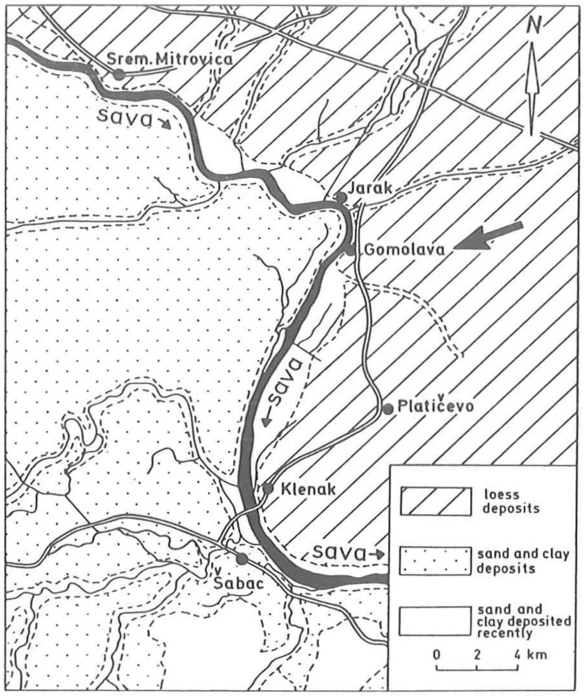


Fig. 7. The deposits in the surroundings of Gomolava (after: *Carte géologique de la R.S. de Serbie*, Institut de recherches géologiques et géophysiques de Belgrade, 1968).

the chance that samples were taken in a place where only a selection of species can be found, such as house-floors, places where water basins or other objects have stood, might possibly matter. Seeing, however, that the samples may cover a long period of time, these influences will in many cases not bear heavily on the results (see f.i. sample 33, in which almost nothing but the remains of a burnt floor were found. However, the mollusc diagram does not show odd fluctuations).

Considering that the percentages may fluctuate between samples as a result of many factors, it seems best to look at the general trend of the changes over a great number of samples.

In this connection, figure 6 shows that from the bottom layers upwards, the percentage of moving water molluscs increases and the percentage of ditch molluscs diminishes. The percentage of molluscs occurring in a great variety of biotopes, the group of catholic water species, increases at first from the bottom layers upwards. Later, as from sample 35, the percentage decreases again.

The presence of the Eneolithic humus at a depth of c. 3 m is not reflected in the trend of the proportional abundance of the ecological groups of water-molluscs. This demonstrates that water-molluscs found in the layers of the Eneolithic humus must have got there from higher or lower layers as a result of disturbance of the soil.

The relative decrease in time of molluscs from stagnant or slowly moving waters, the ditch group, and the increase in relative numbers of the moving water group in the same layers, is interpreted as follows.

The fist Vinča inhabitants of Gomolava found three different types of water in the neighbourhood. First a marshy area along the river Sava, southwest of the spot where they settled (Clason, 1979). Possibly part of this marsh was still extant between the tell and the river. It had come into existence by the Sava's overflowing its banks every year in winter. Next to the marsh the Vinča dwellers found a small stream that joined the Sava north of the mound (Clason, 1979).

In those days the river Sava was flowing at some distance from the dwelling mound. How far away is unknown. Jovanović (1965) mentions that in the period of 1915-1965 the riverbed near Gomolava has moved 15-17 m to the east. Today erosion would have a still greater effect.

With the aid of a geological chart, it is shown in figure 7 what deposits can now be found on both sides of the Sava in the neighbourhood of Gomolava. On the right-hand side of the river only river deposits in the form of sand and clay are found on the surface. On the left-hand side loess deposits can be found along the Sava from Sremska Mitrovica to as far as Sabac.

Owing to erosion on the one hand and deposition on the other, the river Sava has in the course of time moved its bed. From the figure it can be concluded that, concerning the Sava near Gomolava, this meandering movement has resulted in a diversion in a north-easterly or easterly direction. One of the effects of this diversion is that in the area where the Sava has flown, sand and clay deposits are found on the surface. The Sava has not yet cut into the loess-soil left of the river near Gomolava. At high water-levels fine sand and clay may have been deposited in the low-lying lands on both sides of the river.

The figure referred to suggests, quite plausibly, that earlier the Sava has flown at some distance from the tell.

In the Vinča period the population used clayish soil for house-building, which they digged up on the tell, immediately next to their houses. Most probably also wet loam from the river Sava or, possibly, from the marsh was employed for building purposes. Along with the loam water-molluscs, like *Unio* sp, have been brought up to the tell.

A relatively high percentage of the water-molluscs from the Vinča period, belongs to the ditch group, in this period mainly represented by *Valvata cristata* and *Planorbis planorbis.* Both species generally occur in stagnant water with a rich vegetation, *V.cristata* preferring shallower water (Lozek, 1964). The group of catholic water-species comprises, in the Vinča period, snails of the species *Bithynia tentaculata* and *B.leachi, Gyraulus albus* and *Armiger crista. B.tentaculata* occurs in stagnant water, but also in streaming brooks; *G.albus* in stagnant and slowly moving water; *A.crista* and *B.leachi* occur mainly in stagnant water (Lozek, 1964).

In the older periods the distance to the Sava was probably too great to draw for common use there. Water was brought up from the nearby marsh. Sometimes land-snails living thereabouts were carried off too (fig. 6, the 'marsh-group'). Whether use was made of water from the small stream cannot be determined. *Gyraulus albus* and *Bithynia tentaculata* may, in addition to in slowly moving water, also have lived in the marsh.

In more recent periods the distance to the Sava has been reduced. By a better use of animal traction and carts (Clason, 1979) for the transportation of materials, the accessibility of the river was improved. For house-building loam from the river was used. In the course of time, water was more often drawn from the river Sava. The percentage of moving water-molluscs therefore increases and the molluscs of the ditch and catholic water group diminish.

*The percentage of water-molluscs.* When comparing samples of the Vinča period with more recent ones, the percentages of water-molluscs show, when excluding the effects of the Eneolithic humus, obviously a decrease in number. This can be explained as follows.

Near Gomolava the banks along the outer bend in the Sava are steep as a result of sediment being continuously washed away. When taking samples of the sludge layer in 1980, it appeared that the number of molluscs in this layer was low. Owing to the erosion of substratum the environment is probably not congenial to a great number of mollusc species. The moving water of the Sava itself contains a negligible number of molluscs. In the outer bend of the Sava practically no water-plants are found.

When sampling a marsh with a luxurious vegetation, the chance to find water-molluscs is considerably better. It may be that snails live on small plants; a great variety of species may live in the sludge.

In more recent periods during which the influence of the river on life in Gomolava becomes greater, relatively more water will be drawn from the Sava. Accordingly, a lower total number of water-snails will be brought onto the dwelling mound.

Table 5 shows that the absolute number of water-molluscs in samples 49 to 41 inclusive, increases; beyond that it shows the reverse. The increase is mainly caused by the ditch-molluscs *Valvata cristata* and *Planorbis planorbis*, the catholic species *Armiger crista* and *Gyraulus albus*, and the moving-water species *Valvata piscinalis*. *V.piscinalis* occurs in the sludge layer of moving, sometimes of stagnant, water (Boycott, 1936; Lozek, 1964).

The simultaneous increase and decrease in numbers of these species may be indicative of the first dwellers from the Vinča period having used wet loam for their housebuilding from the marsh. When digging loam from the marsh not only *V.piscinalis* was brought up in great numbers, but also *V.cristata, P.planorbis, A.crista* and *G.albus*, which lived in the marsh too. Why, from sample 39 upwards, the absolute numbers of water-molluscs decrease that suddenly is not clear. Use of loam from the marsh must have diminished anyway.

*The land-snails.* When examining the ecological groups of land-snails in figure 6, it seems evident that in the Vinča period the number of woodland-molluscs is relatively as well as absolutely small (tables 7 and 8).

As the number of woodland-molluscs is low, it may be assumed that the quantity of material imported from woodlands, containing land-snails, has not been great. The quantity of material brought up from more open and dry country cannot be determined, because the snails it contains may also have lived on the mound itself. Owing to the number of snails of the species *Vitrea contracta*, the proportions of woodland-snails is, in the Late Eneolithic and in the Bronze and Iron ages, significantly higher. Besides in wooded areas, this species occurs in more open country, under stones, often somewhat concealed in the ground (Lozek, 1964). Recently it was found c. 100 m from Gomolava in bushy country and under low brushwood (see Appendix). The sudden increase and the relatively great numbers of *V.contracta* from sample 21 upwards are hard to explain, because this species could have lived on the tell, or could have been brought to the tell in greater numbers, as well.

The interpretation of the occurrence or absence of land-snails in samples from habitation layers obviously presents great problems. If more mollusc diagrams of dwelling mounds would be available, data could be compared which would possibly facilitate the interpretation of the occurrence of land-snails in the Gomolava diagram.

### 5.2.3. *An earlier investigation in 1977: Gomolava 1977*

In 1977 Dr. B.S. Ottaway sampled and sifted a small part of the tell Gomolava: an area of 2 m square and c. 5 m deep. The site of this excavation on the tell is marked by the co-ordinates S44 (Jovanović, 1965; fig. 3).

Samples were taken at random per layer. The thickness of the layers varies. Before sifting, the samples were floated in order to extract seeds. In the same way floating shells were extracted. These were not included in this analysis.* The smallest mesh size of the sieves was one and a half millimetres, so that a great

* The results of the analysis of floating shells were published after this manuscript had been finished (Bottema & Ottaway, 1982).

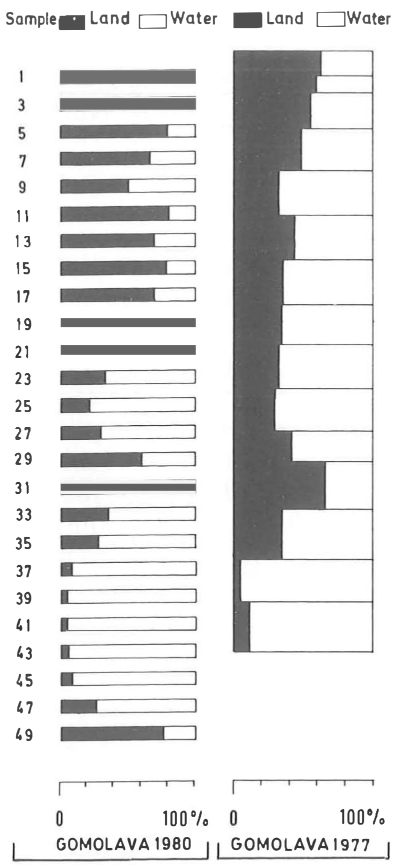


Fig. 8. The land-water frequencies of Gomolava 1980 and 1977.

number of molluscs were washed away through the sieve. The lower bottom samples were, unfortunately, not available for analysis. As these samples are, as far as the mollusc material is concerned, far from complete, only the land-water frequency of this analysis (Gomolava 1977) and that of Gomolava 1980 is compared (table 13; fig. 8).

Figure 8 shows that the proportional abundance of land and water-molluscs varies between Gomolava 1977 and 1980, particularly in the top layers. However, when studying the changes layer by layer in order to determine whether the percentage of land-snails increases or decreases, it appears that the diagrams are in keeping with each other, save an occasional peak in Gomolava 1980. As to the effect of the Eneolithic humus on the land-water frequency, the resemblance between both analyses is quite close. At the Gomolava 1977 investigation the humus was found in the bottom part of layer III.5. In both analyses a marked increase in the percentage of land-snails about and in the humus layer is evident.

The difference in percentages between the samples of 1977 and those of 1980 is attributable to the differing methods of extraction: Gomolava 1977 flotation and use of one and a half millimetre and 3 mm sieves; Gomolava 1980 use of half millimetre and one and a half millimetre sieves.

### 5.2.4. *The pits*

The average height of the highest point of the pits, that is the surface where the pits have been dug, is, compared with the stratigraphy of Gomolava 1980, approximately at the level of samples 37 and 39. Some pits lie higher, up to the level of sample 33, others lower, down to samples 41 and 43.

When examining these refuse-pits, it will be considered to what extent the proportional abundance of land- and water-molluscs, as well as of the various ecological groups, differs from the percentages in the surface-layer where the pit was dug.

The land-water frequency in the various pits, as represented in table 11 and plotted in figure 9, shows that the percentage of land and water-molluscs may differ considerably between pits. Land-molluscs average 42 %; water-molluscs 58 %. As sifting was done with a sieve with no smaller mesh size than one and a half millimetres, a great many (mainly water; 5.1.4.) molluscs must have got lost.

The layers with shell of *Unio* sp. and *Helix pomatia* are not included in the investigations. As a great number of molluscs are missing, due to the methods used, it seems best to look at the occurrence of species as compared to Gomolava 1980.

*The water-molluscs.* When examining figure 6, Gomolava 1980, it appears that the percentage of water-molluscs round samples 37 and 39 is over 90 %. This high percentage is caused by great numbers of *Valvata piscinalis, V. cristata, Gyraulus albus* and *Planorbis planorbis* (table 5).

Table 10 gives the absolute numbers of water-molluscs per species per pit. In these pits *Valvata piscinalis* and *Planorbis planorbis*

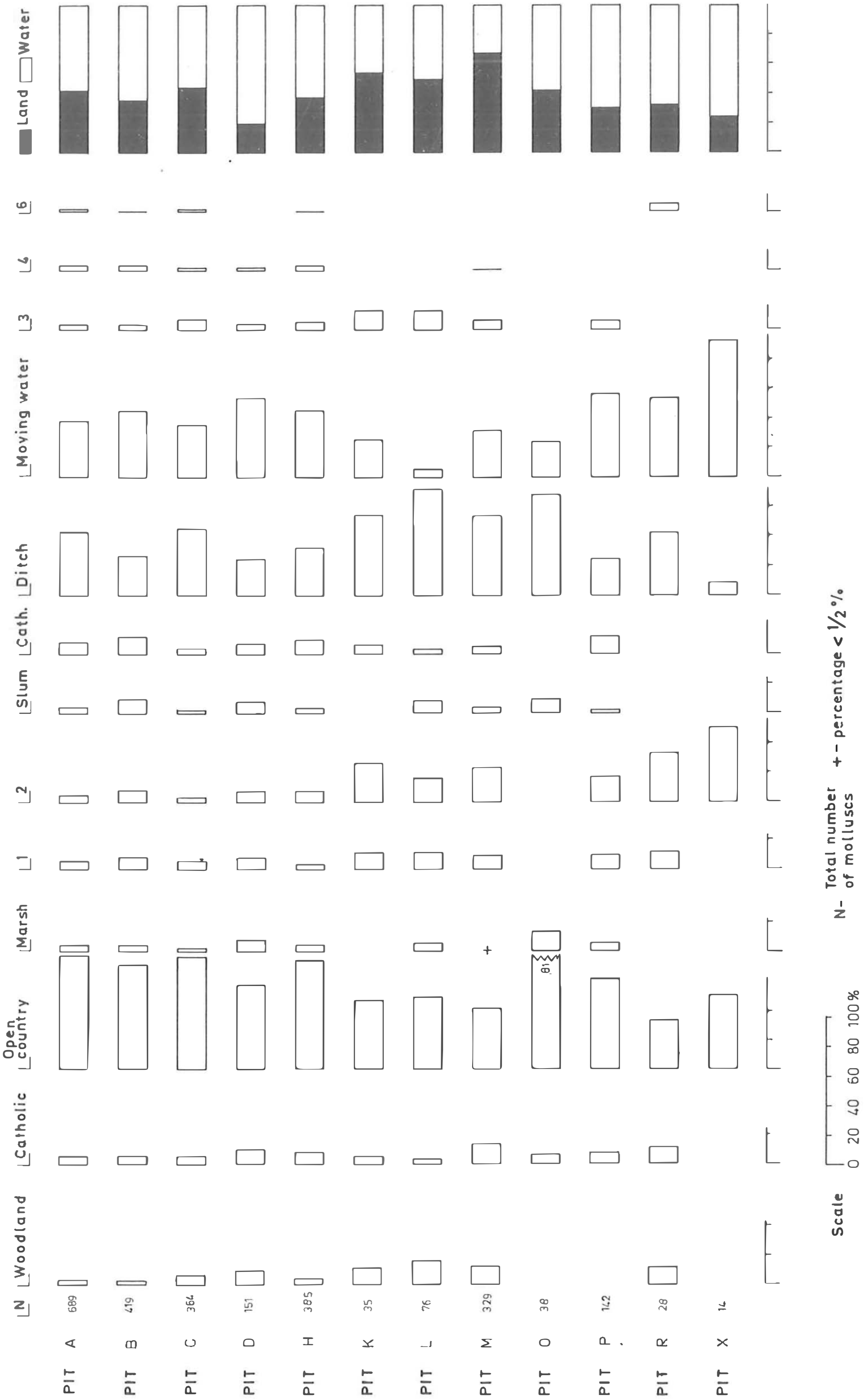


Fig. 9. The mollusc diagram of the pits.

are relatively numerous. A striking phenomenon is the occurrence of a great number of shells of the species *Planorbis corneus. V.cristata* is almost never met with; half-grown specimens may have been washed through the one and a half millimetre sieve.

It would be interesting to know which species could have lived in the pits when these were water-logged. The slum species *Anisus leucostomus* and *Lymnea truncatula* may live in surroundings that dry up periodically. *Gyraulus albus* may occur in small pools (Boycott, 1936), as *Planorbis planorbis* and sometimes *P.corneus* do (Lozek, 1964). *Valvata piscinalis* is generally not met with in this kind of environment (Boycott, 1936).

Seeing the results in table 10, it is by no means impossible that there has been water in most pits, in which f.i. *Planorbis planorbis, Gyraulus albus* and *P.corneus* lived. Some of these shells, however, may have been brought along from the marsh. The occurrence of shells of the 'slum group' points perhaps to pits that dry up periodically. These species can, however, also live in pits that do not dry up. The shells of the 'moving water group' may have been dropped into the pit by man, along with refuse such as remnants of clay from the Sava. It is also possible that among these species remnants occur of *Unio* that were used for human consumption.

*The land-snails.* In comparison with Gomolava 1980, the relative profusion of *Chondrula tridens, Granaria frumentum frumentum* and *Oxychilus inopinatus* in the pits is conspicuous (table 9). In samples 37 and 39 of Gomolava 1980 only three specimens of *Chondrula tridens* were found and none of *Granaria frumentum* nor of *Oxychilus inopinatus.* However, at this investigation the total number of land-snails per sample is low in these layers. All of these three species live in dry and sunny country, generally sparsely covered with brushwood (Lozek, 1964). As *Chondrula tridens* and *Granaria frumentum* are mainly found in pits, and in considerably smaller numbers in the samples of Gomolava 1980, man must have imported most of these species from outside the tell.

The woodland species are largely represented by *Cochlodina laminata*, which is mainly found in leaf litter in the shade of woods, and coppice sometimes on tree-trunks (Kerney & Cameron, 1979). Pit 'M' contains specimens of *Bradybaena fruticum*, which lives in moist places such as hedges and woods edges (Kerney & Cameron, 1979). Both species are probably imported by inhabitants, together with branch material from the wood. Shells of Clausiliidae may have also been brought up from wooded areas. To this family, however, species belong that live as well in drier places, like on walls.

Part of the woodland-snails, and possibly other species too, may have got into the pits after the pits' sides had collapsed. In that case their shells are older than those dumped in the pit by man. The depth of some pits reaches down to beneath the so-called primeval humus. Some of the woodland-snails in the pit may originate from this humus layer.

Unfortunately but few positive conclusions can be drawn from the investigation of the pits. Owing to an inaccurate method of extraction a great many shells have got lost. The question whether mollusc material has been imported by man, whether it lived in the pits or came to rest there after a disturbance, presents big problems.

The layers containing *Unio* sp and *Helix pomatia* would be interesting objects for closer examination It may be that the former were collected once a year in autumn (Clason, 1979), resulting in these layers showing a stratification build up per year, by which it is possible to calculate for how long these pits have served as a refuse dump.

By counting the 'growth-rings' of shells of *Unio* sp, it should be possible to determine not only the age of the mussels, but the season in which they were collected as well. Thus, Koike (1980) obtained satisfactory results when measuring the sea mussel *Meretrix lusoria.*

## 5.3. Dating of deposits by means of molluscs

In many cases deposits from interglacial and postglacial periods can be approximately dated by means of land and freshwater-molluscs. Following climatic variations, migrations of various species of molluscs took place, often over great distances. Owing to this some species happened to disappear from, or to penetrate into certain regions.

Kerney (1977), for instance, composed a

zonation for Southern England, concerning the last part of the Weichselien glacial and the postglacial hereafter, based on the presence or absence of a number of land-mollusc species.

Deposits from younger periods are more difficult to date by means of collected mollusc-material. Owing to a more stable climate the past 6000 years (Evans, 1972: p. 17), migrations of various mollusc species pass off much more gradually, and over smaller distances. Of most mollusc species no accurate distribution maps, dating back to these periods, are known. Only if such data were to become more readily available, it would be possible to date younger deposits.

As to the Gomolava mollusc investigation, the scarcity of information on mollusc distributions renders dating, based on mollusc material, impossible.

## 6. CONCLUSIONS

For the extraction of as many mollusc shells as possible from the samples, the use of a sieve of maximum half millimetre mesh size is to be preferred.

Periods during which the tell Gomolava was inhabited can, by comparing proportional abundances of land and water-molluscs, be distinguished from periods of non-occupancy.

The proportional abundance of the various groups of water-molluscs, which were virtually all brought up to the tell by man, can indicate to what extent man made use of the various types of water in the neighbourhood of the tell during a certain period. Thus, it is apparent that at Gomolava the influence on daily life of the river Sava steadily increased in younger periods. By then the nearby marsh, from which loam was probably carried off for house-building in former periods, fell into disuse.

Land-snails, found in layers dating from the occupancy of the mound, may have been imported by man or may have lived on the tell originally. As such the interpretation of this group presents, in view of a reconstruction of the environment on and about the tell, great problems.

Investigation of material from garbage-pits near Vinča houses, shows that these pits may have been water-logged. Here, also, the interpretation of the occurrence of some land-snail species is very difficult.

If more mollusc diagrams of tells or other deposits, perhaps in the vicinity of Gomolava, were available, it would be possible to compare data from these diagrams, whereby their interpretation would become less troublesome. In that way layers might be dated as well, with reference to the occurrence of certain species of molluscs.

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## 9. KEYWORDS

Yugoslavia, Vojvodina, Hrtkovci, Gomolava, Neolithic, Bronze Age, Iron Age, Roman Age, Middle Age, archaeozoology, Vinča, Kostolac, Mollusca, water-sieving, environment.