THE "LARGE TOWERS" OF ROMAN DOBRUJA*

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Keywords: *phrourion*-tower, artillery battery, interior load-bearing structure/masonry pillars, crosswall.

Abstract: The area of Dobruja has revealed, in most late fortresses, examples of rectangular towers remarkable both for their large dimensions and for their interior load-bearing structure represented by massive masonry pillars. The present study proposes for this particular type of defensive architecture the function of artillery battery. The implications that this hypothesis has on the conception of the local and zonal defensive system are examined. In the second part of the study a reconstruction proposition is made for this special type of defensive element.

Rezumat: În zona Dobrogei au fost descoperite la majoritatea cetăților târzii turnuri rectangulare, remarcabile atât pentru dimensiunile lor mari cât și pentru structura de rezistență internă, reprezentată de pile masive de zidărie. Studiul propune pentru acest tip particular de arhitectură defensivă funcțiunea de baterie de artilerie. Sunt analizate implicațiile pe care această ipoteză le are asupra conceperii sistemului defensiv local și zonal. În cea de-a doua parte a studiului este formulată o propunere de reconstituire pentru acest element defensiv special.

The Late Roman fortifications built in the area of Dobruja[1] in the interval from the end of 3rd to the end of 4th century[2] are distinguished by the use of a defensive formula characterised by the introduction of towers with elongated U-shaped and fan-shaped plans developed exclusively outside the outer line of the curtain. Although similar defensive installations can also be found in other parts of the empire,[3] the great number of fortresses that use this defensive formula in Dobruja[4] points to a construction habitude, if not even a proper architectural-defensive programme extended to the whole region. Certainly, this manner of fortification did not exclude from the register of defensive elements the towers with rectangular plans (Abritus – eastern side, Ulmetum – south sector). However when they are employed these towers express, by the reduced amplitude of their footprint[5] and their disposition within the precinct, an efficient way of adapting the fortification to the defensive feature of the terrain.

Different from this situation, a special category of towers with rectangular plan – placed in areas which do not benefit of natural defence – is represented by the towers of very large dimensions (Fig. 1). These defensive elements contain a series of constructive particularities which indicate with precision a specific defensive structuring.

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1 We use this toponym to designate the area of Scythia Minor situated north of Callatis – Zaldapa – Gaber line, where there is a concentration of fortifications with defensive features characteristic to the 4th century AD (Lander 1984, p. 255; Torbatov 2002, p. 527). These configurations may also be encountered at some fortresses in the Moesia Secunda province, such as Abritus, Iatrus or Augustae. Yet among the fortresses of the neighbouring province only three – Abritus, Iatrus, Durostorum (*castra*) – contain rectangular towers of large dimensions, which are analysed within the present study. For this reason, in respect to the more frequent presence of these elements on the territory of Dobruja, we consider the three fortifications either as isolated cases (Abritus, Iatrus), or as characteristic to the area of Dobruja (Durostorum).

2 The upper limit of the chronological interval is represented by the fortification of Ulmetum, recently dated to the end of 4th – early 5th century (Băjenaru 2010, p. 47).

3 Such as Udruh, el-Lejjun or Quasr-Qărŭn (Castra Dionysiados).

4 Capidava, Troesmis-East, Noviodunum, Halmyris, Ibida, Ulmetum, Tropaeum Traiani, Histria, Durostorum (*castra*).

5 For example *ca.* 140 sq m, the surface of 'the second south-east tower' (Pârvan 1913, p. 255), as compared to *ca.* 460 sq m, the area of tower *TM* at Noviodunum (Baumann 2010, pp. 57-119; dimensions *cf.* V. Apostol, inedited research). The area includes the surface of the perimeter walls (front, sides) and of the curtain along the breadth of the tower.

Caiete ARA, 3, 2012, p. 81-95, București.

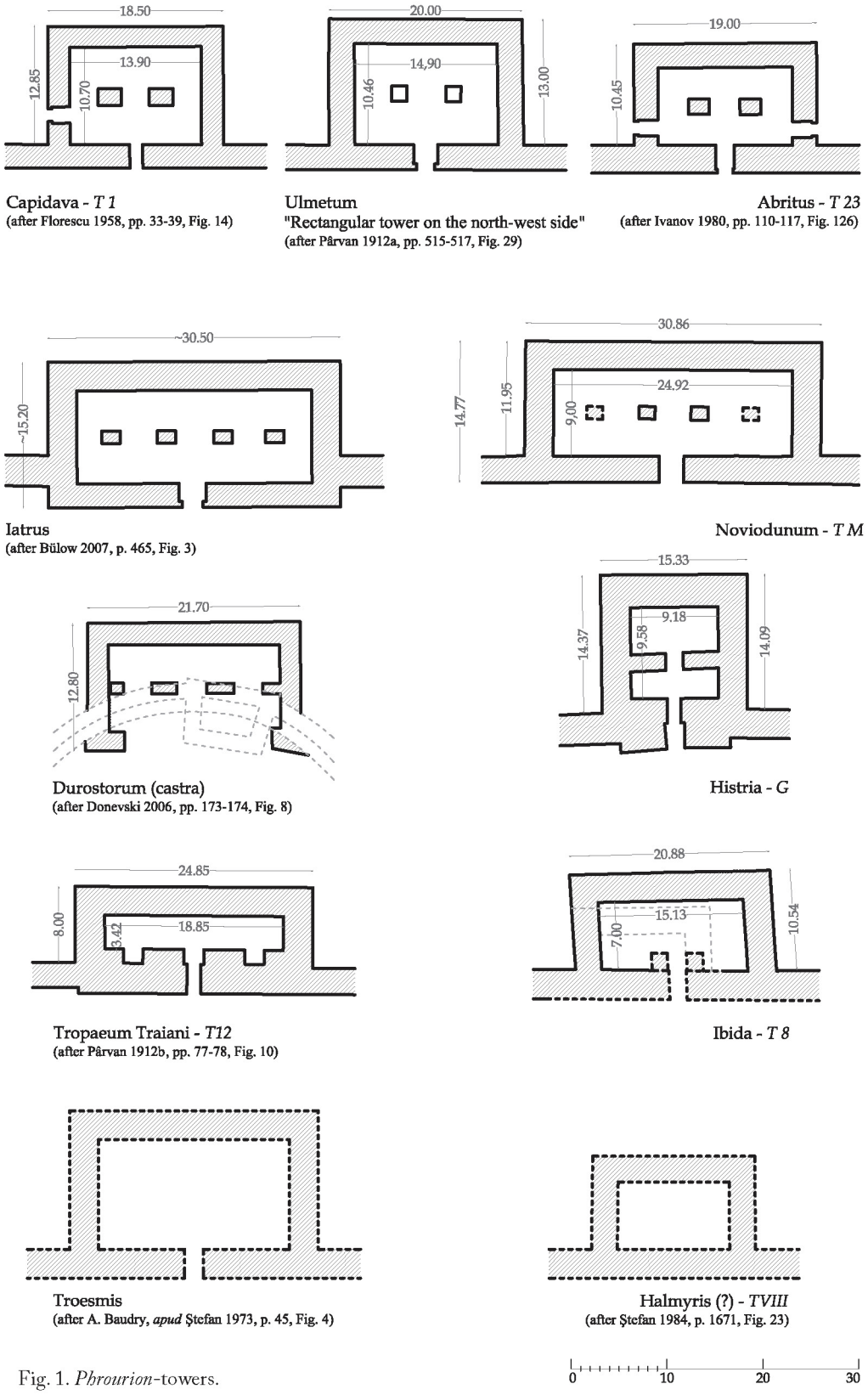

Fig. 1. *Phrourion*-towers.

To designate this special defensive configuration, the term *phrourion* is used in the specialized literature.[6] Generic denominations are used more frequently – 'great tower',[7] 'storage-tower',[8] 'commander's tower'[9] – which have the merit of expressing a dimensional attribute, evident nonetheless, but do not reflect clearly its defensive nature.

Architectural characteristics: The shape of these defence structures is rectangular in all cases, with a breadth of 2 to 4 times larger than that of current defensive elements. The long side of the plan's rectangle lines in most cases with the direction of the curtain[10] and it is at least 1.5[11] larger than the sides' perpendicular to the curtain. Upper limits of the ratio between these two sides (Bd /Pj)[12] are reached at Noviodunum (2.6) or at Iatrus (2.1).[13]

Another characteristic is expressed by the way the interior supporting structure is configured: either with massive median pillars (the general case), or with large pillars engaged to the rear wall of the tower (Tropaeum Traiani, Ibida-?), or even with internal crosswalls (Histria). The dimensional extent of these structural elements meant to support a large load at the defence level suggests the presence within the towers of heavy artillery machines,[14] concentrated, as we may see in the case of some artillery batteries attested for the Hellenistic period.[15]

The *phrourion*-tower belongs in all cases to defensive configurations which have in common as current element the U-shaped tower (Fig. 2). We believe that the insistence with which this configuration is used reveals a characteristic relevant for the understanding of its defensive role. In all cases, such a rectangular tower is flanked on either side by U-shaped or fan-shaped towers,[16] more or less spaced (16-23 m). The rounded front of the U-shaped towers confers, besides other defensive advantages expressed by their shape,[17] a 'panoramic' defence of the immediate surroundings, including the vulnerable corners of the *phrourion*-tower.

It seems that this type of defensive system – *phrourion*-tower flanked by two U-shaped towers – meant to improve local deficiencies of the central element, further emphasises the importance given to the *phrourion*-tower. This latter was not aimed for the defence at the base of the walls, but it was designed to gain tactical advantage at great distance: from these artillery batteries one could shoot with the siege engines (*ballistae*, *catapultae*) concentrated fire with a high destructive force upon the assault machines (especially mobile towers - *helepolis*) or upon compact groups of attackers. The wide breadth of the tower front (Bd) indicates the juxtaposed disposition of several artillery machines. The simple rectangular shape, in contrast to the other defensive elements, with more elaborate plan shapes, is the expression of the experimentation of a

6 Pârvan 1912a, p. 515; Florescu 1972, p. 24; Lander 1984, pp. 218-219; Zahariade 2006, p. 99. Φρούριον designates in ancient sources, either of Roman age, or of Greek, a type of fortification, slightly more developed than a *pyrgos-turris* (for Greek era *v.* Avram, Nistor 1982; for minor Roman-Byzantine fortifications *v.* Băjenaru 2010, p. 51). In order to designate this particular defensive element we are going to use the term *phrourion*, with the sense of fort, defensive element amplified dimensionally in respect to current fortification elements.

7 Noviodunum – tower *TM*; Histria – tower *G* (Pârvan 1916, pp. 704-705); Capidava – towers *T1*, *T4* (Florescu 1958, p. 31, p. 47).

8 Tropaeum Traiani – tower *T12* is used in the last functioning period for depositing grain or other products (*cf.* Pârvan 1912b, p. 78).

9 Ulmetum – rectangular tower on the north-west side (Pârvan 1912a, pp. 515-517).

10 Except the 'Large Tower' (*G*) and Tower *E* at Histria. The towers are not built *a fundamentis* in the interval between end of 3rd – end of 4th cent., as are the other towers. Certainly, the initial defensive structuring of the late precinct, which occurred in the period Probus - Aurelian, had a major role in the reconstruction of the time of Constantine. We consider, as well, that it reflects a certain type of structuring of the *phrourion*-tower (*v. infra*).

11 Ulmetum – the great rectangular tower on the north-west side.

12 Bd – breadth (dimension measured in the direction of the curtain wall); Pj – exterior projection (dimension measured from the exterior outline of the curtain to the front of the defensive element).

13 As well in the case of the *phrourion*-tower of Tropaeum Traiani (*T12*) the value of the Bd/Pj ratio is large (2.95), but we have presented here the cases which we consider representative: the type of *phrourion*-tower with piers set along the median longitudinal axis.

14 A ballista of average size weighs around half a ton. *Cf.* Campbell 2003, p. 21.

15 Such as Syracuse – Euryalos, Ephesus – 'St. Paul's Prison', Selinunte – North Gate or Orminium (Winter 1971, pp. 176-188).

16 When the precinct side is short, such as the case of the north-west side of the fortification of Capidava.

17 For example they deflect enemy projectiles or lack areas which would be vulnerable to the blows of battering rams, such as the corners of rectangular towers.

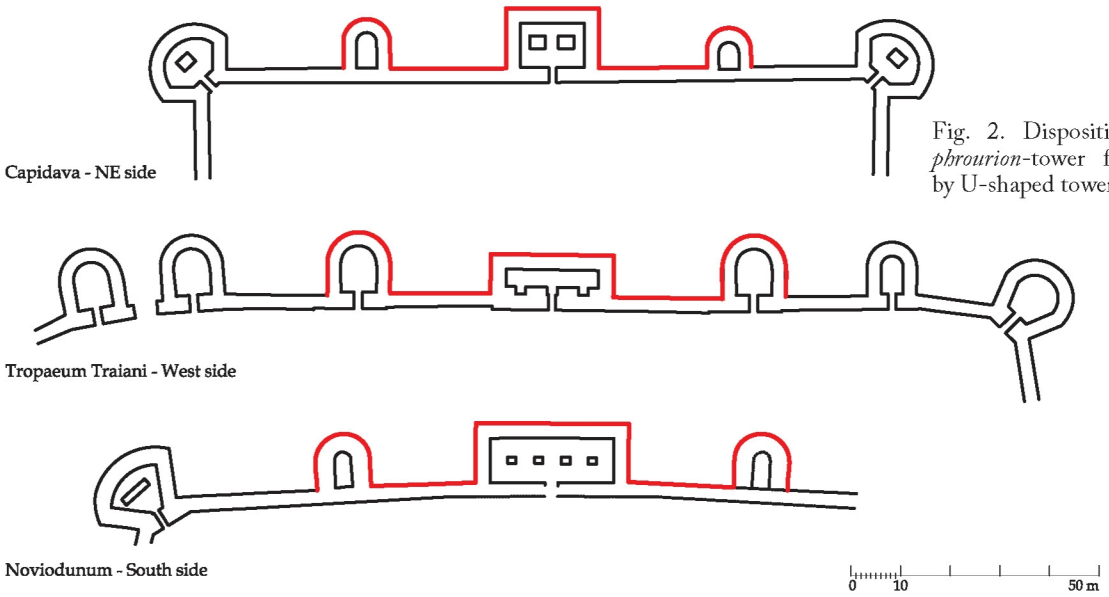

Fig. 2. Dispositions – *phrourion*-tower flanked by U-shaped towers.

space with particular features (large span[18] and fronts, exceeding the current values) which can hold very heavy defensive artillery machines.

Functional – defensive features. The discovery at Ibida in *phrourion*-tower *T8*[19] of a number of 60 *ballistae* projectiles, on two functioning levels, attests the use of the afore mentioned defensive structures along the 4th century AD. The archaeological research has also revealed and clarified the fact that only after the end of 5th century – start of 6th century does the lower floor of the towers take other functions, mainly storage. Therefore, assigning the name 'storage-tower' to these structures does not describe the defensive element, but reflects only the shift in the initial function.

According to weight, the discovered projectiles can be inscribed in two categories – 2-5 *minas*[20] and 10 *minas* (Table 1). This information brings further clarifications in the types of artillery machines used during the 4th century at Ibida: the *very light weight ballista* and the *light weight ballista*.[21] The use of the two types of *ballista* in the same defensive element (artillery battery tower) may clarify some aspects regarding the configuration of towers at the beginning of the 4th century: the heavier of the *ballistae* (the *light weight ballista* of 8-12 *minas*) probably occupied a level entirely, while the small ones (the *ballista* of 2-5 *minas*) may have

[18] The width of the rectangle described by the interior space.

[19] A number of *ca.* 60 stone projectiles, fragmentary or entire, have been discovered on two archaeological levels dated in the course of 4th cent. AD (Paraschiv *et alii* 2010).

[20] Some of the authors who analysed the chapter (X, 10-12) dedicated to artillery machines in Vitruvius consider that the 10 pounds (*librae*) are actually 10 Greek *minas*, a mistake owed to the copyists. P. Gros notes a certain contamination, in Vitruvian manuscripts in general, between Vitruvius' personal experience and the Greek bibliography he used, based on a different measuring system (*cf.* Vitruvius, pp. 1394 - 1396, footnote 183). We will use the classification according to the Greek weight unit. The unit of measure – *mina* – has approximately the same weight in Greek and Roman periods, even if expressed differently as to the base measuring unit (*drachma*). 100 Greek *drachmas* = 1 Greek *mina* = 0.431 kg (~ 0.44), while 128 Roman *drachmas* = 1 Roman *mina* = 0.436 kg (~ 0.44).

[21] The categories of *ballistae*: **1.** *light weight ballista*: the 10-*mina* (4.4 kg) ballista takes the first place in the list made by Philon (Philon 53-4, *apud* Marsden 1969, p. 26) as to the ratio between weight and diameter of the torsion springs; **2.** *medium weight ballista*: current dimensions in Hellenistic period are up to 40 *minas*, with a larger circulation of those around 25 *minas*; **3.** *heavy* and *very heavy weight ballista*: they could reach very large dimensions which allowed shooting projectiles of up to 65 kg; **4.** *very light weight ballista*: Philon describes a ballista with dimensions inferior to those of the light weight ballista, which uses 2-*mina* (0.88 kg) projectiles. This last, according to Philon's recommendations, can be used in narrow tunnels such as those used in mining. The discovery in Carthage of 900 projectiles which can be inscribed in a medium size category, of 5 *minas* (2.2 kg), also suggests the current use of small size ballistae (*cf.* Campbell 2003, pp. 17-22). Likewise, Vitruvius (X, 11) opens his correspondence list between the projectile weight and torsion springs diameter with the 2-pound (*libra*) *ballista*.

1 *mina* (Greek) = 0.431 kg (~0. 44)	
SMALL *BALLISTA* 8-12 *mina* (3.5-5.2 kg)	
Weight	Diameter
3.50 kg (7.95 *mina*)	14-16 cm
3.75 kg (8.52 *mina*)	12-15 cm
4.25 kg (9.65 *mina*)	max. 14 cm
4.25 kg (9.65 *mina)*	11-18 cm
4.75 kg (10.79 *mina)*	max. 18 cm
VERY SMALL *BALLISTA* 2-5 *mina* (1.3-3.5 kg)	
0.75 kg (1.7 *mina*)	7-9 cm
1.25 kg (2.84 *mina*)	10-11 cm
1.50 kg (3.40 *mina*)	9-12 cm
2.00 kg (4,54 *mina*)	11-12 cm
2.25 kg (5.11 *mina)*	12-13 cm

Table 1. Projectiles from tower *T8* of Ibida

been used in association with conventional weapons for short distance defence, within another level. This type of disposition is suggested by the dimensions necessary for an artillery battery, which would have clearly occupied the entire span of a level. A *light weight ballista* of *ca*. 10 *minas* requires an operation space of *ca*. 6 m in length and 3 m in width,[22] which would have made the use within the same level of more types of weapons – artillery and conventional weapons – rather improbable, in a space such as that of the tower of Ibida, with a span o *ca*. 7 m. Thus, the position of the artillery battery (consisting, at Ibida, of ballistae of 10 *mina*) may have been at the upper storey[23] (*v. infra*), above a conventional defence storey situated at the level of the parapet walk.

Projectile 'deposits' have been discovered at Ulmetum as well, 'in front of the entrance to the large rectangular south tower': 30 projectiles of ca. 15 cm diameter.[24] They came, therefore, from a 10-*mina* stone projector (Table 1). Of course, the dimensions of the interior space of the tower where the projectiles have been discovered allowed its use for artillery, but not at the level reached by the *phrourion*-tower ('the commander's tower') of the same site, where an artillery battery could well be hosted, given its capacity of taking up to six 10-*mina ballistae*.[25] These details are necessary for emphasising the fact that, even though the majority of towers have the destination of hosting defensive artillery starting probably with the first half of 3rd century,[26] the introduction of artillery in concentrated form becomes a particular aspect of defensive architecture of the next century.[27] Moreover, we stress the fact that the fan-shaped or elongated U-shaped towers[28] of large dimensions and with central pillar – used along with the *phrourion*-towers – may be as well employed analogously to artillery batteries. The large dimensions of interior pillars, increased above the normal structural needs[29] indicate the defensive function, without having the amplitude of *phrourion*-towers. In an artillery battery such as that of Noviodunum a number of 8-10 artillery machines may be placed, while in the fan-shaped tower of Capidava, Dinogetia or Noviodunum only 3-4 such machines. Going back to the case of the 'large south rectangular tower' of Ulmetum,[30] we note that no more than two such siege machines might have been placed on the surface of the defence level within the tower.

Tactical features: Examining the position of *phrourion*-type towers in the fortified ensembles we note that they are systematically placed against areas lacking natural defence, areas where the defenders of the fortress could expect organised attacks (Fig. 3). The use of the *phrourion*-tower as artillery battery expresses

[22] Campbell 2003, p. 21.

[23] On the favourable disposition, from the defensive point of view, of artillery machines at the upper levels of the towers, *v.* Marsden 1969, p. 117; Ober 1987.

[24] Pârvan 1913, p. 265.

[25] According to the reconstruction hypothesis presented further, the interior space of the upper level of this tower may be divided in three bays *ca*. 6 m wide. In each bay one could install two artillery machines.

[26] Structures meant to support artillery pieces – *ballistaria* – are epigraphically attested at High Rochester starting with the year 220. What kind of a structure are the discovered inscriptions referring to is unfortunately unknown (Wilkins 2003, p. 71).

[27] J. Lander notes that the increase in the footprint of towers, occurred in late military architecture, was probably determined by the introduction of heavy weight artillery (Lander 1984, pp. 258-259)

[28] The fortifications of Capidava – *T2*, *T6*, Ulmetum – north and east corner towers, Noviodunum – *TC* have fan-shaped towers with central pillar, while the fortifications of Dinogetia – *T8* and Halmyris – *TXII* (Zahariade *et alii* 2009) have towers with an elongated U-shaped plan, with central pillar as well.

[29] The tower *TC* of Noviodunum, towers *T1*, *T10* of Dinogetia (Baumann 2010, pp. 120-139; Ştefan 1954, Fig. 1).

[30] The span corresponding to the front breadth of the tower (13.50 m) might have probably not exceeded 8 m – a maximum dimension for a ceiling on wooden beams (tower dim. *cf*. Pârvan 1913, p. 253).

Fig. 3. Disposition of *phrourion*-towers on those sides exposed to direct attack.

a fundamental tactical change occurred at the end of the 3rd century as a response to a new type of attack, different from previous raids, now with a vast number of combatants and great repetitive potential.

This defence solution is expressed at the level of the urban ensemble by the intense fortification of just a reduced area within a larger perimeter with weaker fortifications, of earth ramparts.[31] The fundamental idea which marks off this Late Roman defensive type from the Byzantine or Medieval ones is that the heavily fortified area does not act exclusively as a stronghold and refuge, but has also as an active role, of protecting the settlement grown around the walled fortification and surrounded by the earth ramparts. Therefore, planning for an effective long distance defence generated the necessity for the introduction of such long range artillery batteries. Thus we might explain the disposition of the exterior ramparts of Noviodunum or Troesmis, which are situated, maybe not by chance, at the limit of the range of *ballistae*[32] – between 300-360 and 460 m (Fig. 4).

Even if artillery batteries may not be considered an innovation in the large domain of defensive structures, this concentrated disposition, inherited from the Hellenistic period, is a new configuration in the Roman world of the end of 3rd century AD. Until the time of the Severans, the Romans had been less inclined to use artillery on defensive purpose, even if known since the Hellenistic period. But in the context of the 4th century, the use of heavy weight artillery was certainly considered an important tactical advantage to be used against the Goths. Ancient authors recount about the strong psychological effect[33] of these weapons on the Goths and about their lack of preparedness for the use of captured siege engines. Certainly, it was a question of time for the Goths to gain these specialized combat techniques themselves, but apparently a question of long time. Until the battle of Hadrianopolis (378 AD) these artillery batteries are still built,[34] as can be seen at the fortifications of Ulmetum, dated at the end of 4th century.

Thus one can discuss about the edification of *phrourion*-towers as of a true defensive programme applied in Scythia Minor, the geographical area where this configuration was used, not perchance a first bastion in front of the Gothic invasions. The fortifications of Iatrus, Abritus, Durostorum (*castra*), Tropaeum Traiani, Capidava, Ulmetum, Ibida, Troesmis-East, Noviodunum, Halmyris and Histria are radically reconfigured starting with the last part of 3rd century[35] (Fig. 5). The transformations contain important innovations,[36] and the artillery battery is one of them. The crisis moment of the mid 3rd century determined a return to consecrated Hellenistic models, and the Danube line and Scythia Minor become territories for

[31] Al. Ştefan (Ştefan 1973, p. 104) considers that the three rampart-ditch defence lines built around the masonry fortifications are meant to defend urban habitation areas corresponding to the Early Period (the ampler rampart – III), respectively to the Late Period (ramparts I and II).

[32] In the Hellenistic Period a *ballista* had a destructive effect on siege machines used by aggressors up to a distance of 150-300 m. The disposition of the auxiliary defensive system proposed by Philon, with two lines of ramparts and three ditches, is also the key to the deciphering of the working of the ballista. From a distance of ca. 180 m (*cf.* Marsden 1969, p. 91, Fig. 2) where is the outer edge of the last ditch and up to 365 m (*Ibidem*, p. 90, Fig. 1) the destructive effect on the siege machines used by the aggressors is maintained. E.W. Marsden considers that in Roman period artillery machines were efficient even up to a distance of 460 m (*Ibidem*, p. 91). Above this limit they could still produce significant damage to attack formations.

[33] For example Ammianus Marcelinus, XXXI, XV, 11.

[34] Several minor fortifications erected in the time of Valentinian I or Valens (Veröce, Tahitotfalu, Szigetmonostor, Dere Patak, Dunafalva, Bac) have a structural configuration similar to that of the *phrourion*-tower: rectangular tower developed along a direction parallel to the defence line (usually parallel to the Danube or Rhine line) and an interior supporting structure made of massive masonry pillars. If these minor fortifications, named 'burgus with landing-place' used, as it has been suggested (*cf.* Lander 1984, pp. 288-289), defensive artillery for remote control of important crossing points, then large scale use of artillery battery until toward the end of 4th cent. can be attested in the case of minor fortifications as well. However, also in the category of minor fortifications there are records of structural procedures similar to those used for the *phrourion*-towers, even when the plan shape is not similar. We consider that the so-called '*burgus with tetrapylon*' fortifications (Băjenaru 2010, pp. 165-168) express, by the introduction of the massive interior pillars, the same defensive principle – the use of artillery batteries.

[35] Opinions regarding the transformations and chronology of the enumerated fortresses in: Bülow 2007 and respective bibliography; Ivanov 1980; Donevski 2006, p. 173, Fig. 8, pp. 183-185; Pârvan 1912b; Barnea *et alii* 1979; Mărgineanu Cârstoiu 1981; Bogdan Cătăniciu 2001; Florescu 1958; Florescu 1975; Pârvan 1912a; Pârvan 1913; Băjenaru 2010, p. 47; Paraschiv *et alii,* 2010; Scorpan 1980; Ştefan 1974; Baumann 2010; Suceveanu *et alii,* 1954; Domăneanţu, Sion 1982.

[36] *V.* Lander 1984, pp. 252-262.

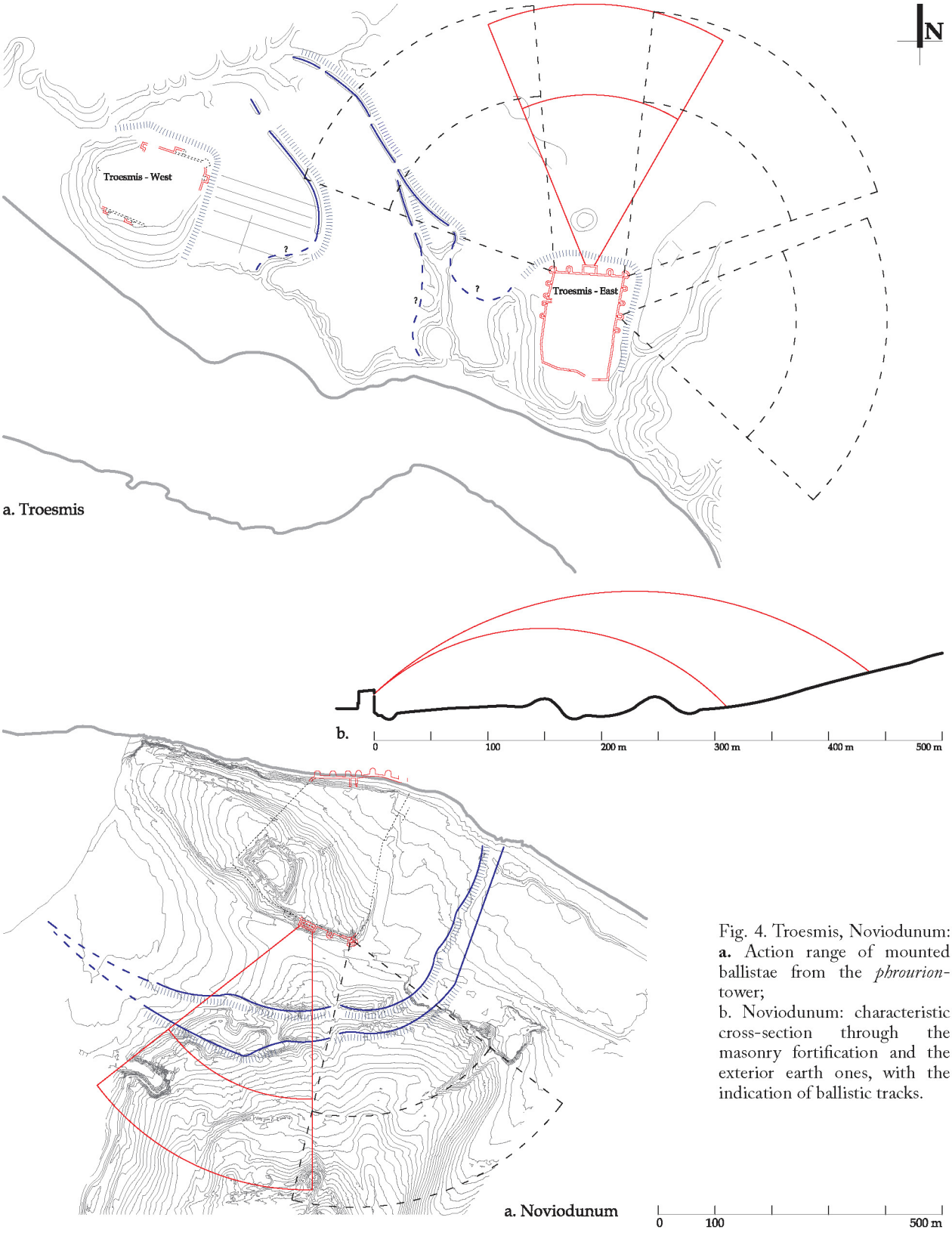

Fig. 4. Troesmis, Noviodunum:
a. Action range of mounted ballistae from the *phrourion*-tower;
b. Noviodunum: characteristic cross-section through the masonry fortification and the exterior earth ones, with the indication of ballistic tracks.

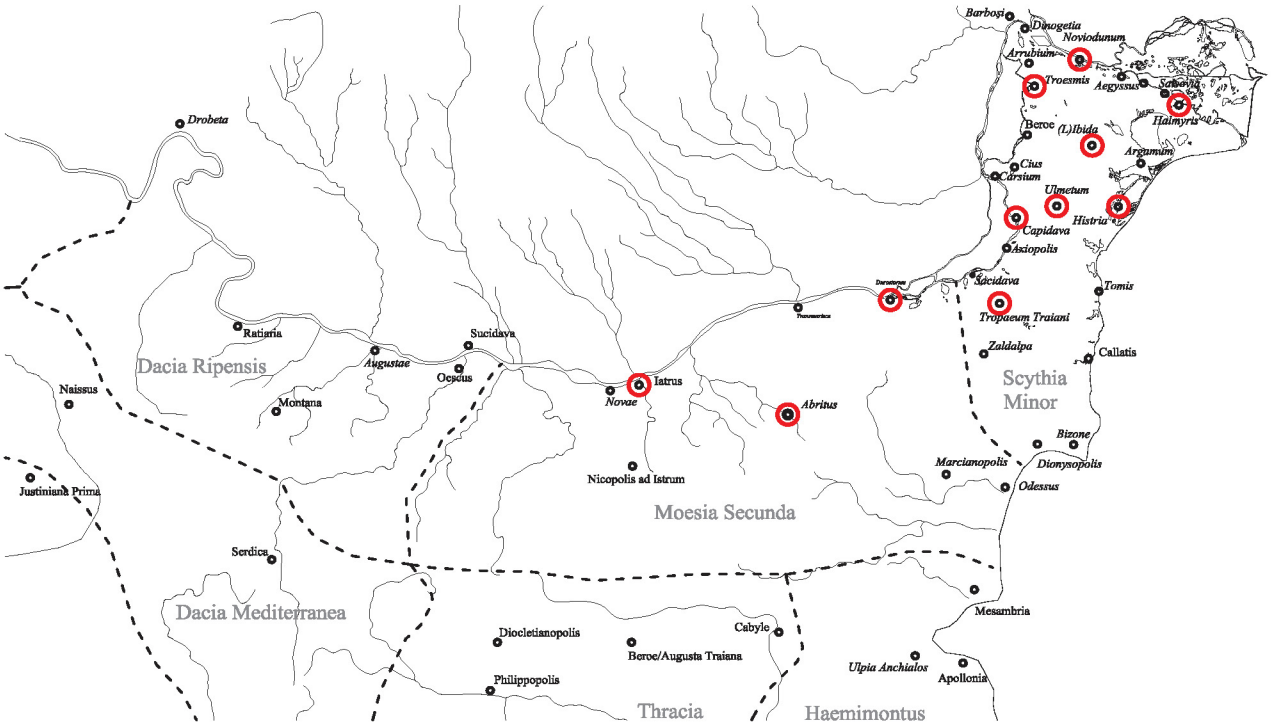

Fig. 5. Territorial disposition of fortresses which used the *phrourion*-tower.

special experiments. The *West Gate* of Halmyris seems to be inspired by the Arcadia Gate of Messene[37] or by that of Augustan period from Conimbriga, a transposition of the same model,[38] the gates of 'opera a tenaglia' type of Abritus and Iatrus, possibly Zaldapa (*North-West Gate*)[39] too, transpose models described by Philon and used during the Republican period at Telesia.[40] The artillery batteries of Selinunte (a large semicircular tower with additional interior support structure), 'St. Paul's Prison' of Ephesus (rectangular tower with additional interior support structure),[41] the artillery battery of Orminion (a platform flanked by two U-shaped towers),[42] all may be regarded as reference examples experienced by Roman strategists starting with the last part of 3rd century.

Reconstruction of the *phrourion*-tower (hypothesis)

We started from the premise that a fundamental indicator for the reconstruction can be the determination of the type of functional relation between the defence levels and the parapet walk. Most of the towers built in the 4th century use the curtain wall as base for the rear wall[43] erected above the level of the parapet walk. The dimensioning of the curtain wall width – along the breadth of the tower – must allow both the erection of the rear wall of the tower above the parapet level, and the width of the parapet walk. The rear wall does not hold a main defensive function, but, in case of *phrourion*-towers (with the interior space span perpendicular to the curtain line) this wall takes an important role in terms of the load-bearing structure: on it rest all the beams which support the floors. The vestiges of tower *G* of Histria are the only ones which retain indications referring to the width of the rear wall (1.80 - 1.90 m); the preservation of this archaeological evidence was favoured by

37 Adam 1982, p. 90, Fig. 58.
38 Gros 2001, p. 52, p. 48, Fig. 30.
39 Torbatov 2003.
40 Gros 2001, pp. 39-40.
41 Winter 1971, pp. 178-183.
42 Bakhuizen 1986.
43 The wall parallel to the front of the tower.

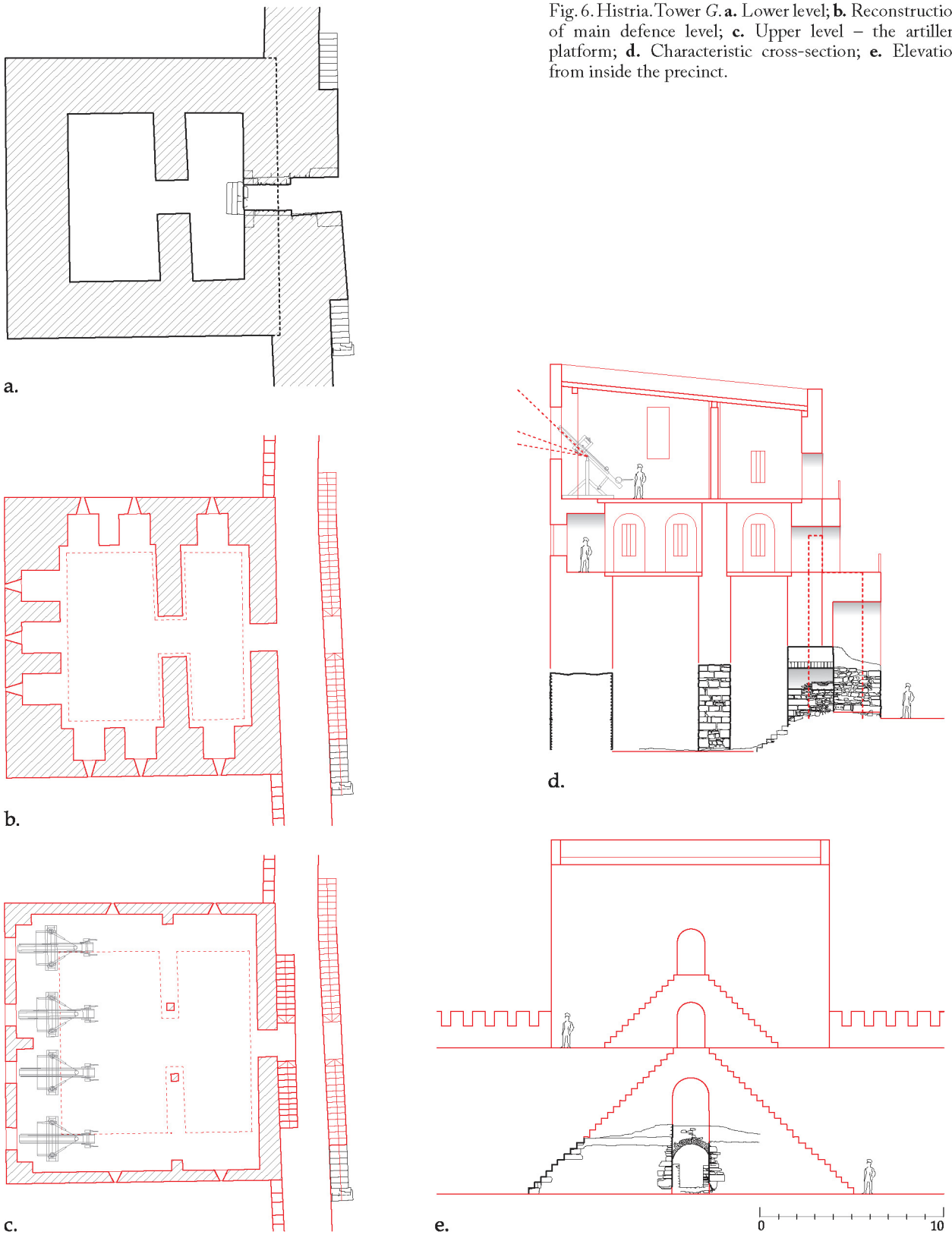

Fig. 6. Histria. Tower *G*. **a.** Lower level; **b.** Reconstruction of main defence level; **c.** Upper level – the artillery platform; **d.** Characteristic cross-section; **e.** Elevation from inside the precinct.

the position of the rear wall, adjoining the curtain wall (Fig. 6.a). According to the character of the functional relation between the parapet walk and the defence levels, two types of towers can be proposed:

- *Towers with upper level connected directly to the parapet walk*: the position adjacent to the curtain of tower *G* of Histria suggests also the possibility of having another defence level, above the one at the height of the parapet walk, connected directly with this latter: in the width of the curtain wall (2.33 - 2.65 m) – to which the rear wall is adjoined – there is room for both the parapet walk and a stair leading to an upper level (*ca.* 1 m)[44] (Fig. 6.c).

- *Towers with independent upper level*: Considering that most of the 4th century curtain walls have widths of *ca.* 3 m and the level of the parapet walk was paved with stone slabs projected out up to 30 cm,[45] it seems that after the erection of the rear wall of the tower the available strip, *ca.* 1.50 m wide,[46] allowed just the layout of the parapet walk[47] (Fig. 7.b).

A different mode of positioning the towers with respect to the curtain line was recorded at the military fortification of Iatrus.[48] Here, the *phrourion*-tower is not placed like in most known situations, projecting entirely out of the exterior line of the curtain. The tower develops both outwards and inwards. The curtain wall is interrupted by the tower and the parapet walk traverses its interior room. Consequently, a vertical circulation to an upper level – placed above the parapet walk level – might have been placed only inside the tower.

Defensive-architectural elements:

1. *The lower level* of the towers is preserved at most of the late fortifications in Dobruja. In none of the cases could traces of loopholes be identified. Therefore, the lower level had no direct defensive role.[49] The way in which the towers are placed, generally outside the 'plateau' defended by the curtain, determined the existence of a level which compensates the large difference of height among the plateau and the base of the outward-falling slope where the tower raises. This lower level is not directly related to the tower, but communicates directly with the interior of the fortress by means of stairs cut in the width of the curtain. This functional separation is even more evident in cases where the difference among the interior and exterior floor levels is very large. For this reason, at Dinogetia the entry from the interior of the fortress could not lead to the lower level, but straight to the defence level above it. Therefore, one may assume the existence of a secondary vertical circulation inside the towers, beside the main one, connected to the parapet walk. These interior vertical circulations were easily accessible to the defenders inside the towers or to the personnel serving the artillery, but in the situation of an attack during which regrouping was vital, these circulations would have not only been insufficient, but they would have represented a conception error.

[44] The stair preserved *in situ* which connected the walking level inside the fortress with the parapet walk has a width of 96 cm.

[45] See for instance this detail at the Hellenistic fortification of Pydna (Adam 1982, pp. 115-163). For the Late Roman Period, several stone slabs discovered recently at Ibida (Mihăilescu-Bîrliba *et alii* 2011; Aparaschivei *et alii* 2011) describe a type of finish for the parapet walk (V. Apostol, unpublished research) identical to that of the Hellenistic fortification.

[46] For example at Ulmetum a width of the parapet walk of 1.14 m can be reconstructed. V. Pârvan noted that the smallest width of the curtain wall (in the area of the access stairs cut into the width of the wall) is 1.74 m (Pârvan 1913, p. 266). Taking out ca. 60 cm, the minimum dimension of a defence parapet, we obtain the mentioned value; if we add 30 cm to this, the dimension of he brackets, we reach a value of 1.44 m for the width of the parapet walk, a value which is close to the one proposed.

[47] It is possible in exceptional situations for the parapet walk to have smaller values, but in the analysed case a reduction of the parapet walk which would have made possible only a one-way circulation along the entire length of a *phrourion*-tower (ca. 31 m at Noviodunum) would have produced serious defensive problems – preventing from rapid access to critical points, from regrouping etc. We mention that a conventional dimension for a two-way circulation (two persons – without fight gear – that pass one by the other in opposite directions) is minimum 120 cm (Neufert 2004, p. 31, Fig. 22; p. 31, Fig. 62/5).

[48] Bülow 2007, p. 465, Fig. 3.

[49] An example is the corner tower (*TC*) of Noviodunum: the way the masonry pillar is placed (the north-east corner of the pillar is situated at ca. 90 cm from the perimeter wall) accounts for a reduced attention at the utilisation of the space on defensive purpose. This space was definitely used for storage though, probably for ammunition. Defensive uses are found, nevertheless, in special situations, at tower *TII* on the north-east side at Halmyris and at tower *T1* at Capidava, which have posterns at the lower level, for outside communication. These two situations show special defensive adaptations conditioned by the presence of a main access nearby (Halmyris) and, probably by the necessity to provide connections to the outside in case of siege, for the fortress of Capidava which only has one gate.

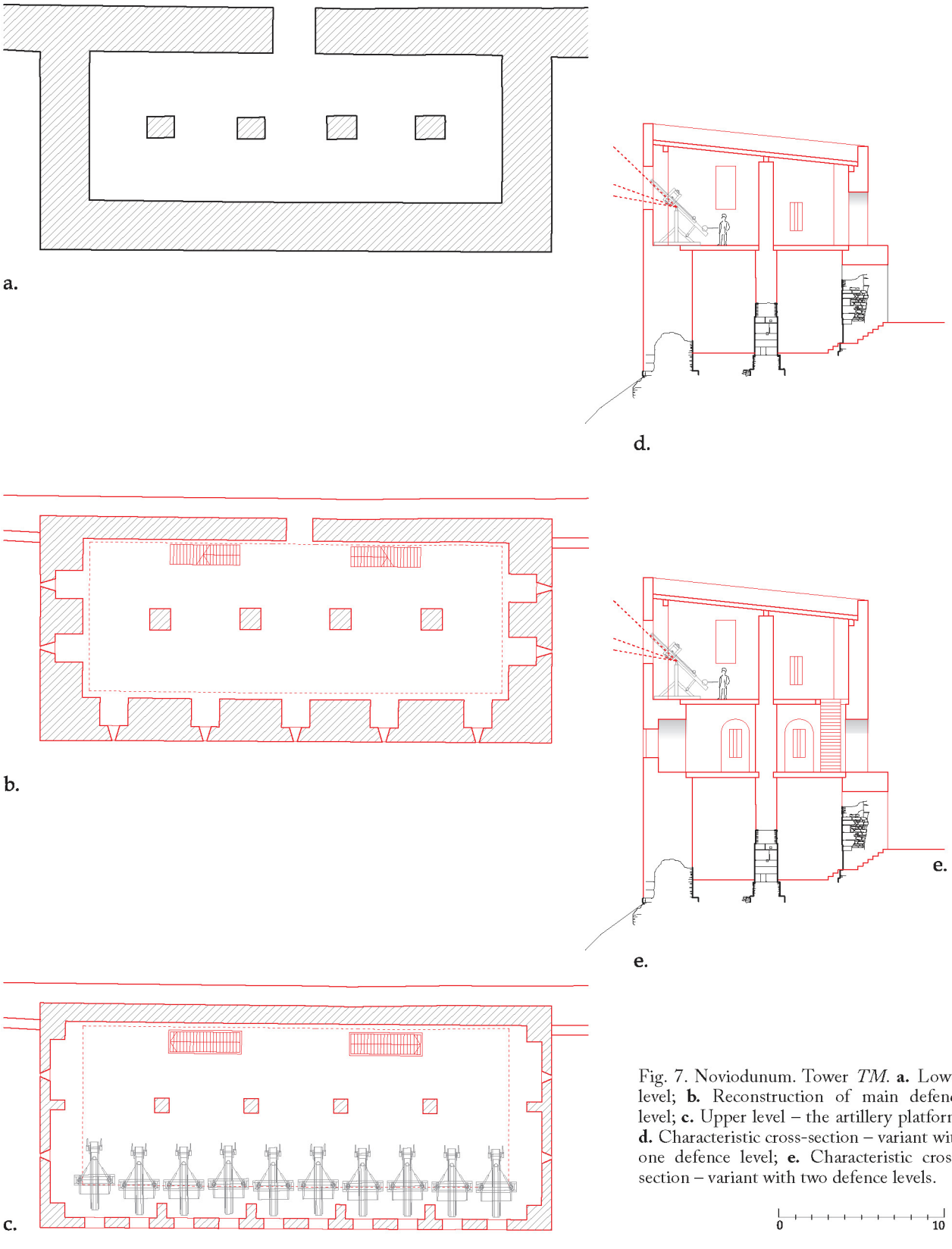

Fig. 7. Noviodunum. Tower *TM*. **a.** Lower level; **b.** Reconstruction of main defence level; **c.** Upper level – the artillery platform; **d.** Characteristic cross-section – variant with one defence level; **e.** Characteristic cross-section – variant with two defence levels.

- The height of the lower level has large variations according to the grade of the slope where the tower is built. For example, at Dinogetia a height of 5.50 m can be reconstructed for tower *T4*, and 3 m for tower *T10*.[50]

2. *The main defence level.* Above the lower level there was, probably, a *conventional defence level* with narrow loopholes. The hypothesis of the existence of such a level may be supported by the mentioned observations made at Ibida and Histria, as well as by the presence of the large masonry pillars and internal crosswalls which could support two further storeys. In some cases (Histria, Ulmetum), *phrourion*-towers project outside the curtain line significantly more than the neighbouring defensive elements (towers, bastions), and the Bd/Pj ratio tends to unitary values.[51] We consider that this mode of tracing the plan expresses the persistence in the *phrourion*-tower of the primary defensive function of a tower, that of defending the adjacent curtains. Therefore, we consider it possible that these types of plan indicate the presence of a main defence level situated below the level of the artillery battery, which, as mentioned before, must have occupied an entire level.

Nevertheless, it is not unlikely to have in some situations the artillery batteries located at this level. The absence of a direct connection between the parapet walk and a defence level above it, as suggested by the cases of Iatrus and possibly of Noviodunum, describes either an 'isolated' disposition of the artillery battery situated at the upper level, or the absence of an upper level and the disposition of the artillery battery at the level of the parapet walk.

- The height of the defence space at the level of the parapet walk can be reconstructed but theoretically, by the summing of current heights for some architecture elements existent in such towers: parapet – 0.9-1.5 m; loophole or window – 1-1.5 m; masonry (arch, lintel) – *ca.* 0.5 m; ceiling – 0.4 m. The result is a hypothetic height of minimum 2.80 m and maximum 3.90 m.

- At the defence level it is possible for the side walls and the front walls to have maintained a width close to that corresponding to the lower level; in order to support the ceiling beams a recess of maximum 50 cm must have been adopted.

In the area of the windows deep recesses were certainly made, where the windows were to be opened, like those from the fortifications of Rome (Maxentius' stage),[52] Constantinople or later at some fortifications built or rebuilt by Justinian (Resafa)[53] (Fig. 6.b, Fig. 7.b).

3. *The upper level – the artillery platform.* Current towers or gate towers were probably provided with a sloped roof, necessary in the climate conditions of Dobruja. The roof could rest on a thinner perimeter wall (60-90 cm), structured in a manner resembling an *epalxis*, with a defensive role similar to that of terraced towers bordered by battlements. The height of this parapet could reach 2-2.5 m. In the case of terraced roofs, the height of the parapet was sensibly lower, of max. 2 m. Nevertheless, the dimension of the construction effort required to cover the considerable surfaces of the towers at some fortresses might have also determined the use of the terrace configuration. If in case of regular towers the two covering variants are equally plausible, in the case of artillery towers the sloped roof variant is the only one acceptable,[54] because the ballistae and catapults were made of materials vulnerable to atmospheric agents: wood, iron, bronze, organic materials (for the springs) (Fig. 6.c, Fig. 7.c).

According to the necessity to provide large openings in the front wall of the tower, associated to the type of horizontal protection (usually tile coverings), one may recompose the way in which this level could have been built. Firstly, there was the necessity for a very thin wall or parapet (*ca.* 60-90 cm) so as to allow the artillery machines to be brought as close to the exterior line of the front as possible. On the other hand, a very small width of this parapet-wall – as we see at some Hellenistic towers (50-60 cm) where artillery machines

[50] At towers T4 and T10 imprints of beams (ca. 20 x 30 cm) which supported the lower level ceiling are preserved in the masonry. For *T4* dimensions *cf.* M. Mărgineanu Cârstoiu, unpublished research; for *T10* measurements V. Apostol.

[51] Ulmetum (*phrourion*-tower of north-west side): 1.53; Histria (G): 1.08; Histria (E): 1.41.

[52] Baatz 1983, p. 138, Fig. 123.

[53] Karnapp 1968.

[54] Even if the climate would allow uncovered artillery platforms, in the case of Hellenistic fortresses in Greece and Asia Minor they are all covered. These configurations describe the sensibility of siege engines to atmospheric agents (Ober 1987).

were installed[55] – would have not been sufficient to support roof structures with spans as large as those of the artillery batteries. The perimeter enclosure along the front line and maybe the side walls may possibly have been made with buttresses laid perpendicularly to the wall lines, the distance between them closed with a thinner parapet.

- The height of the wall through which the artillery machines fired may be deduced by analysing the shooting angle of the ballistae. In order to obtain as large a destructive effect as possible, the shooting angle was lower than 45°.[56] Considering a maximum grade (45°), we may obtain a height of *ca.* 5 m. From the top of this front wall the roof fell toward the interior of the precinct, with a slope of minimum 10°[57] (Fig. 6.d, Fig. 7.d, e).

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[55] For example the rear walls of some towers from Messene are only 55 cm wide, while the side and front walls are 58 cm (Adam 1982, p. 63, Fig. 29).

[56] Marsden 1969, pp. 89-90; Campbell 2003, p. 21.

[57] We consider that a tile covering with lower slope could not drain meteoric waters effectively.

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